SUPPLEMENT TO NBS CIRCULAR 460

Supplementary List of Publications of the National Bureau of Standards July 1, 1947, to June 30, 1957

UNITED STATES DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

UNITED STATES DEPARTMENT OF COMMERCE • Sinclair Weeks, *Secretary*
NATIONAL BUREAU OF STANDARDS • A. V. Astin, *Director*

Supplementary List of Publications of the National Bureau of Standards July 1, 1947, to June 30, 1957

(With Subject and Author Indexes)

Supplement to National Bureau of Standards Circular 460
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FOREWORD

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to Government agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. The program is carried out in the following technical divisions and offices: Electricity and electronics, optics and metrology, heat, atomic and radiation physics, chemistry, mechanics, organic and fibrous materials, metallurgy, mineral products, building technology, applied mathematics, data processing systems, basic instrumentation, weights and measures, cryogenic engineering, radio propagation, and radio standards.

The results of the Bureau's work take the form of either actual equipment and devices or published papers, which appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three monthly periodicals, available from the Government Printing Office: The Journal of Research, the Technical News Bulletin, and Basic Radio Propagation Predictions. There are also five series of nonperiodical publications: The Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports, and Miscellaneous Publications.

The Supplement is a complete list, with brief abstracts, of Bureau publications issued during the period July 1, 1947, to June 30, 1957. It replaces the Supplement to National Bureau of Standards Circular 460 covering the period July 1, 1947, to June 30, 1952. Circular 460 for the period 1901 to June 30, 1947 remains in effect.

This publication was compiled and indexed in the Bureau's Publication Section by Betty L. Arnold.

A. V. Astin, *Director*.

CONTENTS

Supplementary List of Publications of the National Bureau of Standards July 1, 1947, to June 30, 1957

This Supplement lists the publications of the National Bureau of Standards from July 1, 1947, to June 30, 1957. A brief abstract for each publication is given. Subject and author indexes are included, and general publication information is furnished. This catalog and previous lists (see page 3) give references to the publications printed by the Bureau during the period 1901 to June 30, 1957. Over 6,000 papers have been issued.

1. GENERAL INFORMATION

PURCHASE PROCEDURES

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ANNOUNCEMENTS OF BUREAU PUBLICATIONS

There are several official sources of information as to new publications of the National Bureau of Standards. The following announcements are issued regularly by governmental agencies. In addition, many of the technical journals carry notices of new Bureau publications of interest in their respective fields.

Technical News Bulletin. Issued monthly by the National Bureau of Standards. Announces all new publications by members of the staff, including those appearing in outside journals. Available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Annual subscription, $1; $1.35 foreign. Single copies, 10 cents each.

Monthly Catalog of United States Government Publications. Issued monthly by the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C. Annual subscription, with consolidated annual index, $3.00; $3.75 foreign.

Price Lists. Publication lists prepared by the Superintendent of Documents on special subjects. These will be furnished free, on application, if the subject concerning which information is desired is stated.

List of Selected Government Publications. Issued semimonthly by the Superintendent of Documents. Each list is arranged alphabetically by subjects, with annotations and prices. May be obtained free from that office.

Building Materials and Structures Reports. The Superintendent of Documents maintains a free mailing list of addresses to receive notices of new reports in this series.

Business Service Check List. Weekly announcement of publications of the Department of Commerce. Lists titles and prices of National Bureau of Standards publications, as well as those of other offices of the Department of Commerce. Available from the Superintendent of Documents for $1.25 a year domestic; $2.25 foreign.

CATALOGS OF BUREAU PUBLICATIONS

Previous catalogs and this Circular give a complete list of the titles and brief abstracts of the Bureau's publications up to June 30, 1957. These lists are available from the Superintendent of Documents, United States Government Printing Office, Washington 25, D. C., at the prices given below, or they may be available for consultation in libraries maintaining sets of Bureau Circulars.

	Price
Circular C24, 7th edition: Publications of the Bureau of Standards 1901 to 1925. 271 pages, including brief abstracts and subject index	$0. 45
Circular C24 Supplement: Supplementary list of publications of the Bureau of Standards, July 1, 1925, to December 31, 1931. 214 pages, including brief abstracts and subject index	$0.40
Circular 24 Supplement: Supplementary list of publications of the National Bureau of Standards, January 1, 1932, to December 31, 1941. 386 pages, including brief abstracts. The subject and author indexes cover the period 1901 to December 31, 1941	$0. 50
Circular 460: Publications of the National Bureau of Standards 1901 to June 30, 1947. 375 pages, including subject and author indexes. Brief abstracts are included for the period January 1, 1942, to June 30, 1947	$1. 00
Supplementary List of Publications of the National Bureau of Standards, July 1, 1947, to June 30, 1957. 373 pages, including subject and author indexes	$1. 50

MAILING LISTS

Names of individuals are not placed on the Bureau's mailing lists. The principal distribution is by the Superintendent of Documents on a sales basis. A limited edition of each paper is printed for Bureau administrative needs and for official distribution to cooperating laboratories, technical organizations, Government agencies, and to leading public and educational institutions libraries. In addition, the Superintendent of Documents distributes copies of selected Bureau publications to the Government depository libraries listed below.

DEPOSITORY LIBRARIES IN THE UNITED STATES

The Superintendent of Documents, United States Government Printing Office, is authorized by law to furnish Government publications to designated depository libraries. The libraries listed below are now receiving certain selected publication series of the National Bureau of Standards for general reference use. Whether or not a given library has a copy of any particular publication can only be determined by inquiry at the library.

ALABAMA

Auburn: Alabama Polytechnic Institute Library.
Birmingham:
    Howard College Library.
    M. Paul Phillips Library.
    Public Library.
Florence: State Teachers College Library.
Jacksonville: State Teachers College Library.
Mobile (Spring Hill): The Thomas Bryne Memorial, Spring Hill College.
Montgomery:
    Department of Archives and History Library.
    State and Supreme Court Library.
Tuskegee Institute: Hollis Burke Frissell Library.
University: University of Alabama Library.

ALASKA

College: University of Alaska Library.
Juneau: Territorial Historial Library and Museum.

ARIZONA

Flagstaff: Arizona State Teachers College Library.
Phoenix:
    Department of Library and Archives.
    Phoenix Public Library.
Tempe: Matthews Library.
Tucson: University of Arizona Library.

ARKANSAS

Clarksville: College of the Ozarks Library.
Conway: Hendrix College Library.

ARKANSAS—Continued

Fayetteville: University of Arkansas Library.
Little Rock: Little Rock Public Library.
Magnolia: Southern State College, J. M. Peace Library.
Russellville: Arkansas Polytechnic College Library.
State College: Arkansas State College Library.

CALIFORNIA

Bakersfield: Kern County Free Library.
Berkeley: University of California Library.
Clarement: Pomona College, Honnold Library.
Davis: University of California Library.
Eureka: Eureka Free Library.
Fresno: Fresno County Free Library.
Long Beach: Public Library.
Los Angeles:
    University of Southern California Library.
    Los Angeles Public Library.
    Los Angeles State College of Applied Arts & Sciences Library.
    Loyola University Library.
    Occidental College Library.
    University of California at Los Angeles Library.
Oakland: Oakland Public Library.
Pasadena: California Institute of Technology Library.
Redding: Shasta County Free Library.
Redlands: University of Redlands Library.
Richmond: Richmond Public Library.
Riverside: Riverside Public Library.

CALIFORNIA—Continued

Sacramento:
    California State Library.
    City Free Library.
San Diego: San Diego Public Library.
San Francisco:
    Mechanics Mercantile Library.
    San Francisco Public Library.
    San Francisco State College, Social Science and Business Library.
Santa Barbara: Santa Barbara Public Library.
Stanford Univ.: Stanford University Library.
Stockton: Stockton Free Public Library.

COLORADO

Boulder: University of Colorado Library.
Colorado Springs: Colorado College, Coburn Library.
Denver:
    Colorado State Library.
    Public Library.
    Regis College Library.
    U. S. Air Force Academy.
    University of Denver, Mary Reed Library.
Fort Collins: Colorado State College of Agriculture and Mechanic Arts Library.
Golden: Colorado School of Mines Library.
Gunnison: Western State College Library.
Pueblo: McClelland Public Library.

CONNECTICUT

Bridgeport: Bridgeport Public Library.

Hartford:
    Connecticut State Library.
    Hartford Public Library.
    Trinity College Library.
Middletown: Wesleyan University, Olin Library.
New Haven: Yale University Library.
New London:
    Connecticut College, Palmer Library.
    U. S. Coast Guard Academy Library.
Storrs: University of Connecticut Library.
Waterbury: Silas Bronson Library.

DELAWARE

Dover: Delaware State Library.
Newark: University of Delaware Library.
Wilmington: Wilmington Institute Free Library.

DISTRICT OF COLUMBIA

Washington:
    Department of Agriculture Library.
    Department of Commerce Library.
    Department of Health, Education, and Welfare Library.
    Department of Interior Central Library.
    Department of Justice Main Library.
    Department of State Library.
    National War College Library.
    Naval Records and Library, Navy Department.
    Post Office Department Historical Library.
    Public Library.
    Treasury Department Library.

FLORIDA

Coral Gables: University of Miami Library.
De Land: Sampson Library of John B. Stetson University.
Gainsville: University of Florida Library.
Jacksonville: Jacksonville Public Library.
Lakeland: Lakeland Public Library.
Miami: Miami Public Library.
Tallahassee:
    Florida Agricultural and Mechanical College Library.
    Florida State Library.
    Florida State University Library.
Tampa: University of Tampa Library.
Winter Park: Rollins College, Mills Memorial Library.

GEORGIA

Athens: University of Georgia General Library.
Atlanta:
    Atlanta Public Library.
    Georgia State Library.
Augusta: Library of Richmond County Academy and Junior College of Augusta.
Collegeboro: Georgia Teachers College Library.

GEORGIA—Continued

Dahlonega: North Georgia College Library.
Emory University: Asa Griggs Candler Library.
Milledgeville: Georgia State College for Women Library.
Savannah: Savannah Public Library.
Valdosta: Valdosta State College Library.

HAWAII

Honolulu:
    Library of Hawaii.
    University of Hawaii Library.

IDAHO

Boise:
    Boise Public Library
    Idaho State Law Library.
Caldwell: Strahorn Memorial Library.
Moscow: University of Idaho Library.
Pocatello: Idaho State College Library.
Rexberg: Ricks College Library.

ILLINOIS

Carbondale: Southern Illinois University Library.
Carlinville: Blackburn College Library.
Chicago:
    Chicago Public Library.
    Chicago Teachers College Library.
    John Crerar Library.
    Museum of Science and Industry Library.
    Newberry Library.
    University of Chicago Libraries.
Decatur: Decatur Public Library.
Elsah: The Marshall Brooks Library.
Evanston: Northwestern University Library.
Freeport: Freeport Public Library.
Galesburg: Galesburg Public Library.
Jacksonville: MacMurray College Library.
Joliet: Public Library.
Kankakee: Olivet Nazarene College Library.
Lisle: St. Procopius College Library.
Lockport: Lewis College of Science and Technology Library.
Monmouth: Monmouth College Library.
Normal: Illinois State Normal University Library.
Peoria: Peoria Public Library.
Rock Island: Rock Island Public Library.
Rockford: Public Library.
Springfield: Illinois State Library.
Urbana: University of Illinois Library.

INDIANA

Bloomington: Indiana University Library.
Crawfordsville: Wabash College Library.
Evansville: Evansville Public Library.
Fort Wayne: Public Library.
Gary: Gary Public Library.
Greencastle: De Pauw University Library.
Hanover: Hanover College Library.
Indianapolis:
    Indiana State Library.
    Indianapolis Public Library.
Lafayette: Purdue University Library.
Muncie: Public Library.
Notre Dame: University of Notre Dame Library.
Richmond: Morrison-Reeves Library.
Terre Haute: Indiana State Teachers College Library.
Valparaiso: Valparaiso University Library.

IOWA

Ames: Iowa State College Library.
Cedar Falls: Iowa State Teachers College Library.
Council Bluffs: Free Public Library.
Des Moines:
    Iowa State Traveling Library.
    Public Library.
Dubuque: Carnegie Stout Free Public Library.
Fairfield: Fairfield Free Public Library.
Grinnell: Grinnell College Library.
Iowa City: State Univrsity of Iowa Library.
Lamoni: Graceland College Library.
Mount Pleasant: Iowa Wesleyan College Library.
Mount Vernon: Cornell College Library.
Sioux City: Public Library.

KANSAS

Baldwin City: Baker University Library.
Emporia: William Allen White Library, Kansas State Teachers College.

KANSAS—Continued

Hays: Forsyth Library of Fort Hays Kansas State College.
Lawrence: University of Kansas Library.
Manhattan: Kansas State College Library.
Pittsburg: Porter Library, Kansas State Teachers College.
Salina: Kansas Wesleyan University Library.
Topeka:
  Kansas State Historical Society Library.
  Kansas State Library.
Wichita: University of Wichita Library.

KENTUCKY

Ashland: Ashland Public Library.
Bowling Green: Western Kentucky State Teachers College Library.
Danville: Centre College Library.
Frankfort:
  State Law Library.
  Kentucky State College Library.
Lexington: University of Kentucky Library.
Louisville:
  Louisville Free Public Library.
  University of Louisville Library.
Morehead: Johnson Camden Library, Morehead State College.
Murray: Murray State Teachers College Library.
Pikeville: Pikeville College Library.

LOUISIANA

Baton Rouge:
  Louisiana State University Law Library.
  Louisiana State University Library.
  Southern University Library.
Lafayette: Southwestern Louisiana Institute Library.
Lake Charles: McNeese State College Library.
Natchitoches: Northwestern State College of Louisiana.
New Orleans:
  Law Library of Louisiana.
  Loyola University Library.
  New Orleans Public Library.
  Tulane University, Howard-Tilton Memorial Library.
Ruston: Louisiana Polytechnic Institute Library.
Shreveport: Shreve Memorial Library.

MAINE

Augusta: Maine State Library.
Bangor: Bangor Public Library.
Brunswick: Bowdoin College Library.
Lewiston: Bates College Library.
Orono: University of Maine Library.
Portland: Portland Public Library.
Waterville: Colby College Library.

MARYLAND

Annapolis:
  Maryland State Library.
  U. S. Naval Academy Library.
Baltimore:
  Enoch Pratt Free Library.
  Johns Hopkins University Library.
  Morgan State College Library.
  Peabody Institute Library.
Chestertown: Washington College, George Avery Bunting Library.
College Park: University of Maryland Library.
Gaithersburg: Montgomery County Department of Public Libraries.
Westminster: Western Maryland College Library.

MASSACHUSETTS

Amherst:
  Amherst College Library.
  University of Massachusetts, Goodell Library.
Boston:
  Boston Athenaeum Library.
  Boston Public Library.
  State Library of Massachusetts.
Brookline: Public Library.
Cambridge:
  Harvard College Library, Serials Division.
  Massachusetts Institute of Technology Library.
Lowell: Lowell Textile Institute Library.
Lynn: Lynn Public Library.
New Bedford: Public Library.
Tufts College: Tufts College Library.
Wellesley: Wellesley College Library.

MASSACHUSETTS—Continued

Williamstown: Williams College Library.
Worcester:
  American Antiquarian Society Library.
  Free Public Library.

MICHIGAN

Ann Arbor: General Library of University of Michigan.
Battle Creek: Willard Library.
Benton Harbor: Benton Harbor Public Library.
Bloomfield Hills: Cranbrook Institute of Science Library.
Detroit:
  Detroit Public Library.
  University of Detroit Library.
  Wayne University, General Library.
East Lansing: Michigan State College of Agriculture and Applied Science Library.
Flint: Robert N. Mandeville High School Library.
Grand Rapids: Grand Rapids Public Library.
Houghton: Michigan College of Mining and Technology Library.
Kalamazoo: Public Library.
Lansing: Michigan State Library.
Muskegon: Hackley Public Library.
Port Huron: Port Huron Public Library.
Saginaw: Hoyt Public Library.

MINNESOTA

Collegeville: St. Johns University Library.
Duluth: Duluth Public Library.
Minneapolis:
  Public Library.
  University of Minnesota Library.
Moorhead: State Teachers College Library.
Northfield:
  Carleton College Library.
  St. Olaf College Library.
Saint Peter: Gustavus Adolphus College Library.
St. Paul:
  Minnesota Historical Society Library.
  Minnesota State Law Library.
  St. Paul Public Library.
Stillwater: Stillwater Public Library.

MISSISSIPPI

Cleveland: W. B. Roberts Memorial Library, Delta State Teachers College.
Columbus: J. C. Fant Memorial Library of Mississippi State College for Women.
Hattiesburg: Mississippi Southern College Library.
Jackson:
  Mississippi Library Commission.
  Mississippi State Library.
State College: Mississippi State College, Mitchell Memorial Library.
University: University of Mississippi Library.

MISSOURI

Cape Girardeau: Kent Library Southeast Missouri State College.
Columbia: University of Missouri Library.
Fulton: Westminster College Library.
Hannibal: Free Public Library.
Jefferson City:
  Lincoln University Library.
  Missouri Supreme Court Library.
Kansas City:
  Kansas City Public Library.
  Rockhurst College Library.
  University of Kansas City Library.
Liberty: William Jewell College Library.
Rolla: School of Mines & Metallurgy Library.
St. Joseph: St. Joseph Public Library.
St. Louis:
  St. Louis Public Library.
  St. Louis University Library.
  Washington University Library.
Springfield: Drury College Library.
Warrensburg: Central Missouri State College Library.

MONTANA

Bozeman: Montana State College Library.
Butte: Montana School of Mines Library.
Helena:
  Helena Public Library.
  Historical Society of Montana Library.
Missoula: State University of Montana Library.

NEBRASKA

Blair: Dana College Library.
Crete: Whitin Library of Doane College.
Fremont: Midland College Library.
Lincoln:
  Nebraska State Library.
  University of Nebraska Library.
Omaha:
  Municipal University of Omaha Library.
  Omaha Public Library.
Scottsbuff: Scottsbuff Public Library.

NEVADA

Carson City: Nevada State Library.
Hawthorne: Mineral County Public Library.
Reno:
  University of Nevada Library.
  Washoe County Library.

NEW HAMPSHIRE

Concord: New Hampshire State Library.
Dover: Dover Public Library.
Durham: University of New Hampshire Library.
Hanover: Dartmouth College Library.
Laconia: Laconia Public Library.
Manchester: City Library.

NEW JERSEY

Atlantic City: Free Public Library.
Bayonne: Free Public Library.
Camden: Camden Free Public Library.
Convent Station: Santa Maria Library of College of St. Elizabeth.
Elizabeth: Public Library.
Jersey City: Free Public Library.
Madison: Rose Memorial Library.
New Brunswick:
  Free Public Library.
  Rutgers University Library.
Newark: Public Library.
Princeton: Princeton University Library.
Rutherford: Fairleigh Dickinson College Library.
South Orange: Seton Hall University Library.
Trenton:
  Division of State Library, Archives and History—Department of Education.
  Free Public Library.

NEW MEXICO

Albuquerque: University of New Mexico.
Hobbs: Hobbs Public Library.
Las Vegas: New Mexico Highlands University, Rodgers Library.
Santa Fe: New Mexico State Law Library.
Silver City: New Mexico State Teachers College Library.
State College: New Mexico College of Agriculture and Mechanic Arts Library.

NEW YORK

Albany: New York State Library.
Brooklyn:
  Brooklyn College Library.
  Brooklyn Public Library.
  Pratt Institute Library.
Buffalo:
  Buffalo and Erie County Public Library.
  Grosvenor Library.
Canton: St. Lawrence University Library.
Elmira: Elmira College Library.
Farmingdale: Long Island Agricultural and Technical Institute Library.
Flushing: Queens College Library.
Glens Falls: Crandall Library.
Hamilton: Colgate University Library.
Ithaca:
  Albert R. Mann Library, New York State Colleges of Agriculture and Home Economics.
  Cornell University Library.
Jamaica:
  Queens Borough Public Library.
  St. Johns University Library.
New York City:
  College of the City of New York Library.
  Columbia University Library.
  Cooper Union Library.
  Fordham University Library.
  New York Law Institute Library.
  New York Public Library (Astor Branch).
  New York Public Library (Lenox Branch).
  New York State Maritime College Library.
  New York University General Library.

NEW YORK—Continued

Newburgh: Newburgh Free Library.
Potsdam: Clarkson College of Technology Library.
Poughkeepsie: Vassar College Library.
Rochester:
  Rochester Public Library, Edgerton Branch.
  University of Rochester Library.
St. Bonaventure: St. Bonaventure College Library.
Schenectady: Union College Library.
Staten Island: Wagner College Library, Grymes Hill.
Syracuse: Syracuse University Library.
Troy: Troy Public Library.
Utica: Utica Public Library.
West Point: U. S. Military Academy.
Yonkers: Yonkers Public Library.

NORTH CAROLINA

Chapel Hill: University of North Carolina Library.
Charlotte: Queens College Library.
Cullowhee: Western Carolina College Library.
Davidson: Library of Davidson College.
Durham: Duke University Library.
Greensboro: Agricultural and Technical College Library.
Greenville: East Carolina College Library.
Raleigh:
  D. H. Hill Library of North Carolina State College.
  North Carolina State Library.
Salisbury: Catawba College Library.
Wilson: Atlantic Christian College, Clarence L. Hardy Library.
Winston-Salem:
  Public Library of Winston-Salem and Forsyth County.
  Wake Forest College Library.

NORTH DAKOTA

Bismarck:
  State Historical Library.
  State Law Library.
Fargo: North Dakota Agricultural College and Experiment Station Library.
Grand Forks: University of North Dakota Library.
Minot: State Teachers College Library.
Valley City: State Teachers College Library.

OHIO

Akron: Akron Public Library.
Alliance: Mt. Union College Library.
Ashland: Ashland College Library.
Athens: Ohio University Library.
Bluffton: Musselman Library of Bluffton College.
Bowling Green: Bowling Green State University Library.
Bucyrus: Bucyrus Public Library.
Cincinnati:
  Public Library.
  University of Cincinnati Library.
Cleveland:
  Adelbert College Library of Western Reserve University.
  Cleveland Public Library.
Columbus:
  Columbus Public Library.
  Ohio State Library.
  Ohio State University Library.
Dayton: Dayton Public Library.
Delaware: Charles Slocum Library of Ohio Wesleyan University.
Gambier: Kenyon College Library.
Granville: Denison University Library.
Hiram: Hiram College Library.
Marietta: Marietta College Library.
Oberlin: Oberlin College Library.
Oxford: Miami University Library.
Portsmouth: Free Public Library.
Springfield: Warder Public Library.
Steubenville: Carnegie Library.
Toledo: Toledo Public Library.
Van Wert: Brumback Library of Van Wert County.
Youngstown: Youngstown Public Library.

OKLAHOMA

Ada: East Central State Teachers College Library.
Alva: Northwestern State Teachers College Library.
Durant: Southeastern Teachers College Library.
Edmond: Central State College Library.
Enid: Carnegie Public Library.
Langston: Langston University Library.

OKLAHOMA—Continued

Norman: University of Oklahoma Library.
Oklahoma City: Oklahoma State Library.
Shawnee: Oklahoma Baptist University Library.
Stillwater: Agricultural and Mechanical College Library.
Tahlequah: Northeastern State Teachers College Library.
Tulsa: University of Tulsa Library.

OREGON

Ashland: Southern Oregon College of Education Library.
Corvallis: Oregon State College Library.
Eugene: University of Oregon Library.
Forest Grove: Pacific University Library.
La Grande: Eastern Oregon College of Education Library.
Portland:
- Library Association of Portland.
- Reed College Library.

Salem: Oregon State Library.

PENNSYLVANIA

Allentown: Muhlenberg College Library.
Bethlehem: Lehigh University Library.
Bradford: Carnegie Public Library.
Carlisle: Dickinson College Library.
Erie: Erie Public Library.
Harrisburg: Pennsylvania State Library.
Haverford: Haverford College Library.
Huntingdon: Juniata College Library.
Lancaster: Franklin and Marshall College, Fackenthal Library.
Meadville: Allegheny College Library.
Philadelphia:
- Free Library of Philadelphia.
- Philadelphia Commercial Museum Library.
- Temple University, Sullivan Memorial Library.
- University of Pennsylvania Library.

Pittsburgh:
- Carnegie Free Library of Allegheny.
- Carnegie Library of Pittsburgh.
- University of Pittsburgh Library.

Reading: Reading Public Library.
Scranton: Scranton Public Library.
State College: Pennsylvania State University Library.
Swarthmore: Swarthmore College Library.
Warren: Warren Library Association.
Washington: Memorial Library of Washington and Jefferson College.
Wilkes-Barre: Kings College Library.
Williamsport: James V. Brown Library.

PUERTO RICO

Mayaguez: University of Puerto Rico, College of Agriculture and Mechanical Arts Library.
Rio Piedras: University of Puerto Rico General Library.

RHODE ISLAND

Kingston: University of Rhode Island Library.
Providence:
- Brown University Library.
- Providence Public Library.
- Rhode Island State Library.

Westerly: Westerly Public Library.

SOUTH CAROLINA

Charleston: Charleston College Library.
Clemson: Clemson College Library.
Columbia:
- South Carolina State Library.
- University of South Carolina Library.

Orangeburg: State Agricultural and Mechanical College.
Rockhill: Carnegie Library of Winthrop College.

SOUTH DAKOTA

Brookings: Lincoln Memorial Library of South Dakota State College.
Mitchell: Dakota Wesleyan University Library.
Pierre: South Dakota Free Library Commission.
Sioux Falls: Carnegie Free Public Library.
Spearfish: Black Hills Teachers College Library.
Vermillion: University of South Dakota Library.
Yankton: Yankton College Library.

TENNESSEE

Chattanooga: Chattanooga Public Library.
Clarksville: Austin Peay State College Library.
Johnson City: East Tennessee State College Library
Knoxville: University of Tennessee Library.
Memphis: Cossitt Library.
Murfreesboro: Middle Tennessee State College Library.
Nashville:
- Joint University Libraries.
- Nashville Public Library.
- State Library Division, Tennessee State Library and Archives.

Sewanee: University of the South Library.

TEXAS

Abilene: Hardin Simmons University Library.
Austin:
- Texas State Library.
- University of Texas Library.

Beaumont: Lamar State College of Technology Library.
Canyon: West Texas State Teachers College Library.
College Station: Agriculture and Mechanical College of Texas Library.
Commerce: East Texas State Teachers College Library.
Dallas:
- Dallas Public Library.
- Southern Methodist University Library.

Denton: North Texas State Teachers Library.
El Paso: El Paso Public Library.
Fort Worth:
- Forth Worth Public Library.
- Texas Christian University Library.

Galveston: Rosenberg Library.
Houston: Houston Public Library.
- University of Houston.

Huntsville: Sam Houston State Teachers College, Estill Library.
Kingsville: Texas College of Arts and Industries Library.
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RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 39, JULY—DECEMBER 1947

RP1807. Solution of problem of producing uniform abrasion and its application to the testing of textiles..............Herbert F. Schiefer

A general mathematical solution to the problem of producing uniform abrasion over a plane area of a specimen from every azimuthal direction was worked out. This solution requires that the abradant and the specimen rotate in the same direction and with the same angular velocity. The specimen may revolve about the center of the abradant with any angular velocity in the same or opposite direction as its direction of rotation. The specimen must not extend beyond the boundary of the abradant. Simple revolution of abradant about specimen and of specimen about abradant without rotation of either are special solutions. The special solution in which the specimen does not revolve about the center of the abradant is the simplest one from mechanical considerations. A machine based upon this special solution is described, and preliminary results obtained with it are discussed. 10 p.

RP1808. Chromaticities of Lovibond glasses....Geraldine Walker Haupt and Florence Lesch Douglas

This paper reports by means of a series of graphs the chromaticity coordinates of certain Lovibond unit glasses and of pairs of such glasses in combination with an illuminant of color temperature 2,842° K. (illuminant *A*). The chromaticities were computed according to the 1931 International Commission of Illumination (ICI) standard-observer and coordinate system. The points graphically representing the x- and y-values have been labelled according to the Lovibond numbers and have been connected by lines to form a network. A similar graph is included for a few Lovibond glasses in combination with illuminant *C*. The Lovibond glasses are those from the National Bureau of Standards set designated as "BS9940", and the spectrophotometric data on which the colorimetric computations are based are those published by Gibson and Harris [2]. 10 p.

RP1809. Development of standards for analytical filter papers
Bourdon W. Scribner and William K. Wilson

Filter papers used for ordinary qualitative and quantitative analyses were treated to obtain data for recommended standards of quality. The papers comprised the products of two domestic and three foreign manufacturers.

Tests were made for retention of fine precipitates, time of flow of water, ash, and wet bursting strength by modified methods developed at the Bureau. Density, alpha-cellulose, copper number, and acidity were also determined. Instances of filter paper becoming too brittle for use through deterioration have been observed. Stable papers are characterized by a high content of alpha-cellulose, a low copper number, and low acidity. Furthermore, the degraded cellulose of deteriorated filter papers may cause erroneous analytical results.

The ash, bursting strength, density, and time of flow of water varied considerably for papers made for the same stated use. The alpha-cellulose content and copper number also varied considerably in papers made by different manufacturers. The acidity of all the papers was low. The papers showed a correlation between density and time of flow of water.

Data are given showing the much greater decrease in alpha-cellulose and increase in copper number of papers of poor condition of cellulose than of papers of good quality of cellulose when subjected to accelerated aging. Data are also included on the poor condition of cellulose in deteriorated paper as compared with paper that had not deteriorated. Degraded cellulose is soluble in alkaline solutions and to some extent in water, and examples are given of how this may affect analyses.

Recommended standards are given for the properties considered of the most importance: alpha-cellulose, copper number, acidity, ash, bursting strength, and time of flow of water. 7 p.

RP1810. An improved method for measurement of gel strength and data on starch gels..Walter J. Hamer

A method is described for the measurement of gel strength that involves essentially the determination of the shearing force required to fracture gels. Weight is applied to standard disks embedded in the gels. A standardization of the method is outlined. Several applications are given to illustrate the precision of the method and its use in studies of starches of various kinds. No exact correlation between gel strength and the granular size or the amylose or amylopectin contents of starches was found. 9 p.

RP1811. Cold-starting abilities of various substitute motor fuels
Ronald E. Streets

Tests of various nonhydrocarbon fuels in a standard eight cylinder automotive engine showed the starting abilities of single constituent fuels to be rather lmited, but the addition of small percentages of more volatile fuels lowered the minimum starting temperature to a marked degree.

A limited number of tests under altitude conditions also showed a further reduction in minimum starting temperature of each of the fuels used. This should compensate to some degree for the lower average temperatures generally encountered at higher altitudes, so that for any one area it would be possible to obtain satisfactory starting with a minimum amount of blend changes. 9 p.

RP1812. Heats of combustion and isomerization of the eight C_8H_{16} alkylcyclohexanes.............Walter H. Johnson, Edward J. Prosen, and Frederick D. Rossini

The heats of isomerization of the eight C_8H_{16} alkyl cyclohexanes were determined by measurement of the ratios of the heats of combustion in the liquid state of purified samples of these compounds by the procedure previously described for other hydrocarbons. The data yield the following values for the heat of isomerization in the liquid state at 25° C, ΔH°, of ethylcyclohexane into the dimethyl-cyclohexanes, in kilocalories per mole: Ethylcyclohexane, 0.00; 1,1-dimethylcyclohexane, —1.58±0.28; *cis*-1,2-dimethylcyclohexane, 0.08 ±0.25; *trans*-1,2-dimethylcyclohexane, —1.46 ±0.27; *cis*-1,3-dimethylcyclohexane, —2.57 ±0.22; *trans*-1,3-dimethylcyclohexane, —0.85 ±0.21; *cis*-1,4-dimethylcyclohexane, —0.83 ±0.21; *trans*-1,4-dimethylcyclohexane, —2.45 ±0.22. These data were combined with the value previously reported for the heat of combustion of ethylcyclohexane to obtain values for the heats of combustion of the seven dimethylcyclohexanes in the liquid state at 25° C. (For the two isomers of 1,3-dimethylcyclohexane, the labels "*cis*" and "*trans*" are here applied to the lower and higher boiling isomers, respectively.) 4 p.

RP1813. Resistance-temperature relation and thermoelectric properties of uranium................Andrew I. Dahl and Milton S. Van Dusen

The paper describes measurements made on the resistance-temperature relation and the thermoelectric properties of several samples of uranium. The resistance-temperature relation showed sharp breaks at about 650° and 770° C, indicating the existence of transformation points. The very rapid change in resistance occurred at a somewhat higher temperature on heating than on cooling. Only slight irregularities in the thermoelectric properties were noted in the region of the transformation points. 6 p.

RP1814. Infrared absorption spectrum of carbon disulfide
Earle K. Plyler and Curtis J. Humphreys

The infrared absorption spectrum of carbon disulfide has been remeasured in the region from 2 to 24 μ with cells up to 5 mm in thickness. Fifteen bands were observed, some however being of low intensity. The strongest band for the liquid occurs at 6.62 μ, and the second harmonic of this band was observed at 2.22 μ, but the first harmonic, which should be at about 3.33 μ, was not observed, in accordance with the selection rules for a symmetrical linear molecule. Four combination bands were observed between 3 and 5 μ, whose wavelengths were in good agreement with the calculated values. A combination band, which is represented by the difference between two fundamentals, occurs as a broad, moderately strong band in the region of 11.6 μ. A weak band, observed at 15.27 μ, corresponds with the wavelength of the inactive vibration of the molecule. However, when this region was studied with a 140 cm cell filled with the saturated vapor of CS_2 at room temperature, no band was observed. In the vapor state a total of six bands were found at wavelengths less than 20 μ. The fundamental band at 6.5 μ shows a side branch that is probably due to the isotopic effect produced by C^{13}. Some small bands that were observed may be attributed to the $C^{12}S^{32}S^{34}$ molecule. As would be expected for this molecular configuration, the spectrum of CS_2 as observed may be classified into an array of terms analogous to those of CO_2. A band of 12.7 μ has different intensities for samples obtained from two different sources and may be caused by an impurity. This band did not appear when the cell containing the vapor was used. 8 p.

RP1815. Influence of boron on some properties of experimental and commercial steels.................Thomas G. Digges and Fred M. Reinhart

Tests were made to determine the influence of boron additions with simple and complex intensifiers on the cleanliness, structure, austenite, and McQuaid-Ehn grain sizes, hardenability, notch toughness (Charpy impact) at room and low temperatures and tensile properties of "split" heats of both experimental and commercial steels. The testing program with the experimental steels was extended to include a study of the effect of deoxidation on the above properties and the influence of boron on transformation temperatures and weldability and the recovery of boron on remelting.

Boron was determined chemically by a distillation-colorimetric method, or spectrographically, and in some steels by both methods.

The presence of boron had no significant influence on the cleanliness, hot-working, transformation temperatures, softening by tempering, weldability, or tensile properties of the steels. However, boron lowered the coarsening temperature of austenite. The hardenability of many of the experimental, and all of the commercial steels, was markedly increased by boron, but no correlation was found between hardenability and the amount of boron added or retained in the steels. Thus the magnitude of the effect of boron on hardenability appears to depend upon the form in which it exists in austenite and not necessarily upon the amount present. The hardenability of steels with high-soluble nitrogen was not materially enhanced by boron, but it was possible to retain its effect in high-nitrogen steels (low-soluble nitrogen) by fixing the nitrogen with nitrides.

A small amount of boron was often beneficial to notch toughness at room temperature of steels when fully hardened and tempered at low temperatures whereas its presence, especially in relatively large amounts, was usually either without effect or was detrimental to notch toughness at room and low temperatures when the hardened steels were tempered at high temperatures. 65 p.

RP1816. Absorption spectra in the detection of chemical changes in cellulose and cellulose derivatives......John W. Rowen, Charles M. Hunt, and Earle K. Plyler

The spectral absorption of thin films of cellulose acetate, regenerated cellulose, the acetate and regenerated cellulose after oxidation with nitrogen dioxide gas, and the regenerated cellulose after oxidation with periodic acid followed by chlorous acid, are recorded for the infrared from 2 to 15 microns and the ultraviolet from 215 to 400 millimicrons. The regenerated cellulose absorbed ultraviolet radiant energy only at the short wavelength end of the region studied, and there the transmittance of a film 2.8 microns thick was only slightly reduced. The acetate and oxidized celluloses absorbed in this region to a greater extent but gave no narrow absorption bands. Marked changes were observed in some of the absorption bands in the infrared region in going from cellulose acetate to regenerated cellulose and to their oxidation products. These changes were correlated with changes in the OH, CO, and COOH groups. The results indicate the possibility of estimating the amount of these groups present by spectral absorption measurements. 8 p.

RP1817. Anodic current efficiency in the counterflow electrolysis of uranyl chloride solutions ....Walter J. Hamer

Anodic current efficiency or the chlorine-oxygen ratio in the electrolysis of aqueous solutions of uranyl chloride was determined by a counterflow method at a temperature of 25° C. Because of the hydrolysis of dissolved chlorine, measurements were made only after sufficient time had elapsed to assure a state of equilibrium. Different concentrations of electrolyte, various electrode materials, and several current densities were employed to ascertain the effects of such changes.

The standard potentials of the oxygen and chlorine electrodes are such that oxygen should be evolved at anodes in the electrolysis of chlorides. However, chlorine is liberated because of the relative magnitudes of the oxygen and chlorine overvoltages. The value of overvoltage is dependent on the electrode material and the nature of the electrode surface. For uranyl chloride the current efficiencies increase in the order: magnetite, arc carbon, graphite, metallic carbides, and the platinum metals. Magnetite, the carbides, arc carbon, and graphite erode or pencil during electrolysis. Palladium black and platinum black becomes dispersed in the electrolyte. The highest current efficiency obtained was 97 percent, and the data indicated that current efficiencies of 100 percent cannot be realized for aqueous solutions of uranyl chloride at 25° C. The method is general and may be used in the determination of the current efficiency of many electrode processes. The method may also be adapted to the continuous production of gases of known purity. 7 p.

RP1818. Analysis by the mass spectrometer of a liquid hydrocarbon mixture containing C_3-C_5 paraffins and olefins............Vernon H. Dibeler and Fred L. Mohler

A study of two methods for removing small samples from a liquified hydrocarbon mixture of known composition has been made with a mass spectrometer. The first method, that of opening the cylinder valve and allowing the mixture to evaporate slowly into an evacuated reservoir, was shown to give varying compositions depending on the rate of evaporation. The second method employed a low-temperature bath to cool the mixture below the boiling point of all components at atmospheric pressure. A portion of the liquid was then isolated in a pipette and completely expanded into a gas reservoir. Five successive samplings agreed with the composition certified by the Phillips Petroleum Co. within the experimental error. 6 p.

RP1819. An indentation method for measuring wear........Samuel A. McKee

This paper describes a method for accurately measuring the wear that takes place on the bearing surfaces of machinery. The method consists of making minute indentations in the wearing surface by means of a specially shaped diamond point. As material is worn from the surface, the dimensions of the marks change with the amount of material removed. Measurements of the dimensions of these marks before and after wear provide a means for determining the amount of wear that has taken place.

Apparatus is described for using this method for the measurement of wear occurring in the cylinders of aircraft engines. The results of tests with engines in operation indicate that the method is practicable. Curves are also given showing typical wear data obtained in engine cylinders.

The chief advantages of the method over the usual methods are (1) greater accuracy, (2) a precise indication as to where wear occurs, and (3) the measurements are not affected by growth, shrinkage or distortion of the machine element under test. 7 p.

RP1820. Effect of magnification on the precision of indoor telescope pointing...Francis E. Washer

The principle variables affecting the precision of telescope pointing at an indoor target are magnification, brightness, and vernier acuity of the observer's eye. A series of experiments were performed in which magnification was the principle variable. All observations were made by a single observer, thus reducing variation in the vernier acuity. The brightness of the background against which the target was viewed was maintained at approximately the same level throughout the experiments to minimize effects arising from variation of brightness. Under these conditions, the relation between probable error of a single pointing (PE_s) and magnification (M) is approximately PE_s (in seconds)$=\frac{4.962}{M}+0.068$. 9 p.

RP1821. Heats of formation and isomerization of the eight C_8H_{12} alkylcyclohexanes in the liquid and gaseous states........Edward J. Prosen, Walter H. Johnson, and Frederick D. Rossini

From experimental data recently obtained on the heats of combustion of the eight C_8H_{16} alkylcyclohexanes in the liquid state at 25° C, together with auxiliary data on the differences in the heats of vaporization at 25° C and on the difference in heat content of the gas between 0° K and 25° C, values are calculated for the following properties: the heat of isomerization of ethylcyclohexane into the given dimethylcyclohexane in the gas state at 25° C, and also in the gas state at 0° K; the heat of formation, from the elements, of the given isomer in both the liquid and gas states at 25° C and in the gas state at 0° K. The relation of the energy content to the structure of these molecules is discussed, including the labeling of the lower and higher-boiling forms of 1,3-dimethylcyclohexane as *cis* and *trans*, respectively. 3 p.

RP1822. Some recent advances in our understanding of the chemistry of portland cement.................................Robert H. Bogue

A review is given of some of the more important advances that have been made in our understanding of portland cement during the war years, or more specifically from 1942 to 1946. The field covered is limited strictly to chemical research, and no attempt is made to include more than the outstanding contributions. The presentation is given of thirteen investigational fields of study, classified in four major divisions. The more significant results are brought together in a summary. 14 p.

RP1823. Shunts and inductors for surge-current measurements.John H. Park

The special requirements that must be fulfilled by a shunt intended to be used in surge-current measurements are explained. A tubular shunt with coaxial potential leads that meets these requirements is described, and factors affecting its design are discussed. A theoretical derivation of the "skin effect" in this type of shunt at high frequencies is gven in one of the appendices.

The advantages of using a mutual inductor for obtaining oscillograms of the rate of change of current during a surge are outlined, and several types of mutual inductors developed especially for this purpose are described. Theoretical derivations, given in the appendices, indicate that the concentric-tube mutual inductors described in this paper can be used to measure the high-frequency components of a current surge up to 70 megacycles with less than 10 percent error.

Several shunts and mutual inductors of the designs described in this paper were constructed for use in the high voltage laboratory at the National Bureau of Standards. Their complete description and oscillograms showing results obtained with them are included. 22 p.

RP1824. Validity of the cosine-fourth-power law of illumination
Irvine C. Gardner

The cosine-fourth-power law states that the irradiance at any point in the image formed by a photographic lens, in the absence of vignetting, is equal to $E_0 \cos^4 \beta$, where E_0 is the irradiance at the center of the field, and β is the angle between the axis of the lens and the conjugate chief ray in the object space. Although not usually so stated, this law involves the additional assumption that the lens is free from distortion. With this assumption, the law applies rigorously when the diaphragm is between the lens and object and the object is at an infinite distance. If the diaphragm is between the lens and the image plane, there may be cases in which the irradiance falls off less rapidly from the center of the field outward than is predicted by the cosine-fourth-power law. A type of negative distortion is defined for which the irradiance is uniform over the entire image. When the diaphragm is within the lens system (the more common condition for photographic lenses), one must know the distortion of the portion of the lens following the diaphragm before a definite statement regarding the irradiance of the image can be made. The departures from exactness of the cosine-fourth-power law arise partly because the effective area of the entrance pupil is a function of the obliquity of the incident chief ray. A method is given for measuring this variation in effective area. 7 p.

RP1825. Acid-base reactions in benzene and other organic solvents: behavior of bromphthalein magenta with different classes of organic bases
Marion Maclean Davis and Priscilla J. Schuhmann

Practical and theoretical aspects of acid-base reactions in benzene and other organic solvents are discussed. The synthesis of the indicators bromphthalein magenta E and B (the ethyl and *n*-butyl esters of tetrabromophenolphthalein) and of their tetraalkylammonium salts is described. Qualitative and spectrophotometric data concerning the color reactions of the indicators with primary, secondary, and tertiary aliphatic amines, substituted guanidines, and other nitrogen bases in benzene and other types of organic solvents are presented. An explanation offered for the color phenomena is also applicable to sulfonephthaleins and other indicators.

Examples are given of the quantitative measurement of the relative reactivity of bases with bromphthalein magenta in benzene. Illustrations are furnished of the application of the indicators to the quantitative estimation of acids and bases, to measurements of the relative strengths of organic acids, and to the differentiation of primary, secondary, and tertiary aliphatic amines.

During the spectrophotometric investigations, it was necessary to design new types of absorption cells suitable for volatile solvents and for thin layers of solution. A description of these cells is given. 43 p.

RP1826. Observations on the control of grain size in magnesium casting alloys............Vernon C. F. Holm and Alexander I. Krynitsky

The methods investigated for the control of grain size in magnesium casting alloys were (1) stirring of carbonaceous solids into the molten alloy, (2) bubbling of carbon monoxide through the melt, (3) melting in a silicon carbide crucible, and (4) treatment with lump magnesite. In the last method, the magnesite was placed deep in the molten metal, where it dissociated thermally, generating a carbonaceous gas that bubbled through the melt. The grain size and tensile properties were determined on specimens from each melt, and these were compared with data from melts that had been superheated as well as those that had received no special treatment. The results indicate that magnesium alloys that have been properly treated with carbonaceous materials possessed grain-size and tensile properties equivalent to those obtained in superheated metal. The magnesite method is a simple, inexpensive, and convenient means of developing a fine-grained structure in magnesium casting alloys. 6 p.

RP1827. Acceptance sampling by variables, with special reference to the case in which quality is measured by average or dispersion
John H. Curtiss

This paper is devoted to a presentation of the theory and practice of certain types of acceptance sampling plan based on the statistical tests of hypotheses. The basic concepts of the statistical theory are discussed in detail, and are then applied to obtain a number of specific formulas for the single sampling case. 20 p.

RP1828. Freezing points of cobalt and nickel............Milton S. VanDusen and Andrew I. Dahl

The freezing points of nickel and cobalt on the International Temperature Scale have been determined on samples from the same lots of metal used by Day and Sosman in their freezing-point determinations on the gas-thermometer scale. The freezing temperatures on the International Temperature Scale are

Nickel	1,455°±1° C.
Cobalt	1,495°±1° C.

A value of the constant C_2 in Wien's (or Planck's) radiation law has been calculated on the basis of the observed ratios of brightness of black bodies at the freezing points of nickel and gold, cobalt and gold, and palladium and gold, and the values of the freezing temperatures of these metals on the thermodynamic scale as derived from the work of Day and Sosman. The average value of C_2 was computed to be 1.438 cm degrees. 5 p.

RP1829. Influence of the atmosphere upon the precision of telescope pointing
Francis E. Washer and Leo W. Scott

The probable error of a single pointing (PE_s) was measured under conditions such that the effect of the air column intervening between observer and target was introduced or eliminated at will. The substantial reduction in PE_s for the air-column-eliminated method as compared with the air-column-present method showed that precision in outdoor pointing is definitely limited by the air column. Some approximate computations were made to show that the value of PE_s cannot be appreciably reduced by increasing the magnification of the telescope above 20. 6 p.

RP1830. Alkylbenzenes in the C_8 fraction from five different catalytic petroleum refining processes. . Anton J. Streiff and Frederick D. Rossini

This report gives the results of the analysis, by measurements of freezing points of appropriate mixtures, supplemented by analytical distillation, of the four individual C_8 alkylbenzenes (ethylbenzene, *o*-xylene, *m*-xylene, and *p*-xylene) occurring in the product from the following five different catalytic petroleum refining processes: (1) Hydroforming, (2) Two-pass Fixed Bed, (3) Three-pass Fixed Bed, (4) Low-temperature Fluid, and (5) High-temperature Fluid. The data indicate that the relative amounts by volume of the four C_8 alkylbenzenes are not greatly different in the five different products being, on the average, as follows: ethylbenzene, 12; *o*-xylene, 21; *m*-xylene, 48; *p*-xylene, 19. These amounts correspond substantially to those called for in chemical thermodynamic equilibrium for the operating temperatures involved. 6 p.

RP1831. Heat capacities at high temperatures of uranium, uranium trichloride, and uranium tetrachloride.................Defoe C. Ginnings and Robert J. Corruccini

The enthalpies referred to 0° C of uranium in the range 0° to 900° C, of uranium trichloride in the range 0° to 725° C, and of uranium tetrachloride in the range 0° to 425° C, have been determined using the "drop" method with an ice calorimeter. Derived values of entropy referred to 0° C and specific heat are given. The samples were of high purity. Two first-order transformations of uranium were observed and the heats of transition calculated from the experimental data. No evidence of first- or second-order transitions in the chlorides was found. 8 p.

RP1832. Specific heat, enthalpy, and entropy of uranyl fluoride
Paul F. Wacker and Ruth K. Cheney

The heat capacity of uranyl fluoride was measured from 13° to 418° K by using a vacuum-type calorimeter equipped with thermostated radiation shields. From the data so obtained, the enthalpy $H°—H°_0$ was calculated to be 63.96, 77.62, and 108.15 int. joules per gram at 298.16°, 338.16°, and 423.16° K, respectively, and the entropy was calculated to be 0.4400, 0.4830, and 0.5635 int. joules per degree-gram at the same temperatures. No evidence of a transition was found. The values of the specific heat, enthalpy, entropy, and free energy are tabulated at 5-degree intervals of temperature. 4 p.

RP1833. Purification, purity, and freezing points of *n*-decane, 4 alkylcyclopentanes, 9 alkylcyclohexanes, 2 monoolefins, 1, 2-butadiene, and 2-butyne of the API-Standard and API-NBS series. Anton J. Streiff, Evelyn T. Murphy, Janice C. Zimmerman, Laurel F. Soule, Vincent A. Sedlak, Charles B. Willingham, and Frederick D. Rossini

This report describes the purification and determination of freezing points and purity of 18 hydrocarbons of the API-Standard and API-NBS series, including one paraffin, four alkylcyclopentanes, nine alkylcyclohexanes, two monoolefins, one diolefin, and one acetylene. 29 p.

RP1834. Electrodeposition of tungsten alloys containing iron, nickel and cobalt.....Abner Brenner, Polly Burkhead, and Emma Seegmiller

Methods of electrodepositing tungsten alloys with metals of the iron group have been developed. Some of the properties of the alloys have been determined and indicate that the alloys may be of commercial value. The plating solutions consist essentially of the appropriate metal salts, together with salts of certain hydroxy-organic acids in ammoniacal solutions at a pH of about 8.5. The deposits are smooth, strong, and brittle. The nickel and cobalt alloys become ductile on heating. As plated, the nickel and cobalt alloys have a hardness of 350 to 700 Vickers, and the iron alloy, 700 to 900 Vickers. The alloys undergo precipitation hardening and the cobalt-tungsten alloys retain their hardness when hot. 33 p.

RP1835. Deposition of nickel and cobalt by chemical reduction
Abner Brenner and Grace Riddell

A process has been developed for depositing nickel and cobalt from hot solutions of hypophosphite without the use of current. The reduction of metal occurs only on certain catalytic metal surfaces. By specific pretreatments, the adhesion of the deposits can be improved and by other pretreatments, the reduction can be induced on noncatalytic surfaces. The reduction can be inhibited completely by the presence of certain ions in the plating solution or by the catalytic metal surface becoming inactive. The possible mechanism of the reaction and the factors affecting the rate of deposition are discussed. The deposits produced by this process are sound, hard, and of good quality. 11 p.

RP1836. Calculations on countercurrent electromigration
G. Breit and F. L. Friedman

The mathematical problems presented by the countercurrent electrolysis method for isotope separation are treated under the simplified assumptions described in the text as (a), (b), (c), (d), (e), and (f) in section II, 2, of this paper. The solutions are worked out in section II, 3, for a tube of finite length. The formulas are put into numerical form in equations 9e, 9f, etc. Simpler formulas are obtained in section II, 4, in the approximation of tubes of infinite length. Some of the results are presented in the form of graphs that are described in section III. The orders of magnitude of effects to be expected are discussed in section IV. 13 p.

RP1837. Activity coefficients in aqueous mixtures of phosphates with sodium chloride, sodium bromide, and sodium iodide, and the pH of phosphate buffer solutions..........................Roger G. Bates

The electromotive force of cells with hydrogen electrodes and silver-silver bromide or silver-silver iodide electrodes was measured at 25° C. The electrolyte in each cell consisted of an aqueous mixture of (a) potassium dihydrogen phosphate, (b) disodium hydrogen phosphate, and (c) sodium bromide or sodium iodide. The molalities of (a) and (b) were always equal, whereas the ratio of the molality of (c) to that of (a) or (b) was 1, 0.5, or 0.2. The ionic strengths ranged from 0.04 to 0.25. The data are compared with similar measurements for phosphate-chloride mixtures reported in an earlier paper. At a given ionic strength, the activity-coefficient term, $f_{H_2PO_4}f_X/f_{HPO_4}$ where X represents halide, increases when bromide at a given concentration is substituted for chloride at the same concentration, or when iodide replaces bromide. Accurate values for the pH of phosphate buffer solutions with and without added salt can be obtained only at low ionic strengths. 7 p.

RP1838. Thermal expansion of some copper alloys............Peter Hidnert and Harrison S. Krider

This paper gives the result of an investigation on the linear thermal expansion of some brasses, bronzes, and other copper alloys for various temperature ranges between room temperature and 300° C.

The coefficients of expansion of tellurium copper (0.6% of tellurium) are in close agreement with the coefficients of expansion of electrolytic copper (99.97%). The addition of 10 percent of aluminum, 2 percent of iron, and 0.4 percent of tellurium to copper had slight effect on the coefficients of expansion.

Figures 1 and 2 of the paper summarize the coefficients of expansion of copper-zinc alloys and copper-nickel alloys with and without addition of other elements, from the present and previous investigations. The curve for copper-zinc alloys shows that the coefficients of expansion increase with increase in the zinc content. A change in the slope of this curve due to a change from alpha brasses to beta brasses was noted. The addition of 10 to 18 percent of nickel to copper-zinc alloys reduced the coefficients of expansion to a marked extent, but the addition of tin, lead, or aluminum increased the coefficients of expansion.

The curves for copper-nickel alloys in figure 2 indicate that the coefficients of expansion decrease with increase in the nickel content. The curvilinear relation between the coefficients of expansion and nickel content (atomic percent) of copper-nickel alloys is typical of relations for properties of binary alloys having structures composed of solid solutions. 6 p.

RP1839. Alkylbenzenes in the C_9 fraction from seven representative crude petroleums.........Alphonse F. Forziati and Frederick D. Rossini

This report presents the results of an analysis, by analytical distillation by the A. P. I. Research Project 6, and by spectrographic examination by the Socony-Vacuum Laboratories, the Standard Oil Development Co., and the Sun Oil Co. of the individual C_9 alkylbenzenes (except 1,2,3-trimethylbenzene) and of tertbutylbenzene occurring in the C_9 fraction from the following seven representative crudes: (A) Ponca, Okla.; (B) East Texas; (C) Bradford, Pa.; (D) Greendale-Kawkawlin, Mich.; (E) Winkler, Tex.; (F) Midway, Calif.; (G) Conroe, Tex. 9 p.

RP1840. Experimental study of the Koppers-Hinckley-Podbielniak apparatus and method for the determination of conjugated dienes
Martin Shepherd, Richard Thomas, Shuford Schuhmann, and Vernon Diebeler

There is reported an experimental study of the accuracy, reproducibility, and general operating characteristics of the Koppers-Hinckley-Podbielniak apparatus and Analytical Method L. M. 2.1.1.7 (or 2.1.1.9) of the Office of Rubber Reserve for the determination of conjugated dienes in hydrocarbon mixtures. Physical equilibria and physico-chemical behavior of the analytical system are discussed, accuracy and reproducibility are evaluated, and certain operating precautions are given. 17 p.

RP1841. Measurements of heat of vaporization and heat capacity of a number of hydrocarbons.........Nathan S. Osborne and Defoe C. Ginnings

Using a new calorimeter, accurate measurements have been made of the heat capacities of twelve hydrocarbons in the range 5° to 45° C, and of the heats of vaporization of fifty-nine hydrocarbons at 25° C. These hydrocarbons, having from 5 to 10 carbon atoms per molecule, include 35 paraffins, 3 alkylcyclopentanes, 10 alkylcyclohexanes, and 11 alkylbenzenes. 25 p.

RP1842. Sorption of nitrogen and water vapor on textile fibers
John W. Rowen and R. L. Blaine

Measurements were made of the adsorption of nitrogen and water vapor on six purified textile fibers and titanium dioxide. It was found that all of the fibers had a relatively low capacity for the adsorption of nitrogen as compared with the capacity for the adsorption of water vapor. The surface area values ranged from 0.31 square meter per gram for nylon to 0.98 square meter per gram for viscose rayon. The values of the free surface energies of adsorption as calculated by the Gibbs adsorption equation were the same for wool, cotton, silk, and rayon fibers but differed for the two synthetic polymers, nylon and acetate rayon. 8 p.

RP1843. Sieve test of metal powders........................Rolla E. Pollard

Reproducible results were obtained in sieve tests of sponge iron, electrolytic iron, electrolytic copper, and nickel when certain variables affecting the sieving characteristics of the powders were eliminated or controlled. One of these was a cumulative sampling error resulting from repeated riffle cutting of limited powder supplies. Another was the effect of exposure of the powder to humid atmospheres. The effects of both variables were demonstrated in tests with sponge iron. Variations of considerable magnitude were observed when either variable was uncontrolled.

Significant variations also were noted when the same powders were sieved with different sets of certified sieves. These differences were reduced considerably in magnitude when comparisons were made on the basis of the size of the average opening as determined during the certification tests instead of the nominal sieve opening.

Development of more effective methods for controlling these variables or evaluating their effects would improve the reproducibility of sieve tests. 19 p.

RP1844. Table and Mollier chart of the thermodynamic properties of 1, 3-butadiene........................Cyril H. Meyers, Carl S. Cragoe, and Eugene F. Mueller

This paper contains a working table and Mollier chart of the thermodynamic properties of 1, 3-butadiene in engineering units, for which the data were calculated from a set of empirical equations. These equations have been published elsewhere and shown to be consistent with exact thermodynamic relations and to represent the observed data within the limits of the experimental accuracy. The table covers the properties of the saturated fluid over the temperature range extending from the triple point (—164.05 °F) to within 20 degrees of the critical temperature (305.6 °F). Examples are solved to illustrate the use of the table and Mollier chart (log P versus H). Several other charts are also presented. 16 p.

RP1845. Heats, equilibrium constants, and free energies of formation of the alkylcyclopentanes and alkylcyclohexanes......John E. Kilpatrick, Helene G. Werner, Charles W. Beckett, Kenneth S. Pitzer, and Frederick D. Rossini

For cyclopentane, cyclohexane, the seven dimethylcyclohexanes, and the normal alkylcyclopentanes and alkylcyclohexanes, values are presented for the following thermodynamic properties to 1,000° or 1,500°K: The heat of formation from the elements; the free energy of formation from the elements; and the logarithm of the equilibrium constant of formation from the elements. For cyclopentane, cyclohexane, and the normal alkylcyclopentanes and alkylcyclohexanes, values are also given to 1,500°K, for the following properties: The heat-content function; the free-energy function; the entropy; the heat content; and the heat capacity.

Equilibrium constants and concentrations are given in tabular and graphical form for some reactions of isomerization, hydrogenation, and cyclization. 21 p.

RP1846. Factors affecting operation of apparatus for counting alpha particles in an ion counting chamber.............................F. J. Davis

The resolving times of two amplifier circuits for the counting of alpha particles in a cylindrical ion chamber is discussed. The original circuit, using a floating grid on the first stage of the amplifier, gave a resolving time of 2.5×10^{-3} second. An improved circuit using a 1-megohm grid resistor on the first stage lowered the resolving time to 1.4×10^{-4} second.

The effect on the counting rate of the presence of small amounts of CO, CO_2, H_2O and HCl in the ion chamber was found to be negligible. The presence of 1 percent of air, however, reduces the counting efficiency by 20 percent.

A method whereby the collection time of radon in radium solutions may be of the order of ½ hour is given. Experiments show that boiling and bubbling nitrogen through 200 ml radium solutions for 17 minutes removes 99.99 percent of the radon. The absorption of radon by small neoprene meteorlogical baloons was found to be approximately (0.03%/min)/100 cm². 5 p.

RP1847. A statistical analysis of some mechanical properties of manila rope
Sanford B. Newman and J. H. Curtiss

Breaking strength, weight, and circumference are three important qualities that are determined when fiber ropes are submitted for test.

These properties are all subject to some variation because of differences in fiber quality, method of fabrication, and previous treatment. The results of tests on more than 800 samples of 3-strand manila ropes ranging in size from $3/16$ in. to 3 in. in diameter are tabulated and analyzed by the methods of modern mathematical statistics. Considerable emphasis is placed on the rationale and details of the methods of analysis, as they are considered to be applicable to a broad variety of similar projects. 9 p.

RP1848. Voltage anomalies of the glass electrode and the chemical durability of the glass..............Donald Hubbard and Gerald F. Rynders

Additional work has been done on the correspondence between voltage departures (errors) of electrodes prepared from Corning 015 glass and the change in the chemical durability of the glass. The results confirm and extend the earlier findings that voltage departures of the electrode are accompanied by durability changes of the glass. The pronounced voltage departures in the alkaline region and in hydrofluoric acid solutions are accompanied by conspicuous attack of the glass. Dilute solutions of acids that do not form soluble compounds of silica cause swelling of the glass. This swelling is repressed as the concentration of the solutions is increased. As is to be expected from the distribution law and Donnan membrane considerations, this repression of swelling was also brought about by high concentrations of organic acids and salts as well as by the so-called "strong" acids. The attack of Corning 015 glass by alkaline solutions of different ions was found to be in the other, $Na^+ > Li^+ > K^+ > Ba^{++} > NH_4^+$, which is the same order dictated for these ions by the voltage departure data. 10p.

RP1849. Instability of simply supported square plate with reinforced circular hole in edge compression..........Samuel Levy, Ruth M. Woolley, and Wilhelmina D. Kroll

A method is presented for computing the compressive buckling load of a simply supported elastic rectangular plate having a central circular hole reinforced by a circular doubler plate. Numerical results are presented for six square plates having hole diameters up to one-half of the plate length. Comparison of these results with those computed for plates without holes shows that an unreinforced circular hole causes a relatively small reduction in buckling load, and reinforcement of a circular hole by a doubler plate causes a substantial increase in buckling load. 7 p.

TITLE PAGE AND CONTENTS FOR VOLUME 39. 6 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 40, JANUARY—JUNE, 1948

RP1850. Vulcanization of synthetic rubbers by the Peachey process
Norman Bekkedahl, Fred A. Quinn, Jr., and Elmer W. Zimmerman

The Peachey process, which vulcanizes natural rubber by subjecting it alternately to sulfur dioxide and hydrogen sulfide gases, has been found to vulcanize the more common synthetic rubbers. The polymers studied were natural rubber, GR–S, GR–M, GR–I, GR–A, Hycar OR–15, Hycar OR–25, Hycar OS–10, Hycar OS–20, and Hycar OS–30. Good cures were obtained with all of the polymers except GR–M. None of the synthetic rubbers cured any faster than natural rubber. The nitrile and the styrene copolymers of butadiene cured at about the same rate or somewhat slower. GR–I required roughly 50 times as long as natural rubber for an equivalent cure, and GR–M required even longer. 7 p.

RP1851. Measurement of ozone over the Organ Mountains, New Mexico
Ralph Stair

This paper gives data on the total amount of ozone above the Organ Mountains at White Sands Proving Grounds in New Mexico from June 29, to July 4, 1947, as determined from ultraviolet measurements by a phototube and filter method. The measurements indicate ozone in the stratosphere in amount equivalent to a layer of about 0.21 cm thickness at normal temperature and pressure, which is in good agreement with determinations by others for the same latitude and season of the year.

The total ozone value and the solar-energy curve in the region of short ultraviolet wavelengths outside the earth's atmosphere check closely with previous work with the same instruments at Mount Evans, Colo., in 1936 and 1938. 11 p.

RP1852. Note on volume effect in coiling molecules............Robert Simha

An estimate of the magnitude of the interference effect in a coil-like molecule is made by calculating the nearest neighbor density w around a given link as a function of the total number of contributing chain units. It is shown for instance, that in a chain consisting of several hundred units, the first 15 contribute about 75 percent of the total nearest neighbor density at distances below the length of a link. The plots presented indicate that after about the first 20 links, the rate of increase of nearest neighbor density begins to flatten off. It is also possible to derive the modification of the distribution function of chain-ends in real chains for a given form of w. 3 p.

RP1853. Dissociation of SF_6, CF_4, and SiF_4 by electron impact
Vernon H. Dibeler and Fred L. Mohler

The dissociation by electron impact of SF_6, CF_4, and SiF_4 has been studied with a consolidated mass spectrometer. Data are also given on the appearance potentials of various ions in the mass spectra and measurements on the isotope abundance of sulfur, carbon, and silicon. The observed appearance potentials of the F^+ ion in SF_6 and CF_4 and the C^+ ion in CF_4 were found to be lower than the calculated value assuming formation of a positive atom ion and a free electron, but nearly equal to the calculated value assuming the formation of a positive atom ion and a negative fluorine ion. The large relative abundance of the SF_4^{++} ion in SF_6 and the CF_2^{++}ion in CF_4 is taken to indicate the formation of these ions by removal of two F^- ions in the former and possibly an F^- ion and a free electron in the latter case. 5 p.

RP1854. Physical properties of electrodeposited chromium....Abner Brenner,
Polly Burkhead, and Charles Jennings

The following properties of chromium, deposited under a wide variety of plating conditions, have been measured; density, hardness, tensile strength, Young's modulus of elasticity, ductility, electrical resistivity, and stress in the deposit. The oxygen and hydrogen content were determined. The effect of heat treatments up to 1,200° C on certain of these properties has been determined, and some work has been done on the properties of chromium-iron alloys deposited from modified chromic acid solutions. A relation between the hydrogen and oxygen content of the deposits has been shown to exist, and the effect of the oxygen content on the physical properties has been studied. 29 p.

RP1855. Surface tension of compositions in the systems $PbO-B_2O_3$ and $PbO-SiO_2$........Leo Shartsis, Sam Spinner, and Alden W. Smock

The surface tension of a series of compositions ranging from 0 to 100 percent of PbO in the system $PbO-B_2O_3$ and of compositions ranging from 0 to 35 percent of SiO_2 in the system $PbO-SiO_2$ was measured by a modification of the anchor ring method. The volatility and changes in composition of members of each system upon heating were found to be related to the surface tension and its change with composition. Some correlation between the temperature coefficient of surface tension and expansivity was noted. 6 p.

RP1856. Expansion effects shown by some pyrex glasses......Arthur Q. Tool
and James B. Saunders

Thermal expansion data are presented, which apparently confirm a previously expressed belief that some of the borosilicate glasses containing a high percentage of silica are essentially two-component glasses. One of these components is presumably composed almost entirely of silica and forms into a comparatively rigid and continuous spatial network that pervades the whole glass. This formation develops before the glass is cooled into the annealing range of the other component that is composed of a portion of the silica and most of the other constituents. On being cooled into its annealing range and particularly on reaching temperatures below this range, the low-temperature component also forms a fairly rigid network that is interlaced with that of the high-temperature component. The latter, being composed mainly of silica, possesses a considerably lower expansivity than the other. Consequently, the low-temperature component, whenever it behaves as a rigid network, elastically compresses the other component on cooling and is, in turn, elastically distended. Annealing the glass at suitable temperatures relaxes the compressions and distensions. Such relaxations cause expansions and contractions that are unlike those found in a normal single-component glass. As a result, thermal expansion cycles obtained on glasses containing a high percentage of silica show certain peculiarities. Several cases in which these peculiarities appear are presented and discussed. 17 p.

RP1857. Cavity pressure method for measuring the gain of hearing aids
E. L. R. Corliss and G. S. Cook

A cavity pressure method for measuring the gain of hearing aids has been developed. It has the advantage of requiring no "dead" room, allowing a compact setup. The method has been investigated as to its validity and the degree to which diffraction effects are avoided. Comparisons with free-field data are made. The applicability of results obtained by this method to the specification of gain characteristics for hearing aids is discussed. 7 p.

RP1858. Lenses of extremely wide angle for airplane mapping
Irvine C. Gardner and Francis E. Washer

If the illumination of the image produced by a wide angle lens covering a field of 120 degrees follows the cosine-fourth-power law, the illumination at the edge of the field will be one-sixteenth that at the center in the absence of vignetting. By introducing negative distortion, the illumination may be expected to be more uniform from the center to the edge of the field. In particular, if there is no vignetting, and if the diaphragm precedes the lens, there will be uniform illumination, even for a field as great as 180 degrees, if the distortion is such that $r'=f \sin \beta$, where r' is the distance from center of the field to a given image point, β is the corresponding angular distance from the axis in the object space, and f is the focal length corresponding to the part of the image in the neighborhood of the axis.

During the war Zeiss developed a mapping lens with a large amount of negative distortion and a second rectifying system by which undistorted copies could be obtained from the distorted negative made with the camera lens. A German mapping lens and a rectifying unit have been brought to this country, and detailed results of tests made at the National Bureau of Standards are given in this paper. The lens, termed the Pleon, covers a field of 130 degrees, and the distortion closely follows the law $r'=f \beta$, the distortion being somewhat less than that of the preceding formula. Measurements of the resolving power, of the effective size of the entrance pupil for different angular distances from the axis, and of the net distortion of the two systems are reported. In a final print there is significant residual distortion resulting from the failure of the distortions of the two systems to exactly annul each other. 11 p.

RP1859. Effect of annealing and other heat treatments on the pH response of the glass electrode........Donald Hubbard and Gerald F. Rynders

The effect of annealing and other heat treatments on the pH response of electrodes prepared from Corning 015 glass has been studied and a comparison made with the accompanying changes in hygroscopicity of the glass. New, unleached electrodes continued to give the correct pH response after being annealed near the critical temperature as indicated by the expansion curve for Corning 015 glass. Electrodes that were leached in 0.1 *N* HCl at 80° C lost much of their pH function when given identical heat treatments. The pH response of a typical glass electrode, held 10 minutes at 500° C after being leached in 0.1 *N* HCl for 6 hours at 80° C, was reduced from 59 millivolts per pH (the theoretical value at 25° C) to 22 millivolts per pH. A few seconds in hydrofluoric acid solution restored the pH function of these "dead" electrodes, showing that the inhibiting effect was confined to the outer surface of the electrode bulbs. Evidence obtained by the interferometer indicated that the thickness of this inhibiting layer was less than 5.8×10^{-6} centimeter. Hygroscopicity determinations made on leached samples of the powdered glass showed that the "sorption" power was greatly reduced by heat treatment, whereas for unleached specimens this property was much less affected. From the evidence obtained it seems reasonable to interpret the loss in pH function shown by glass electrodes on heat treatment as being due to the formation of a thin nonhygroscopic silica-rich layer. The resulting electrodes behaved in a manner similar to electrodes prepared from glasses of low hygroscopicity. 8 p.

RP1860. Infrared radiation from a Bunsen flame............Earle K. Plyler

The infrared emission spectrum of the flame of a Bunsen burner has been measured with prisms of LiF, NaCl, and KBr. In the region of 2.7 μ, the emission band has been resolved into two bands, 2.5 and 2.7 μ, and a series of 15 lines from 2.8 to 3.1 μ. These emission lines are separated by about 22 cm^{-1} and fall in the spectral region where the rotational-vibrational band of OH should occur. The spacing between lines, however, is too small for the changes in the energy levels of the OH molecule. This separation agrees very well with the calculated value for certain rotational states of the H_2O molecule. The long wavelength band at 15 μ has been observed in both CO burned in the air and the Bunsen burner flame. The present detection of this band represents the first confirmation of the original observations of Rubens and Aschkinass. Several bands have been observed with a grating instrument, and their frequencies check well with known energy transitions. The region from 12 to 24 μ has been measured with a KBr prism for the Bunsen flame. It contains a large number of the pure rotational lines of water vapor. In addition to the H_2O lines, there are two strong bands, 14 and 15 μ, which are produced by CO_2. 8 p.

RP1861. Perforated cover plates for steel columns; compressive properties of plates having ovaloid, elliptical, and "square" perforations
Ambrose H. Stang and Bernard S. Jaffe

Tests were made to determine the mechanical properties of perforated cover plates intended to be used as a substitute for lattice bars or batten plates in built-up box-type columns. These tests supplement and extend the range of perforation shapes beyond that described in preceding reports.

This paper gives the results for seven plates having perforations of ovaloid shape, six with the long axis parallel to the load, and one with the short axis parallel to the load; three plates having elliptical perforations with the major axis parallel to the load; two plates having square perforations with rounded corners for one of which the load was parallel to the side of the square, and for the other of which the load was parallel to a diagonal. A column having a solid plate was also tested for comparison with the columns having perforated plates.

Tests were made to determine the stiffness of the perforated plate columns relative to that of the column having a solid plate, the distribution of stress on the edge of the perforation, and the strength of each column. 8 p.

RP1862. Behavior of certain sugars and sugar alcohols in the presence of tetraborates—correlation of optical rotation and compound formation......Horace S. Isbell, Joseph F. Brewster, Nancy B. Holt, and Harriet L. Frush

In the present investigation, the changes in the equilibrium specific rotation caused by the addition of either sodium or potassium tetraborate to solutions of D-glucose, D-fructose, L-sorbose, sucrose, mannitol, and sorbitol have been observed and the results interpreted. Measurements have been made for various concentrations of carbohydrates with fixed concentrations of borate, and for various concentrations of borate with fixed concentrations of carbohydrate. It was thus possible to observe independently the effect of variation in the concentration of either carbohydrate or borate. The results indicate that glucose, fructose, sorbose, and sorbitol form three borate compounds, that mannitol forms two, and sucrose one. The optical rotations of the compounds have been estimated, and the composition of the solutions discussed. Extensive tables have been included, giving the optical rotations of the above-mentioned carbohydrates in the presence of sodium and potassium tetraborate. 21 p.

RP1863. Effect of inhibitors on the corrosion of zinc in dry-cell electrolytes
Clarence K. Morehouse, Walter J. Hamer, and George W. Vinal

This paper deals with a study of substitutes for mercury and chromate films in curtailing the corrosion of the zinc anode of Leclanché dry cells at high temperatures. Organic compounds containing the carbonyl group (such as furfural), heterocyclic nitrogen-containing compounds like quinaldine, and certain commercial products were found to be effective in retarding the corrosion of zinc in dry-cell electrolytes.

Although these types of materials retarded the corrosion of zinc, dry cells made with them did not have the expected increase in shelf-like or electrical output. The inhibitors either reacted with the paste wall to decrease its strength, or formed an insoluble film over the entire surface of the zinc anode that contributed to its internal resistance. No parallelism was observed between the electrican output of the cells and the percentage of inhibitor used in their construction. On the other hand, the paste wall of the dry cell, which is usually a starch-flour gel, was found to have inhibiting properties. Starch was inert, but flour had inhibiting properties. The active inhibiting agent of the flour is gluten. The constituents of gluten, namely, glutenin, and gliadin and mesonin in different states of aggregation were isolated, and the last two were found to be effective in retarding the corrosion of zinc. These materials can be incorporated in dry cells and increase their capacity at moderate temperatures. 11 p.

RP1864. Thermodynamic functions for molecular oxygen in the ideal gas state..Harold W. Woolley

The thermodynamic functions for molecular oxygen in the ideal gas state have been calculated using recent values of physical and spectroscopic constants. Values of C_p°, $H^\circ—E_0^\circ$ $—(F^\circ—E_0^\circ)/T$, and S° are given, directly calculated or interpolated, for every twenty degrees up to 700°K and for every hundred degrees up to 5,000°K. 6 p.

RP1865. Measurement of water in gases by electrical conduction in a film of hygroscopic material and the use of pressure changes in calibration........................Elmer R. Weaver and Ralph Riley

The electrical conductivity of a thin film of such material as phosphoric acid changes over a wide range with changes in the concentration of water in the atmosphere with which it is in contact. By adjusting the pressures of a sample of gas of known and one of unknown composition, they can be made to have the same concentration of water, shown by the production of equal resistances of the detecting film. Apparatus and procedures for making such adjustments and calculating analyses are given in detail, and numerous applications are described. The method has the merits of simplicity, speed, and great sensitivity. Only small samples are needed, and few substances interfere. 46 p.

RP1866. Electric quadrupole coupling of the nuclear spin with the rotation of a polar diatomic molecule in an external electric field...U. Fano

Formulas are given that serve to determine the hyperfine spectrum of a rotating molecule in various cases, depending on the external field strength and on the rotational quantum number. A complete calculation is carried out for a case in which only one of the nuclei has a quadrupole moment, the molecule is in a rotational state ($1:\pm1$ or 0), and the interaction between the field and the molecular dipole is comparable to that between the dipole and the nuclear spin. 9 p.

RP1867. Preliminary study on portions of the systems Na_2O-CaO-Al_2O_3-Fe_2O_3 and Na_2O-CaO-Fe_2O_3-SiO_2......................William R. Eubank
and Robert H. Bogue

Portions of the quaternary system Na_2O-CaO-Al_2O_3-Fe_2O_3 have been studied by the exploration of (1), the plane CaO-$4CaO.Al_2O_3.Fe_2O_3$-$(Na_2O+3Al_2O_3)$ and (2), planes above the base system CaO-$5CaO.3Al_2O_3$-$2CaO.FE_2O_3$ containing successively increasing amounts of Na_2O up to 6 percent. A portion of the quarternary system Na_2O-CaO-Fe_2O_3-SiO_2 has been studied by the exploration of a plane containing 5 percent of Na_2O above the base system CaO-$2CaO.SiO_2$-$CaO.Fe_2O_3$.

In the pseudo system CaO-$4CaO.Al_2O_3.Fe_2O_3$-$(Na_2O+3Al_2O_3)$, the compound $Na_2O.8CaO.3Al_2O_3$ was found to exist as a primary phase, and the area in which the plane cuts the $Na_2O.8CaO.3Al_2O_3$ primary-phase volume was established. Three points on univariant curves were located. The iron phase ($4CaO.Al_2O_3.Fe_2O_3$ solid solution) was observed to exist in a solid-solution series.

In the system Na_2O-CaO-$5CaO.3Al_2O_3$-$2CaO.Fe_2O_3$, it was found that the compound $Na_2O.8CaO.3Al_2O_3$ appears at an Na_2O concentration of about 4.2 percent. However, because soda is taken into solid solution by other phases, it was not feasible at this time to determine the invariant point for $Na_2O.8CaO.3Al_2O_3$, $3CaO.Al_2O_3$, $5CaO.3Al_2O_3$, and $4CaO.Al_2O_3.Fe_2O_3$ solid solution.

In the system Na_2O-CaO-$2CaO.SiO_2$-$CaO.Fe_2O_3$, no ternary compounds were observed up to the 5-percent limit of Na_2O employed. A soda-containing phase was found to occur in solid solutions with α $2CaO.SiO_2$, which may precipitate on cooling, forming inclusions in the β $2CaO.SiO_2$, or enter into reaction with the glassy phase. 10 p.

RP1868. Theory and design of a cavity attenuator.............J. J. Freeman

The fields generated by an arbitrary current distribution exciting a piston-type or cavity attenuator are developed, and symmetric distributions exciting maximum amplitudes of the dominant mode and minimum amplitudes of unwanted modes are investigated. The relative error in voltage measurement due to spurious modes is computed as a function of spacing between exciting and receiving coils for certain simple current distributions. The relative merits of circular and rectangular attenuator cross sections are discussed. 9 p.

RP1869. Theory of Wagner ground balance for alternating-current bridges
Richard K. Cook

A method is described for getting the Wagner ground balance of an alternating-current bridge when used with any three-terminal source. The basic idea is to insert impedances between the two ungrounded terminals of the source, and the corresponding terminals of the Wagner ground arm and the bridge, so as to "balance" approximately the currents from the source. The method is applicable to high-voltage type Schering bridges. Such a bridge, incorporating the principles of the new method for securing the Wagner ground balance, has been designed and built principally for measurement of the small capacitances, about 50 $\mu\mu$f, of some types of condenser microphones. 5 p.

RP1870. Correlations of the gel strength of paste walls and the shelf life of electric dry cells..................................Walter J. Hamer

Paste walls of most dry cells consist of starch-flour gels. Their characteristics were studied by means of gel-strength measurements and correlated with the shelf life of dry cells. Interactions were observed between the paste wall and the dry-cell electrolyte and the depolarizing mix of manganese dioxide. Attempts were made to eliminate or retard these reactions. These included the use of addition agents, of different varieties of starches and flours, of modified starches, and of fractions of natural starch and natural flour. Only the flour fractions, gliadin and mesonin, in different states of polymerization were found to give an increase in the electrical output of dry cells. No significant differences were found in the electrical output of dry cells made with different starches, and the use of modified starches and starch fractions decreased the electrical output of dry cells. The beneficial effects of the flour fractions were attributed to their action in curtailing the local action at the zinc anodes of dry cells. 12 p.

RP1871. Determination of sulfur in bone char................Victor R. Dietz,
Helen R. Higginson, and Cola Parker

In sugar technology the established analytical procedures were found to give erroneous results for the "sulfide" sulfur and "total" sulfur in bone char. The error was found to be caused by the presence of organic sulfur in the carbonaceous component. Solution of the total sulfur in bone char was obtained by three independent methods: (1) After oxidation with nitric and perchloric acids, (2) after air oxidation in an intimate mixture with sodium carbonate and magnesium oxide, (3) after oxidation with nitric acid in a modified Carius tube. The precipitate of barium sulfate was found to be contaminated with calcium and phosphate from the bone char. It was discovered in the present work that barium sulfate was easily and completely soluble in hot 70-percent perchloric acid, thus making possible a purification by reprecipitation. Quantitative precipitation was verified by using known mixtures of calicum chloride, phosphoric acid, and sulfuric acid. The distribution of the total sulfur between the carbonaceous residue and filtrate resulting from the conventional acid treatment of bone char was determined after digestion in three mixtures: nitric and hydrochloric acids, potassium chlorate and hydrochloric acid, and hydrochloric acid alone. It was shown that the sulfur contained in the gases evolved with hydrochloric acid (determined by combustion with air followed by gravimetric barium sulfate) was greater in most samples than that determined as sulfide-sulfur (precipitated as cadmium sulfide and determined idiometrically). The distribution of the total sulfur between filtrate, residue, and evolved gases was influenced by deliberate variations in the acid leaching process. 12 p.

RP1872. Effect of support on the performance of vane anemometers
Galen B. Schubauer and Gerald H. Adams

One of the more important factors affecting the accuracy of a measurement of air speed with a vane anemometer is the manner in which the instrument is supported. An awareness of this fact is important, because the user must devise his own support. It is shown that seemingly minor changes in the support may change the indicated speed by 5 percent, and that holding an anemometer in the hand may increase the indicated speed by as much as 17 percent. In order to insure the reliability of a speed measurement, an interference-free type of support is recommended. 6 p.

RP1873. Heat of combustion of phenyl-beta-naphthylamine (N-phenyl-2-naphthylamine)...........Donald E. Roberts and Ralph S. Jessup

The heat of combustion of purified solid phenyl-beta-naphthylamine, (*N*-phenyl-2-naphthylamine) in forming gaseous carbon dioxide, liquid water, and gaseous nitrogen, has been determined from measurements with a bomb calorimeter. The value obtained (—ΔH_c° at 25° C) is 37909.6 int j/g (1987.07 kcal/mole), with an estimated value of 8.3 int j/g (0.43 kcal/mole) for the standard deviation of the mean, obtained by making allowance for both accidental and systematic errors. 3 p.

RP1874. Calibration of X-ray measurement of strain........John A. Bennett and Herbert C. Vacher

In order to increase the precision of strain determination by X-ray methods, 12 measurements of ring radius were made on each of two patterns for the customary incidence angles of 90° and 45°. For a specimen to which uniaxial stress was applied, a method was developed for handling the data to give one value representative of these 24 readings. When these values (obtained on a flat steel specimen loaded in bending) were compared with mechanical strain measurements, it was found that the X-ray measurements were proportional to the maximum principal strain up to the beginning of plastic deformation, and the precision was such that a change corresponding to 1,000 lb/in.^{2} should be detectable. 9 p.

RP1875. Magnetic measurement of the thickness of composite copper and nickel coatings on steel.......Abner Brenner and Eugenia Kellogg

A magnetic method has been developed for measuring the thickness of composite coatings of copper and nickel, electrodeposited on steel. The method consists in measuring the attractive force between the specimen and two permanent magnets of different strengths. The total thickness of the deposit and the relative thickness of copper and nickel layers can be determined from a set of calibration curves. 5 p.

RP1876. Behavior of experimental zinc-steel couples underground Irving A. Denison and Melvin Romanoff

The behavior of zinc anodes for the protection of iron and steel cathodically was investigated in eight diverse soil environments. The experimental unit consisted of a small steel ring to which was connected from one to three zinc cylinders to provide different area ratios of zinc to steel. Corrosion of the steel cathodes was prevented over the test periods of from approximately 3 to 6 years except in one poorly conducting soil and in a very alkaline soil. Measurements of galvanic current and open- and closed-circuit potentials made on the experimental couples during the course of the test are interpreted in terms of the extent cathodic protection received. Measurements of the apparent current required for cathodic protection as indicated by current-potential curves are compared with the currents actually required to prevent corrosion. 13 p.

RP1877. Disintegration of antimony-124..Irving Feister and Leon F. Curtiss

The radiations from radio antimony of 60-day half-period SB^{124}, have been investigated in a magnetic lens electron spectrometer. The beta-ray spectrum was found to have two components with maximum energies of 0.57 ±0.02 and 2.24 ±0.05 million electron volts. The gamma-ray spectrum has two lines, one at 0.60 ±0.01 and the other at 1.69 ±0.02. million electron volts. It appears quite certain that the 0.60 Mev gamma ray originates from SB^{124}, and therefore these measurements substantiate the disintegration scheme proposed by Meyerhof and Scharff-Goldhaber [1], with a small revision of energies. 5p.

RP1878. Stabilization of austenitic stainless steel......Samuel J. Rosenberg and John H. Darr

A study was made of the resistance to intergranular attack of 23 18% Cr–10% Ni austenitic corrosion-resisting steels in 12 different initial conditions. Susceptibility to intergranular attack was determined after seven sensitizing treatments, followed by exposure for a maximum of 14 days in a boiling acidified copper sulfate solution.

It was found that maximum susceptibility to intergranular attack was developed by sensitizing either 8 or 21 days at 1,020° F. The straight carbon austenitic steels were quite vulnerable to attack, although decrease in carbon content decreased the degree of vulnerability. The columbium- and titanium-treated steels were satisfactorily resistant to attack provided the Cb/C or

Ti/C ratios were sufficiently high. These ratios varied, depending on the initial condition of the steel. The carbon content of the treated steels had no influence upon the resistance to intergranular attack, the predominating factor being the Cb/C or Ti/C ratio. 18 p.

RP1879. Measurement of the slipperiness of walkway surfaces
Percy A. Sigler, Martin N. Geib, and Thomas H. Boone

The establishment of a safety code for walkway surfaces has been materially handicapped by the lack of an adequate method of measuring slipperiness. The mechanics of walking as related to slipping and the design of testing instruments are briefly discussed. In order to test floors in actual service a portable slipperiness tester of the pendulum-impact type was designed and constructed. The design is based on the premise that, in the process of ordinary walking, slipping is most likely to occur when the walkway surface is first contacted by the edge of the heel. The instrument and test procedure are described. The effects of varying some of the constants of the instrument, such as the angle of contact between the test heel and the walkway surface, and the pressure between the heel and the walkway, are discussed. Typical results obtained with both rubber and leather test heels and under both dry and wet conditions are given for various flooring and finishing materials.

In general, the traction furnished by dry rubber heels is much better than that obtained with dry leather heels. Many walkway surfaces are hazardous when wet. Good antislip properties under wet conditions are usually associated with rough particles that project through the film of water and thus prevent its action as a lubricant. 8 p.

RP1880. Perforated cover plates for steel columns: summary of compressive properties...............Ambrose H. Stang and Martin Greenspan

Eighty-eight steel perforated cover plate columns have been tested in the elastic range. The experimental axial rigidity under compressive load of the uniformally perforated lengths has been compared with theoretical values. The agreement in general was very good.

The distribution of stress on the edge of the perforation of these columns was also measured. The maximum values of stress concentraton found experimentally have been compared with theoretical values obtained for a single hole in a large plate. These experimental values also in general agreed with the theoretical values.

The values of the average stress on the net area for the compressive tests to destruction of 28 perforated plate columns were in nearly all cases greater than the maximum stress at failure for columns of the same size having solid plates. 13 p.

RP1881. Changes in the indices of refraction and liquidus of a barium crown glass produced by the partial substitution of some oxides
Edgar H. Hamilton, Oscar H. Grauer, Zeno Zabawsky, and C. H. Hahner

Optical glasses with high indices of refraction and Abbe values are very desirable for wide-angle lenses. In order to determine the range of compositions in which glasses of this type could be produced, oxides of Li, Be, Ca, B, La, or Th, were substituted for BaO or SiO_2 in a three- or four-component base glass. Substitutions were made on a mole-for-mole basis. The indices of refraction for the C, D, F, and G' lines and the liquidus were determined for each glass. Experimental glasses with indices of refraction (n_D) and Abbe values from 1.600 to 1.714 and 62.2 to 52.7, respectively, were made in small platinum crucibles. 14 p.

RP1882. Influence of low temperatures on the mechanical properties of 18:8 chromium-nickel steel.............D. J. McAdam, Jr., G. W. Geil, and Frances Jane Cromwell

By means of tension tests of notched and unnotched specimens, an investigation has been made of the mechanical properties of various 18:8 chromium-nickel steels between room temperature and —188° C. One of the steels was ferritic; the others were of the metastable austenitic type. Plastic deformation of the metastable austenitic alloys causes a phase change and thus hardens the alloy. The rapidity of this change increases with decrease in temperature. At low temperatures the hardening due to the phase change is so rapid that the load-extension curve sometimes has two maxima. For this reason six important strength indices sometimes are required to evaluate the mechanical properties. 18 p.

RP1883. Absorption of X-rays in air. . Frank H. Day and Lauriston S. Taylor

Studies have been undertaken to determine the absorption in air of X-rays produced by voltages from 10 to 200 kv (constant potential) for various initial filtrations. A free-air ionization chamber on tracks is used to obtain absorption data over a 150-cm distance. No appreciable change in quality of X-rays is observed in this distance because of the air absorption. Hence, for short distances, effective air absorption coefficients for heterogeneous X-rays of various qualities have been determined. 7 p.

RP1884. Location of the galvanometer branch for maximum sensitivity of the Wheatstone bridge.......................... F. Ralph Kotter

The battery and galvanometer connections to a Wheatstone bridge may be interchanged without altering the condition for balance. One of the combinations will give a higher sensitivity than the other, but the calculation of the better arrangement is often somewhat tedious. This paper presents a "rule-of-thumb" method of determining the better arrangement, which requires only a knowledge of the resistance of the bridge arms and the value of the external critical damping resistance of the galvanometer. 4 p.

RP1885. Second dissociation constant of oxalic acid from 0° to 50° C, and the pH of certain oxalate buffer solutions...... Gladys D. Pinching and Roger G. Bates

The second dissociation constant of oxalic acid was determined at intervals of 5 degrees from 0° to 50° C by measurement of the electromotive force of cells without liquid junction. Hydrogen and silver-silver-chloride electrodes were employed. The solutions were composed of potassium binoxalate. sodium oxalate. and sodium chloride. The value of the second dissociation constant, K_2, in the temperature range studied is given by the equation

$$-\log K_2=\frac{1423.8}{T}-6.5007+0.020095T,$$

where T is the absolute temperature. The thermodynamic quantities associated with the second dissociation step were calculated. The paH values of 8 solutions of potassium binoxalate and sodium oxalate in the ratio 1:5 were determined at 11 temperatures. 12 p.

RP1886. Pyrolytic fractionation of polystyrene in a high vacuum and mass spectrometer analysis of some of the fractions
Samuel L. Madorsky and Sidney Straus

Samples of polystyrene of an average molecular weight of about 230,000 and weighing 25 to 50 mg, were pyrolyzed in a vacuum of 10^{-6} mm of mercury at 350° to 420° C. Time of pyrolysis varied from 0.5 to 4 hours. The following fractions were obtained: (1) A solid residue having an average molecular weight of 2.182, (2) a wax-like fraction consisting of a mixture of a dimer, trimer, and tetramer of styrene, with an average molecular weight of 264, (3) a liquid fraction consisting of 94.3 mole percent of styrene, 5.6 mole percent of toluene, and traces of ethyl benzene and methyl styrene, (4) a gaseous fraction consisting mainly of carbon monoxide. Composition of all fractions and relative amounts of the wax-like and liquid fractions were found to be independent of time and temperature of pyrolysis, or of the amount of the original sample of polystyrene. A maximum yield of styrene, amounting to 42 weight percent of the original sample of polystyrene, was obtained at 420° C. The fact that only small fragments, not larger than the tetramer, were volatilized, leads to the conclusion that the larger fragments remain entangled in the mass of macromolecules and break up into smaller fragments, which then volatilize. 9 p.

RP1887. Resin bonding and strength development in offset papers
Charles G. Weber, Merle B. Shaw, Martin J. O'Leary,
and Joshua K. Missimer

A series of experimental offset papers was made in which the strength and resistance to surface pick were developed mainly by bonding the fibers with a synthetic resin instead of by the conventional beating. The papers were made from three widely different furnishes of commercial wood pulps, and the principal bonding agent was melamine-formaldehyde resin. In all instances, the resin-bonded papers were superior with respect to curling, oil absorption, folding endurance, and resistance to tear to gel-bonded control papers with comparable bursting strength and resistance to pick. Expansion also was improved in sulfite-soda papers. Only small amounts of resin were required to greatly improve the strength of papers composed principally of short-fibered filler pulps. 9 p.

RP1888. Metastable transitions in mass spectra of fifty-six hydrocarbons
Evelyn G. Bloom, Fred L. Mohler, Jonathan H. Lengel,
and C. Edward Wise

In the mass spectra of 56 saturated and unsaturated hydrocarbons, all the observable metastable transitions have been identified. In 362 cases, there are 32 different transitions involving loss of masses 2, 15, 16, 26, 27, 28, 29, 30, 42, and 44. The occurrence of a metastable transition depends on the intensity of both the initial ion peak and the final ion peak. 6 p.

RP1889. Determination of small amounts of oxygen in organic compounds
William W. Walton, Francis W. McCulloch, and W. Harold Smith

A method based on the Unterzaucher procedure has been developed for the determination of small amounts of oxygen in organic compounds. The method involves the pyrolysis of the sample in an atmosphere of helium, conversion of the oxygen compounds that are formed to carbon monoxide by passage of the products over pellets of carbon at a temperature of 1,120° C, and collection of the carbon monoxide in a flask of known volume. Interfering substances are removed by passage of the gas through a liquid-air or potassium-hydroxide trap before collection of the gas. The percentage of carbon monoxide in the collected gas is determined through use of the NBS colorimetric indicating gel. As little as 0.01 percent of oxygen can be determined readily. 5 p.

RP1890. Infrared emission spectra of flames..................Earle K. Plyler
and Curtis J. Humphreys

The infrared emission spectra of a hydrogen flame and of a natural gas flame have been compared in the region from 1.7μ to 24μ. Emission bands have been observed at 1.87μ, 2.78μ, 4.37μ, 6.26μ, and 15μ that are produced by molecules of H_2O and CO_2. Another band at 3.316μ is attributed to methane. From 3.0μ to 3.8μ there are a number of rotational lines, some of which may be produced by OH and others by H_2O molecules. As the temperature of the flame was increased, the rotational lines became more intense. Five lines in the region from 3.4μ to 3.8μ agree closely in position with the predicted rotational lines of the P branch of the $2\rightarrow1$ vibrational band of OH. These lines correspond to values of K equal to 11, 12, 13, 14, and 15. Wave numbers of some of the observed rotational lines were found to show a good correspondence with predicted values for K equal to 11 to 36, for lines extending from 9μ to 24μ. In addition to this series of lines, there are other lines that are produced by the rotational states of H_2O molecule. A discussion is included of the various methods of observing flame spectra. 8 p.

RP1891. Pressure-volume-temperature data for oxygen......Cyril H. Meyers

To satisfy the demand for data on oxygen at higher pressures, an equation has been developed that represents the available experimental data within the accuracy of the observed values. Values of the virial coefficients are given for densities in Amagat units in the temperature range —200° to +200° C. Values of pressure in pounds per square inch^2 are tabulated corresponding to temperatures from —50° to +150° F and densities up to 320 times the density at 70° F and 1 atmosphere. These data are also presented in a chart, with pV/RT and pressure as coordinates. 10 p.

RP1892. Reduction of sphero-chromatic aberration in catadioptric systems
Robert E. Stephens

Schmidt and Maksutov catadioptric systems suffer from sphero-chromatic aberrations that are of opposite sign. By the use of a hybrid system, whose corrector is a deep-meniscus lens with an aspheric curve on the external surface, the sphero-chromatic residuals have been reduced and, as a consequence, usuable relative apertures have been increased. 3 p.

RP1893. Some energy relations in the systems $PbO-B_2O_3$ and $PbO-SiO_2$
Leo Shartsis and Edwin S. Newman

Heats of solution of a series of glasses in the system $PbO-B_2O_3$ were measured in 2 N nitric acid with a simple vacuum-bottle calorimeter. Heats of solution of a series of glasses in the system $PbO-SiO_2$, ranging in composition from 6 to 35 percent of SiO_2, were measured in a mixture of HF and 2.5 N nitric acid with an electrically calibrated isothermal-jacket calorimeter. From these data, and heats of fusion available in the literature, calculations were made of the heats of reaction of the component oxides in either amorphous or crystalline states in forming glasses in these systems. 8 p.

RP1894. Divided flow, low-temperature humidity test apparatus
Arnold Wexler

An apparatus is described, based on the principle of divided flow, for producing air of known relative humidity at temperatures below 0° C with an average error of 3 percent. It was designed primarily for testing and calibrating at low temperature the electric-hygrometer elements used in radiosondes, although any device with a diameter less than 1⅛ in. may be inserted into the test chamber of the apparatus. It is capable of producing rapid and discrete changes in relative humidity at constant temperature, a desirable feature for studying lag characteristics. It is provided with a control for obtaining any air velocity up to 1,500 ft/min. 8 p.

RP1895. Gradual damping of solitary waves............Garbis H. Keulegan

This paper treats the problem of the damping by viscous action of translation waves. A short exposition is given of Boussinesq's boundary layer theory for wave motion, and expressions for the damping of rectangular and solitary waves are derived. Scott Russell's experimental results for solitary waves are compared with the theory, and satisfactory agreement is found to exist. This fact makes it legitimate to apply the formulas developed to correct in model tests on harbors or in other tests of a like nature for the dissipative effects that occur in shallow-water waves. 12 p.

TITLE PAGE AND CONTENTS FOR VOLUME 40. 6 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 41, JULY—DECEMBER 1948

RP1896. Dipole moments and molecular association of some picrates of primary, secondary, and tertiary amines in benzene and dioxane
Arthur A. Maryott

The dielectric constants of dilute benzene and dioxane solutions of primary, secondary, and tertiary amine salts of picric acid were measured. Dipole moments are reported for the picrates of the following amines; in benzene: tri-*iso*-amyl-(11.9), tri-*n*-butyl-(11.9), triethyl-(11.7), diethylbenzyl-(11.8), di-*n*-butyl- (11.5), di-*n*-propyl- (11.5); in dioxane: tri-*n*-butyl- (12.2), di-*n*-butyl- (12.1), *n*-octyl- (12.1), and *n*-octadecyl- (12.3). The picrates of primary and secondary amines show a pronounced tendency to associate in benzene, as evidenced by the nonlinear variation in dielectric constant with concentration, but not in dioxane. The effect of the size and shape of the alkylammonium ion and of hydrogen bonding on the association are discussed. 6 p.

RP1897. Acid-base equilibrium constant and dipole moment of tribenzylammonium picrate in benzene from measurements of dielectric constant.......................................Aruthur A. Maryott

The equilibrium constant for the dissociation of tribenzylammonium picrate into picric acid and tribenzylamine in benzene at 30° and 40° C has been determined from the variation of dielectric constant with concentration. The heat of reaction is in the neighborhod of 11.4 kilocalories per mole. The dipole moment of tribenzylammonium picrate, 12.0×10^{-18}esu, is substantially the same as found previously for the picrates of the more strongly basic alkylamines. The dipole moment of picric acid, 1.75×10^{-18}esu, was also determined. 2 p.

RP1898. Amino derivatives of mannuronic acid.............Harriet L. Frush and Horace S. Isbell

A new type of sugar derivative that may prove to be of value in synthetic processes has been prepared from mannuronic lactone by reaction with ammonia. The structure of the new substance, 1-aminomannuronamide, has been determined, and certain crystalline derivatives have been prepared. 6 p.

RP1899. Properties of barium-magnesium titanate dielectrics
George R. Shelton, Ansel S. Creamer, and Elmer N. Bunting

Dielectrics having compositions in the system $BaTiO_3$-4MgO:TiO_2-TiO_2 were matured (less than 0.1% of absorption) at 1,275° to 1,425° C. Data are given for the dielectric constant *K* at a frequency of 1 mc/s and various temperatures from —60° to +85° C, and for *Q*, the reciprocal of the power factor, at 25° C and frequencies of 50, 1,000, and 20,000 kc/s and 3,000 mc/s. Values of *K* (1 mc/s and 25° C) ranged from 12 to 1,550 and those of *Q* from 9 to 10,000. Values of *K* decreased, and those of *Q* increased for several weeks after specimens were matured, when the content of BaO was greater than 30 percent and that of TiO_2 less than 50 percent. Partial restoration of the original values of *K* and *Q* resulted from heating these specimens at various temperatures for brief periods. Linear thermal expansion (25° to 700° C) ranged from 0.46 to 0.71 percent. A few specimens of barium-strontium titanate were tested for the effects of thermal history on the properties. 10 p.

RP1900. Acid-base reactions in organic solvents. Behavior of some halogenated derivatives of phenolsulfonephthalein with different classes of organic bases in benzene........Marion Maclean Davis, Priscilla J. Schuhmann, and Mary Ellen Lovelace

This paper, the second in a series concerning the use of indicator dyes to study the reactions of organic acids and bases in organic solvents, deals with halogen derivatives of phenolsulfonephthalein. Spectrophotometric data are given for mixtures of bromocresol green, bromophenol blue, iodophenol blue, and tetrabromophenol blue with primary, secondary, and tertiary aliphatic amines in benzene; and qualitative data are tabulated for chlorophenol blue, bromochlorophenol blue, chlorophenol red, bromophenol red, bromocresol purple, and bromothymol blue. Comparisons are made of the phenolsulfonephthaleins and the bromophthalein magentas. The structural changes that accompany the color phenomena are discussed. Suggestions are made regarding the use of the indicators in inert solvents. 14 p.

RP1901. Concentration of copper 63 by the countercurrent electromigration method....................Samuel L. Madorsky and Sidney Straus

Concentration of ^{63}Cu by the countercurrent electromigration method is described. The electromigration cell was operated with cupric sulfate as the electrolyte for periods of about 400 to 500 hours. A definite, though small, concentration of ^{63}Cu in the cathode compartment of the cell was obtained. The terminal separation coefficient was about one-third as large as that found for chlorine under similar conditions. 4 p.

RP1902. An instrument for the rapid production of a decimal series of potentials and its application to ballistic measurements
Howard S. Roberts and Harvey L. Curtis

An instrument for producing decimal subdivisions of a chosen potential was developed for calibrating a cathode-ray oscillograph, often within a few milliseconds after the ballistic record had been obtained. The maximum potential could be chosen as any integral multiple of 10 millivolts, with a maximum of 100 millivolts. To permit this choice, ten 10-ohm coils were connected in series, and a current of 1 milliampere was sent through them. Then the drop in potential over each coil was 10 millivolts, and the maximum output potential was the product of 10 millivolts and the number of coils included between the output terminals. The decimal subdivisions of the chosen potential were obtained by varying the current in the ten 10-ohm coils in steps of 0.1 milliampere from 0 to 1.0 milliampere by shunt resistances. The calibration started with zero voltage when the shunt resistance was zero, and the shunt resistance increased in such steps that the current in the 10-ohm coils increased in 0.1 milliampere steps and hence the output voltage in decimal steps of the chosen maximum potential. The shunt resistances were inserted by opening switches that normally short-circuited them. For oscillograph calibration these switches were opened in succession by a falling weight.

The numerical data used for illustration are based on decimal subdivision of the maximum available potential. The general case is treated, however, showing that a calibrator of this type may be used for any desired number of potential steps. 7 p.

RP1903. Viscoelastic properties of polymer solutions..........John D. Ferry

In a concentrated polymer solution, the entanglement of long-chain molecules results in a transient network structure, to which may be attributed certain aspects of the viscoelastic behavior of such a system. A suitable mechanical model for representing this network as a first approximation is a retarded Maxwell element with one spring and two dashpots. Experimental measurements of mechanical properties of polymer solutions may be made either by periodic deformation under conditions where inertia forces can be neglected or by propagation of transverse waves. The data are expressed in terms of frequency-dependent parameters from which can be derived the constants of the corresponding mechanical model. A solution of polystyrene in xylene is cited as an example. In this case, analysis in terms of a recent theory of Kuhn suggests that elastic energy may be stored in the network strands by twist against the potential hindering free rotation about bonds in the chains. 10 p.

RP1904. Density and refractive indices of lactose solutions
Emma J. McDonald and Anne L. Turcotte

The density and refractive indices of lactose solutions in the range of unsaturation are reported to five decimal places at 20° and 25° C. For solutions of higher concentration up to 50-percent lactose, the corresponding values are reported at 25° C and for refractive indices alone at 15° C. 6 p.

RP1905. Stress-corrosion tests on high-strength aluminum alloy sheet
Hugh L. Logan and Harold Hessing

This paper describes stress-corrosion tests on high-strength aluminum alloy sheet. The materials investigated were 24S–T, aged 0 to 12 hours at 375° F; R301–T; bare and clad 75S–T; bare and clad R303–T275; and bare and clad R303–T315 alloys. The materials were exposed unstressed and stressed in tension to three-quarters of the yield strength in a sodium chloride-hydrogen peroxide solution and in a marine atmosphere. The zinc bearing alloys, 75S–T and R303–T, were also exposed, while stressed by bowing, in a boiling 6-percent NaCl solution. Corrosion damage was evaluted from losses in tensile strength and elongation. Commercial 24S–T material, aged 4 hours or longer, and the other alloys as supplied by the manufacturers, with the exception of the R301–T alloy, were resistant to stress-corrosion cracking. 18 p.

RP1906. Strain test for evaluation of rubber compounds
Frank L. Roth and Robert D. Stiehler

Measurements of elongation of rubber vulcanizates at a fixed stress have been made with a precision much greater than can be obtained in the usual measurements of stress at a specified elongation. Such measurements form the basis of a strain test developed to characterize rubber vulcanizates in control and research testing. Statistical analyses show that the errors introduced in the actual strain measurements are negligible compared to those introduced by variations during compounding and curing, whereas the errors introduced by the usual measurements of stress at a specified elongation are of the same order of magnitude. The high precision of strain testing has been used to detect variations within a single sheet of vulcanized rubber and variations among sheets cured from the same compounded batch. It has also been possible to determine with a single sheet its change in stiffness or modulus with age. The uniform treatment of specimens in the strain test makes them particularly useful for precise measurements of set. Further, it has been found that the decrease in elongation with time of cure apparently follows the laws of a second-order chemical reaction, and consequently it is possible to represent the data by an equation involving three vulcanization parameters. 7 p.

RP1907. Strain tester for rubber..............William L. Holt, Ellis O. Knox
and Frank L. Roth

A tester for measuring the strain of rubber vulcanizates when subjected to a predetermined stress is described. The operation of the tester and a description of the apparatus for cutting and measuring the test specimens are presented. With this equipment, routine determinations of a point on the stress-strain curve can be made with greater accuracy and precision than has hitherto been possible with the usual stress-strain equipment. This strain test also requires less labor than the customary stress tests. 8 p.

RP1908. Barium aluminate hydrates..Elmer T. Carlson and Lansing S. Wells

Methods of preparation, optical properties, and X-ray diffraction data are reported for six barium aluminate hydrates. Three of these were obtained successively by precipitation from supersaturated barium aluminate solutions at 30° C. The first, designated by the empirical formula $1.1BaO.Al_2O_3.6H_2O$, is metastable with respect to the second, $BaO.Al_2O_3.7H_2O$, which in turn is metastable with respect to $BaO.Al_2O_3.4H_2O$. Two lower hydrates, $BaO.Al_2O_3 2H_2O$ and $BaO.Al_2O_3.H_2O$, were prepared hydrothermally. $2BaO.Al_2O_3.5H_2O$ was obtained from boiling barium aluminate solutions. 7 p.

RP1909. Aliphatic halide-carbonyl condensations by means of sodium
Edgar A. Cadwallader, Abraham Fookson, Thomas W. Mears, and
Frank L. Howard

As a part of an investigation of the synthesis of highly branched aliphatic hydrocarbons that is being conducted at the National Bureau of Standards for the National Advisory Committee for Aeronautics, the Navy Bureau of Aeronautics, and the Army Air Forces, several compounds have been prepared by interaction of alkyl halides and various carbonyl compounds in the presence of sodium. This reaction makes possible the synthesis of certain highly branched compounds not easily obtainable by other means. 8 p.

RP1910. Barium 2-ketolactobionate and the corresponding barium bromide double salt................William W. Walton and Horace S. Isbell

As a preliminary step in the development of methods for the preparation of 2-ketoaldobionic acids for use in the synthesis of glycosidic derivatives of ascorbic acid, the preparation of 2-ketolactobionic acid has been studied. By oxidation of lactose osone with bromine in the presence of barium carbonate, barium 2-ketolactobionate was obtained and separated in the crystalline state. In addition to the normal barium salt, a double salt containing barium bromide was found. This salt is unique in that it is the first and only crystalline barium bromide salt of a sugar acid reported in the literature. It crystallizes freely and is useful for the separation and identification of 2-ketolactobionic acid. 5 p.

RP1911. Infrared prism spectrometry from 24 to 40 microns..Earle K. Plyler

A prism of KRS–5 (thallium-bromide-iodide) has been used to measure the transmission of various substances in the infrared region from 24 to 40 microns. The prism was installed in a Perkin-Elmer spectrometer, and a Golay detector was employed for measuring the energy. Transmission data were obtained for polystyrene, polyethylene, and different samples of KRS–5. Also measurements have been made on the cut-off of KBr, AgCl, and other crystals. The rotational spectrum of the water-vapor molecule has been measured to 39.2 microns, and the known frequencies of these absorption bands have been used for the calibration of the prism. 4 p.

RP1912. Mass spectra of octanes..........Evelyn G. Bloom, Fred L. Mohler, J. H. Lengel, and C. Edward Wise

Mass spectra of the 18 isomers of octane have been measured. The sensitivity at the maximum peaks in each spectrum relative to *n*-butane is computed as well as the total ionization relative to *n*-butane. Tables and plots of relative intensities in the mass spectra are given, and some correlations with structure are found. All isomers with a tertiary butyl radical have similar spectra. The other isomers tend to dissociate at carbon atoms with one or two side chains attached to them. This determines whether the loss of two or three carbon groups in dissociation is probable. Loss of four carbon groups is probable whenever the molecule ion can break in half in a single dissociation process. 5 p.

RP1913. Effects of substitute fuels on automotive engines..Clarence S. Bruce, Jesse T. Duck, and A. R. Pierce

Tests were made to determine the operating characteristics of automotive engines with respect to cylinder wear, carbon deposits, life of accessories, and vapor lock. Fuels circulating through standard type pumps for a period equivalent to 200,000 miles had no visible effect on pump diaphragms. Cylinder wear with various fuels was determined by an optical instrument, the McKee wear gage. Wear is determined from changes in lengths of indentations made in cylinder walls with a precisely shaped diamond tool. The wear with alcohol was about half that with leaded gasoline. Carbon deposits also were much lower. There was no indication of dilution of crankcase oil by alcohol. The temperature limits for operation without vapor lock were established for various blends of alcohol with ether and with acetone. 15 p.

RP1914. Applications of magnetochemistry to polymers and polymerization

Pierce W. Selwood

After a brief review of fundamental definitions, experimental methods, theoretical and semiempirical results on diamagnetic substances, two topics are considered: First, studies of the diamagnetic anisotropy of crystalline and oriented materials. Using solid naphthalene as an illustration, it is shown how to obtain the principal molecular susceptibilities from the measured parameters of the single crystal and the molecular orientations in the unit cell as derived from X-ray studies. Conversely, the direction cosines for solid diphenyl are calculated from the measured macroscopic susceptibilities and the susceptibilities of the molecule. Results recently obtained on the anisotropy of cellulose, protein fibers, and stretched rubber indicate the value of such methods, particularly for oriented polymers containing aromatic groups, because of the large effects of the latter. Next, attention is devoted to the paramagnetism of oxygen and free radicals that can be utilized as a measure of the concentration of the species. Radical concentrations as low as 10^{-6} mole per liter may be estimated by means of a modification of the Gouy-balance. It has been employed in a study of the thermal polymerization of styrene at 66° C. From the changes in diamagnetism in the course of the reaction, the rate of consumption of oxygen present is determined. Assuming this to be due to combination with styrene radicals, the rate of thermal initiation is estimated to be 3.8×10^{-14} mole^{-1} liter sec^{-1}. However, in order to obtain by magnetic methods directly the free radical concentration in ordinary chain polymerization processes, the senstivity would have to be improved by several orders of magnitude. 12 p.

RP1915. Thickness of inhibiting films on glass electrode surfaces

Donald Hubbard and Gerald F. Rynders

The thickness of voltage-inhibiting films produced on glass surfaces by heat treatment after leaching has been studied by means of the glass electrode and the interferometer procedure previously used for determining the chemical durability of glasses. The glass electrode gave conspicuous voltage departures (errors) and alterations (swelling) of the surface that were just detectable by the interferometer. This corresponds to approximately 0.01 fringe, or four times the unit cell dimension for cristobalite. The inhibiting effect of films of electric conductors, such as metallic silver, has been qualitatively compared with the inhibiting effect of films prepared from electric nonconductors, such as petrolatum and silicone stopcock grease. 6 p.

RP1916. Light-sensitive papers as controls for testing textile colorfastness and stability of materials under arc lamp exposure

Herbert F. Launer

A simple method of control of the integrated exposure of the fluctuating arc lamps used in the textile and other industries for testing lightfastness of textile dyeings and stability toward light of materials in general, is described. A piece of light-sensitive paper is placed in lamps along with materials to be tested, and the exposure is terminated when a match with a standard, observable with the unaided eye, is obtained. The standard is a strip of the same batch of paper that has been exposed in a master lamp to a definite light dosage. The method is based upon standard light quantities and is thus largely independent of variation between batches of light-sensitive paper.

The variations among fading lamps used in the textile industry and the causes, such as differences in lamp models, and line voltage, are discussed. A 4-percent difference in line voltage leads to a difference in radiant output of 11 percent in the waveband from 300 to 480 millimicrons, the region probably causing most of the fading of dyed textiles. Variations in line voltage considerably larger than 4 percent are probable in many communities.

The papers were made in batches of 20 to 30 thousand test pieces by dip-dyeing special cotton-rag or wood-fibers papers with aqueous solutions of Niagara Blue G, or with Victoria Blue B in aqueous ethanol. One paper was made by beater-dyeing wood fibers with Niagara Blue G to give a nonleaching paper and was sized with melamine resin to impart high wet strength, making the paper suitable for lamps with water spray. Other paper-dye combinations were studied.

Data are presented indicating the visual sensitivity of the various types of papers from 1 to 100 hours of usual arc exposure, the permanence of the papers during storage in the dark, the uniformity throughout each batch, and the effect of nonuniformity, temperature effect, lasting qualities of the standard strips during use, correlation with textile dyeings, and the effect of intermittent exposure.

The master lamp used for standardizing the papers, its accessories, and reproducibility of input power and radiant output are discussed. 9 p.

RP1917. Expansive characteristics of hydrated limes and the development of an autoclave test for soundness...............Lansing S. Wells,
Walter F. Clarke, and Ernest M. Levin

A technique for preparing, curing, and autoclaving 1- by 1- by 10-inch cement-lime bars was developed, and the expansive characteristics of 80 commercial hydrated limes were determined. On the basis of chemical analysis and percentage of unhydrated oxide, the hydrated limes were classified into four series: high-calcium, regularly hydrated dolomitic, highly hydrated dolomitic ,and magnesian. Data on the expansions of cement-lime bars prepared in the proportions of 2 parts cement to 1 part lime, 1 part cement to 1 part lime, and 1 part cement to 2 parts lime, by weight, and autoclaved to 295 pounds per square inch gage pressure for 3 hours, showed that bars prepared with the regularly hydrated dolomitic limes, which had the highest percentages of unhydrated oxides, had the highest percentages of expansion. The high-calcium limes, characterized, in general, by the lowest percentages of unhydrated oxides, gave the lowest percentages of expansion. Most of the highly hydrated dolomitic limes had percentages of unhydrated oxide and expansion that were comparable to those of the high-calicum limes. An increase in the proportion of lime in the cement-lime bars was attended by an increase in expansion. The method for determining the linear expansion of cement-lime bars autoclaved at a steam-gage pressure of 295 lb/in.^{2} (equivalent to a temperature of 216° C.) was found to be reproducible, by three independent operators. The effect of 17 different portland cements on the expansion of cement-lime bars showed that the expansion values for a particular lime tended to increase as the expansion value of the constituent cement increased. Arbitrarily subtracting the expansion of the neat cement from the total expansion gave the most uniform result for the "net" expansion of the lime. With an autoclave specially modified for ascertaining the behavior of cement-lime bars during the course of autoclaving, it was found that only a slight amount of the total expansion occurred before a temperature of 150° C. was reached, but above 150° C. a rapid expansion rate was noted, which in turn tapered off before a temperature of 216° C. was reached. Retarding the rate of heating resulted in a decrease in the total expansion. Finally, from criteria set forth for a procedure for determining the soundness of hydrated limes, a test is proposed with a suggested limit of expansion of 1.0 percent. 26 p.

RP1918. Concentration of isotopes of mercury in countercurrent molecular stills........Samuel L. Madorsky, Paul Bradt, and Sidney Straus

Mercury was refluxed in countercurrent molecular stills in order to concentrate ^{204}Hg. Two glass stills, with heater and cooler placed outside the distillation columns, and one still, consisting of a glass column heated externally and a stainless-steel cooler placed concentrically inside the column, were used. As compared with a 10-cell steel column described previously, these columns showed poor performance, mainly because the hold-up was too small. There are definite indications, however, that with liquids having a lower surface tension than Hg, these columns will perform as well as the 10-cell steel column. Mass-spectrometer analyses of isotope ratios of the Hg-isotope concentrates were in good agreement with density determinations. 6 p.

RP1919. Determination of lactose alone and in the presence of sucrose by the method of Munson and Walker................Lester D. Hammond

The existence of uncertainties in the tables employed in the determination of lactose, alone and in the presence of sucrose, by the method of Munson and Walker has led to the redetermination of the reducing-sugar values from which these tables were calculated. The original tables were based on the weights of cuprous oxide corresponding to various weights of lactose, and in the present paper all values are referred to the weights of copper determined electrolytically. Data showing the magnitude of the contamination of the cuprous oxide under the conditions prevailing in the method are given. The table of Straughn and Given for mixtures of lactose and sucrose in the ratio of 1:12 is shown to be in error. From the redetermined values an extensive table of the copper values for lactose and for two ratios of lactose and sucrose has been computed. 11 p.

RP1920. Broad-and narrow-beam attenuation of 500- to 1,400-kilovolt X-rays in lead and concrete........Harold O. Wyckoff, Robert J. Kennedy, and William R. Bradford

Both narrow- and broad-beam attenuation curves have been obtained for 500-, 600-, 800-, 1,000-, and 1,400-kilovolt X-rays in lead and concrete. For the experimental conditions used, it is shown that an irradiated area 12 inches in diameter for lead absorbers and 37 inches in diameter for concrete satisfy the barrier conditions required for broad-beam attenuation curves. 8 p.

RP1921. A method for the electron microscopy of wool.......Max Swerdlow and Gloria S. Seeman

A simplified method for making shadowed thermoplastic negative replicas of fibrous materials was developed. Through this technique, fine details of the morphology of the wool fiber, before and after treatment, were clearly revealed by the electron microscope. The structural implications of the electron micrographs are discussed with respect to the subject of wear and in reference to the observations of other investigators. 15 p.

RP1922. Color perceptions of deuteranopic and protanopic observers
Deane B. Judd

It is well establised that about 2 percent of otherwise normal human males are confusers of red and green from birth. There is considerable interest in the question: What do red-green confusers see? From a knowledge of the normal color perceptions corresponding to deuteranopic and protanopic red and green, we may not only understand better why color-blindness tests sometimes fail, and so be in a position to develop improved tests, but also the color-deficient observer may understand better the nature of his color-confusions and be aided to avoid their consequences. If an observer has trichromatic vision over a portion of his total retinal area, and dichromatic vision over another portion, he may give valid testimony regarding the color perceptions characteristic of the particular form of dichromatic vision possessed by him. Preeminent among such observers are those born with one normal eye and one dichromatic eye. A review of the rather considerable literature on this subject shows that the color perceptions of both protanopic and deuteranopic observers are confined to two hues, yellow and blue, closely like those perceived under usual conditions in the spectrum at 575 and 470 mμ, respectively, by normal observers. By combining this result with standard response functions recently derived (Bureau Research Paper RP1618) for protanopic and deuteranopic vision, it has been possible to give quantitative estimates of the color perceptions typical of these observers for the whole range of colors in the Munsell Book of Color. These estimates take the form of protanopic and deuteranopic Munsell notations, and by using them it is possible not only to arrange the Munsell papers in ways that presumably appear orderly to red-green confusing dichromats, but also to get immediately from the notations an accurate idea of the colors usually perceived in these arrangements by deuteranopes and protanopes, much as the ordinary Munsell notations serve to describe the visual color perceptions of a normal observer. 25 p.

RP1923. Electrode function (pH response) of the soda-silica glasses
Gerald F. Rynders, Oscar H. Grauer, and Donald Hubbard

A series of Na_2O-SiO_2 glasses was studied for durability, hygroscopicity, glass electrode function, and apparent response to $[Na^+]$. These glasses show three distinct regions of durability characteristics at pH 4.6: Below 81 percent of SiO_2, where the glass is carried into solution; between 81 and 89.5 percent of SiO_2, where differential solution of the constituents of the glass leaves a swollen silica-rich layer; and a region in which greatly reduced attack was indicated. Glass electrodes of low silica content having poor chemical durability and high hygroscopicity exhibited large voltage departures approaching the values of a "punctured" mercury-filled electrode and a calomel half cell. The apparent response to $[Na^+]$ ranged from 9 to 339 millivolts per pNa for the glasses of 82.6 and 56.6 percent of SiO_2 respectively. 6 p.

RP1924. Effect of temperature on the volume of leather and collagen in water...Charles E. Weir

The coefficients of cubical expansion of 10 tannages of leather and tendon collagen have been measured by using water as the confining liquid. The results, calculated for dry leather of density 1.560 g/ml, show that an average coefficient of 540×10^{-6}/°C applies for collagen and all leathers except chrome-vegetable leather, the coefficient of this tannage being 340×10^{-6}/°C. These averages have a reproducibility indicated by standard deviations of 13×10^{-6}/°C and 37×10^{-6}/°C, respectively. The "shrinkage" or transition temperature is a band rather than a sharp point on the temperature scale. During apparent shrinkage, an increase in real volume of approximately 1 percent occurs. This increase in volume is irreversible, but the thermal expansion below the transition range is nearly completely reversible. The rate of expansion during transition of collagen follows the law of a first-order reaction. The results are interpreted as indicating that the shrinkage does not occur at a characteristic temperature but is a rate process. The transition may be pictured as a change of state possibly coupled with a reaction. 7 p.

RP1925. Image shifts caused by rotating a constant-deviation prism in divergent light.................................James B. Saunders

The use of the constant-deviation prism for producing monochromatic light introduces the problem of image shifts that result from rotating the prism when changing from one spectral line to another. The magnitudes of both the lateral and the axial components of this shift, for a given rotation of the prism, depend upon the position of the axis about which the prism rotates. A position for the axis is known that yields zero lateral shift. The axial shift, however, depends also upon the convergence of the beam and the shape and optical properties of the prism. In this paper a method is presented for locating the positions of the axis of rotation for minimum axial and for minimum total shifts of the foci for both the sagittal and meridian fans of rays. 8 p.

RP1926. Thimble-chamber calibration on soft X-rays..........Frank H. Day

Condenser r-meter thimble chambers of various types have been calibrated against a standard free-air ionization chamber to indicate the wavelength dependance of their readings after exposure to X-rays excited by potentials ranging from 10 to 200 kilovolts. X-ray tubes with low inherent filtration are used. Calibrations are conducted for minimum-filter conditions, and the effect of added filtration on the calibrations is also noted. It has been observed, for instance, that a chamber that reads correctly for filtered radiation of 100-kilovolt quality is in error by a factor of 2.3 for 10-kilovolt X-rays. 6 p.

RP1927. Sources of error in and calibration of the *f*-number of photographic lenses..Francis E. Washer

In problems of photography, where the accuracy of lens marking is critical in determining the proper exposure, the various errors to which these markings are subject is of considerable interest. The present report gives the magnitude of such errors that were found to exist in a representative group of 20 lenses having focal lengths that range from 0.5 to 47.5 in. In addition, the results of calibration of these lenses by a photometric method that permits compensation of light losses resulting from absorption, reflection, and scattering are given. Values of lens transmittance for these lenses are shown. A method of plotting results of nominal, true, and calibrated *f*-numbers is given that permits quick evaluation of the magnitude of the over-all error in terms of fractions of a stop. 13 p.

RP1928. Mass spectrometric investigation of the thermal decomposition of polymers..Leo A. Wall

The application of the mass spectrometer to the study of the thermal decomposition of polymers is described. The relationships between the structure of polymers and yield of monomers on decomposition are discussed. A quantitative treatment relating the compositions of certain coploymers and the yields of monomers is given. Data are presented showing the composition of the volatile hydrocarbons produced by the thermal decomposition of several vinyl and diene polymers. 8 p.

RP1929. Purification, purity, and freezing points of 30 hydrocarbons of the API-Standard and API-NBS series..............Anton J. Streiff, Janice C. Zimmerman, Laurel F. Soule, Marie T. Butt, Vincent A. Sedlak, Charles B. Willingham, and Frederick D. Rossini

This report describes the purification and determination of freezing points and purity of 30 hydrocarbons of the API-Standard and API-NBS series, including eight paraffins, six cycloparaffins, three aromatics, twelve olefins, and one acetylene. 35 p.

RP1930. Calibration of accelerometers..Samuel Levy, Albert E. McPherson, and Edward V. Hobbs

This paper describes three accelerometer calibrators. These calibrators were developed to provide a convenient means for calibrating lightweight accelerometers of the types used for measuring accelerations on airplanes in flight. The first calibrator is a shaking table having a sinusoidal motion with frequencies of 20 to 110 cycles per second and accelerations up to 80 gravity; the second is a portable calibrator producing a known pulse of acceleration with a peak value between 1 and 20 gravity; and the third is a centrifuge, which develops a maximum steady acceleration of about 1,000 gravity. 11 p.

RP1931. Studies of the Mattson shot classifier...........Raymond L. Blaine and Harold J. Valis

The size and distribution of peening and cleaning shot and sand particles of various shape characteristics were determined by use of a new apparatus and with a microscope and by microweighings. Tests indicated that the Mattson apparatus enabled a rapid visual evaluation to be made of size and distribution of shot and sand particles. A more precise evaluation can be made with the apparatus by determining the actual size distribution of the shot or other particles. This apparatus tends to determine the smallest dimension of particles that are irregular in shape and, when used with closely sized sieve fractions, makes possible an evaluation of the shape characteristics of the particles. 8 p.

RP1932. Compilation of thermal properties of hydrogen in its various isotopic and ortho-para modifications.............Harold W. Woolley, Russell B. Scott, and F. G. Brickwedde

New developments in science and industry are aided by accurate knowledge of the behavior of important substances. The great abundance of chemical processes and compounds in which hydrogen is involved make it of particular interest. The experimental and derived data presented here for hydrogen extend over a large range of temperature. Low temperatures are required for the liquid and solid, and moderate and high temperatures occur in chemical reactions.

The available thermal data for H_2, HD, and D_2 in solid, liquid, and gaseous states have been brought together, including the distinctive properties of ortho and para forms of H_2 and D_2. Some data not previously published have been added. The thermal data include thermodynamic functions for the ideal gas state, equilibrium constants, data of state, viscosity, and thermal conductivity with dependence on the pressure, vapor pressure, solid-liquid equilibria, specific heats, and latent heats. Values of state derivatives useful in thermodynamic calculations have been given for normal hydrogen, and the related differences between thermodynamic functions for real and ideal gas states have been evaluated. A temperature entropy diagram for normal H_2 in the range of experimental data is also given. The compiled thermal properties of hydrogen are presented in 38 tables, 33 graphs, and numerous equations. The sources of the data have been given in an extensive bibliography. 97 p.

RP1933. Chemical durability, specular gloss, and transmittance of optical glasses....................Donald Hubbard and Gerald F. Rynders

The chemical durability of three types of optical glass (BSC 517, BaC 572, and F 620) and chemical Pyrex have been studied over an extended pH range by means of an interferometer procedure. The accompanying effect on the appearance (gloss retained) and on the transmittance of the specimens has also been determined. The results illustrate the confusion that might arise from choosing any of the above three properties as an indicator for the serviceability of optical glasses. Below pH 6, in the range of maximum durability for the optical glasses, differential solution of the alkali and heavy metal oxides brings about the formation of silica-rich, reflection-reducing films, which decrease specular gloss of the surface and improve the transmittance of the specimens. 6 p.

RP1934. Bending tests of large welded-steel box girders at different temperatures.................Ambrose H. Stang and Bernard S. Jaffe

Tests were made to determine the effect of constraint caused by geometrical shape and by differences in temperature on the ductile behavior of welded structures. Four large box girders of identical design were fabricated from fully killed steel from the same heat. The box girders were tested as simply supported beams, one girder being tested at each of the following temperatures: —40°, 0°, 40°, and 80° F. The girders tested at —40° and 0° F broke with a square type of fracture. The other two girders could not be broken with the available equipment, although deflections at midspan of more than 16 inches were induced on a 22-foot span. The results of these tests are discussed and compared. 13 p.

RP1935. Standards for low values of direct capacitance........Charles Moon and C. Matilda Sparks

In the measurement of small capacitances, such as the interelectrode capacitance of vacuum tubes, standards are needed for checking the calibration of the measuring equipment. The design, construction, and measurement of a group of small primary and secondary standards of capacitance for this purpose are described, the values of which range from 0.001 to 5.0 microfarads. Capacitators of 0.1 $\mu\mu$f and above are of the Kelvin guard-ring type; those of 0.1 $\mu\mu$f and smaller are of a new "guard-well" type, which permits the construction of primary standards for values as low as desired. 11 p.

RP1936. Experimental verification of theory of landing impact
Walter Ramberg and Albert E. McPherson

Drop tests of an idealized wing and alighting gear were made to provide an experimental check on methods for computing the transient bending stresses in the wing produced by a symmetrical vertical landing impact. The model was dropped in a nearly strain-free condition to make contact at a point below the center of gravity. The forces in the alighting gear, acceleration at the "fuselage", and bending strains in the wing were recorded as a function of time.

According to the statistical theory of Biot and Bisplinghoff, the computed maximum bending stresses, using the first three flexural modes, were found to be 43 to 137 percent greater than the measured values. Using the actual forcing function reduced the difference to less than 20 percent. 12 p.

RP1937. Copolymerization....................Robert Simha and Leo A. Wall

A critical discussion of the mechanism of formation of copolymers by addition polymerization is presented. It deals mainly with the following three fundamental aspects: First, the quantitative treatment of the reaction starting with a scheme consisting of initiation, growth, and termination mechanisms. Expressions for the instantaneous and total copolymer composition and for the over-all rate of reaction as function of monomer composition and of conversion are derived in terms of quantities characteristic of the reaction. Graphical and numerical methods for the determination of these parameters from experimental data are given in detail. The statistical distribution of molecular weights and compositions in the product is considered in relation to the constants of the reaction and to the analogous case of simple polymers.

Second, methods for the analysis of copolymer compositions are discussed and experimental results are summarized. Reactivity ratios describing the behavior in growth of a given radical toward a pair of monomers are tabulated for a series of systems.

Third, these results are interpreted on the basis of resonance and of electrostatic and steric effects as encountered in the study of certain organic reactions.

In addition, degradation of copolymers is briefly considered in the light of the possible types of sequences in the chain. A numerical relation between yield and copolymer composition is derived.

The problems remaining are principally the following: Experimental methods of copolymer analysis, determination of over-all rates of reaction and of individual rate constants, and a more fundamental correlation between structure of monomers and behavior in copolymerization. Also, systematic data on the thermodynamic and rate properties of copolymer solutions should be of great interest, and studies of the bulk properties and their relation to copolymer structure represent a field where research has only recently been initiated. 23 p.

RP1938. Effect of boron on the hardenability of high-purity alloys and commercial steels................Thomas G. Digges, Carolyn R. Irish, and Nesbit L. Carwile

A study was made of the action of boron in relation to the hardenability of high-purity alloys varying in carbon content. The effectiveness of boron in enhancing the hardenability of these alloys and certain steels is believed to be due to its action in retarding the rate of nucleation of ferrite and carbide while in solid solution in austenite. The hardenability of the boron-treated alloys, as determined in terms of the critical cooling rate of small specimens austenitized at a wide range of temperatures, varied with the prior history and with the carbon content. The hardenability of a commercial boron-treated steel, as determined by the end-quench test, was also sensitive to prior thermal treatments. Boron was lost in the decarburized zone of commercial steels, and its rate of diffusion apparently is of the same order of magnitude as that of carbon. The heat treatment of specimens of the alloys and steels to produce a boron constituent and the microstructures of the alloys as cast and as homogenized are described. 30 p.

RP1939. Absorption of radio waves reflected at vertical incidence as a function of the sun's zenith angle.....................Eloise W. Taylor

The diurnal variation of ionospheric absorption is related to the sun's zenith angle. The absorption values for this study were obtained from the continuous automatic field-intensity recordings made at the Central Radio Propagation Laboratory on two frequencies. Because of proximity of the receiving station to the transmitting station, reflections are obtained at nearly normal incidence. An analysis of data covering a period of 3 years indicates that little error is introduced by assuming a linear dependence of absorption upon the cosine of the sun's zenith angle. 5 p.

RP1940. Destruction of superconductivity by current........Russell B. Scott

A series of measurements was made of the return of resistance in superconducting wires when the current was increased up to and beyond the critical value. Wires of pure indium of three different diameters were used, and measurements were made on each wire at four different temperatures. The transition curves for a wire of given diameter were reproducible and were independent of temperature. Measurements on sections of wire 0.6 millimeter long gave substantially the same results as measurements on long wires. The fraction of the normal resistance restored by the critical current varied from 0.77 for a wire 0.36 millimeter in diameter to 0.85 for wires 0.11 millimeter in diameter. The classical formula predicts a value of 0.50. The results are discussed in the light of Landau's theory of the intermediate state, and it is shown that the classical value may be approached for wires of large diameter. 8 p.

RP1941. Study of the modifications of manganese dioxide.
Howard F. McMurdie and Esther Golovato

Past work on the modifications of manganese dioxide of interest in dry-cell manufacture is reviewed. New X-ray data, at both room and elevated temperatures, combined with differential heating curves lead to the conclusion that five types of manganese dioxide exist: (1) well-crystallized pyrolusite; (2) gamma manganese dioxide, a poorly crystallized pyrolusite; (3) ramsdellite; (4) cryptomelane, a form containing essential potassium or sodium; and (5) delta manganese dioxide, believed to be a poorly crystallized cryptomelane. The high-temperature X-ray diffraction data indicated the phase changes that cause the heating-curve effects. A new crystal form of manganosic oxide (Mn_3O_4), stable above 1,170° C, was found to be cubic of spinel structure. Fineness determinations by both the nitrogen absorption and the X-ray line broadening methods were made on selected samples. 12 p.

RP1942. Laboratory evaluation of a method proposed by Gnam for measuring the temperature of rotating parts..................Andrew I. Dahl
and Paul D. Freeze

A thermocouple application suggested by Gnam for measuring the temperature of rotating parts without slip rings or telemetering has been investigated. A rotating circuit, consisting of a thermocouple in series with the rotor coils of a converter, and a stationary circuit, consisting of the stator coils of the converter and a transformer, are linked magnetically. One thermocouple junction is fixed to the rotating part whose temperature is to be measured, and the other protrudes from a hollow shaft into a furnace. The temperature of the rotating part is stationary circuit, as determined by an oscilloscope, used as a null indicator. Full-scale application of this system seems practicable. 7 p.

RP1943. Amides of glucuronic, galacturonic, and mannuronic acids

Harriet L. Frush and Horace S. Isbell

Heretofore the amides of glucuronic, galacturonic, and mannuronic acid were not known, and methods were not available for their preparation. It has now been found possible to obtain the amides of uronic acids from the corresponding 1-amino-uronamides by selective hydrolysis of the glycoslyamino group. An aqueous solution of the 1-amino-uronamide is treated with an acid or a suitable cation exchange resin that replaces the glycoslyamino group by a hydroxyl, forming the free amide. The new compounds, like the sugars, have a free reducing group, and hence they are capable of existing in the pyranose, furanose, and open-chain forms and of displaying mutarotation. D-Glucuronamide, D-mannuronamide, and D-galacturonamide were separated in the alpha pyranose form. The beta pyranose modification of D-galacturonamide was also obtained. The amides are stable crystalline substances, that should prove to be useful representatives of a new class of carbohydrate derivatives. 5 p.

RP1944. Absorption spectra of methane in the near infared

Richard C. Nelson, Earle K. Plyler, and William S. Benedict

A grating spectrometer with a PbS cell for detector has been used for the measurement of the infrared absorption bands of methane in the region of 1.66 μ. Many lines of P, Q, and R branches of the 1.66-μ band have been observed.

These are well resolved and are of the correct structure and spacing for the F_2 component of $2_{\nu 3}$. The lines for values of J up to 10 are sharp, showing no indication of splitting due to interaction with neighboring states or to centrifugal distortion. The rotational constants obtained for this band are $B'=5.178$, $\zeta_3=0.0346$. The latter value s lower than in the ν_3 fundamental. Other bands observed are more complex and irregular, presumably due to mutual interaction. 7 p.

RP1945. Transmittance of near infrared energy by binary glasses

Jack M. Florence, Francis W. Glaze, Clarence H. Hahner, and Ralph Stair

A study has been made of the transmittance of near infrared energy by a number of binary glasses. Of the systems studied, the lithia-silica and lead oxide-silica were found to have the highest transmittance of energy in the range of wavelengths from 3.0 to 5.0 microns. The transmittance of lithia-silica is compared with that of the other alkali-silica glasses. Values of transmittance are given for lead silicate glasses of higher lead content than have been previously reported in the literature. 4 p.

TITLE PAGE AND CONTENTS TO VOLUME 41. 7 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 42, JANUARY—JUNE 1949

RP1946. Response functions for types of vision according to the Müller theory..Deane B. Judd

According to the Müller theory of vision there are three stages in the visual process, an initial photochemical stage, an intermediate chemical stage relating to the chromatic aspect, and a final stage of excitations of the optic-nerve fibers. By taking advantage of recent precise information regarding the metamers characteristic of normal, protanopic, and deuteranopic vision there have been derived the spectral variations of the responses for each stage as functions of wavelength. These response functions account precisely for the same normal metamers as the ICI standard observer, and closely for the same confusions by color-blind observers as the simpler König theory. Furthermore these functions describe chromatic thresholds of the normal eye (Abney, Priest-Brickwedde) as a gradual approach to tritanopic vision as field size and luminance are decreased. 16 p.

RP1947. Rate of shrinkage of tendon collagen: heat, entropy, and free energy of activation of the shrinkage of untreated tendon; effect of acid, salt, pickle, and tannage on the activation of tendon collagen...Charles E. Weir

From isothermal measurements of the rate of shrinkage of tendon collagen, it is concluded that shrinkage is a rate process involving a reaction of first order. The effects of tension and length of soaking before shrinkage are studied. Average values of heat, entropy, and free energy of shrinkage of untreated tendon are obtained by application of the theory of absolute reaction rates to the data. These values are found to be 141 kcal/mole, 349 cal/mole deg, and 24.7 kcal/mole at 60°C, respectively, with standard deviations of 15 kcal/mole, 43 kcal/mole deg, and 0.6 kcal/mole at 60° C, respectively. Measurements of shrinkage temperatures are discussed. The effects of pH, salt, tanning, and pretannage treatments on the activation process are studied. Heat, entropy, and free energy decrease in acid and alkaline media. Salt solutions cause a decrease in heat and entropy but an increase in free energy in concentrated solutions. The effect of salt and acid in combination is complex, but in concentrated salt solutions an increase in free energy is observed. All tannages investigated, with the exception of chrome tanning, appear to reduce the entropy more than the heat, thereby increasing the free energy. Chrome tanning increases heat, entropy, and free energy markedly. An interpretation of the results is given. 16 p.

RP1948. Kinetic study of the reaction of carbon adsorbents with oxygen
William V. Loebenstein, Leland F. Gleysteen, and Victor R. Dietz

A study was made of the kinetics of oxidation of bone char and other carbon adsorbents. The measurements were limited to temperatures between 250° and 390° C. The results were expressed in terms of the fraction of carbon burned per hour at known values of oxygen concentration, temperature, and total rate of flow for activated carbons and bone chars. The rate of oxidation could be expressed either in terms of simple first-order or retarded first-order relationships. A nomograph was used to obtain a rapid estimate of the total fraction of carbon burned at any time for a given rate constant and degree of retardation. The relationship between the reaction-rate constant and the oxygen concentration was linear for a given adsorbent under the same conditions of temperature and flow. Effect of variation in temperature on the rate of oxidation of a new bone char disclosed deviations from the Arrhenius equation even over a 100-deg interval. The influence of time, of oxygen concentration, and of temperature on decarbonization is discussed in relation to the conditions necessary in industrial operations for attaining the optimum uniformity in the carbon content of bone char. 9 p.

RP1949. Weather resistance of porcelain enamels exposed for seven years
William N. Harrison and Dwight G. Moore

A study of the weather resistance of porcelain-enameled architectural panels was begun at the National Bureau of Standards in 1939. The study involves 864 1-foot-square panels and a like number of 4- by 6-inch laboratory specimens. A previous report (1942) gave the results after 1 year of exposure. The present paper describes the condition of the panels after 7 years of weathering at Washington, D. C., St. Louis, Mo., Lakeland, Fla., and Atlantic City, N. J.

The results of the 7-year inspection showed a good correlation between the acid resistance of enamels and their resistance to weathering. Where initial coverage was complete and no mechanical damage had occurred, protection of the metal by the enamel for all specimens was unimpaired after 7 years.

Fading of colored enamels occurred only on those panels with very poor acid resistance. 14 p.

RP1950. On the precision of a certain procedure of numerical integration
Harry D. Huskey. With an appendix by Douglas R. Hartree

An example of numerical integration is given that shows very systematic effects in the less significant digits. This lack of randomness gives rounding-off errors that exceed the predicted standard deviation by a factor of three.

The example considered in this paper shows that systematic rounding-off errors can occur in numerical integration, irrespective of the number of digits kept in the contributions to the integral. In the appendix this phenomenon is examined, and criteria are set up to detect the cases in which it may arise to a serious extent. 6 p.

RP1951. Treatment of leather with synthetic resins..............Rene Oehler and Timothy J. Kilduff

Laboratory methods have been developed for treating leather with synthetic resins. The first method of treatment may be accomplished by immersing the leather specimens in monomer and subsequently polymerizing *in situ;* the second method consists of immersing the specimens in polymer solutions; and the third method involves immersion in a solution of partially polymerized liquid resin, which is further polymerized in the leather itself. The last method was developed in cooperation with the Thiokol Corporation, using Thiokol LP–2.

Abrasion resistance of vegetable-tanned crust leather treated with *n*-butyl methacrylate, polymerized *in situ,* is increased by approximately 75 percent, as measured on the National Bureau of Standards abrasion machine. Treatment with Thiokol LP–2 increased abrasion resistance by approximately 30 percent. However, treatment of vegetable-tanned crust leather with polybutyl methacrylate solution-polymer resulted in no improvement in abrasion resistance. One-half-hour water absorption data show a reduction of one-tenth to one-third that of untreated leather, depending upon the kind of treatment and leather.

By proper choice of monomers and polymerization conditions, stiffness may be controlled to meet the needs of different types of leather.

Water vapor permeability of shoe upper leather is reduced 60 percent, but is still considered ample for foot comfort. 11 p.

RP1952. Noise spectrum of a diode with a retarding field..Jacob J. Freeman

A general expression for the noise-power spectrum generated by the random emission of electrons of arbitrary trajectories within a waveguide is obtained. A numerical solution of the potential distribution within a plane diode is effected, and a family of curves from which the potential distribution may be obtained is graphed. A graphical comparison between several actual potential distributions and Von Laue's solution is given. The above results are utilized to derive the equivalent mean-square fluctuation current due to the space charge within a diode for two cases of potential distribution, namely, the linear distribution, and that distribution which occurs at the neighborhood of the beginning of the retarding field. For the case of the linear potential distribution, the equivalent noise temperature of the diode conductance is shown to be equal to the cathode temperature. 14 p.

RP1953. A spiral contractometer for measuring stress in electrodeposits Abner Brenner and Seymour Senderoff

An improved instrument for the measurement of stress in electrodeposits is described. Its operation entails the electrodeposition of a metal coating on the outside of a metal helix and the measurement of the change in radius of curvature of the helix induced by the stress in the electrodeposit. The change in radius of curvature is read from a dial on the instrument. Formulas for the calculation of stress are given, and sources of error and correction factors for them discussed. Data are presented to demonstrate the reproducibility of measurements and the validity of the results. The variation of stress with plate thickness has been investigated and shown to be related to the variation in grain size of the deposit. The advantages of the instrument and fields for its application are indicated. 16 p.

RP1954. Calculation of stress in electrodeposits from the curvature of a plated strip................Abner Brenner and Seymour Senderoff

Formulas are derived for the calculation of stress in electrodeposits from the curvature developed in a plated strip. All the formulas are derived from the fundamentals of the theory of elasticity and the relationships among the various formulas are shown. Simplified formulas are derived and their limits of applicability demonstrated. Correction factors for a number of variables and specific formulas for different experimental procedures are presented. 19 p.

RP1955. Laboratory wear tests with automotive gear lubricants
Samuel A. McKee, James F. Swindells, Hobert S. White, and Wayne Mountjoy

In the past, most of the work with the SAE extreme-pressure lubricants testing machine has been confined to the testing of the load-carrying capacity of gear lubricants under certain fixed operating conditions that simulate high speed and shock load. This paper describes a different use of the machine for the determination of the wear with gear lubricants under conditions simulating high torque and low speed. The modifications to the machine and the procedure used are described in detail.

Data were obtained with a straight mineral oil and 11 representative samples of commercial lubricants commonly used in automotive gears, when operating at 225° F and various constant loads. The loads covered were 90, 135, 180, and 225 pounds (scale reading). These data showed marked differences in the performance of the lubricants in the higher load range. The trends shown by these differences were in reasonable agreement with the known service performance of these lubricants.

Other information given includes an indication of run-in wear, the change in surface roughness of the test cups with wear, and the effect of the original surface roughness on the rate of wear. 6 p.

RP1956. The system BaO-B_2O_3....Ernest M. Levin and Howard F. McMurdie

A phase equilibrium diagram of the system BaO-B_2O_3 has been constructed from data obtained essentially by the quenching method. Four congruently melting compounds were identified: $BaO.4B_2O_3$, melting at 879° ±5° C; $BaO.2B_2O_3$, melting at 900° ±5° C; $BaO.B_2O_3$, melting at 1,095° ±5° C; and $3BaO.B_2O_3$, melting at 1,383° ±5° C. Some optical properties of these compounds were determined with the petrographic microscope, and X-ray diffraction data suitable for their identification were obtained. Barium metaborate, $BaO.B_2O_3$, showed an inversion occurring between 100° and 400° C. Mixtures containing less than 30 percent of BaO were found to separate on fusion into two liquid layers, one of which contained 30 percent of BaO, whereas the other was nearly pure B_2O_3. A curve showing indices of refraction of the quenched glasses is also presented. 8 p.

RP1957. Separation of the 177° to 200° C fraction of petroleum and the isolation of normal undecane...................Morton B. Epstein, Beveridge J. Mair, Charles B. Willingham, and Frederick D. Rossini

This report describes the separation of the 177° to 200° C fraction of petroleum (Ponca, Okla., crude) by means of regular distillation, azeotropic distillation, adsorption, and crystallization. A regular distillation at high efficiency with high reflux ratio separated the original petroleum into a series of substantially constant-boiling fractions. Appropriate blends of material of nearly the same boiling point were subjected to azeotropic distillation to produce a separation of the aromatic hydrocarbons from the paraffinic and cycloparaffinic hydrocarbons, with a partial separation of the latter two classes from each other. The fractions intermediate between the aromatic hydrocarbons and the paraffins plus cycloparaffins were further processed by adsorption to separate all the aromatic hydrocarbons. The azeotropic distillation yielded fractions very rich in normal undecane, and from these a pure sample of normal undecane was separated by crystallization. 6 p.

RP1958. Winter measurements of ozone over the Organ Mountains, New Mexico..Ralph Stair

This paper gives data on the total amount of ozone above the Organ Mountains at the White Sands Proving Ground in New Mexico from December 16 to 19, 1947, and from January 6 to 8, 1948, as determined from solar ultraviolet measurements by a phototube and filter method. The measurements indicate ozone in the stratosphere in an amount equivalent to a layer about 0.19 centimeter in thickness at normal temperature and pressure for each of the two periods. 8 p.

RP1959. Effect of convection currents on the distribution of striae in pots of optical glass................Conrad A. Faick, Arthur E. Williams, and Gerald F. Rynders

The striae distribution in pots of optical glass was studied and the role of convection currents in causing this distribution established. Tracing the convection currents and studying the effect of various cooling techniques on such currents was achieved through the introduction of copper oxide into the melts on their removal from the furnace. 17 p.

RP1960. Expansion effects of annealing borosilicate thermometer glasses
Arthur Q. Tool and James B. Saunders

The expansivity of many glasses can be increased almost 10 percent by increasing the equilibrium temperature from 150 to 200 deg C above the lowest such temperature attainable by long annealing treatments in the lower part of the annealing range. By changing the equilibrium temperatures of a number of the better known borosilicate thermometer glasses, the increase in expansivity per degree increase in equilibrium temperature was found to be about 2.4×10^{-9} at 100° C. Also, it was found that the average values of the change in volume per degree Centrigrade change in the equilibrium temperature approximated 7.8×10^{-5} when the volumes were measured at room temperature. As these effects concern the performance of thermometers, the results obtained are used to demonstrate their relation to certain ice point fluctuations that are observed in thermometers. It is shown that under particularly adverse conditions the ice point reading may be changed by as much as 30 deg C. Under more normal conditions of use, this source of error is considerably diminished, but it still remains important in precise work. Also, small changes in the value of the graduations anywhere along the stem may result from changes in the expansivity of the glass as its equilibrium temperature is changed by use at temperatures in the annealing range. 12 p.

RP1961. Zeeman effect and *g*-values for neutral nitrogen and oxygen
Carl C. Kiess and George Shortley

Zeeman patterns of red and infrared lines of nitrogen and oxygen, as observed in magnetic fields of 35,000 and 86,000 gausses, at the National Bureau of Standards and the Massachusetts Institute of Technology, respectively, show various degrees of distortion due to Paschen-Back interaction. The interpretation of these patterns has afforded an interesting application of quantum theory to the elucidation of the Paschen-Back effect. The *g*-values derived for the energy levels of N I and O I are the first to be announced for neutral atoms of atomic number less than neon, 10, and are found to conform with those required for *LS*-coupling despite the fact that the term intervals do not conform with the Landé ratios. 25 p.

RP1962. The International Temperature Scale of 1948........H. F. Stimson

The International Temperature Scale is based upon six fixed and reproducible equilibrium temperatures to which numerical values have been assigned and upon specified interpolation formulas relating temperature to the indications of specified measuring instruments. This is the first revision of the scale adopted in 1927. It is designed to conform as nearly as practicable to the thermodynamic centigrade scale as now known, while incorporating certain refinements based on experience to make the scale more uniform and reproducible than its predecessor. A new value for the temperature of the silver point and the use of Planck's law with a new value for the radiation constant, c_2, are the only changes which produce significant effects on numerical values assigned to temperatures. 9 p.

RP1963. Absorption by sound-absorbent spheres.............Richard K. Cook and Peter Chrzanowski

The absorption of a plane wave of sound by a sphere is computed. The calculations are based on the assumption that the complex ratio of sound pressure at a point on the sphere's surface to the normal component of particle velocity is a constant independent of the direction of incidence ("normal impedance assumption"). Absorption measurements were made on hair-felt covered spheres placed in a reverberation room, and were compared with the computed absorption by means of the reverberation room statistics appropriate for spheres. The theory and measurements both show that absorbent spheres can have absorption coefficients greater than unity. The discrepancies between theoretical and experimental coefficients seem to indicate that the normal impedance assumption is not valid for the hair-felt used in the experiments. 5 p.

RP1964. Heats, equilibrium constants, and free energies of formation of the C_3 to C_5 diolefins, styrene, and the methylstyrenes......John E. Kilpatrick, Charles W. Beckett, Edward J. Prosen, Kenneth S. Pitzer, and Frederick D. Rossini

For the C_3 to C_5 diolefins, styrene, and the methylstyrenes, values are presented for the following thermodynamic properties to 1,500° K: Heat-content function, free-energy function, entropy, heat content, heat capacity, heat of formation from the elements, free energy of formation from the elements, and logarithm of the equilibrium constant of formation from the elements. Equilibrium constants and concentrations are given in tabular and graphical form for some reactions of isomerization and dehydrogenation. 16 p.

RP1965. Accurate determination of the deadtime and recovery characteristics of Geiger-Müller counters..........................Louis Costrell

A brief description of the theory of operation of Geiger-Müller counters is presented, with special emphasis on the deadtime and recovery characteristics. An electronic gating instrument is described that has been developed for the determination of deadtime and recovery characteristics to an accuracy of 1 percent or 2 microseconds. Experimental data are presented showing variation of deadtime and recovery time with counter pressure and overvoltage. 9 p.

RP1966. Heats of combustion and isomerization of the six C_7H_{14} alkylcyclopentanes...................Walter H. Johnson, Edward J. Prosen, and Frederick D. Rossini

The heats of isomerization of the six C_7H_{14} alkylcyclopentanes were determined by measurement of the ratios of the heats of combustion of purified samples of these compounds in the liquid state by the procedure previously described for other isomeric hydrocarbons. The data yield the following values for the heat of isomerizations, $\Delta H°$, in the liquid state at 25° C, of ethylcyclopentane into each of the dimethylcyclopentanes, in kilocalories per mole: Ethylcyclopentane, 0.00; 1,1-dimethylcyclopentane, —2.06±0.12; *cis*-1,2-dimethylcyclopentane, —0.44±0.20; *trans*-1,2-dimethylcyclopentane, 1.86 ±0.16; *cis*-1,3-dimethylcyclopentane, —1.11±0.24; *trans*-1,3-dimethylcyclopentane, —1.60±0.14. These values were combined with values for the differences in the heats of vaporization of these isomers to obtain values for the heats of isomerization in the gaseous state at 25° C.

Utilizing the values previously reported for the heats of combustion and formation of ethylcyclopentane in the liquid and gaseous states at 25° C, values were calculated for the heats of combustion and formation of the five dimethylcyclopentanes in the liquid and gaseous states at 25° C. 5 p.

RP1967. Surface available to nitrogen in hydrated portland cements
Raymond L. Blaine and Harold J. Valis

Measurements were made of the adsorption of nitrogen, oxygen, and argon at or near the boiling point of the adsorbate on samples of hydrated portland cement. Surface-area values calculated on the basis of the Brunauer-Emmett-Teller theory indicated an increase in surface available to nitrogen with age of test specimens when a high water-cement ratio was used in preparing the paste but not when a low water-cement ratio was used. Temperature of storage and type of moist storage made little difference in the apparent surface available to nitrogen. Surface values calculated from the N_2, O_2, and A isotherms were much smaller than those previously reported, which were calculated from the adsorption of water vapor. 11 p.

RP1968. Heat of isomerization of the two butadienes......Edward J. Prosen, Frances W. Maron, and Frederick D. Rossini

The heat of isomerization of 1,3-butadiene to 1,2-butadiene, in the gaseous state at 25° C was determined by measurement of the ratio of their heats of combustion in oxygen to form carbon dioxide and water. The combustion of the gaseous hydrocarbon occurred in a flame at constant pressure in a glass calorimetric reaction vessel of improved design. A complete description of the new calorimetric reaction vessel is given.

The following experimental value is reported for the reaction of isomerization:

1,3-butadiene(gas) = 1,2-butadiene(gas), ΔH° at 25° $C = 12.78 \pm 0.16$ kcal/mole.

Using the value for the heat of formation of 1,3-butadiene previously reported, the following calculated values are given for the reactions of formation and combustion of 1,2-butadiene:

4C(solid, graphite) $+3H_2$(gas) $= C_4H_6$(1,2-butadiene, gas), ΔH° at 25° $C = 39.53 \pm 0.28$ kcal/mole.

C_4H_6(1,2-butadiene, gas) $+5\frac{1}{2}$ O_2(gas) $= 4CO_2$(gas) $+ 3H_2O$(liquid, ΔH° at 25° $C = -620.69 \pm 0.28$ kcal/mole.

7 p.

RP1969. Optical glass of interferometer and Schlieren quality for wind-tunnel optics..................................Leroy W. Tilton

Large disks for wind tunnels should be uniform in optical thickness within $\pm 1/16\ \lambda$ if highest accuracy in measurements by interference fringes is to be insured. This means that heterogeneities in the glass shall be less than $\pm 5 \times 10^{-7}$ in refractive index for thicknesses of 3 or 4 centimeters. Evidence is cited to show that differences in chemical composition in good glass may not prevent realization of the desired uniformity, and that stress birefringence cannot be an important preventing factor. The remaining source of nonuniformity in glass is the existence of temperature gradients during annealing that can cause changes in structure, and it has been found that these can be reduced within required limits simply by encasing the glass, during annealings, in a sufficient number of concentric boxes composed of alternately heat-conducting and insulating layers. 8 p.

RP1970. A standard of small capacitance......................Chester Snow

A formula is derived for computing the electrical capacitance of an absolute standard that is a modification of the ordinary parallel-plate condenser with coplanar guard. The modification consists in placing the circular face of the electrode at the bottom of a cylindrical hole in the guard. The analogous two-dimensional arrangement is also considered. The two cases are formulated as special cases of a more general one, in such a manner as to show that certain approximate formulas have errors of the same order of magnitude in each case. The magnitude of the error is then determined by comparison with an exact formula obtained for the two-dimensional case by conformal transformation. With certain restrictions, easily made in practice, this error seems to be less than one part in two thousand. 22 p.

RP1971. Properties of aqueous solutions of perchloric acid
Langhorne H. Brickwedde

Several properties of the system $HClO_4$-H_2O for concentrations of $HClO_4$ varying from 0 to 70 percent by weight have been measured from —60° to +75°C. These properties include density, viscosity, electrical resistivity, and freezing temperatures of the solutions. An empirical relation between electrical resistivity, kinematic viscosity, and temperature has been found to be of the same form as the relation which Vinal and Craig found for sulfuric-acid solutions. The properties of perchloric-acid solutions of interest for battery work have been discussed. Some measurements of electrical resistivity of solutions containing the lead salt formed as a perchloric-acid battery discharges have been measured. 21 p.

RP1972. Characterization of some commercial soaps by X-ray diffraction
Gopal S. Hattiangdi

The diffraction of X-rays by 29 commercial soaps was investigated. The patterns indicate that the soaps are crystalline, and the data have been used to identify the various phases in the solid soaps. The single long-spacing value obtained for the toilet, medicated, glycerin, coco, and washing soaps is indicative of the existence of a single crystal type in these soaps. The exhibition of two or three sets of long-spacing values by the shaving soaps is indicative of the presence in these soaps of two or three individual phases.

The moisture content of these soaps indicates that the toilet and medicated soaps are either hemihydrates or monohydrates; the coco soaps, dihydrates; and the shaving soaps, monohydrates. 11 p.

RP1973. Characterization of alkali soaps by electron microscopy
Gopal S. Hattiangdi and Max Swerdlow

The morphological differences between several closely related alkali soaps have been determined by the techniques of electron microscopy. The crystalline alkali soaps consist of an interlocked mesh of bundled fibers, whereas the liquid-crystalline soaps exhibit a flagellar and/or featureless phase. The micellar groupings for the individual soaps are unique, and a scheme based upon the electron micrographs is suggested for their characterization. The structures of lithium, sodium, and potassium palmitates are closely related. The laurate, palmitate, and stearate of sodium also exhibit homologous structures.

The results of these morphological investigations offer a rapid and accurate means of identification and have been successfully applied to the problem of characterizing commercial soaps of unknown composition. 18 p.

RP1974. Some physical chemical properties of aqueous solutions of soaps and soapless detergents......Gopal S. Hattiangdi, William W. Walton, and James I. Hoffman

A study has been made of the effect of concentration on the surface tension, electrical conductance, pH, opacity, and foam formation of aqueous solutions of 30 typical commercial soaps and 6 popular soapless detergents. The soaps included the following types: Toilet, "medicated," glycerin, coco, washing (laundry), and shaving soaps. The results are explained on the basis of the colloidal nature of the solutions and the soap phases that have been found in the solid soaps by studies of X-ray diffraction and electron microscopy. The significance of the results in terms of micelle formation and the relationship between micelles and detergent actions are discussed. 8 p.

RP1975. Doubly charged ion spectra in mass spectra of hydrocarbons
Fred L. Mohler, Evelyn G. Bloom, Edmund J. Wells, Jr.,
Jonathan H. Lengel, and C. Edward Wise

A compilation of doubly charged ions in the mass spectra of 148 hydrocarbons has been made, based on mass spectra published in the American Petroleum Institute Catalog of Mass Spectral Data. In hydrocarbons with three, four, or five carbon atoms, the most probable double ionization process involves loss of all but two or three hydrogen atoms without breaking carbon bonds. Unsaturated molecules give larger doubly charged ion peaks than saturated molecules, and ions with an even number of hydrogen atoms tend to be more abundant than those with an odd number. In saturated hydrocarbons with six or more carbon atoms, double ionization with breaking of carbon bonds is most probable, but in benzenes and highly unsaturated molecules, double ionization without loss of carbon atoms is probable. These heavier molecules show distinctive differences depending on molecular structure.

The ratio of ion current at 70 volts to that at 50 volts ionizing voltage is an indication of the appearance potential of the ion. It increases as the number of hydrogen atoms removed increases, and the results indicate that hydrogen atoms are removed in pairs to give H_2. 10p.

RP1976. Heats, equilibrium constants, and free energies of formation of cyclopentene and cyclohexene..................Morton B. Epstein,
Kenneth S. Pitzer, and Frederick D. Rossini

For cyclopentene and cyclohexene, values are presented for the following thermodynamic properties to 1,500° K: heat-content function, free-energy function, entropy, heat content, heat capacity, heat of formation from the elements, free energy of formation from the elements, and logarithm of the equilibrium constant of formation from the elements. Equilibrium constants are given in graphical form for some reactions of isomerization, dehydrogenation, and disproportionation. 4 p.

RP1977. Preparation of calicum melibionate..............William W. Walton
and Horace S. Isbell

It has been found possible to prepare the comparatively rare salt, calcium melibionate, in any desired quantity by electrolytic oxidation of a crude solution of melibiose. The melibiose solution, prepared from commercial raffinose, is subjected to electrolytic oxidation in the presence of calicum carbonate and calcium bromide, and the calcium melibionate is crystallized directly from the electrolyte. The optical rotation of a 2-percent aqueous solution of calcium melibionate, expressed on the anhydrous basis, was found to be $[\alpha]_D^{20}+106.2°$ which disagree with the value, $[\alpha]_D^{17}+88.6°$, reported in the literature. Calcium melibionate forms a basic calcium salt, $Ca(C^{12}H^{21}O^{12})^2.4CaO$. This is analogous to the basic calcium salts of lactobionic and maltobionic acids. 3 p.

RP1978. Polarographic limiting currents................John Keenan Taylor,
Roberta E. Smith, and Irvin L. Cooter

A cathode-ray oscillograph and special camera were used to record instantaneous values of the current for the dropping-mercury electrode. The results show that the Ilkovic equation does not represent the current as a function of time. The relation between the average current during the life of a drop and that measured by several polarographic circuits was determined. 9 p.

RP1979. Stress distribution near reinforced circular hole loaded by pin
Samuel Levy and Frank C. Smith

This paper presents a theoretical analysis for the stress distribution in a flat plate near a reinforced circular hole loaded by a pin, and a comparison of the theory with test results for a plate of sandwich construction. It is assumed that an auxiliary reinforcement at the edge of the hole is so rigid that no distortion of the shape of the hole occurs due to the load. The plate is reinforced in the vicinity of the hole by circular "doubler" plates. The theory and experiment are found to be in good agreement. 8 p.

RP1980. Volumetric determination of columbium........Howard B. Knowles
and G. E. F. Lundell

The quantitative determination of columbium based on reduction by amalgamated zinc and reoxidation with potassium permanganate has, in general, produced results that lack both accuracy and precision. A study of the various factors involved indicates that essential conditions require adequate duration of reduction in the presence of an excess of zinc and a proper concentration of both acid and columbium. A procedure is described whereby columbium, in a sulfuric acid solution, is quantitatively reduced by amalgamated zinc to the trivalent form and subsequently oxidized to the quinquevalent state. 4 p.

RP1981. Effect of concentration on the viscosity of dilute solutions
Robert Simha

A theory of the higher coefficients of the viscosity-concentration curve of a suspension of nonspherical particles is presented. Starting with the simple model of a dumbbell, the flow around a single particle and its modification due to interaction with other particles are considered. It is shown that the coefficients a_i in the equation

$$\eta=\eta_0(1+a_1c+a_2c^2+a_3c^3+\ldots.)$$

are related to each other, namely,

$$a_2=k_1a_1,\ a_3=k_2a_1{}^3\ldots.\ ,$$

where the k's are independent of molecular size, in agreement with empirical equations. An explicit value for k^1 is obtained that applies also to models consisting of various arrays of spheres. The variation of k^1 with molecular shape is discussed, and various factors affecting the numerical values and the validity of the last-mentioned equation are pointed out. 10 p.

RP1982. Acidic dissociation constant of ammonium ion at 0° to 50° C, and the base strength of ammonia......................Roger G. Bates
and Gladys D. Pinching

The acidic dissociation of many acids has been studied in detail, but weak bases have generally been neglected because of the experimental difficulties encountered in the investigation of some of their buffer solutions by electromotive-force methods. These difficulties may arise from volatility of the free base or the existence of extraneous electrode reactions such as the formation of ammine complexes at the silver-silver-chloride electrode. In this study of ammonia, special saturators were used to prevent, insofar as possible, the removal of ammonia from the solutions by the hydrogen gas. A correction was applied for the amount of diammine silver complex formed at the silver-silver-chloride electrode, and this silver ion was prevented by mechanical means from reaching the platinum electrodes.

With these precautions, the acidic dissociation constant of ammonium ion at 0° to 50° C was determined from electromotive-force measurements on 19 buffer solutions containing equal molalities of ammonia and ammonium chloride. The changes of free energy, heat content, entropy, and heat capacity that accompany the dissociation processes in the standard state were derived from the temperature coefficients of the acidic dissociation constant of ammonium ion and of the basic dissociation constant of ammonia. The activity coefficient of ammonium chloride in equimolal buffer solutions at 25° C was calculated. 12 p.

RP1983. Concrete as a protective barrier for gamma rays from radium
Harold O. Wyckoff and Robert J. Kennedy

Several papers [1, 2, 3] and Handbooks [4, 5] have been published during the past 20 years dealing with barrier requirements for shielding against gamma radiation from radium. These publications have usually suggested lead for the barriers because a large proportion of the applications required restricted space and ready transportability of the barrier and gamma-ray source. For high-energy X-ray installations, it is often more economical to use concrete barriers. It has been suggested that concrete might also be useful for shielding in gamma-ray installations if attenuation curves were available. The present paper presents this required information for radium. 5 p.

RP1984. Transient vibration in an airplane wing obtained by several methods
Walter Ramberg

Analysis of the flexural transients in a model airplane wing following a "soft" unsymmetrical two-point landing impact indicates that Williams' method, separating "static" and vibrational response, is superior to the normal modes method used by Biot and Bisplinghoff, in leading to values in good agreement with experiment without using more than four modes. A method of coupled modes suggested by Levy leads to values of the response about as accurate as those from Williams' method with as few as three vibrational modes.

None of the three methods showed rapid convergence for the response following a "hard" impact of the same shape as the soft impact, but with only one-fifth of the duration. Attempts to develop a traveling wave method for the solution of this problem have been unsuccessful so far. 11 p.

RP1985. Use of plastic replicas in evaluating surface texture of enamels
Joseph C. Richmond and Allen C. Francisco

A technique for making ethyl cellulose replicas of enameled and other surfaces is described. Photographic prints of a number of replicas are shown and methods of analyzing the replicas are discussed.

The haze of replicas was used to evaluate 25 enamels abraded in the Standard Porcelain Enamel Institute Surface Abrasion Test. Graphs are shown comparing these ratings with those obtained by the standard method, by visual estimates of the abrasion as seen on the enameled specimens, and by visual estimates of the abrasion as seen in the replicas. The haze of replica method appears to offer advantages for evaluating the amount of abrasion. 12 p.

RP1986. An electric gage for measuring the inside diameter of tubes
Abner Brenner and Eugenia Kellogg

An electric gage has been developed for measuring the bores of small guns or tubes of about ½-inch inside diameter. Its operation depends on the mutual inductance of two coils. The instrument has a solenoid mounted on each prong of a fork. The current induced in the secondary varies inversely with the distance between the primary and secondary coils. The gage is calibrated with rings of known diameter, and the diameter of a tube or gun bore is read directly on the dial of the instrument. 4 p.

RP1987. Effect of boron on the structure and some physical properties of plain cast irons..........Alexander I. Krynitsky and Harry Stern

The effects of boron additions, ranging from 0.001 to 0.48 percent, on the properties of various gray cast irons were determined by casting chill plates, wedge castings, and arbitration bars. Cooling curve data indicated that during solidification boron produced an undercooling effect, which increases with increasing boron content. Boron increases the depth of chill in chill plates and wedges, as well as the hardness of arbitration bars and chill plates. Boron decreases the size and quantity of graphite, increases the free carbide content, and tends to increase the amount of eutectic structure. "Structureless" envelopes around the pearlite islands and "structureless islands" in the cementite matrix accompany an increase in the boron content. 15 p.

RP1988. Improved single-unit Schiefer abrasion testing machine
Herbert F. Schiefer, Lawrence E. Crean, and John F. Krasny

A greatly improved single-unit Schiefer abrasion testing machine and a number of new abradants were developed. The abrasive wear on a variety of materials was found to be extremely uniform over the abraded area. On woven fabric the wear was similar to that observed in actual service. The effect of the amount of plasticizer in plastics and the effect of yarn and cloth construction in textiles on the resistance to abrasion were readily shown by the results obtained with the machine. A quantitative method for measurement of the amount of abrasion, based upon the change in electrical capacitance of the specimen, was developed for textiles, and a quantity that is a measure of destruction or ruin was defined. This method was applied to obtain an isoriun map of a large area of a trouser leg and clearly indicated a number of areas at which excessive abrasive wear had occurred in service. 17 p.

RP1989. Pyrolysis of polyisobutene (vistanex), polyisoprene, polybutadiene, GR–S, and polyethylene in a high vacuum....Samuel L. Madorsky, Sidney Straus, Dorothy Thompson, and Laura Williamson

Samples of polyisobutene, polyisoprene, polybutadiene, GR–S, and polyethylene, weighing about 25 to 50 milligrams, were pyrolyzed in a vacuum of about 10^{-6} millimeter of mercury in a specially designed apparatus at temperatures ranging between 300° to 475° C. The volatile products of pyrolysis were separated into four fractions: (IV) gaseous, volatile at —196° C; (IIIA) liquid, at —75° C; (IIIB) liquid, at 25° C and (II) wax-like fraction, volatile at the temperature of pyrolysis. The gaseous fraction was analyzed in the mass spectrometer and was found to consist in all cases of CH_4. The liquid fraction, IIIA, was analyzed similarly and was found to give a mass spectrum characteristic for any given polymer. A molecular weight determination of the wax-like fraction by the microfreezing-point-lowering method, showed it to vary from 543 to 739, depending on the polymer from which the fraction was obtained. It is shown that the method of pyrolytic fractionation of high molecular weight polymers, in conjunction with mass spectrometer analysis of the more volatile fractions, can serve as a means of identifying the polymers. 16 p.

RP1990. Basis of the application of network equations to waveguide problems
David M. Kerns

A systematic and general formulation of the concepts and the conditions that underlie the technique of the application of network equations to waveguide problems is presented. The discussion is guided by a formulation of what may be called the *transducer concept*, according to which, essentially, a transducer is a power-transfer device which is to be described only in terms of external characteristics. Waveguide and circuit devices are considered as transducers whose terminal phenomena are electromagnetic fields varying harmonically with time. The basic task is then the definition of suitable terminal variables characterizing the terminal fields. The construction of variables of this kind for waveguide transducers is discussed in considerable detail; for circuits, for which suitable variables are voltage and current, the construction is sketched. *Transducer theory* is defined, discussed, and illustrated by the development of selected relations of the theory, and is shown to coincide with much of what is generally connoted by "theory of four-terminal networks."

As a matter of interest and importance in applications of the technique, derivations of a rather general reciprocity theorem and of a version of Foster's reactance theorem are included. Both theorems apply to both waveguide and circuit structures. 26 p.

RP1991. A study of laboratory Bunsen burners for natural gas
John H. Eiseman

Sixteen different laboratory-type Bunsen burners, sold as suitable for natural gas, were purchased and their limits of operation determined. Eight of the burners were of the Meker type, and eight were straight-tube burners. The results of the study indicate the need for certain changes in design if satisfactory operating characteristics are to be obtained with natural gas.

A comparison of the dimensions of these burners with the fundamental relations for good burner operation brought out the following three major reasons for their unsatisfactory performance: Too small a port area, improper throat size, and insufficient primary air opening. In addition to these three factors, use of the proper orifice size was also found to be of importance. Two burners, one a straight-tube and the other a Meker type, were modified so that they complied with the requirements as determined by this study. Both burners were found to be greatly improved and were capable of producing a hot, stable flame over a range of gas rates approximately double their former usable rates. 14 p.

RP1992. Studies on the purification of collagen..............James M. Cassel
and Joseph R. Kanagy

Several methods of purifying collagen were studied. The effects of particular treatments of collagen were followed by nitrogen determinations, by electrometric titration analyses, and by electrophoretic measurements.

Treatment of the raw material with trypsin, as in the conventional method for the preparation of collagen, results in changes that lead to a degradation of the collagen in subsequent extractions. Treatment with dilute salt solution followed by trypsin produces a material of comparatively low isoelectric point (pH 5.5). Apparently soaking in dilute salt solution is not detrimental to collagen, and it is recommended that this type of extraction be substituted for the extraction with trypsin.

A technique for removing all but a negligible part of the mineral content from collagen is described, and a procedure is recommended for use in the preparation of ash-free gelatin.

A specification is proposed for purified collagen: (1) The water extract shall have a pH range of 6.0 to 7.0; (2) the isoelectric point (determined electrophoretically) shall be between pH 6.0 and 7.5; (3) the material shall have an ash content of less than 0.1 percent, total nitrogen content of 17.8 to 18.1 percent, and an amide nitrogen content (determined by hydrolyzing for 20 hours in 0.1 N hydrochloric acid at 90° C) of at least 3.8 percent, expressed as percentage of total nitrogen. 9 p.

RP1993. Flame spectrum of acetylene from 1 to 5 microns....Earle K. Plyler
and Curtis J. Humphreys

The spectrum of an oxyacetylene flame obtained with a welding torch has been observed and measured by using a Perkin-Elmer spectrometer, with a LiF prism. Bands were observed at 1.2, 1.3, 1.52, 1.85, 2.0, 2.3, 2.48, and 2.8 μ, which agree in position and general appearance with bands originating in the methane flame, except for newly observed bands at 1.5 and 2.3 μ. The 1.5-μ band probably represents the $\nu_1+\nu_3$ combination in the C_2H_2 molecule, and the 2.3-μ band is probably the R-branch of the $2\nu_1$ band of CO, the P-branch being overlapped by the R-branch of the 2.7 μ H_2O band.

The band at 2.8μ shows fine structure on the long wavelength side consisting of 29 lines between 2.8 and 3.6 μ, when a flame of reduced oxygen content is used. With a hot flame obtained with the maximum amount of oxygen, this number is reduced to 10 in the region from 3.1 to 3.7 μ, some of which show good agreement with calculated values for the $2\rightarrow1$ band of OH. On the long wavelength side of the intense CO_2 emission band at 4.45 μ, 27 rotational lines have been observed, some of which agree closely with the rotational absorption lines of the CO fundamental. This structure was also observed in the methane-oxygen flame.

Evidence for the validity of the interpretations of certain features of these bands as originating in OH and CO is critically examined, and it is concluded that further observations with the higher resolution provided by a grating spectrometer, will be required to establish the certain identification of the spectra of OH and CO in the flame. 6 p.

RP1994. Viscosity of deuterium oxide and water in the range 5° to 125° C
Robert C. Hardy and Robert L. Cottington

Measurements of the absolute viscosity of deuterium oxide of 99.5 percent purity and of water were made over the range 5° to 125° C. It is estimated that these determinations are accurate within 0.1 percent in relation to the value 1.0050 centipoise for the viscosity of water at 20° C. The work also included determinations of density of deuterium oxide over the range 90° to 125° C. Values for the viscosity and density of 100-percent deuterium oxide were obtained by linear extrapolations. The ratio of the viscosity of deuterium oxide to that of water at the same temperature was found to be 1.3052 at 5° C. This ratio decreased at a diminishing rate with increase in temperature to a value of 1.1456 at 125° C. 6 p.

RP1995. Determination of efficiency of microwave bolometer mounts from impedance data..David M. Kerns

An impedance method of determining the input-to-bolometer-element power-transfer efficiency of bolometer mounts of the type used in microwave power measurements is formulated, and the theoretical basis of the method is outlined. The method stems from the consideration of the bolometer mount as a transducer. Under certain conditions, which are discussed, this transducer is representable as a two-terminal-pair network, and its parameters can be determined, essentially as in the case of ordinary networks, from observation of input impedance (in waveguide or coaxial line) as a function of load impedance (bolometer resistance). Convenient formulas are given for the calculation of power-transfer efficiency from such impedance data. 7 p.

RP1996 Ultraviolet absorption spectra of seven substituted benzenes
Ralph Stair

The ultraviolet absorption spectra of seven substituted benzenes have been measured in the region of 220 to 300 millimicrons. The substances were *n*-, *iso*-, *sec*-, and *tert*-butylbenzene and 1,2-, 1,3-, and 1,4-diethylbenzene. The wavelengths (also frequencies in centimeters^{-1}) are shown for the absorption bands for each substance. Spectral absorbancy curves are given for the same concentration in each case. The hydrocarbons were NBS Standard Samples prepared in connection with American Petroleum Research Project 6 and were highly purified in the Chemistry Division of this Bureau. These spectral data should be of value in chemical analysis in the field of ultraviolet absorption spectroscopy.

The measurements were made with a Beckman quartz spectrophotometer on 1-centimeter cells of the hydrocarbons in a solution of isooctane (2,2,4-trimethylpentane). 7 p.

RP1997. Acid-base equilibrium constants for the reaction of tribenzylamine with picric acid and with trinitro-*m*-cresol in benzene, from spectrophotometric data........................Marion Maclean Davis
and E. Anne McDonald

The relative acidic strengths of picric acid and trinitro-*m*-cresol in benzene have been measured spectrophotometrically in terms of their reactivity with the base, tribenzylamine. The respective constants found for the combination of tribenzylamine with picric acid and with trinitro-*m*-cresol in benzene at 25° C are 1.58×10^3 and 4.48×10^2. The same relative order of strengths would be predicted on theoretical grounds. The constant for picric acid is in close agreement with previous measurements of the dielectric constant of benzene solutions of tribenzylammonium picrate. The method used for assessment of the relative strengths of the two acids is superior to measurements of their ionic dissociation in water. 9 p.

RP1998. Transmission of reverberant sound through single walls
Albert London

Transmission of reverberant sound through homogeneous single walls has been investigated theoretically and experimentally. Random incidence sound-transmission measurements were made on homogeneous walls of aluminum, plywood, and plasterboard. The results were found to be in satisfactory agreement with a modified version of a theoretical treatment first given by Cremer, which postulates that the wall impedance has a resistive component in addition to its mass reactance and a stiffness reactance resulting from the occurrence of flexural waves. Two of three parameters that are required to predict the transmission loss, namely, resistance, and critical flexure frequency, the third one being mass, are evaluated from the experimental data in such a way as to obtain the best fit between the theoretical and experimental results. Conditions under which the mass law of sound transmission may be assumed to be valid are investigated in detail by studying the behavior of Rayleigh's transmission law, which takes into account the compressional waves induced in the wall.

Experimentally, it was found that considerable improvement in transmission loss could be obtained by applying a fairly substantial sound-absorbent blanket to one of the faces of a homogeneous wall. 11 p.

RP1999. Separation and identification of the major c_7 to c_{10} components of triptene residue............Philip Pomerantz, Thomas W. Mears, and Frank L. Howard

As a part of an investigation conducted under the auspices of the National Advisory Committee for Aeronautics, the Bureau of Aeronautics of the Department of the Navy, and the Department of the Air Force, embracing the synthesis and isolation of highly branched hydrocarbons, a series of systematic distillations was carried out on "triptene residue," a synthetic alkylate made at the Radford Laboratories of the General Motors Corporation.

This report describes the isolation thereby of two heptenes, four octenes, and three nonenes; the identification of four heptenes, two octenes, three nonenes, and six decenes not resolvable by fractional distillation; and the isolation of two heptanes, two octanes, one nonane, and five decanes formed by hydrogenation of mixtures of olefins. Physical constants for the isolated products and graphs showing the course of the several distillations are presented.

The analysis presented is based, where individual olefins were isolated, on the distillation curves; where the mixtures obtained by distillation were more complex, the analysis is based on ozonolysis data and/or distillation data of the hydrogenated product.

The mechanism of successive methylation by which the several olefins in the mixture were derived has been shown to be valid. 16 p.

TITLE PAGE AND CONTENTS TO VOLUME 42. 6 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 43, JULY—DECEMBER 1949

RP2000. Volume changes observed in small concrete cylinders during freezing and thawing using a mercury displacement dilatometer
Rudolph C. Valor, Jr.

A mercury-displacement dilatometer is described for continuously determining the changes in bulk volume of small concrete cylinders during freezing and thawing. Various types of freezing and thawing cycles were employed in which the 40° to —20° F range was covered at various rates. The results presented are representative volume-temperature relationships obtained for specimens tested in air-dry, partially saturated, and "vacuum-saturated" moisture conditions. Relationships for air-dry specimens yielded uniform thermal-expansion data, but those for partially saturated specimens showed departures from uniformity that are ascribed to the freezing and thawing of water in the pore structures of the specimens. Vacuum-saturated specimens showed much larger departures and failed as a result of a single cycle of freezing and thawing. 20 p.

RP2001. Electrophoresis of modified collagen................James M. Cassel and Joseph R. Kanagy

Electrophoretic studies were made on collagen samples that were modified by a variety of treatments. The isoelectric point of collagen heated at 140° C in air is pH 5.3, and that of collagen shrunken by heating in water is pH 5.2, as compared with pH 7.0 for the untreated collagen. Deaminized collagen was isoelectric at pH 4.6.

The isoelectric point of purified collagen was lowered by tanning with basic chromium sulfate solutions. Samples were tanned to contain 0.6-, 1.0-, 1.8-, and 2.5-percent of chromium expressed as chromic oxide. A maximum shift in isoelectric point was observed with a sample in which 1.8-percent of chromic oxide was fixed. Chrome tanning a deaminized collagen sample had only a small effect on the isoelectric point. A vegetable-tanned leather and vegetable-tanned collagen were isoelectric at pH 3.2. Chrome retanning a vegetable-tanned collagen did not affect its isoelectric point.

The electrophoretic behavior of tanned collagen is compared with that of unstretched nylon. 8 p.

RP2002. Infrared absorption spectra of cyclo-hydrocarbons..Earle K. Plyler and Nicolo Acquista

The infrared absorption spectra of 19 hydrocarbons have been measured in the 3.4-micron region, and the location of the two CH_2 vibrations has been determined. The vibrations occur at 2,854 and 2,927 cm^{-1} for the methylclohexane and 2,866 and 2,952 cm^{-1} for the methylcyclopentane. For cyclohexene the wave numbers of the bands are 2,845 and 2,934 cm^{-1}, and for cyclopentene they occur at 2,853 and 2,959 cm^{-1}.

The region from 2 to 4 microns has been measured for methylcyclohexane, ethylcyclohexane, *cis*-1,2-dimethylcyclohexane, *trans*-1,2-dimethylcyclohexane, and the corresponding cyclopentanes. Also, the spectra of cyclohexene and cyclopentene have been measured from 2 to 4 microns. The near infrared bands of methylcyclohexane, methylcyclopentane, and ethylcyclopentane have been classified as fundamentals and as combinations of long wavelength bands. 12 p.

RP2003. Low-temperature performance of radiosonde electric hygrometer elements...Arnold Wexler

The performance of radiosonde electric hygrometer elements was investigated in the temperature range from 0 to —40° C. It was found that an element indicated relative humidity with an average deviation of ±2.4-percent relative humidity from the average calibration for all of the elements tested. The maximum deviation in indication of any element did not exceed 10.5-percent relative humidity. The lag in response was found to increase markedly with decrease in temperature, to depend upon the magnitude and direction of relative humidity change, and the relative humidity from which the change was made. 8 p.

RP2004. Refractive index of natural rubber for different wavelengths Lawrence A. Wood and Leroy W. Tilton

The refractive indices of a prism of natural rubber have been measured at five different wavelengths in the visible region by the use of a spectrometer. Values of the rate of change of index with temperature at each wavelength have been computed for the range 19.5° to 30.3° C. The Eykman equation in differential form is used to calculate the expansivity from the index and its rate of change with temperature. It is concluded that the two-constant Cauchy and Sellmeier dispersion equations are inadequate to represent the data. The dispersion observed for rubber is found to be essentially the same as that of hydrocarbons of similar structure but of low molecular weight. 8 p.

RP2005. Metastable transitions in mass spectra of hydrocarbons
Evelyn G. Bloom, Fred L. Mohler, C. Edward Wise,
and Edmund J. Wells

This paper gives a compilation of metastable transition peaks in mass spectra of about 170 hydrocarbons based on experimental data that have been published in the American Petroleum Institute Catalog of Mass Spectra Data. One hundred different transitions have been found and identified. These are tabulated according to the mass lost in the transition. Masses lost are 1, 2, 15, 16, 26, 27, 28, 29, 30, 40, 42, 43, 44, 56, 57, and 58. Nearly all transitions can be ascribed to breaking of one bond with or without the transfer of one hydrogen atom to the charged or to the neutral fragment. The data include those previously reported in Research Paper 1888 [1]. 6 p.

RP2006. Impedance characteristics of some experimental broad-band antennas
for vertical incidence ionosphere sounding.............H. N. Cones

This paper presents the results of measurements of the modulus of input impedance of a number of nonresonant antennas over a continuous frequency range from 1 to 25 megacycles per second. These antennas were constructed as part of a design problem of developing an effective radiating system for vertical-incidence ionospheric sounding equipment. The data are in the form of curves, and the antennas are compared with each other from the standpoint of uniformity of impedance over the frequency range. The use of multiple-wire construction to lower the average input impedance, to minimize impedance variations, and to increase radiation efficency is discussed. 8 p.

RP2007. Formulas for the percentage points of the distribution of the arithmetic mean in random samples from certain symmetrical universes
Uttam Chand

Using the method of Fisher and Cornish, the $100\epsilon\%$ point of the distribution of the arithmetic mean in random samples of size N from any universe having finite cumulants, K_1, K_2, K_3, . . . , is expressed to order $1/n^2$ as a function of (*i*), the first five positive integral powers of the $100\epsilon\%$ point of a standardized normal variable, and (*ii*) the quantities K_1, $(K_2)^{1/2}$, and $K_r/(K_2)^{r/2}$ for $r=3$, 4, 5, and 6. The numerical coefficients involved are evaluated for the case of sampling from the normal, rectangular, double-exponential, sech, and sech^2 distributions, and the accuracy of the resulting formulas illustrated by numerical examples. 2 p.

RP2008. Refractive indices of thallium bromide-iodide crystals for visible and
infrared radiant energy..........Leroy W. Tilton, Earle K. Plyler,
and Robert E. Stephens

The refractive indices of two specimens of thallium bromide-iodide (KRS_5) were measured at a constant room temperature of 27° C from 0.577 to 39 microns by use of a minimum-deviation spectrometer and a Perkin-Elmer infrared spectrometer equipped with a calibrated screw for operation of the Littrow mirror. In order to cover the entire region over which the prisms are transparent, many known wavelengths were used, including lines of mercury, sodium, hydrogen, and helium for the visible region. A cadmium-mercury lamp was the source from 1 to 2 microns. From 2 to 39μ various absorption bands of carbondioxide, water, methylcyclohexane, polystyrene, and polyethylene were used, with a Globar as source, for the identification of wavelengths. 6 p.

RP2009. Fundamental aspects of the reaction of oxygen with carbon adsorbents...........William V. Loebenstein and Neil L. Pennington

The kinetics for the oxidation of the carbon in a coconut-shell charcoal, a new bone char, two service bone chars, and a spent bone char was found to be retarded first-order in character. The experimental data were obtained in a flow system with nitrogen-oxygen gas mixtures at temperatures below 400° C. Using the initial fractional rate of oxidation of the carbon as the criterion of evaluation, a linear plot against oxygen concentration was obtained for each temperature at which the combustion was studied. The influence of temperature was expressed as the sum of two exponential Arrhenius-type terms. A single relationship was derived by combining the effects of these two variables. This relationship proved equally valid when applied to all carbon adsorbents investigated. Some reaction mechanisms were proposed that were consistent with the experimental findings of the investigation. 10 p.

RP2010. Mass spectrum of pentaborane (B_5H_9)..........Vernon H. Dibeler, Fred L. Mohler, Laura Williamson, and Robert M. Reese

The mass spectrum of B_5H_9 has been measured, and the monoisotopic spectrum has been computed using the isotope abundance $B^{10}=0.200$ and $B^{11}=0.800$. The mass spectrum shows that the molecule has a marked tendency for ionization with loss of either two or four hydrogen atoms, but little tendency to lose one or three. The high yield of ions containing five boron atoms and the tendency to give up either two or four hydrogen atoms suggests a five-membered ring structure with two pairs of loosely bound hydrogen atoms. Since the spectrum is quite different from that of C_5 ring compounds, however, no definite conclusion concerning the structure is drawn at present. 4 p.

RP2011. Effect of chromium plating on the endurance limit of steels used in aircraft..Hugh L. Logan

Chromium plating reduced the endurance limits of both normalized and hardened (quenched and tempered) SAE X4130 steels; the reduction was larger for the hardened steel. The endurance limits for steel of a given hardnes decreased with increased plating bath temperatures. Baking of the plated steel, at temperatures up to 350° C, reduced the endurance limit; baking at 440° C increased the endurance limit of the plated steel. However (for hardened steel) baking did not restore the endurance limit to that of the unplated steel. Damaging effects of chromium on the endurance limits of plated steels are attributed to stresses in the chromium and/or steel, which are increased by low temperature baking but are relieved in part by baking at 400° to 440° C. 12 p.

RP2012. Heats of combustion and formation of cyclopropane
John W. Knowlton and Frederick D. Rossini

The data of this investigation give $\Delta Hc° = -2091.38 \pm 0.54$ absolute kilojoules (or -499.85 ± 0.13 kcal) per mole, at 25° C for the heat of combustion of gaseous cyclopropane in oxygen to form gaseous carbon dioxide and liquid water. With this value, the heat of formation of gaseous cyclopropane, from solid carbon (graphite) and gaseous hydrogen each in its thermodynamic standard reference state, is calculated to be $\Delta Hf° = +12.74 \pm 0.14$ kcal/mole, at 25° C. The heat of isomerization of gaseous cyclopropane into gaseous propylene is calculated to be $\Delta H° = -7.86 \pm 0.18$ kcal/mole, at 25° C. 3 p.

RP2013. Influence of strain rate and temperature on the creep of cold-drawn ingot iron...............William D. Jenkins and Thomas G. Digges

A study was made of the effects of variations in both strain rate and temperature on the creep characteristics in tension of cold-drawn ingot iron. The third stage of creep began without necking or without the presence of cracks of microscopic dimensions, but considerable necking occurred in all specimens tested to fracture. The resistance to creep in the second stage and the resistance to fracture increased as the best temperature was decreased. The stress required to initiate fracture also increased as the strain rate increased. The general trend was for the ductility at fracture to increase with an increase in the strain rate and the plastic extension at fracture to decrease with an increase in temperature.

The plastic extension at the beginning of the third stage was less than about 1 percent, except in specimens tested at relatively high strain rates or at a low temperature. 15 p.

RP2014. Differences between the International Temperature Scales of 1948
and 1927..Robert J. Corruccini

Tables and a graph are presented showing differences that exist between temperatures expressed on the International Temperature Scale of 1927 and the recently adopted International Temperature Scale of 1948. 4 p.

RP2015. An instrument for measuring longitudinal spherical aberration of
lenses...Francis E. Washer

An instrument is described that permits the rapid determination of longitudinal spherical and longitudinal chromatic aberration of lenses. Specially constructed diaphragms isolate successive zones of a lens, and a movable recticle connected to a sensitive dial gage enables the operator to locate the successive focal planes for the different zones. Results of measurement are presented for several types of lenses. The instrument can also be used without modification to measure the small refractive powers of goggle lenses. 8 p.

RP2016. Volume dilatometry..............................Norman Bekkedahl

The volume dilatometer, although inexpensive and simple in construction and principle, is found to be a valuable research tool, not only for obtaining data on volume coefficients of thermal expansion, but also for studying phase changes in solids and liquids. The preparation and operation of the volume dilatometer are described in detail. An illustrative calculation is given using data obtained from volume-temperature measurements on a sample of butyl rubber from about —30° to +90° C, using mercury as a confining liquid in the dilatometer. 12 p.

RP2017. Relation between entrance and exit pupils of telescopic systems
Irvine C. Gardner

The definitions of the entrance and exit pupils, as commonly given, are formulated in terms of paraxial imagery only. For telescopic systems the definitions have been extended to apply to extra-axial points and to include the effects of pupil aberrations. If a telescopic system is free from distortion and an incident plane wave emerges as a plane wave free from aberrations, it is shown that exact relations between conjugate chords in the entrance and exit pupils can be derived by application of principles of the wave theory. These results are applied to give the variation in theoretical resolving power over the field of a telescopic system. Equivalent relations are derived by equating the flux of energy in the incident beam to that in the emergent beam. A relation between the illuminations of the object and image plane is derived. 4 p.

RP2018. Mechanisms for the formation of acetylglycosides and orthoesters
from acetylglycosyl halides..Horace S. Isbell and Harriet L. Frush

To obtain information concerning the stereomeric factors that affect the course of replacement reactions, a study has been made of the replacement of the halogen of certain acetyglycosyl bromides by methanol in the presence of silver carbonate (the Koenigs-Knorr reaction). The investigation shows that the solvent and the temperature greatly influence the course of the reaction when the configuration is *trans* but have little influence when the configuration is *cis*. The experimental data support the concept that under definite stereomeric conditions a solvated orthoester intermediate takes part in the reaction at low temperatures. At higher temperatures part of the reaction appears to take place through a free orthoester ion. By selection of suitable experimental conditions, it was possible to direct the orthoester reaction in large measure to either the methyl orthoacetate or the methyl acetyglycoside with apparent retention of configuration. 11 p.

RP2019. Studies on the flame photometer for the determination of Na_2O and
K_2O in portland cement..William R. Eubank and Robert H. Bogue

A study has been made on the Perkin-Elmer model 52–A flame photometer to establish its suitability for the determination of Na_2O and K_2O in portland cements and cement raw materials, such as argillaceous limestones and clays. An essential factor in the successful application of the method is the use of suitable standard solutions for each type of material analyzed. Such solutions were developed and excellent results obtained. This paper gives the photometric results due to numerous variables and presents a recommended procedure. On cements, the averages of the differences between the direct-intensity photometric and the gravimetric values obtained were 0.012 percent for Na_2O and 0.024 percent for K_2O. Slightly closer agreement was obtained with the internal-standard method, but uncertainties due to the possible presence of Li_2O give greater reliability to the direct-intensity method. The advantages of flame photometry, both in time and accuracy, are such as to warrant its recommendation for the purpose examined. 10 p.

RP2020. Ultra-microtomy by a new method.............Sanford B. Newman,
Emil Borysko, and Max Swerdlow

Polymerization of *n*-butyl methacrylate monomer is used as a rapid and simple means for embedding fixed biological material. The solid resin provides an optically clear matrix for cutting very thin sections, one at a time, with a slightly modified conventional rotary microtome. Advance of the embedded specimen toward the knife is obtained from the thermal expansion of a brass specimen holder. These ultrathin sections have uniform thickness, large area, and integrity of tissue structure. They are suitable for producing transmission images at the higher magnifications of the conventional light, phase-contrast, and electron microscopes. Metallic shadowing of the sections provides greater contrast as well as a three-dimensional aspect to the structural details of the tissue. Micrographs and a bibliography are presented. 17 p.

RP2021. Determination of nitrogen in steel..John L. Hague, Rolf A. Paulson,
and Harry A. Bright

A rapid semimicro method for the determination of nitrogen in steel is described. A 0.5- to 1.0-gram sample is usually required, and the nitrogen is put into solution as ammonium sulfate by suitable treatment of the sample with sulfuric acid. The ammonia is separated from the bulk of the sample by steam distillation from an alkaline solution. The distillate is collected in boric acid solution, and the nitrogen is determined by titration with 0.01-*N* acid. Provision is made for the solution of difficultly soluble nitrides. The effect of some of the commonly used alloying elements on the acid solubility of nitrogen compounds in steel is discussed. An accuracy of the order of 0.002 percent of nitrogen or better is indicated for samples containing up to about 0.05 percent of nitrogen and about 0.003 percent for the range of 0.05 to 0.15 percent of nitrogen. In the lower range of nitrogen contents, 0.002 percent and less, better accuracy can be obtained by attention to pertinent details and the use of a colorimetric method for the determination of the ammonia. A single determination can be completed in about 10 minutes after solution of the sample, and a group of 10 determinations can be carried out in approximately 2 hours. 7 p.

RP2022. Seasonal variation of ozone at Washington, D. C.........Ralph Stair

This paper gives data on the variation in the total amount of ozone in the atmosphere above Washington, D. C., covering a 9-year period extending from 1934 to 1943. The amount of ozone was determined from solar ultraviolet measurements made by means of a phototube and filter method on direct sunlight.

The ozone determinations indicate a seasonal variation having a maximum value during late winter and early spring (range 0.20 to 0.30 centimeters normal-temperature pressure) with a minimum value in late summer or early fall (range 0.16 to 0.20 centimeters normal-temperature pressure).

No correlation appears to exist between total ozone value and surface pressure pattern or between ozone value and sunspot number. A close correlation does, however, exist between total ozone and air temperatures at altitudes near 8 kilometers, that is, within the upper part of the troposphere. A slight opposite correlation appears to hold for altitudes within the stratosphere, with the change-over occurring near the level of the tropopause. 12 p.

RP2023. Surface tension of molten zinc borates..................Leo Shartsis and Rodrigo Canga

The surface tension of melts in the system ZnO-B_2O_3, ranging from 0 to 79.5 percent of ZnO, were measured with a maximum pull-on-cylinder method. In the two-liquid region, which extends from approximately 0 to 53 percent of ZnO, the value of surface tension was that of B_2O_3 within the limits of experimental error. With percentages of ZnO beyond the two-liquid region, the surface tension value increased rapidly. Melts containing approximately 55 to 65 percent of ZnO showed minima in the curves of surface tension versus temperature. Melts containing approximately 65 to 75 percent of ZnO had positive temperature coefficients of surface tension. The melt containing 79.5 percent of ZnO had a negative temperature coefficient of surface tension. The denisities at room temperature were also measured 6 p.

RP2024. A comparison of direct colorimetry of titanium pigments with their indirect colorimetry based on spectrophotometry and a standard observer...Deane B. Judd

Recent work by Jacobsen in the colorimetry of titanium pigments has indicated that the ICI standard observer weights too lightly the spectral region below 430 millimicrons to accord with visual perception by average observers. This paper presents a repetition of this work for a single pair of titanium-pigment paints whose difference was measured by spectrophotometric means and then by seven observers by means of a visual colorimeter. Four of the seven observers corroborated Jacobsen's conclusion; three checked closely the standard observer. A modified standard observer based upon the spectral luminosity determinations of Gibson and Tyndall and Wald has been derived and is shown to account closely for the settings of the group of four observers that disagreed with the standard observer. 9 p.

RP2025. Properties of calicum-barium titanate dielectrics..Elmer N. Bunting, George R. Shelton, and Ansel S. Creamer

Dielectrics having compositions in the system $3CaO:TiO_2$-$BaTiO_3$-TiO_2, were matured at 1,260° to 1,500° C. Data are given for the compositions, heat-treatments, absorption, shrinkage, and for K, the dielectric constant, and Q, the reciprocal of the power factor, at 25° C for frequencies of 50, 1,000 and 20,000 kilocycles per second and for 3,000 megacycles per second when K is not greater than 50. Values of K were also determined at 1 megacycle per second for various temperatures from —60° to +85° C. Lowest values of Q (and highest of K) were associated with specimens of high baria content. Linear thermal expansion (25° to 700° C) ranged from 0.65 to 0.87 percent. The specimens of some compositions were unstable and changed in K and Q values with time. 8 p.

RP2026. Heats, equilibrium constants, and free energies of formation of the dimethylcyclopentanes.....Morton B. Epstein, Gordon M. Barrow, Kenneth S. Pitzer, and Frederick D. Rossini

For the five dimethylcyclopentanes, values are presented for the following thermodynamic properties to 1,500° K: heat content function, free energy function, entropy, heat content, heat capacity, heat of formation from the elements, free energy of formation from the elements, and logarithm of the equilibrium constant of formation from the elements. Equilibrium constants and concentrations are given in tabular and graphical form for some reactions of isomerization. 6 p.

RP2027. Cathode heater compensation as applied to degenerative voltage-stabilized direct-current power supplies.......Robert C. Ellenwood and Howard E. Sorrows

A new method of compensating a degenerative-type voltage stabilizer that simplifies the design of precision stabilized direct-current power supplies is discussed. If the operating voltages of the direct-current amplifier in the comparator circuit of the stabilizer are properly chosen, compensation for line voltage changes is obtained from the corresponding changes in the "heater-to-plate transconductance." An equation for the over-all stabilization factor of the compensated stabilizer is presented in terms of the stabilization factor of a simple degenerative stabilizer. Output voltage changes of less than 0.005 percent for ±10-percent change in line voltage were obtained from experimental tests of sample power supplies with 350 volts output. 6 p.

RP2028. Mechanical properties of laminated plastics at —70°, 77°, and 200° F. John J. Lamb, Isabelle Albrecht, and Benjamin M. Axilrod

Laminates of an unsaturated polyester reinforced with glass fabric and of phenolic resin reinforced with asbestos fabric, high-strength paper, cotton fabric, and rayon fabric were tested in impact, bending, tension, and compression at —70°, 77°, and 200° F. Special apparatus was constructed for conducting the tests at the extreme temperature conditions. The impact strength of the glass-fabric laminate increases at —70° and decreases at 200° F relative to 77° F; the impact strengths of cotton- and rayon-fabric laminates decrease at —70° and increase at 200° F; the paper and asbestos-fabric laminates have small changes in impact strength with temperature. The flexural, tensile, and compressive strengths and moduli of elasticity increase at —70° and decrease at 200° F relative to the 77° F values.

Tests made at room temperature after heating the materials at 200° F for 24 hr indicate that prolonged heating with consequent loss of moisture content and further cure of the resin may offset the effect of high temperature alone. In flexural tests made at 150° F and 90-percent relative humidity, two laminates showed considerable loss in strength. 33 p.

RP2029. An absolute measurement of resistance by the Wenner method
James L. Thomas, Chester Peterson, Irvin L. Cooter, and F. Ralph Kotter

This paper reports the results of a project started in 1929 for the measurement of resistance in terms of length, time, and the permeability of free space. For this method a mutual inductor was constructed whose value was determined within a few parts in a million in terms of its measured dimensions. Resistance was then measured in terms of this inductance and frequency, using Wenner's commutated direct-current method. The results of the measurements give a value of 0.999994 absolute ohm for the unit now maintained at this Bureau.

The dimensions of the mutual inductor were determined in 1938 and again in 1948. A comparison of the change in inductance, because of drifts in dimensions, with the electrical determinations made on the two dates shows that there has been no appreciable change during the interval in the value of the unit of resistance as maintained at this Bureau. This is the first method that has been devised to test the stability of the unit to a few parts in a million. 67 p.

RP2030. Directional effects in dielectric properties of molded rubber
Arnold H. Scott

Slabs of rubber-filler mixtures were prepared in such a way that flow in sheeting and molding was greatly accentuated in one direction. This paper describes the method of molding and gives values of dielectric constant and dissipation factor for measurements made on a variety of mixtures in which the samples were prepared and arranged for measurements in the direction of flow during molding and in the two mutually perpendicular directions. For some mixtures the values were much higher in one direction than in the others. A possible explanation for this is given. By using cubes of the material as spacers for an optical interferometer, linear thermal expansivities were measured in three mutually perpendicular directions. Some mixtures had greater expansivities in one direction than in others, but there was no correlation with the dielectric constants and dissipation factors. 10 p.

RP2031. Infrared absorption spectra of the liquid butenes and 1,3-butadiene
E. Carroll Creitz and Francis A. Smith

The infrared absorption spectra, from 1 to 15 microns, of 1-butene, 2-methylpropene (isobutene), *cis*-2-butene, *trans*-2-butene, and 1,3-butadiene have been recorded in the liquid phase under pressures sufficient to liquify them at room temperature.

The spectra of the same samples in the vapor phase have been recorded and are presented for comparison.

A rock-salt prism was used for the range from 2 to 15 microns. The spectra of the same samples, both liquid and vapor, were obtained at higher resolution over the range from 1 to 4.2 microns using a lithium fluoride prism, and are presented for comparison.

The spectra obtained from the liquid phase provide data for the development of a procedure for the analysis of liquid plant streams by spectrometric methods. 11 p.

RP2032. Potential problems and capacitance for a conductor bounded by two intersecting spheres.................................Chester Snow

Formal expressions, as series and integrals, are derived for the external potential, which takes on assigned values on the two spherical boundary surfaces—either when the body is alone or when it is in any given axially symmetric electrostatic field. This is effected by representing a given function $f(x)$, for $1<x<\infty$, as a complex integral whose variable is the parameter μ of a Legendre function $P_{\mu-\frac{1}{2}}(x)$ or $Q_{\mu-\frac{1}{2}}(x)$.

The capacitance of the conductor is found as a series, whose terms involve psi-functions and vanish with $1/n$ like n^{-2}. This is transformed into a formula depending upon a series whose n^{th} term vanishes with $1/n$ like n^{-14}.

In case the two spheres intersect at an angle ω, which is a rational fraction of 2π, the capacitance is given in finite terms involving complete elliptic integrals, which is $Q_{-\frac{1}{2}}$.

The field, or electrostatic potential is given in finite terms when $\omega=n\pi/m$, where m is any positive integer, and $n=1$, 2, 3, or 4. The cases $n=3$, $n=4$ involve elliptic functions. These would permit the exact computation in finite terms of the penetration of an external applied field into a cavity with any angular aperture. 31 p.

RP2033. Electron optical observation of magnetic fields............L. Marton
and S. H. Lachenbruch

The electron optical analog of the "Schlieren" method may be used to explore electromagnetic fields where conventional methods fail. Furthermore, a related shadow method, especially suitable for the quantitative evaluation of such fields, has been found.

Properties of the Schlieren patterns produced by a magnet consisting of two point poles are predicted by a mathematical analysis. An experimental Schlieren pattern, produced by a magnetized recording wire, is interpreted qualitatively and compared with a powder pattern.

The related shadow method is applied to the magnetized wire. The experimental data are shown to agree well with theoretical formulas derived from this hypothesis and yield reasonable numerical values for the field strength and for the separation of the point poles to which each magnetized region is assumed equivalent. 20 p.

RP2034. Some physical properties of porcelains in the systems magnesia-beryllia-zirconia and magnesia-beryllia-thoria and their phase relations..............S. M. Lang, L. H. Maxwell, and R. F. Geller

The ternary eutectic for the system MgO-BeO-ZrO_2 was located at mole composition 4MgO:5BeO:3ZrO_2 and 1,669° C, and that for the system MgO-BeO-ThO_2 was located at mole composition 5MgO:10BeO:1ThO_2 and 1,797° C. No binary or ternary compounds were found in either of the systems, and an area of solid solution is indicated for each. A number of bodies were found suitable for various high-strength and high-temperature services where thermal shock resistance is not of prime importance. The compressive strength values at room temperature ranged as high as 266,000 lb/in.^{2} for some porcelains in both systems. The maximum values for the strength in bending at room temperatures and at 1,800° F (982° C) were considerably higher for the MgO-BeO-ZrO_2 bodies (39,000 and 32,000 lb/in.^{2}, respectively) than for the MgO-BeO-ThO_2 bodies (14,000 and 16,000 lb/in.^{2}, respectively), and the modulus of rupture value at 1,800° F (982° C) of one body in the binary system MgO-ZrO_2 was 29,000 lb/in^2. The resistance to thermal shock for the MgO-BeO-ZrO_2 porcelains was fair to good, and for the MgO-BeO-ThO_2 porcelains it was poor. All of the MgO-BeO-ZrO_2 bodies can be matured in commercial kilns used currently in the porcelain industry, whereas part of the MgO-BeO-ThO_2 porcelains and none of the MgO-ZrO_2 porcelains can be so matured. 19 p.

RP2035. Laboratory flow tests of fixed spray nozzles with hydrocarbons and with air.............................M. R. Shafer and H. L. Bovey

The metering characteristics of fixed spray nozzles of the type used in some turbo-jet engines have been investigated. Some of the nozzles supplied by the Navy Department contained burrs, metal particles, and improper machining, which caused erratic fluid metering. After being reconditioned, a group of 26 nozzles was flow-tested with five different fluids to determine the effects of fluid density, viscosity, and supply pressure upon the rate of discharge of the nozzles. The results indicate that it is impracticable to correct for differences in the physical properties of the test fluid. A comparative method of flow-testing fixed nozzles with air is described. Although this method leaves much to be desired, it appears useful for safe and rapid sizing of nozzles to within ±3 percent of their actual flow. 9 p.

RP2036. Mechanical production of very thin oscillator plates..Leland T. Sogn and Walter J. Howard

To produce quartz oscillator plates thinner than 0.005 inch, it has been necessary to modify the usual lapping methods and machinery. The thickness at which the crystal carrier (nest) stretches or buckles is the limiting factor in the conventional apparatus. The modifications described in this report consist of replacements for the conventional top lapping plate with corresponding changes in the crystal carrier. The development is presented in chronological order from the simple pressure block method to the more elaborate forms using automatic truing. The improved equipment is capable of producing 0.001-inch-thick quartz crystals and can be used for producing equally thin wafers from a variety of other materials. 6 p.

RP2037. Instability in shear of simply supported square plates with reinforced hole.....................................Wilhelmina D. Kroll

The critical shear stresses were determined for five elastic, simply supported square plates with central circular holes of diameter one-eighth and one-fourth the length of a side. Comparison of the numerical results obtained with those computed for plates without holes shows that, although an unreinforced hole may cause a large reduction in the critical shear stress of the plate, reinforcement of the hole by a circular doubler plate causes a substantial increase in the shear buckling load. 8 p.

RP2038. Physical properties of sixty API-NBS hydrocarbons
Alphonse F. Forziati and Frederick D. Rossini

The results of experimental determinations of the density at 20°, 25°, and 30° C, the refractive index, n_D, at 20°, 25°, and 30° C, and the boiling point and pressure coefficient of the boiling point, at 1 atmosphere, are reported for 60 hydrocarbons of the API-NBS series, including 17 paraffins, 14 alkylcyclopentanes, 8 alkylcyclohexanes, and 21 alkylbenzenes. 4 p.

RP2039. Fatigue characteristics of electroformed sheets with and without iron backing............Harry K. Herschman and Carroll Thomas

The flexural fatigue properties were determined for electroformed sheets of iron-nickel, and iron-nickel-chromium, and of plates composed of electroformed iron nickel sheets bonded with solder or a plastic adhesive to open-hearth iron. The fatigue limit of the iron-nickel composite was decreased when a thin deposit of chromium was applied to the nickel face. Heating the iron-nickel-chromium sheets at 260° C (500° F) before machining improved their fatigue properties. Apparent further beneficial effects resulted by heating after machining. The fatigue limits of the plates bonded with the plastic adhesive were significantly higher than those joined by soldering. Two brushed coats of the plastic adhesive applied to the mating surfaces of the composite layers of the plates appeared somewhat more favorable to higher fatigue limits than a combination one brushed and one sprayed coat procedure. 10 p.

RP2040. Interfacial instability and mixing in stratified flows
Garbis H. Keulegan

When a liquid flows over a body of heavier liquid, with which it is miscible, an interface may be formed at which there is a sharp discontinuity of densities but not necessarily of velocities. As the relative velocity is increased, waves are formed at the interface, and at a critical velocity, mixing begins by the formation of eddies periodically ejected from the crests of the waves. The numerical values of a criterion for mixing, whose form was derived from theoretical considerations, were determined experimentally. Experimental data were also obtained on the relation of the amount of mixing to the relative velocity of the liquids at velocities higher than the critical. 14 p.

RP2041. The remainder in linear methods of approximation......W. E. Milne

The following discussion grows out of an effort to formulate a systematic treatment of the error for such diverse processes as interpolation, numerical differentiation, numerical integration, harmonic analysis, approximation by Least Squares, approximation by equating moments, and other allied operations.

First of all, a systematic and uniform procedure is exhibited by which a desired method of approximation may be explicitly constructed. Second, by suitable transformation the remainder is put in a form in which it is possible in many cases to estimate its approximate magnitude. And third, the theory is applied to a variety of concrete examples, and bounds are obtained for the magnitude of the error. 11 p.

RP2042. The freezing point of uranium.......................Andrew I. Dahl and Harold E. Cleaves

The freezing temperature of uranium of about 99.99-percent purity was measured with an optical pyrometer and found to be 1,133°±2° C. Both the initial purity and the initial freezing temperature were lower than the foregoing values. However, holding the metal at temperatures just above the melting point for several hours resulted in a decrease in the content of several impurities and an increase in the freezing temperature to a final constant value.

The freezing temperature was not greatly affected by the crucible material, similar values being obtained in beryllia, thoria, and graphite crucibles. 5 p.

RP2043. Dissociation constants of weak bases from electromotive-force measurements of solutions of partially hydrolyzed salts
Roger G. Bates and Gladys D. Pinching

A method for the determination of dissociation constants of weak electrolytes by electromotive-force measurements of solutions of partially hydrolyzed salts of a weak acid and a weak base is described. Although the precision is only half that of the conventional emf method, this procedure has particular advantage in determining the dissociation constants of certain bases, for some of the experimental difficulties encountered in adapting the usual method to solutions containing these bases can be overcome or reduced. The hydrogen-ion concentration of a solution of a salt of this type depends upon the constants of the weak acid, the weak base, and water. If two of these are known, the third can be evaluated by means of emf measurements without the necessity of knowing the exact hydrogen-ion concentration, which is usually difficult to obtain. Hydrogen electrodes and silver-silver chloride electrodes are used in the cells, and the solutions are aqueous mixtures containing the ions of the salt and an alkali chloride. The equations for the calculation of dissociation constants are developed. The method was tested by a determination of the basic dissociation constant of tris(hydroxymethyl)aminomethane at 20°, 25°, and 30° C from three series of measurements: (a) by the conventional emf method; (b) by emf studies of the hydrolysis of mixtures of the amine and primary potassium phosphate; and (c) by emf studies of the hydrolysis of mixtures of the amine and potassium *p*-phenolsulfonate. The three determinations were in acceptable agreement. The negative logarithm of the basic dissociation constant, pK_b, was found to be 5.946 at 20°, 5.920 at 25°, and 5.896 at 30° C. 8 p.

RP2044. A reduction-of-area gage for use at low temperatures
Glenn W. Geil and Nesbit L. Carwile

A reduction-of-area gage for measuring the change in diameter of cylindrical or notched tension specimens during tests at controlled temperatures is described. The gage was designed especially for use in tests of specimens completely submerged in a temperature-controlled bath at temperatures ranging from —196° to +100° C. The calibration of this gage showed that measurements can be made with an accuracy of 0.0001 inch. Some results obtained with the use of this gage are illustrated by true stress-true strain curves for annealed ingot iron, cold-worked nickel and cold-worked 18:8 chromium nickel steel tested in tension at —188° and —196° C. 6 p.

RP2045. Mass spectra of C_5H_8 isomers....Fred L. Mohler, Evelyn G. Bloom, Laura Williamson, C. E. Wise, and E. J. Wells

Mass spectra of ten C_5H_8 isomers are described. These comprise spiropentane, methylenecyclobutane, cyclopentene, six dienes and 1-pentyne. The mass spectrum of each of these compounds has distinctive characteristics, but these are not correlated with the molecular structure in an obvious manner. The ratio of total ionization to that of *n*-butane covers a small range of values from 0.96 to 1.09, and the same range of values is found in other C_5 hydrocarbons. The doubly charged ion spectrum is very prominent in some pentadienes, with $C_5H_2^{++}$ the largest peak. 4 p.

RP2046. A note on the numerical integration of differential equations
W. E. Milne

An integration method for ordinary differential equations is developed, in which the approximation formulae contain derivatives of higher order than those contained in the differential equation itself. The method is particularly useful for linear differential equations. Numerical examples are given for Bessel's differential equation. 8 p.

RP2047. Measurement of the distintegration rate of sodium^{22} by the coincidence method...J. L. Herson

A coincidence method of measuring the absolute disintegration rate (total strength) of sodium^{22} sources is described.

Prevention of false coincidences and the separation of the total gamma counts observed in the basic measurements into nuclear and annihilation radiation incident to the positron emission is accomplished by magnetic deflection and a series of supplementary measurements in which a platinum-cylinder Geiger-Müller gamma counter is used. A copper cylinder gamma counter was used in the basic measurements.

The radioactive preparation was an aqueous solution of NaCl of 1 milligram per milliliter concentration and with a ratio of radioactive $Na^{22}Cl$ to carrier (stable) NaCl of the order of 1 to 10^{10}. The disintegration rate of the test source (0.8 milliliter of this solution) was found to be 2.15×10^4 disintegrations per second with a conservatively estimated accuracy of ±5 percent. Of the total gamma counts, 70 percent was of nuclear origin; whereas 30 percent were due to annihilation radiation.

The efficiency of the platinum counter relative to that of the copper counter in detecting annihilation radiation (0.51 Mev) was 2.9. Their detecting efficiencies for nuclear gamma radiation (1.3 Mev) were nearly alike. 3 p.

RP2048. Submicroscopic structure of cellulose from nitrogen sorption measurements....................Charles M. Hunt, Raymond L. Blaine, and John W. Rowen

When cotton linters were soaked in cold 10-percent sodium hydroxide, washed, and neutralized, and transferred successively to methyl alcohol and benzene, and carefully dried at reduced pressure, a surface area as high as 71.3 square meters per gram was obtained by the Brunauer, Emmett, Teller technique. Previous areas for untreated cotton were all below 1 square meter per gram. Linters carried through the above steps after soaking in water instead of alkali had an area as high as 47.3 square meters per gram. When the alkali-treated sample was conditioned in water vapor to 3.3 percent gain in weight, the surface decreased to 31.6 square meters per gram; further conditioning to an 11.0-percent gain in weight decreased the surface to 2.1 square meters per gram.

The isotherms of the treated samples showed strong hysteresis, whereas the isotherms of untreated cotton showed little or no hysteresis.

Calculations of pore size distribution by the method of Wheeler and Shull indicated these materials have rather narrow distributions, the alkali-treated material having a maximum at a pore radius of about 20 Angstroms and the water-soaked material maximum at about 16 Angstroms. 8 p.

RP2049. Vapor pressures and boiling points of sixty API-NBS hydrocarbons Alphonse F. Forziati, William R. Norris, and Frederick D. Rossini

Measurements of vapor pressures and boiling points, over the range 48 to 780 millimeters of mercury, and above about 11° C, were made on 60 purified hydrocarbons. The apparatus consisted of an electrically heated boiler, a vapor space with a vertical reentrant tube containing a platinum thermometer having a resistance of 25 ohms, and a condenser. Measurements of the temperature of the liquid-vapor equilibrium were made at 20 fixed pressures maintained automatically. The values of the fixed pressures were determined by calibration of the apparatus with water using the vapor pressure-temperature tables prepared at this Bureau.

The experimental data on the hydrocarbons were correlated, the method of least squares being used, with the three-constant Antoine equation for vapor pressures, $\log P=A-B/(C+t)$ or $t=B/(A-\log P)-C$. Experimental data, together with the values of the three constants of the Antoine equation applicable over the range of measurement, are reported for 60 API–NBS hydrocarbons, including 17 paraffins, 14 alkylcyclopentanes, 8 alkylcyclohexanes, and 21 alkylbenzenes. 9 p.

RP2050. Bond of concrete reinforcing bars..................Arthur P. Clark

The tests reported were made to compare the resistance to slip in concrete (bond) of deformed bars when tested in beams and companion pull-out specimens, to secure information on the effects of size of bar, the type of deformations on the bars, and the strength of concrete on the bond. The bars were cast in a horizontal position in all test specimens. The variables were depth of concrete under the bar, length of embedment of the bar in the concrete, strength of concrete, and diameter of bar. Slip of the bar was measured at the loaded and free ends. Three tests were made each with 2 in. of concrete under the bar, with 15 in. of concrete under the bar, and with 8-, 12-, and 16-in. embedments.

Bond strengths for the beams and the pull-out specimens were affected similarly by changes in the geometry of the bars and the bond test specimens. They were greater when the bars were near the bottom than when they were near the top of the specimens as cast. The highest bond strengths were obtained with bars having deformations conforming to suggested requirements for maximum spacing and minimum height and providing ratios of shearing to bearing areas less than 10, usually less than 6. 15 p.

RP2051. Analysis of the direct-current bolometer bridge.....David M. Kerns

The behavior of a direct-current Wheatstone bridge with a nonlinear element (bolometer) in one arm, as used in the measurement of microwave power, is analyzed. Results of rather general applicability are obtained by ascribing arbitrary values to the resistances making up the bridge-network and by employing a resistance law of a general form for the bolometer element. Emphasis is placed upon the development of first-order theory in convenient form. General characteristics of the behavior of the type of network (and nonlinear element) under consideration are indicated. Results obtained include expression for the derivatives of galvanometer current with respect to radio-frequency power, ambient temperature, source-voltage, and source-resistance. 9 p.

RP2052. A method and apparatus for determining the ignition characteristics of plastics..................................Nicholas P. Setchkin

A method for the determination of the ignition temperatures of plastics is described. It is suitable for the determination of a flash-, as well as self- or autogenous-ignition temperatures. The flash temperature is that temperature at which the specimen yields combustible gases ignitible by a flame. The self-ignition temperature is the lowest temperature of supplied air, under optimum conditions of air flow, at which a reaction of the specimen, or of its decomposition products, begins and is self-accelerated to the state of combustion. The described method generally results in lower and more consistently reproducible values of the self-ignition temperature than those reported by several other investigators.

Twenty-seven different specimens of plastics, covering a wide range in characteristics, were tested by the method described. 18 p.

TITLE PAGE AND CONTENTS TO VOLUME 43. 6 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 44, JANUARY—JUNE 1950

RP2053. The 1949 scale of color temperature..................Deane B. Judd

Because of the revision of the International Temperature Scale to use the Planck radiation formula instead of the Wien, with a new value assigned to the constant c_2, the scale of color temperature in use here since 1934 has been revised. The details of this revision are given, and the results are summarized in a table showing the conversion of color temperature on the 1934 scale to that on the present, or 1949, scale. The use of lamp standards of color temperature to obtain known spectral distributions of radiant flux between 380 and 770 millimicrons is discussed, and comparisons are made between the 1922 scale of color temperature and the 1934 and 1949 scales for this purpose. 8 p.

RP2054. Note on the disintegration of wool in abrasion tests
Herbert F. Schiefer and John F. Krasny

The coating that formed on the abradant when a specimen of wool fabric was abraded and caused the rate of abrasion to increase approximately ten times in three successive tests was examined critically. Microchemical analyses showed that it had the same composition as the unabraded fabric. Infrared absorption curves of the coating and of the powder of the unabraded fabric, ground in a vibratory ball mill, showed the same absorption characteristics. Electron micrographs of the coating showed that it contained extremely small particles, many of which were approximately spherical in shape and about 100 to 200 Angstroms in size. Similar particles were observed in the abraded debris when the specimen was kept wet with water during the abrasion test and also in the powder into which the unabraded fabric was ground in the vibratory ball mill. It was concluded that the coating that formed on the abradant consisted of extremely small particles of wool, which appear to correspond in shape and size to the elemental structural units (keratin molecules) proposed in recent concepts of the structure of wool. 6 p.

RP2055. A bolometer bridge for standardizing radio-frequency voltmeters
Myron C. Selby and Lewis F. Behrent

In the course of work on r-f standardization projects of the National Bureau of Standards, practical equipment and techniques were developed for measurement of 20 millivolts to 1.9 volts at radio frequencies below 700 megacycles, with further broadening of these ranges still in progress. The devices employed do not require frequency corrections, so that results are based on direct-current measurements, which can be made quite accurately. Reproducibility and agreement with independent methods was found to be ±1 percent or better. The primary function of the equipment is to make available a standard voltage of any desired value and frequency within the above range that would be required for a highly accurate and at the same time practical voltmeter-calibration procedure. In addition, the equipment may be used for direct measurement of r-f generator voltages; as a known standard of r-f impedance; and for accurate power measurements of 20 microwatts to 100 milliwatts. An analytical study of the range-limiting factors of this technique is presented, appropriate curves and illustrations are shown, and major steps of procedure are listed.

An independent method and appropriately designed equipment for accurate r-f voltage determinations based on measurements of direct current and of linear dimensions along a transmission line of known characteristic impedance are also described. 6 p.

RP2056. Influence of temperature on the adsorption of water vapor by collagen and leather........................ ....Joseph R. Kanagy

The adsorption of water vapor by collagen, commercial hide powder, and several leathers was determined at various relative humidities ranging from about 0 to 96 percent, at 28°, 50°, and 70° C. Determinations were also made on chestnut and quebracho tannins at 28° C at various relative humidities. The results indicate that at 50-percent relative humidity the variation of moisture content for 1 degree change in temperature is equivalent to that for 1 percent change in relative humidity. A specially purified collagen has higher affinity for water than does hide powder, showing that the previous chemical treatment influences adsorption. The results obtained from the experiments on the tannins and the hide powder show that tanning does not decrease water vapor adsorption at relative humidities below 70 percent.

From the results of the adsorption measurements, heats of adsorption were calculated by means of the Clausius-Clapeyron and Brunauer, Emmett, and Teller equations. The leathers show higher heats of adsorption for low moisture regains than does collagen, indicating that they contain some groups that are more highly active toward water than those in collagen. Free energy and entropy values for the adsorption at 50° C are given. The effect of high temperatures on moisture adsorption is studied by subjecting specimens to elevated temperatures and then determining the adsorption at 28° C. Methods are given for estimating moisture content for conditions that have not been studied experimentally. The change of water adsorption with temperature can be expressed by a simple relation involving the log of the percentage of water adsorbed and the inverse of the absolute temperature. 15 p.

RP2057. Soil-corrosion studies, 1946: ferrous metals and alloys
Irving A. Denison and Melvin Romanoff

This report contains the results of measurements of corrosion made on a variety of wrought and cast ferrous materials after exposure to different soil conditions for periods up to 14 years. The steels ranged in composition from fractional percentages of nickel and chromium to the high concentrations typical of wholly austenitic steels. The soils ranged from well aerated soils deficient in soluble salts to poorly aerated soils containing high concentrations of water-soluble materials. The magnitude and progress of corrosion with respect to both weight loss and pitting are interpreted in relation to the properties of the soils at the test sites. A comparison is made of the corrosion of specimens of plain wrought materials and cast iron. 29 p.

RP2058. Transmission of reverberant sound through double walls
Albert London

The transmission of reverberant sound through a double wall, which consists of two identical single walls coupled by an airspace, is investigated both theoretically and experimentally. A theory is developed, which gives good agreement with experiment. In order to compute the transmission loss of a double wall, it is necessary to know the impedance Z_w of the single wall. Z_w was determined from experiments conducted on the single wall and includes the effects of mass, dissipation, and flexural motion. The treatment shows that it is impossible to get a large improvement in transmission loss for a double wall relative to a single wall under reverberant-sound field conditions if the single wall is considered to have only mass reactance. In addition, the customary normal incidence theory is totally inadequate in explaining the behavior of a double wall in a reverberant-sound field.

For double walls having air coupling only, very shallow airspaces can produce appreciable increases in transmission loss over a single wall. An absorbent material, when inserted in the airspace, produces large improvements only when the mass of the walls is relatively light and has but little effect for heavy walls. Honeycomb or other nonabsorbent cellular structures having no cell walls in a direction normal to the wall faces do not result in an increase in transmission loss. Air-coupled walls having no solid sound-conducting paths between individual septa are extremely effective sound insulators as compared to conventional double-wall constructions. The theory indicates that a large improvement in the transmission loss of a double wall can be obtained by using as components single walls with high internal dissipation. 12 p.

RP2059 Solution of the telegrapher's equation with boundary conditions on only one characteristic........................George E. Forsythe

Forecasting a certain idealized horizontal, autobarotropic, nonviscous, nondiverging atmospheric flow considered by Rossby leads to an unusual boundary-value problem for the telegrapher's equation, involving boundary values on only one characteristic. It is shown how to find unique solutions periodic in the longitude; these are represented in terms of a Green's function. A procedure for computing the Green's function is set down and is shown to be optimal in a restricted sense. The Green's function is tabulated for 72 longitudes and 14 time-values. An alternative solution by a difference equation is mentioned. 14 p.

RP2060. Table of modified bernoulli polynomials............Gertrude Blanch
and Roselyn Siegel

The polynomials tabulated are $b_k(x)$, where $b_k(x)$ is related to the Bernoulli polynomial $B_k(x)$ by the formula

$$b_k(x)=[(-1)^{k\frac{1}{2}}(2\pi)^k B_k\left(\frac{x}{2\pi}\right)]/k!.$$

Range of parameters: $k=1\ (1)11$; $x=\pi y/36$, $y=0(1)36$. The entries are given to 17 decimal places. The functions were computed in connection with the tabulation of a solution to the telegrapher's equation by George E. Forsythe. 5 p.

RP2061. Electrodeposition of alloys of phosphorus with nickel or cobalt
Abner Brenner, Dwight E. Couch, and Eugenia Kellogg Williams

Alloys containing nickel or cobalt and as much as 15 percent of phosphorus have been electrodeposited from solutions containing phosphites. The alloys are hard and may be further hardened by heat-treating at 400° C. The high-phosphorus nickel alloy is more resistant to attack by hydrochloric acid than pure nickel deposits. The high-phosphorus alloys are bright as deposited, but their reflectivities are lower than those of buffed coatings of pure nickel. 14 p.

RP2062. Influence of the ground on the calibration and use of VHF field-intensity meters.....................................Frank M. Greene

One type of error known to be present in VHF field-intensity meters (30 to 300 Mc) is caused by the influence of the ground on the value of the antenna voltage-transfer ratio. This is a result of fluctuation of the receiving-antenna input impedance with height and changing ground conditions. An approximate method is presented for calculating the input impedance of horizontal dipole antennas over earth having finite values of dielectric constant and conductivity. The effect of both changes in ground conditions and antenna terminating impedance on the above error is calculated as a function of the antenna height. Measured values are presented in support of the above method, and the results are discussed. 8 p.

RP2063. Determination of curvature by an osculometer.....Harvey L. Curtis

The experimental determination of the curvature at a point of a plotted curve can be made by means of an osculometer, which is a series of arcs of known curvature. One use of such information is in the computation of the acceleration of a body for which a displacement-time curve has been constructed. By this method the acceleration can be obtained with the same accuracy as by double differentiation without the necessity of plotting the velocity time curve. 4 p.

RP2064. A multicolumn countercurrent molecular still...Samuel L. Madorsky

A 10-column countercurrent molecular still, based on refluxing by gravity feeds and circulation of the liquid by means of magnetic pumps, is described. Each column consists of a concentric evaporator having a surface of 300 square centimeters, surrounded by a water-cooled condenser. The still is provided with an overflow cup at the top, a reservoir at the lower end and a pump for raising the liquid from the reservoir to the overflow cup. All the condensates move by gravity from column to column in one direction, and all the residues move similarly in the opposite direction, thus producing countercurrent refluxing of the liquid. The still is designed to operate at such a rate of evaporation that the amount of distillate from each column is slightly greater than the amount of residue from the same column. Operating on a binary mixture, the still gives a separation of the two constituents equivalent to 13 theoretical plates. 5 p.

RP2065. Hydrocarbons in the 108° to 116° C fraction of petroleum
Augustus R. Glasgow, Jr., Charles B. Willingham,
and Frederick D. Rossini

This report describes the analysis of the hydrocarbons in the 108° to 116° C aromatic-free fraction of petroleum, which is shown to be composed of eleven hydrocarbon compounds, of which three are present only in very small amount. For these eleven compounds, the normal boiling points (of high purity samples not from the present investigation) and the estimated amounts by volume in the original Ponca, Okla., crude petroleum are as follows: 2,5-dimethylhexane, 109.11° C, 0.055 percent; 1,*trans*-2,*cis*-4-trimethycyclopentane, 109.28° C, 0.22 percent; 2,4-dimethylhexane, 109.43° C, 0.055 percent; 2,2,3-trimethylpentane, 109.84° C, 0.004 percent; 1, *trans*-2,*cis*-3-trimethylcyclopentane, 110.4° C, 0.26 percent; 3,3-dimethylhexane, 111.97° C, 0.03 percent; 2,3,4-trimethylpentane, 113.47° C, 0.005 percent; 1,1,2-trimethylcyclopentane, 113.72° C, 0.06 percent; 2,3,3-trimethylpentane, 114.76° C, 0.006 percent; 2,3-dimethylhexane, 115.61° C, 0.06 percent; and 2-methyl-3-ethylpentane 115.65° C, 0.04 percent. 15 p.

RP2066. Concrete as a protective barrier for gamma rays from cobalt-60
Robert J. Kennedy, Harold O. Wyckoff, and William A. Snyder

The broad-beam and narrow-beam attenuation of Co^{60} gamma rays has been investigated experimentally, and the data are presented here. In protective barriers the geometry necessarily requires the use of broad-beam attenuation curves to determine the required barrier thickness. This paper presents attenuation curves for lead, concrete, and steel necessary for determining the required protection for any particular cobalt source in storage or transportation. There is also included a table for shielding requirements for Co^{60} sources of 10 millicuries to 2 curies. 6 p.

RP2067. Pulse packing in magnetic recording wire............Irvin L. Cooter

An oscillographic method is described for determining the relative pulse packing of different types of magnetic recording wire used for pulse storage. Typical curves are presented to show the influence of the amplitude, duration, and repetition rate of the magnetizing pulses on the pulse packing in two types of recording wire.

A powder pattern method is also described for visually observing the length of the magnets produced in the wire by the magnetizing pulses. Photographs are shown of typical patterns. The data obtained by this method verify the pulse packing data obtained by the oscillographic method. 10 p.

RP2068. Note of the stabilization of acetylglycosyl halides and sugar acetates
Horace S. Isbell and Harriet L. Frush

The paper reports that highly reactive acetylglycosyl halides and sugar acetates can be stabilized by mixing them with a small proportion of finely powered calicum or barium carbonate. 2 p.

RP2069. Phase-equilibrium studies of the high-lime portion of the quinary system Na_2O-CaO-Al_2O_3-Fe_2O_3-SiO_2.............William R. Eubank

Two means, one graphic and the other analytic, for studying the phase-equilibrium relations in a portion of the five-component system Na_2O-CaO-Al_2O_3-$Fe_2O_3SiO_2$ are described. Using the graphic procedure, compositions in two series of planes in the quinary system were investigated by the quenching method. In each of the two series one component was held constant and another given different values in successive planes. In each plane two components remained constant while three were varied. In this way the minimum temperature for complete melting in each plane was determined. Data for a number of these planes were then employed to locate the quinary invariant point, which was found to have the composition, 1.0 Na_2O, 48.0 CaO, 31.0 Al_2O_3, 13.5 Fe_2O_3 and 6.5 percent of SiO_2. At this point the five crystalline phases, $Na_2O.8CaO.3Al_2O_3$, $3CaO.Al_2O_3$, Fe_2O_3-containing solid solution, $2CaO.SiO_2$, and $3CaO.SiO_2$ exist in equilibrium with liquid.

The temperature of the invariant point was found to be 1,310°±3° C. Compositions including the five constituents and approximating that of portland cement clinker will crystallize completely, upon slow cooling, at or near 1,310°

C. The stable existence of the soda compound $Na_2O.8CaO.3Al_2O_3$ in the presence of the principal components of clinker was established. The data obtained permit a closer approximation of the amount of glass in rapidly cooled clinker. Dicalcium silicate and the iron-containing phase were observed to exist in various forms of solid solution.

Application of an analytic method for locating and following compositions within the quinary system has likewise been made. Equations have been developed and examples are given for depicting specific planes and points within these planes in the quinary system without the necessity of using geometric relations. The graphic and analytic methods, however, complement each other and together serve as a convenient procedure for studying any system of five components. 18 p.

RP2070. The field generated by an arbitrary current distribution within a waveguide..J. J. Freeman

Formulas are derived for the electromagnetic field generated by an arbitrary current distribution within waveguides of rectangular, circular, and coaxial cross sections. These formulas are obtained by generalizing analogous formulas obtained in a previous paper for cavities of the same cross section. As a check on the formulas, it is shown that the field from an axially directed dipole within a circular guide reduces to the free space value as the radius increases indefinitely. 6 p.

RP2071. Back-scatter observations by the Central Radio Propagation Laboratory—August 1947 to March 1948.............W. L. Hartsfield, S. M. Ostrow, and R. Silberstein

A high-power pulsing transmitter and a westwardly beamed antenna system were constructed, and emissions were made from Sterling, Virginia, on 13,660 kilocycles, for reception by USNEL and USAF cooperating groups. CRPL efforts were concentrated on the study of "back scatter" received near the transmitter.

In the controversial issue as to whether back scatter comes from the ground or the *E* region, it was believed that both types were identified, with ground scatter usually predominating, except in the case of long skip.

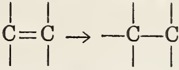
Aids to data interpretation were transponder echoes, reception logs and skip distance maps drawn from concurrent ionospheric data. 6 p.

RP2072. Introduction of measured liquid samples into the mass spectrometer C. Edward Wise, Robert M. Reese, Vernon H. Dibeler, and Fred L. Mohler

Several methods of introducing measured amounts of liquid samples of neohexane and of styrene into a mass spectrometer are compared by measuring the sensitivity (ion current per unit pressure) on mass peaks 71 and 104. A precision microburet and pipet made of thermometer tubing were used to introduce samples of about 0.0015 milliliter. A reproductibility of about 2 percent is obtained with the microburet and of 5 to 8 percent with the pipet. Sensitivities obtained by either method are lower than the sensitivity obtained by a direct pressure measurement using a micromanometer. They are low by 13 percent for neohexane and by 30 percent for styrene. Styrene is retained on the glass walls and in the stopcock grease, and after pumping out 20 minutes some styrene is gradually evolved. 6 p.

RP2073. Heats of polymerization. A summary of published values and their relation to structure...........................Donald E. Roberts

This paper contains a table showing values of heats of polymerization assembled from a survey of the literature. There are 42 substituted vinyl compounds arranged as follows: vinyl alkyls, vinyl aryls, other vinyls, vinyl acids and esters, dienes and copolymers. Values reported by different authors are given for each compound, with corresponding states of monomers and polymers and a notation on the methods used in obtaining the values. A second table gives structural formulas of monomers.

Some values of heats of polymerization to hypothetical polymers having no steric hindrance are calculated from published values of heats of formation of hydrocarbons, making certain assumptions regarding branch groups. The method of calculation is explained. Heat of polymerization, is arbitrarily assigned to four energy effects: (1) the reaction  $\overset{|}{\underset{|}{C}}=\overset{|}{\underset{|}{C}} \rightarrow -\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-$; (2) the effect of side groups on bond energies when there is no interaction between the groups; (3) the effect of steric hindrance between side groups; and (4) the "end effect" arising from the nearness of the double bond to the end of the monomer molecule.

Values of heats of polymerization are compared, and their relation to structure is examined, with particular emphasis on the effect of steric hindrance. Ethylene has the highest and alpha-methylstyrene the lowest heat of polymerization; isobutene and the methacrylates also are low. Disubstitution on the same vinyl carbon is a frequent cause of steric interference, with consequent reduction in heat of polymerization. Large branched substituents may cause steric interference. The substitution of chlorine on the aromatic ring of styrene has little effect on heat of polymerization. Steric interference may prevent polymerization above the dimer. The heat of copolymerization of butadiene and styrene lies between the values for the separate monomers. Heat of copolymerization of other monomer pairs may be higher or lower than the value for the separate components. Heat of polymerization depends somewhat on the ratio of 1,2- and 1,4-addition, and on the amount of crystallinity of the polymers. 12 p.

RP2074. Stress corrosion of wrought magnesium base alloys..Hugh L. Logan and Harold Hessing

The rates of corrosion of many metals and alloys are increased by the presence of tensile stresses in the materials. In order to determine the effect of tensile stress on the behavior of magnesium alloys exposed to corrosive media, stress-corrosion tests were made on several magnesium base alloys at two weather exposure sites, and in the laboratory by continuous immersion in a $NaCl+K_2CrO_4$ solution and by intermittent immersion in a dilute NaCl solution.

The periods of time to failure of specimens exposed under tensile stress in the atmosphere at the National Bureau of Standards were less than those for the same materials exposed in a marine atmosphere at Hampton Roads, Va.

The M1 clad AZ31X-h sheet alloy proved more resistant to stress corrosion than bare AZ31X-h, AZ51X, or AZ61X sheet alloys and AZ80X extruded alloys.

Predictions of relative susceptibility of materials to stress corrosion from intermittent immersion laboratory tests in a 0.01-percent NaCl solution were in good agreement with the results obtained from weather exposure tests at this Bureau. 11 p.

RP2075. Preliminary list of levels and *g*-values for TA II.........C. C. Kiess, G. R. Harrison, and W. J. Hitchcock

A new description of the spectrum emitted by singly ionized tantalum atoms has been compiled from observations made at this Bureau. The list of wavelengths contains about 2,500 lines between 5300 and 2000 A. About a third of these lines, including most of the strong ones, have been classified as transitions among energy levels that were identified with the help of well-resolved Zeeman patterns. The low and metastable levels arise from the electron-configurations $5d^2\ 6s^2$, $5d^3\ 6s$, and $5d^4$. The higher levels with which the low ones combine arise from the excited configurations $5d^2\ 6s\ 6p$ and $5d^3\ 6p$. The presence of the $d^2\ s^2$ configurations in ionized tantalum, almost equal in stability with $d^3\ s$, is noteworthy because it is unknown in the homologous vanadium and columbium ions. 2 p.

RP2076. Electrode function (pH response), hygroscopicity, and chemical durability of Na_2O-CaO-SiO_2 glasses................Donald Hubbard, Given W. Cleek, and Gerald F. Rynders

The hydrogen electrode function (pH response), hygroscopicity (water sorbing property), and chemical durability (surface alteration in solutions of various hydrogen ion concentrations) were measured for a series of Na_2O-CaO-SiO_2 glasses. The resulting data both confirmed and extended the previous conclusion that glasses having inadequate hygroscopicity and poor chemical durability are incapable of producing satisfactory electrodes for pH measurements. Each family of glasses having equal SiO_2 content and varying Na_2O:CaO ratios was found to have a limited composition range that gave electrodes that approached the theoretical voltage. However, low hygroscopicity, poor chemical durability and devitrification limit the number of useful glasses to a small area from which the eutectic composition, 22 percent Na_2O, 6 percent CaO, 72 percent SiO_2 (Corning 015), is already known to be superior for its pH response. For the series of 70 percent SiO_2 content, the pH response and chemical durability curves appear to indicate the compositions at which changes in the primary phase are indicated by the phase diagram of the system. 11 p.

RP2077. Soil-corrosion studies, 1946 and 1948: copper alloys, lead, and zinc Irving A. Denison and Melvin Romanoff

This report contains the results of measurements of the corrosion of copper, lead and zinc, and certain alloys of these metals after exposure to different soil conditions for a maximum of 14 years. The soils to which the materials were exposed range from well-aerated soils deficient in soluble salts to very poorly aerated soils containing high concentrations of water-soluble materials. The magnitude and progress of corrosion with respect to weight loss and pitting are interpreted in relation to the composition of the materials and the properties of the soils at the test sites. Comparative data are given for the corrosion of plain iron and steel, copper, lead, and zinc in typical soil environments. 31 p.

RP2078. Mass spectra of nonanes........Fred L. Mohler, Laura Williamson, C. Edward Wise, Edmund J. Wells, Helen M. Dean, and Evelyn G. Bloom

Mass spectra of the 35 nonanes have been measured with a Consolidated mass spectrometer. Sensitivity (current per unit pressure) at the maximum peak relative to *n*-butane and total ionization relative to *n*-butane are given, as well as relative intensities for 18 mass peaks.

Relations between molecular structure and mass spectra are similar to those found in lighter saturated hydrocarbons. Some general relations between mass spectra and molecular structure of saturated hydrocarbons are given, but these are not sufficient to deduce the structure uniquely from the spectrum. The analysis of mixtures of nonanes will, in general, be impossible unless the sample is a cut containing comparatively few components. 7 p.

RP2079. Syntheses and properties of two olefins, six paraffins, and their intermediates.................Thomas W. Mears, Abraham Fookson, Philip Pomerantz, Edwin H. Rich, Cecil S. Dussinger, and Frank L. Howard

As a part of a study of the desirability of certain hydrocarbon types as jet fuel components, eight aliphatic hydrocarbons have been prepared and purified. This report describes their syntheses and those of several intermediates. Physical constants were measured on the high purity products. 13 p.

RP2080. Effect of deuteration, oxidation, and hydrogen-bonding on the infrared spectrum of cellulose......John W. Rowen and Earle K. Plyler

Regenerated cellulose films were immersed in heavy water (99.58% D_2O) at temperatures up to 52° C for as long as 100 hours in an attempt to effect a substitution of D for the H in the OH groups of the cellulose. The intensity of the OH vibration in the 3-micron region of the spectrum of the films decreased very little. A weak OD vibration appeared in the 4-micron region. The results indicate that only a small fraction of the OH groups of the cellulose participated in an exchange under the conditions of the experiments.

The infrared spectra from 2 to 16 microns of cellulose nitrate, nitrogen dioxide oxidized cellulose, alginic acid, and sodium alginate are recorded. A comparison of the spectra of these polysaccharides indicates that the strong band at 5.75 microns in the spectrum of the oxidized cellulose is due to the C=O vibration of the carboxyl group, and that the bands at 6.07 and 7.01 microns are due to nitrogen-oxygen vibrations.

The intense bands in the 3-micron region of the spectra of a number of cellulose derivatives, attributed to hydroxyl groups, were examined with the aid of the high-dispersion lithium fluoride prism. The minima of the bands were exactly at or close to 2.86 microns (3,500 cm^{-1}). The possibility of the existence of a common type of hydrogen bond in the cellulose derivatives is discussed. 8 p.

RP2081. Vapor pressure and fixed points of oxygen and heat capacity in the critical region..................................Harold J. Hoge

Vapor-pressure measurements on oxygen covering the entire range from the critical point are reported. By measuring short sections of isotherms, the critical temperature and pressure were found to be 154.78° K and 50.14 atm, respectively. The triple point temperature and pressure were found to be 54.363° K and 1.14 mm Hg respectively. The two solid-solid transitions were found to be at 43.80_0° and 23.886° K respectively. Measurements were made of the heat capacity of oxygen in the critical region at six different filling densities. A comparison of the temperature scales of three different laboratories is made, based upon reported values of the fixed points of hydrogen, nitrogen, and oxygen. 25 p.

RP2082. Factors affecting the water-vapor permeability of leather
Joseph R. Kanagy and Robert A. Vickers, III

This investigation was undertaken at the request of the Office of the Quartermaster General, which is endeavoring to obtain fundamental information on the transfer of water vapor through leather, which may be applied in the development of improved Army shoes. The method used for measuring the water vapor permeability is based on the present approved procedure of the American Leather Chemists' Association, but considerable improvement was made in the technique of assembling the permeability cell and in the procedure applied in making the determinations.

The water vapor permeability of leather depends upon a number of factors including thickness of sample, grease content, and the relative humidity and temperature of the atmosphere. It is greatly reduced by the presence of the natural glyceride greases. The grain layer of the leather appears to be the first stratum to become saturated with grease and consequently is a highly influential stratum with respect to water vapor permeability. The finish on the grain layer also has an influence on water vapor transmission. There is no dependent correlation between water vapor permeability and air permeability.

Studies on leathers impregnated with different types of materials, including rubber and acrylate resins, show that the water vapor permeability decreases in the following order: sulfonated oils, acrylate resins, rubber, and stuffing greases. The comparatively high water vapor permeability of the leathers treated with the sulfonated oils and acrylate resins is attributed to the influence of the polar groups in these impregnants.

Studies indicated that flexing of the specimen had no influence on the water vapor permeability of degreased leathers; however, for leathers that contained grease, there was an increase in water vapor permeability on flexing.

The results of the experiments indicate that, in addition to gaseous diffusion, water is transmitted through leather by conduction over the surface or by some form of activated diffusion. Evidence for the conduction mechanism is given by the behavior at low relative humidities, existence of an energy of activation, influence of temperature, comparison of air permeability and water vapor permeability, experiments with fabrics and glass disks, variations of diffusion constants, and the results of studies of the effect of gross air pressure with the dynamic equipment. 16 p.

RP2083. Reduction of halomethanes with lithium aluminum hydride
Vernon H. Dibeler

A study has been made of the reactions of lithium aluminum hydride with methyl bromide, methylene chloride, methylene bromide, methylene iodide, chloroform, bromoform, and carbon tetrachloride. Except for hydrogen and unreacted halide, essentially pure methane was formed in each case. The amount of hydrogen evolved increased with the number of halogen atoms in the molecule, reaching a maximum in the reduction of carbon tetrachloride. This fact, together with the absence of hydrocarbons heavier than methane, indicates that the reaction proceeds by a step-wise process rather than a simultaneous stripping of several halogen atoms from the molecule. 3 p.

RP2084. Crystallization and second-order transitions in silicone rubbers
C. E. Weir, W. H. Leser, and L. A. Wood

In the course of an investigation to determine which rubbers might be suitable for use at low temperatures, interferometric measurements of the length-temperature relationships of silicone rubbers have been made. Crystallization was found between —60° and —67° C in Dow-Corning Silastic X–6160 and in General Electric 9979G silicone rubber, the latter of which contains no filler. Crystallization between —75° and —85° C was found in Silastic 250. Melting occurred over a range of temperature above the temperature of crystallization. The volume change on crystallization varied from 2.0 to 7.8 percent. No crystallization or melting phenomena were observed in Silastic X–6073 between —180° and +100° C. All types of silicone rubber exhibited a second-order transition at about —123° C, the lowest temperature at which such a transition has been observed in a polymer. The coefficient of linear thermal expansion of silicone rubbers containing no filler was found to be about 40×10^{-5}/deg C between —35° and 0° C. 6 p.

RP2085. Refractive index as a function of wavelength for sixty API–NBS hydrocarbons..................................Alphonse F. Forziati

Measurements of the refractive index at 20°, 25°, and 30° C and at seven wavelengths, from 6678.1 to 4358.3 Angstrom units, were made on 60 purified hydrocarbons of the API–NBS series. The apparatus consisted of a precision Abbe-type refractometer, calibrated by means of NBS Standard Samples of hydrocarbons certified with respect to refractive index at the three temperatures and seven wavelengths used. The light sources used were a mercury arc, a sodium vapor lamp, and hydrogen and helium discharge tubes, with suitable filters. A constant temperature bath maintained the temperature of the refractometer prisms constant within ±0.02° C.

The experimental data on the hydrocarbons were adjusted by means of a four constant Hartmann equation, $n\lambda=n_\infty+C/(\lambda-(\lambda^*)^{1.6}$, and a two constant modified Cauchy equation, $\Delta n\lambda=a+b/\lambda^2$. ($\Delta n\lambda$, the change in the refractive index at the wavelength, λ, when the temperature is changed from 20° to 25° C or 25° to 30° C, is used instead of $n\lambda$ of the Cauchy equation).

The computed refractive index at 20°, 25°, and 30° C, together with the values of the specific dispersions, and the constants of the Hartmann and modified Cauchy equations, applicable over the range of measurement, are reported for 60 API–NBS hydrocarbons, comprising 17 paraffins, 14 alkylcyclopentanes, 8 alkylcyclohexanes, and 21 alkylbenzenes. 13 p.

RP2086. Heats of combustion and formation of cellulose and nitrocellulose (cellulose nitrate)..........Ralph S. Jessup and Edward J. Prosen

This paper gives the results of bomb calorimetric measurements of heats of combustion at 30° C of one sample of cellulose and four samples of nitrocellulose from cotton linters, and of one sample of cellulose and four samples of nitrocellulose from wood pulp. The results have been combined with values for the heats of formation of carbon dioxide and water to obtain values of heats of formation of the celluloses and nitrocelluloses. Empirical equations are given expressing heat of combustion and heat of formation of the nitrocelluloses as functions of nitrogen content. 7 p.

RP2087. Thermal and moisture expansion studies of some domestic granites
Arthur Hockman and Daniel W. Kessler

As a part of a study of the physical properties of building stone, thermal expansion determinations were made on 48 samples of domestic granites by the differential interferometer method (with an interferograph recording attachment) over the temperature range —20° to +60° C. Thermal coefficients computed between —20° and +60° C ranged from 4.8 to 8.3×10^{-6} per deg C with an average of 6.2×10^{-6} per deg C. Coefficients obtained on cooling (60° to 0° C) averaged 6.7×10^{-6} per deg C. Expansion curves drawn for all samples indicate slight irregularities in the 0- to 20-deg range in the heating curves of at least 65 percent of the samples. These irregularities are probably caused by moisture changes in the sample during the test.

Moisture expansion determinations were made on the 48 samples by means of the Tuckerman optical strain gage over a 24-hour period at constant temperature. The expansions obtained ranged from 0.0004 to 0.009 percent and averaged 0.0039 percent.

Adverse effects resulting from continued thermal and moisture expansion and contraction of granite are believed to be of some significance in monumental structures that are expected to last for long periods of time. 16 p.

RP2088. Separation of 2,3-dimethylpentane, 1,*cis*-3-dimethylcyclopentane, and 3-ethylpentane from petroleum..........Augustus R. Glasgow, Jr., Charles B. Willingham, and Frederick D. Rossini

This report describes the separation of 3-ethylpentane and the fractionation of 2,3-dimethylpentane and 1,*cis*-3-dimethylcyclopentane from the aromatic-free fraction of petroleum normally boiling in the range 89° to 94° C. These three compounds, together with the four hydrocarbon compounds previously separated, constitute substantially all of the material of this fraction of petroleum. For these seven compounds, the normal boiling points (of high-purity samples not from the present investigation) and the estimated amounts by volume in the original Ponca, Oklahoma, crude petroleum are as follows: 2,3-dimethylpentane, 89.78° C, 0.1 percent; 2-methylhexane, 90.05° C, 0.7 percent; 1,*trans*-3-dimethylcyclopentane, 90.77° C, 0.9 percent; 1,*cis*-3-dimethylcyclopentane, 91.72° C, 0.2 percent; 3-methylhexane, 91.85° C, 0.5 percent; 1,*trans*-2-dimethylcyclopentane, 91.87° C, 0.5 percent; and 3-ethylpentane, 93.47° C, 0.05 percent. 8 p.

RP2089. Interference methods for producing and calibrating end standards
Chauncey G. Peters and Walter B. Emerson

An interferometric apparatus developed at the National Bureau of Standards for ruling meter scales in terms of wavelengths of light requires accurate determination of the length of a decimeter etalon. To compare the results of the interferometric methods of measurement used at this Bureau with those of other national laboratories, etalons of fused quartz having highly polished plane and parallel end surfaces were made and calibrated at this Bureau. They were then sent to the Bureau International des Poids et Mesures, Physikalish-Technische Reichsanstalt, and The National Physical Laboratory for calibration. The lengths of the etalons as determined by the various laboratories are:

Etalon No.	By other Laboratory	By NBS	Difference
	mm	*mm*	*mm*
11......	BIPM 99.999 848........................	99.999 855	—0.000 007
2......	PTR 99.999 934........................	99.999 907	+.000 027
15......	PTR 99.999 899........................	99.999 919	—.000 020
13......	NPL 99.999 862 (initial measurements)..	99.999 872	—.000 010
14......	NPL 99.999 906 (initial measurements)..	99.999 888	+.000 018

These results indicate that diverse interferential methods used by the different laboratories give the same lengths to an average deviation of 0.016μ (1 part in 6,000,000) and to a probable uncertainty much less.

Besides furnishing a direct comparison of the results obtained by different interferential methods, the investigation gives values for the index of refraction of air and also wavelength values for several radiations of krypton and cadmium. These are included in the paper.

Because of inherent advantages of fused quartz etalons as separators for Fabry-Perot interferometers, the methods used in making and calibrating these etalons are given in detail. 24 p.

RP2090. A note on the formation and structure of iron dendrites in a magnesium alloy........Harry C. Burnett, Jr., and Herbert C. Vacher

Metallographic examination of commercially pure magnesium that had been heated to 1,000° C in an iron crucible revealed iron dendrites. Further examination by the microradiographic method showed that the dendrites grew at uniform rates in the dodecahedral directions. 4 p.

RP2091. Lamps and wavelengths of mercury 198........William F. Meggers and F. Oliver Westfall

The production and extraction of artificial $^{198}_{80}$Hg from $^{197}_{79}$Au bombarded by neutrons is described, and the procedure in making electrodeless lamps with $^{198}_{80}$Hg is given in detail. These lamps are excited by high-frequency radio waves; they emit the mercury spectrum entirely free from isotope shifts and hyperfine structures that characterize natural mercury. Fabry-Perot interferometers and a prism spectograph were employed for measuring, relative to Cd 6438.4696 angstroms, the wavelengths of the stronger lines in the visible spectrum of $^{198}_{80}$Hg. Preliminary values for $^{198}_{80}$Hg radiations in normal air are reported as 5790.6627, 5769.5984, 5460.7532, 4358.3377, 4077.8383, and 4046.5717 angstroms, with probable errors not exceeding ±0.0001 angstrom. 9 p.

RP2092. Heat of fluorination of cobaltous fluoride, and the heats of reaction of cobaltic fluoride with hydrogen and with bis (trifluoromethyl) benzene (*a,a,a,a',a',a'*-hexafluoroxylene)..........Ralph S. Jessup, F. G. Brickwedde, and Martin T. Wechsler

Calorimetric measurements of the heats of the following reactions have been made, with the results indicated:

(1) $2CoF_2(c)+F_2(g)=2CoF_3(c)$, $\Delta H(250°C) = —56.1\pm2.0$ kcal;

(2) $C_6H_4(CF_3)_2(g)+14CoF_3(c)=C_6F_{10}(CF_3)_2(g)+14CoF_2(c)+4HF(g)$, $\Delta H(335°C) = —409\pm20$ (?) kcal;

(3) $2CoF_3(c)+H_2(g)=2CoF_2(c)+2HF(g)$, $\Delta H(335°C) = —74\pm4$ kcal.

The values given for the heats of reactions 1 and 3 are consistent, within the assigned probable errors, with available data on the heat of formation of hydrogen fluoride. Reaction 2 was accompanied by unknown side reactions, and the value reported represents the heat of the reactions that actually took place in the calorimeter per 14 moles of CoF_3 reduced. The error in the value given for the heat of this reaction, as written, may therefore be considerably greater than that indicated by the assigned probable error. 6 p.

RP2093. Permanence of glass standards of spectral transmittance
Kasson S. Gibson and Marion A. Belknap

Shortly after the introduction of commercially available photoelectric spectrophotometers, the National Bureau of Standards began issuing calibrated disks for checking the photometric scale of spectrophotometers. At the time these standards were selected no precise information was available regarding their permanence. The present paper represents data showing that the glass standards kept in the files for 16 years with only occasional use have not changed. Data are also given showing the nature of the changes occurring in glasses similar to the standards when exposed under glass to south skylight (including sunlight) for periods up to 3 years. 11 p.

RP2094. A 600-ohm multiple-wire delta antenna for ionosphere studies
H. N. Cones, H. V. Cottony, and J. M. Watts

This paper describes the design and the performance of a multiple-wire delta antenna developed for use with high output impedance, vertical-incidence ionosphere sounding equipment. Graphs are presented showing the terminal impedance of this antenna over the separating frequency range (1 to 25 megacycles), using various lengths of open-wire transmission line. The results of pattern measurements using model techniques are given, showing the expected radiation characteristics of the full-scale antenna. A practical test of the comparative merits of the antenna is described in which ionosphere records obtained by the use of this antenna are compared with those obtained by the use of a larger antenna developed previously. 14 p.

RP2095. Mass spectra of diborane–d_6 and ethane–d_6......Vernon H. Dibeler,
Fred L. Mohler, and Laura Williamson

The complete mass spectra of B_2D_6 and C_2D_6 and the partial spectrum of B_2D_5H have been obtained for ionizing voltages of 50 volts and 70 volts. An analytical procedure is given for deriving the contribution of all ions containing a hydrogen atom from the polyisotopic spectrum of a mixture of B_2D_6 and B_2D_5H. A comparison of spectra of B_2D_6 and B_2H_2 and C_2D_6 and ${}_2C_2H_6$ indicates that substitution of deuterium for hydrogen has only a slight effect on the dissociation probabilities in diborane and ethane. An exception is the occurrence of a metastable transition in B_2D_6 that does not occur in B_2H_6 viz $B_2D_5^+ \rightarrow B_{23}^+ + 2D$.

Simple statistical considerations, based upon the assumption of equal probabilities for the removal of a deuterium or a protium, give a dissociation pattern that differs by more than experimental error from that observed. 6 p.

RP2096. An improved apparatus for the determination of liquidus temperatures and rates of crystal growth in glasses......Oscar H. Grauer
and Edgar H. Hamilton

The liquidus temperature of a glass is the highest temperature at which equilibrium can coexist between the molten glass and the primary crystalline phase. An improved temperature-gradient apparatus is described for the rapid determination of liquidus temperatures and rates of crystal growth in glasses. In this method the use of small glass fragments confined in the cells of a platinum alloy holder largely eliminates the errors inherent in previous gradient methods. The procedure is simple and rapid. Liquidus temperatures in the range from 950° to 1,225° C were determined to a precision of 4 degrees C.

Rates of crystal growth were found to be linear. The usefulness to the glass technologist of data obtained by this method is indicated. 8 p.

RP2097. Infrared spectra of bromochloromethane, dibromomethane, tribromocloromethane, and tetrabromomethane............Earle K. Plyler, W. Harold Smith, and N. Acquista

The infrared spectra of bromochloromethane, dibromomethane, tribromochloromethane, and tetrabromomethane have been measured from 2 to 36 microns. By the use of the results of other workers in Raman spectra it has been possible to classify all the strong bands that have been observed. Many of the weaker bands were classified as combinations and overtones. Only a few of the bands of tetrabromomethane were observed, on account of the breaking down of the compound in solutions of carbon disulfide and carbon tetrachloride. The intense bands of dibromomethane and tetrabromomethane were measured in the vapor state. The infrared absorption bands of these compounds had not previously been measured over an extended range of wavelengths, and these measurements were undertaken to determine the positions of weak bands so that a more complete classification of the spectra of these molecules could be made. 6 p.

RP2098. Mass spectrometric analysis of a standard sample of carburetted water-gas by laboratories cooperating with the American Society for Testing Materials..........................Martin Shepherd

The mass spectrometer was used for the analysis of a standard sample of carburetted water-gas by laboratories cooperating with Subcommittee VII of Committee D–3 of the American Society for Testing Materials. The results of the cooperative analysis show the reproducibility and, in certain respects, the accuracy of this powerful new apparatus for gas analysis. The heating value and the specific gravity of the sample calculated from the analytical data were compared with the known values. Some very creditable work is reported, but the need for improvement and standardization with respect to the determination of hydrogen, carbon monoxide and nitrogen is evident. 14 p.

RP2099. Infrared absorption spectra of hexafluoroethane and of chloropentafluoroethane..José R. Barcelo

In the present paper the infrared absorption spectra of hexafluoroethane and chloropentafluoroethane have been studied. The spectra examined ranged from 2 to 40 microns, and for this purpose lithium fluoride, sodium chloride, potassium bromide, and thallium bromide-iodide (KRS5) prisms were used. The substances studied were in the gaseous state.

This work was undertaken to compare the spectra of two molecules of the same type of structure but with much different properties of symmetry. The spectrum of hexafluoroethane has been previously measured in the infrared to 22 microns, and only small differences are noted in the present work from the previous study. Tables are included, which classify the observed spectra of hexafluoroethane and chloropentafluoroethane as fundamental, combination, and overtone bands. 5 p.

RP2100. Development of very-high-frequency field-intensity standards Frank M. Greene and Max Solow

A description is given of the development of two very-high-frequency field-intensity standards, which are being used at this Bureau for the calibration of commercial field-intensity sets in the range 30 to 300 megacycles. These standards are employed to establish known values of field intensity by either of two methods: (a) the standard-antenna method in which the open-circuit voltage at the center of a receiving dipole is measured directly; (b) the standard-field method in which the current at the center of a transmitting dipole is accurately known. The techniques used for determining the antenna current and voltage are described.

The current distribution on the antenna is determined theoretically, using Schelkunoff's method, which gives the effective length. These values are compared with those obtained by measurement.

Results of field tests at 100 megacycles are presented in which the above two methods were directly intercompared using horizontal polarization. Their accuracy and limitations are discussed. 21 p.

RP2101. Note on the Runge-Kutta method........................W. E. Milne

A comparison is made between the standard Runge-Kutta method of solving the differential equation $y'=f(x,y)$ and a method of numerical quadrature. By examples it is shown that the Runge-Kutta method may be unfavorable even for simple functions f. 2 p.

RP2102. A sampling method for determining the lowest eigenvalue and the principal eigenfunction of Schrödinger's equation
M. D. Donsker and M. Kac

This is a preliminary report on a sampling method for finding the lowest eigenvalue and the corresponding eigenfunction of Schrödinger's equation. The theory underlying the procedure is explained and two cases treated numerically. Although the initial results are encouraging, more experimentation will be needed to fully test the practicality of the method. 7 p.

RP2103. A suggested relocation and respacing of the union colorimeter scale for lubricating oil and petrolatum..................Deane B. Judd,
Lorenzo Plaza, and Marion A. Belknap

At the request of Research Division IX, Committee D–2 of the American Society for Testing Materials, a study of the chromaticities and daylight transmittances of petroleum products has been carried out. From the results of this study a recommended relocation of the ASTM Union colorimeter scale has been derived that is intended to minimize the difficulties frequently experienced in the color-grading of off-color petroleum products. This study also revealed in some detail discrepancies in color-grading between laboratories ascribable to failure of the glass color standards of the various Union colorimeters to conform to the master standards. It has been found possible to respace the color standards along the relocated locus by changes smaller than these interlaboratory discrepancies so as to yield uniform color steps as perceived by the eye under the conditions of observation prescribed by the method of test in ASTM D 155–45T. This relocation and respacing of the Union colorimeter scale is presented as a suggestion for possible adoption by the industry. 10 p.

RP2104. Measurement of the proton moment in absolute units
Harold A. Thomas, Raymond L. Driscoll, and John A. Hipple

By measuring the absolute value of the magnetic field and the frequency required for nuclear resonance absorption in a water sample, the gyromagnetic ratio of the proton has been determined to be $\nu_p=(2.67528\pm0.00006)\times10^4$ sec.$^{-1}$ gauss^{-1}. Using this value with Planck's constant, the value of the magnetic moment of the proton in absolute units bcomes $\mu_p=(1.4100\pm0.0002)\times10^{-23}$ dyne cm/gauss.

A combination of our result with recent measurements of the proton moment in Bohr magnetons gives a value of $e/m=(1.75890\pm0.00005)\times10^7$ emu gram^{-1}. 15 p.

RP2105. Measurement of sixty-degree specular gloss
Harry K. Hammond, III, and Isadore Nimeroff

Specular gloss is the attribute next to color that is most often used in the evaluation of the appearance of objects. For 10 years the American Society for Testing Materials has used a method of test for the 60° specular gloss of paint finishes based on research done at this Bureau. The ASTM method prescribes the illuminator and receiver apertures that are to be used. However, in order to determine the uncertainties involved in the calibration of gloss standards, the rate of change of gloss reading with change of aperture was investigated throughout the gloss scale. This was done by modifying an existing goniophotometer so that it became in effect a versatile glossmeter with provision for accurately controlling all of the known geometrical variables involved. Data obtained on the variation of gloss reading with aperture show that standards with widely different distributions of reflected light can be used to check the adjustment of glossmeters and the conformance of their apertures to ASTM specifications in the increasingly important medium-to high-gloss range. The problem of obtaining the diffuse correction, which involves source polarization and departure of the specimen from a perfect diffusor, has been investigated. 14 p.

RP2106. Rate of shrinkage of tendon collagen: Further effects of tannage and liquid environment on the activation constants of shrinkage
C. E. Weir and J. Carter

Further studies of the rate of shrinkage of tendon collagen are reported. Metallic tannages decreased heat and entropy of activation. Three organic tannages yield evidence of cross-linking by increasing heat of activation. Effects of aqueous solutions of salts of alkali and alkaline earth metals and organic materials are studied. The results—decreased heat and entropy with increasing concentration of alkali salts and a similar behavior with organic solutes over a portion of the concentration range—are interpreted as due to interaction of solutes at hydrogen bonds. Solutions of alkaline earth salts increase heat and entropy of activation. A mechanism of shrinkage designed to explain the results of these studies is proposed. Applications of the experimental method are discussed. 11 p.

RP2107. Molecular microwave spectra tables....................Paul Kisliuk and Charles H. Townes

This paper presents a group of tables that give the frequencies, assignment of quantum numbers, and intensities of over 700 microwave absorption lines. The best available values of other pertinent molecular data, such as moments of inertia, dipole moments, quadrupole coupling constants, and rotation-vibration constants are also included. The frequencies are listed once for each molecule and again in consecutive ascending order of frequency. References are given for all data included. Frequencies listed to the nearest megacycle were generally measured with a cavity wave meter and may be in error by as much as 10 megacycles, whereas those given to a fraction of a megacycle are generally known to an accuracy of about 0.1 megacycle.

A short discussion of microwave spectra and important formulas is given. For easy calculation of hyperfine structure Casimir's function is tabulated up to $J=10$ and $I=9/2$. 34 p.

TITLE PAGE AND CONTENTS TO VOLUME 44. 6 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 45, JULY—DECEMBER 1950

RP2108. Calibration of precision airplane mapping cameras
Francis E. Washer and Frank A. Case

An instrument is described that permits the registration of all the information necessary to calibrate a precision airplane camera on a single negative. Twenty-five collimators arranged at 7.5° intervals along two meridians at right angles provide optically distant targets. These targets are photographed by means of the camera to be tested. Measurements made on the negative yield information on the equivalent focal length, distortion, resolving power, prism effect, orientation of the lines joining opposite pairs of collimation index markers, and location of the principal point. This instrument was designed and built to make the calibration of precision cameras required for all precision cameras used in Government mapping projects. A brief account of the calibration of a typical camera and a discussion of the physical significance of calibrated focal length are given. 16 p.

RP2109. A permeameter for magnetic testing at magnetizing forces up to 300 oersteds............Raymond L. Sanford and Philip H. Winter

A permeameter is described for magnetic testing at values of magnetizing force up to 300 oersteds. It is designed to test specimens of rectangular cross section up to 3 cm wide and 1 cm thick, with a preferred length of 28 cm. The instrument requires only a single specimen and is more simple and rapid to operate than the Burrows permeameter, which for many years has been generally accepted as the standard instrument for magnetic testing in this range. It is an absolute instrument, in that its constants are derived from its own dimensions so that it does not require calibration by any other permeameter. It is estimated that the values of magnetizing force and induction, which are obtained, are accurate within 1 percent, except that for very low values of magnetizing force the precision is the determining factor, and the uncertainty may be of the order of 0.05 oersted. 5 p.

RP2110. Heat capacity of sodium between 0° and 900° C, the triple point and heat of fusion.............Defoe C. Ginnings, Thomas B. Douglas, and Anne F. Ball

Using an improved ice calorimeter and furnace, the enthalpy changes of two samples of pure sodium have been accurately measured by a drop method at a number of temperatures between 0° and 900° C. Equations are derived to fit the data, and values of enthalpy and entropy, based on zero values at 0° C, as well as the heat capacity are tabulated for both the solid and liquid. Sources of significant experimental error are examined critically, and some theoretical implications of the results are discussed qualitatively. 11 p.

RP2111. High-temperature X-ray study of the system Fe_3O_4-Mn_3O_4
H. F. McMurdie, Barbara M. Sullivan, and Floyd A. Mauer

A series of compositions in the system Fe_3O_4-Mn_3O_4 was prepared and examined at high temperatures by X-ray diffraction methods. Although Fe_3O_4 and Mn_3O_4 form a continuous series of substitutional solid solutions stable at room temperatures, those compositions containing less than 60 percent of Mn_3O_4 are cubic, of the spinel type, and the rest are tetragonal. Those compositions that are tetragonal at room temperature pass through a two-phase region when heated and acquire the cubic spinel-type structure at high temperatures. The temperature range of the two-phase (exsolution) region varies with composition. The relation to this system of the minerals vredenburgite and hausmannite is discussed. 7 p.

RP2112. A quantitative study of the carbon monoxide formed during the absorption of oxygen by alkaline pyrogallol......Marthada V. Kilday

The amounts of carbon monoxide evolved during analytical absorptions of oxygen by alkaline pyrogallol were studied with respect to the composition and methods of preparing solutions, the temperature of reaction, the rate of flow of the sample through the solution, the capacity of the reagent for the absorption of oxygen, the partial pressure of reacting oxygen, and the manner of bringing the gas into contact with the reagent. Less than 0.02 percent of carbon monoxide was formed during analyses of gases containing as much as 80 percent of oxygen when the recommended solutions were used in bubbler-type absorption pipettes, and when the samples were passed into the solutions at a rate greater than 20 milliliters per minute at about 25° C. This was true until the solutions had absorbed approximately twelve times their volume of oxygen, after which the formation of carbon monoxide increased significantly. The NBS colorimetric carbon monoxide indicating gel was used for the quantitative determinations of carbon monoxide. A method was developed for preparing pyrogallol solutions that yielded reproducible amounts of carbon monoxide so small that no significant error was caused in the usual analysis. 17 p.

RP2113. Tracing of skew rays...............................Donald P. Feder

This paper presents a set of convenient recurrence formulas for the tracing of skew rays by means of a desk calculator. Because of the increased speed and field coverage of modern lenses, it is frequently desirable to trace such rays in making a complete study of an optical system.

The formulas apply to systems of spherical refracting surfaces. The system need not be centered.

Particularly convenient check formulas are available, which need be applied only at the final surface. 3 p.

RP2114. Strength of heat-resistant laminated plastics up to 300° C

Benjamin M. Axilrod and Martha A. Sherman

The flexural properties of samples of glass-fabric laminates were determined for several conditions of heating and testing. The laminates tested were bonded with various resins, including unsaturated-polyester, acrylic, silicone, phenolic, and melamine types. Flexural tests were made under the following conditions: (1) at 25° C and 50-percent relative humidity after 200 hours of heating at a temperature *T*; (2) at a temperature *T* after 0.5 hour at the temperature *T*; (3) at a temperature *T* after 200 hours at the temperature *T*; and (4) at 25° C and 50-percent relative humidity without heating prior to testing. The temperature *T* was 150°, 200°, and 250° C for condition 1; 150°, 200°, 250°, 300°, and 375° C for condition 2; and 150°, 200°, 250°, and 325° C for condition 3.

The one sample of silicone resin laminate tested was superior to the other laminates in retention of flexural properties at temperatures of 250° C or higher. The single phenolic laminate tested showed good retention of flexural properties when tested at elevated temperatures after 0.5 hour of heating. After prolonged heating the behavior of the phenolic sample was much less satisfactory, the strength being almost negligible at 250° C. The sample of melamine laminate was superior to the phenolic in retention of flexural strength after prolonged heating at 200° and 250° C. The polyester laminates lost at least 80 percent of their flexural strength when tested at 250° C. For each laminate and each test condition loss in modulus of elasticity correlated with loss in flexural strength, but the former loss was less than the latter. The results of one test in which duplicate sets of specimens were heated in still air and in rapidly moving air indicate that the loss of flexural properties during prolonged heating may depend on the method of exposing the specimens. 20 p.

RP2115. Attenuation of oscillatory pressures in instrument lines

Arthur S. Iberall

A theoretical investigation has been made of the attenuation and lag of an oscillatory pressure variation applied to one end of a tube, when the other end is connected to a pressure-sensitive element.

An elementary theory based on incompressible viscous-fluid flow is first developed. The elementary solution is then modified to take into account compressibility; finite pressure amplitudes; appreciable fluid acceleration; and finite length of tubing (end effects). Account is taken of heat transfer into the tube.

The complete theory is derived in an appendix. The results are summarized in eight graphs in a form convenient for use in computing the lag and attenuation of a sinusoidal oscillation in a transmission tube. 24 p.

RP2116. Cotton powder for infrared transmission measurements

Florence H. Forziati, Walter K. Stone, John W. Rowen,
and William D. Appel

Cotton cut in a Wiley mill to pass a 20-mesh screen was ground in a vibratory ball mill similar to one that has been used in Germany and Holland. Contamination of the cotton was practically eliminated by using a chromium-plated hardened steel jar and chromium alloy balls. The jar holder is held by a slip ring instead of being bolted in place. The jar and holder automatically rotate slowly on their axis, and this motion counteracts the tendency of the cotton in the jar to settle and grind nonuniformly. The jar is cooled by blowing air over it and becomes barely warm to the touch.

Five grams of dried cotton disintegrated rapidly during the first 15 minutes of milling. The largest particles remaining after 30 minutes of milling were about 10 microns in major dimension, and there was little reduction of the maximum size with longer milling. Cuprammonium fluidity of the cotton increased rapidly in the first hour of milling and more gradually thereafter. The carboxyl content of the cotton increased very slowly with time of milling and reached only about 0.2 percent after 8 hours. The moisture regain of the cotton at 65-percent relative humidity at 21° C increased rapidly during the first hour of milling, from 7.1 to 12.5 percent, and then remained practically constant. X-ray diffraction measurements showed that the cellulose was converted almost completely to the amorphous form in 30 minutes, and that it underwent little change thereafter.

The powdered cotton obtained from the vibratory ball mill was mulled in mineral oil. The resulting paste was injected into rock salt cells for infrared absorption measurements. The powder worked reasonably well in this procedure, distinctly better than the coarse powders obtained by other methods of grinding. No significant differences were found in the infrared absorption of a regenerated cellulose film, the cotton ground in a Wiley mill to 200 mesh, and cotton ground in the vibratory ball mill for periods of time from 15 minutes to 8 hours.

It is concluded that the vibratory ball mill, as modified, reduces cotton, rapidly and completely, to a very fine powder, suitable for infrared transmission measurements and other purposes. Milling results in practically negligible oxidation of the cellulose, but in a marked decrease in degree of polymerization and in almost complete conversion of crystalline to amorphous cellulose. 5 p.

RP2117. Gravimetric analysis of exhaust gas from gas turbine combustion chambers......................Fillmer W. Ruegg and Carl Halpern

Because of the high air-fuel ratio used in combustion chambers of gas turbines, the concentration of products of combustion is so low that standard volumetric methods of analysis have proved unreliable. A gravimetric method of analysis was developed and applied to the problem, not to identify all of the constituents, but primarily to determine the efficiency of the combustion process. In this method the products of complete combustion, water and carbon dioxide, are separated from each other and from the remainder of the sample, which is then passed into a furnace to burn the combustible components. Carbon dioxide and water are determined by change of weight of solid absorbents. Experiments showed that the method may be used to provide accurate information about the magnitude of the loss of heat due to incomplete combustion, and partial information about the nature of the components of the exhaust gas. 9 p.

RP2118. Absorption of near-infrared energy by certain glasses
Jack M. Florence, Charles C. Allshouse, Francis W. Glaze,
and Clarence H. Hahner

An analysis has been made of the absorption bands of various glasses by calculation of the internal transmittances and surface losses. The wavelengths, in microns, associated with broad absorption bands have been measured, and the active vibrating groups causing the absorption are as follows: 2.7, CO_2; 2.75, OH; 2.75, CO_2; 2.9, OH associated; 3.5, $CO_3{}^{--}$; 3.65, $(NO_3{}^{-})$; 3.8, Si—O bond; 4.0, $CO_3{}^{--}$; 4.15, $(NO_3{}^{-})$; 4.25, CO_2; 4.45, Si—O bond; and 4.7, OH associated. The greatest loss of infrared energy for a number of glasses is caused by surface losses, rather than by true internal absorption. 8 p.

RP2119. Tensile properties of ingot iron at low temperatures..Glenn W. Geil and Nesbit L. Carwile

True stress-strain curves obtained in tension tests at temperatures ranging from —196° to +100° C with ingot iron as annealed, normalized, quenched and tempered, hot-rolled and cold-drawn are presented. Numerous simultaneous load and diameter measurements were made during the entire course of each test. The effects of prior thermal and mechanical treatment of the iron on the true stress-strain relations are discussed.

Graphs are presented showing the influence of the testing temperature, the ferrite grain size, and the initial condition of the iron on the work-hardening characteristics, namely, strain-hardening and strain-aging. The effects of the above factors on yield stress and ultimate stress, and on true stress and true strain at maximum load and at fracture, are presented. The twinning of iron in the tests at low temperatures is briefly discussed. 19 p.

RP2120. Effects of pressure and other variables on determinations of octane number..William J. Levedahl

Knock ratings made at altitude differ significantly from those made at sea level by both the ASTM Motor and Research Methods. Experiments were made in an altitude chamber to determine the effect on measured values of octane number of ambient pressure, engine speed, inlet mixture temperature, spark advance, knock intensity, exhaust back pressure, and diameter of carburetor venturi. The results indicate that no changes short of super-charging the engines will give ratings identical with those determined at sea level. 7 p.

RP2121. Creep of high-purity copper....................William D. Jenkins and Thomas G. Digges

Creep tests were made at 110°, 250°, and 300° F on annealed oxygen-free high-conductivity copper. The rate of loading to the ultimate had a significant effect on the amount of plastic extension and thereby affected the creep behavior. The strain rate during the so-called second stage of approximately constant rate was not constant but varied in a cyclic manner. A less-pronounced cyclic variation was also evident in both the first and third stages. The beginning of the third stage was often accompanied by microcracking, but in other tests this stage was initiated without the presence of such cracks. The parent grains were fragmented during creep, and strain markings were observed in all specimens carried to complete fracture. 21 p.

RP2122. Purification, purity, and freezing points of twenty-nine hydrocarbons of the API-Standard and API-NBS series....Anton J. Streiff, Laurel F. Soule, Charlotte M. Kennedy, M. Elizabeth Janes, Vincent A. Sedlak, Charles B. Willingham, and Frederick D. Rossini

This report describes the purification and determination of freezing points and purity of the following 29 hydrocarbons of the API-Standard and API-NBS series: 2,2,4,6,6-pentamethylheptane; 1,1,2-trimethylcyclopropane; *cis*-2-hexene; *cis*-3-hexene; 2-methyl-1-pentene; 4-methyl-1-pentene; 3-methyl-trans-2-pentene; 4-methyl-*cis*-2-pentene; 4-methyl-*trans*-2-pentene; 4,4-dimethyl-1-pentene; 4,4-dimethyl-*trans*-2-pentene; 2,3,3-trimethyl-1-butene; *trans*-4-octene; 1-nonene; 1-decene; 1-undecene; 1,3-butadiene; 1,2-pentadiene; 1,*cis*-3-pentadiene; 1,*trans*-3-pentadiene; 1,4-pentadiene; 2,3-pentadiene; 2-methyl-1,3-butadiene (isoprene); 1,5-hexadiene; 2,3-dimethyl-1,3-butadiene; 4-ethenyl-1-cyclohexene-(4-vinyl-1-cyclohexene); *cis*-decahydronaphthalene; *trans*-decahydronaphthalene; 2,3-dihydroindene (indan). 19 p.

RP2123. Wide-range phase control with constant attenuation by adjustable impedance in a resistance-loaded bridged-tee network
Myron G. Pawley

Phase may be shifted through a wide range without change in attenuation by means of a properly designed bridged-tee network. Equations are presented, and the necessary relations between circuit constants are deduced for phase control using an adjustable resistance, inductance, or capacitance located in a suitably selected branch of a bridged-tee network. 8 p.

RP2124. Stability of dextrose solutions of varying pH....Emma J. McDonald

A study has been made of the rate of the initial decomposition reaction taking place in dextrose solutions of varying pH. From the change in direct optical rotation over a period of time velocity constants have been calculated for eight values of pH. The results indicate that dextrose solutions are most stable at about pH 4. 4 p.

RP2125. Infrared spectrum of chlorofluoromethane...........Earle K. Plyler and Mary A. Lamb

In order to compare its spectrum with that of other halogenated methanes, the infrared spectrum of chlorofluoromethane has been measured in the gaseous state from 2 to 30 microns. The longest wavelength band was observed at 26 microns. Twenty-five bands have been observed with cells of 5, 60, and 100 centimeters in length and with gas pressures up to 60 centimeters of mercury. Nine of the observed bands have been classified as fundamentals, and the remaining bands are attributed to harmonics and combinations. Several bands in the region from 1.5 to 2.5 microns were measured on a high resolution grating instrument, and it was possible to resolve each of seven bands into a series of lines in this region. These bands are located at 1.657, 1.682, 1.700, 1.755, 2.229, 2.287, and 2.436 microns; the separation of the rotational lines is of the order of 2.3 cm^{-1} for these bands. 6 p.

RP2126. Resin bonding of hardwood fibers in offset papers
Bourdon W. Scribner, Merle B. Shaw, Martin J. O'Leary, and Joshua K. Missimer

A further investigation was made of the application of resin bonding to the development of strength in offset papers made principally of short hardwood fibers that develop little strength by the conventional beating. Melamine-formaldehyde resin was used. The papers were made from hardwood pulps produced at the U. S. Forest Products Laboratory in experimental study of the pulping of aspen, black gum, paper birch, and beech. The pulps were prepared by the mechanical, sulfate, sulfite, and neutral sulfite processes. By the use of the melamine resin, papers having good strength and resistance to pick, combined with low expansion and curl, were produced with very little beating. The pulps that gave the best results comprised aspen sulfate, aspen soda, aspen sulfite, birch sulfite, and black gum sulfate. Resin-bonded papers containing 75 percent of these pulps compared favorably with papers made in the conventional way with the usual 50 percent of commercial hardwood fibers. An appreciable increase in the proportion of hardwood fibers used in offset papers would greatly extend pulpwood resources. 10 p.

RP2127. Determination of very small changes in rate over intervals of several days in mechanical timepieces.............Horace A. Bowman

A device for automatically plotting the isochronism of a clock or watch is described. It was developed to assist in precision tests on marine chronometers and watches, but it may be altered without difficulty to plot the curves for any timepiece. Its accuracy is 0.01 second, which is sufficient for ordinary timepieces, but by a few simple changes this accuracy may be increased. Some of the curves plotted by this instrument are shown. The sensitivity of this instrument, as well as its graphic scale, may be varied depending upon the quality of the timepiece being tested. 5 p.

RP2128. A sulfate susceptibility test for portland cements......W. C. Taylor and R. H. Bogue

A procedure has been developed by means of which portland cements may be given ratings indicative of their resistivity to chemical attack by sulfate-containing solutions. The test, which may be performed in about a day, reveals the intrinsic resistivity to such attack by the cement itself as contrasted with the usual performance tests on mortar or concrete specimens, which require periods of weeks or months. The method involves the measurement of the amount of dissolved SO_3 rendered insoluble when cement is shaken with limewater for a stated period. The test has been examined critically and extensive correlations made with performance tests on laboratory and commercial portland cements. 9 p.

RP2129. Cascade-connected attenuators....................Robert W. Beatty

A method is presented for evaluating the error obtained when the attenuation of a number of cascade-connected attenuators is determined by adding the attenuation of each unit. The error is caused by mismatches at the attenuator junctions and is expressed in terms of reflection coefficients measured at the junctions. The analysis is pertinent to the case in which individual calibrated attenuators are available, but it is not feasible or possible to calibrate the combination of two or more attenuators. A nomogram is drawn that shows the limits of error (for two cascaded attenuators) in terms of voltage standing-wave ratios. Inspection of the nomogram shows that the error for typical UHF and microwave attenuators is generally of the same order of magnitude as the calibration errors. 5 p.

RP2130. Total ionization of hydrocarbons from mass spectral data
Fred L. Mohler, Laura Williamson, and Helen M. Dean

The total ionization is computed by adding all the mass peaks in the spectrum and multiplying by the sensitivity (current per unit pressure) for the maximum peak. This is divided by the corresponding product for *n*-butane to obtain a relative value independent of the units used. Data are taken from the API Catalog of Mass Spectral Data using revised values of sensitivity obtained by measuring pressure with a micromanometer. Total ionizations of all the isomers of a compound are nearly equal with only a few values differing greatly from the mean value. This is true in all cases where data are available for many isomers. With some exceptions total ionization increases with increasing number of carbon atoms in each series C_pH_{2n+2}, C_nH_{2n}, etc. Total ionization tends to decrease in compounds with the same number of carbon atoms and decreasing number of hydrogen atoms but there are many exceptions. Tables summarize data for 198 hydrocarbons.

Values of total ionization of isomers will in some cases permit computing all isomers as a group in chemical analysis without identifying the compounds. 4 p.

RP2131. Generalization of S. Bernstein's polynomials to the infinite interval
Otto Szasz

$$\text{Let } P(u,x) = e^{-xu} \sum_{v=1}^{\infty} \frac{(ux)^v}{v!} f\left(\frac{v}{u}\right), u>0.$$

The paper studies the convergence of $P(u,x)$ to $f(x)$ as $u \rightarrow \infty$. The results obtained are generalized analogs, for the intervals $0 \leqq x \leqq \infty$, of known properties of S. Bernstein's approximation polynomials in a finite interval. 7 p.

RP2132. Numerical determination of characteristic numbers......W. E. Milne

This paper represents a contribution to the problem of characteristic values and characteristic solutions of ordinary linear differential equations. The problem is conceived as a vibration problem in x and t. The partial differential equation is then approximated by a difference equation in both entries. The problem is now to find those frequencies in which a separation in x and t takes place. This is done by finding the roots of a trigonometric expansion of certain order. The method is applied to a number of interesting cases that illustrate various types of situations encountered in problems of physics and engineering. 10 p.

RP2133. An iteration method for the solution of the eigenvalue problem of linear differential and integral operators........Cornelius Lanczos

The present investigation designs a systematic method for finding the latent roots and the principal axes of a matrix, without reducing the order of the matrix. It is characterized by a wide field of applicability and great accuracy, since the accumulation of rounding errors is avoided, through the process of "minimized iterations". Moreover, the method leads to a well convergent successive approximation procedure by which the solution of integral equations of the Fredholm type and the solution of the eigenvalue problem of linear differential and integral operators may be accomplished. 28 p.

RP2134. Measurement of the internal diameters of metallic capillary tubes
Charles T. Collett, John C. Hughes, and Francis C. Morey

As a part of a cooperative research project of the National Bureau of Standards and the National Advisory Committee for Aeronautics on the viscosity of gases at elevated temperatures and pressures, it was found desirable to study the uniformity of the internal diameters of some metallic capillary tubes. This was accomplished by means of a small thread of mercury, using X-ray technique, following the method of Fisher. Eight tubes out of a group of twelve were selected as suitable for use in an absolute viscosimeter, and flow constants were computed. The tubes studied were about 15 feet long, with an internal diameter of about 0.015 inch. Maximum deviation from the average diameter in most cases was about 1.5 percent or less. 5 p.

RP2135. Mass spectra of some simple isotopic molecules...Vernon H. Dibeler, Fred L. Mohler, Edmund J. Wells, Jr., and Robert M. Reese

The mass spectra of H_2, D_2, T_2, HD, and HT have been measured with a Consolidated mass spectrometer with 50-volts ionizing voltage and with a constant magnetic field. The following ratios of atom ions to molecule ions were observed: $H^+/H^+_2=0.0201$, $D^+/D^+_2=0.0096$, $T^+/T^+_2=0.0061$, $H^+/HD^+=0.0096$, $D^+/HD^+=0.0097$, $H^+/HT^+=0.0085$, and $T^+/HT^+=0.0068$. The ratios for T_2 and HT were derived from spectra of two samples containing 91 and 37 atomic percent of T in equilibrium with H. Theoretical values for the ratios were computed for ionization involving transition into the Σ_g state of the molecule ion. These values are lower than the observed ratios, because transitions to higher repulsive states contribute to the observed values at 50-volts ionizing voltage.

Mass spectra of CO and CO_2 containing about 54 atom percent C^{13} were measured under standard operating conditions. For CO the ratio $C^{12+}/C^{12}O^+=0.0540$ and $C^{13+}/\text{-}C^{13}O^+=0.0514$. For CO_2, the ratios are $C^{12}O^+/C^{12}O^+_2=0.0868$, $C^{13}O^+/C^{13}O^+_2=0.0824$, $C^{12+}/C^{12}O^+=0.0564$, and $C^{13+}/C^{13}O^+_2=0.0542$.

A theory of the isotope effect in CO involving simplifying assumptions indicates that the relative probability of producing C^{12+} is 3.5 percent greater than the probability of producing C^{13+}, as compared with an observed difference of 5 percent. 4 p.

RP2136. Response characteristics of temperature-sensing elements for use in the control of jet engines.....Andrew I. Dahl and Ernest F. Fiock

The rate at which a temperature-sensing element located in the gas stream of a jet engine responds to sudden changes in temperature is of great practical importance in the control and operation of such an engine. The factors that determine rate of response are discussed, and the significance of the characteristic time is emphasized. It is shown that laboratory determinations of characteristic time must be made under simulated engine conditions in which the rate of heat transfer by forced convection is the controlling factor. Apparatus used at the National Bureau of Standards for measuring characteristic times is described, and typical results are presented. The rate of response of a device in a jet engine varies greatly with engine speed and with the altitude of flight, so that satisfactory performance of a temperature-actuated control system can be expected only if the sensing element responds with sufficient rapidity under starting conditions and at the flight ceiling. 7 p.

RP2137. Dielectric constants of aqueous solutions of dextrose and sucrose
Cyrus G. Malmberg and Arthur A. Maryott

The dielectric constants of aqueous solutions of dextrose and of sucrose prepared from NBS Standard Samples were determined at 20°, 25°, and 30° C for concentrations up to 50 and 60 percent by weight, respectively. A bridge method was used, and the sources of error involved are considered. The results, relative to a selected value for water, are considered to be accurate to 0.05 percent or better and are expressed in terms of an empirical equation for the purposes of interpolation. 5 p.

RP2138. Response of accelerometers to transient accelerations
Samuel Levy and Wilhelmina D. Kroll

Curves and tables are shown for the response of accelerometers to transient exciting accelerations. Three types of acceleration-time relations are considered. When plotted, they have square, triangular, and half-sine-wave shapes. The natural periods of the accelerometers for which the computations were made were approximately one, one-third, and one-fifth of the duration of the acceleration pulse. The damping coefficients of the accelerometers were 0, 0.4, 0.7, and 1.0 times the critical values. It is indicated that, to obtain an accuracy of better than 5 percent of the peak acceleration in measuring acceleration pulses having the general characteristics of the triangular or sinusoidal pulses, an accelerometer must have a natural period of about one-third the duration of the acceleration pulse, and a damping constant of about 0.4 to 0.7 of the critical value. 7 p.

RP2139. Electrode deterioration in transmit-receive tubes..Judson C. French

An investigation of the failure of a modified 1B24 TR (transmit-receive) tube revealed the cause to be the short circuiting of the pulsed keep-alive cathode to its anode, due to the formation of an unusual deposit on the cathode insulation and on the nearby anode surfaces. Analysis of the deposit showed that it originated at the cathode. To facilitate the investigation, diodes were constructed in which such parameters as distributed capacity, cathode material, current density and wave-form, and water vapor content of the gas fill could be readily varied while maintaining constructional features of the modified 1B24 relevant to the problem. The study disclosed that the glow discharge normally present breaks into a momentary arc, which by local heating of the cathode frees the metal that forms the deposit. Critical factors in the processes were determined, and by their proper control the deposit could be reduced or under some circumstances eliminated. 6 p.

RP2140. Text mixtures for distillation at atmospheric and reduced pressure
Charles B. Willingham and Vincent A. Sedlak

In this paper are reported values for the separation factor for distillation for each of the three pairs of diethylbenzenes for pressures from 30 to 800 mm Hg. Also given are data on the refractive index as a function of composition for the system 1,2-diethylbenzene and 1,3-diethylbenzene. 3 p.

RP2141. Aging of karakul and seal fur skins...............Edward T. Steiner
and Elizabeth R. Hosterman

Physical and chemical data are presented for two types of fur skins of widely different dressings and characteristics to show that deterioration takes place when furs are stored under conditions considered noninjurious. There occur during storage an appreciable loss of strength amounting to as much as 25 to 40 percent, and a change in certain chemical properties. Pelts weakened by aging showed increased soluble nitrogen and water extractives and lower grease contents (petroleum ether extractives) than less aged skins. A fair correlation exists between the observed changes in chemical and physical properties. The presence and quantity of copper in the weakened pelts offer the only reasonable explanation for the cause and the extent of the deterioration. 6 p.

RP2142. Second dissociation constant of succinic acid from 0° to 50° C
Gladys D. Pinching and Roger G. Bates

The second dissociation constant of succinic acid at intervals of 5 degrees from 0° to 50° C was determined from measurements of the electromotive force between hydrogen and silver-silver chloride electrodes in cells without liquid junction. The 19 solutions studied were divided into two series. The first series was made up of aqueous mixtures of sodium acid succinate, sodium succinate, and sodium chloride in the molar proportions 1:3:3. The solutions of the second series contained only sodium acid succinate and sodium chloride, in the molar ratio 1:1. The measurements of the second series were used to compute an approximate value for the first dissociation constant of the acid to be employed in correcting the results of the first series for the amount of free succinic acid formed by hydrolysis.

The second dissociation constant, K_2, for the temperature range studied can be expressed by

$$-\log K_2=1679.13/T-5.7043+0.019153\ T,$$

where t is the temperature on the Kelvin scale. Thermodynamic quantities for the dissociation of acid succinate ion were calculated from the temperature coefficient of the second dissociation constant. At 25° C, the standard free-energy change was found to be 32,182 abs j mole^{-1}, and the changes of heat content and entropy for the dissociation process in the standard state were -450 abs j mole^{-1} and -109.4 abs j deg^{-1} mole^{-1}, respectively. 7 p.

RP2143. Methods of sieve analysis with particular reference to bone char
Frank G. Carpenter and Victor R. Dietz

The procedure for separating particle sizes of solid adsorbents by sieving has been studied in detail because of the influence of the particle size on adsorbent properties. The investigation was conducted chiefly with sieve openings in the range between U. S. Standard Sieves No. 8 and No. 80. The largest source of error is in the testing sieves themselves. This is due to the tolerances permitted by the present specifications. It is feasible to calibrate testing sieves by the use of a calibrated sample of spherical glass beads and thus obtain the opening that is effective in sieving. The calibration of testing sieves in this manner can lead to reproducible sieve analyses by different laboratories. A simple procedure is proposed to determine the uniformity of sieve openings and, thereby, to furnish a criterion for the discard of distorted sieves. An analysis with seven Ro-Tap machines indicated that, in general, best results are obtained when the Ro-Tap is operated at 115 taps/min of the knocker mechanism. The other variables concerned with shaking that were examined are of minor importance and need not be rigidly controlled. As first choice, the weight of the sample should be between 100 and 150 g. The shaking time should be adjusted to the weight and the particle size distribution of the sample according to relationships developed. 19 p.

RP2144. First spectrum of arsenic......................William F. Meggers,
Allen G. Shenstone, and Charlotte E. Moore

The spectrum emitted by neutral arsenic atoms was observed photographically in the infrared, visible, and ultraviolet, and new lines were discovered in each spectral region. Measured wavelengths and estimated relative intensities are given for 330 lines, ranging from 1407.34 to 11679.9 A in wavelength and from 1 to 2000 in intensity. More than 74 percent of the total number and 97 percent of the total intensity of observed lines have been explained as combinations of 30 odd energy levels arising from $4s^2\ 4p^3$ and $4s^2\ 4p^2\ np$ electron configurations and 58 even levels from $4s\ 4p^4$, $4s^2\ 4p^2\ ns$, and $4s^2\ 4p^2\ nd$. The average difference between observed and computed wave numbers is 0.14 cm^{-1}. Most of the observed levels have been assigned to doublet and quartet terms, and spectral series of the type $4s^2\ 4p^3-4s^2\ 4p^2\ ns$ have been identified. Calculations based on these series yield an absolute value of 79165 cm^{-1} for the ground state $4s^2\ 4p^3\ 4s^{\circ}\ {}_{1/2}$ of neutral arsenic atoms, that is, an ionization potential of 9.81 ±0.01 electron volts. 11 p.

RP2145. Recirculating apparatus for testing hygrometers....Arnold Wexler

An apparatus that was developed for producing atmospheres of known relative humidity is described. It was designed, principally, for research on and calibration of radiosonde hygrometer elements at temperatures above freezing, but is equally useful at temperatures down to −40° C. It operates by saturating air at one temperature and then raising the air temperature sufficiently to give any desired relative humidity. The air is recirculated continuously in a closed system. Four identical, but independent, recirculating systems are employed. Discrete changes in humidity and temperature are obtained by means of a novel pneumatic valve that permits the hygrometers under test to be switched, easily, from system to system. Checks on the performance of the apparatus by means of the gravimetric method of moisture determination and the psychrometric method show an average difference in relative humidity of ±1.2 percent. 4 p.

RP2146. An improved apparatus for determining moisture in rubber by distillation with toluene..................................Max Tryon

An improved apparatus has been developed for the determination of water in rubber by distillation with toluene. The volume of the water collected is measured in a graduated capillary tube, which allows more precise measurement than the tapered tube formerly used. The interior of the trap and condenser is coated with a water-repellent silicone polymer to prevent water droplets from adhering to the walls and to improve the accuracy. This paper describes the construction of the apparatus and a procedure for coating its interior with the silicone polymer. A method for calibration of the trap is included in a general procedure for use of the equipment. 6 p.

RP2147. Porcelains within the beryllia field of the system beryllia-alumina-zirconia.....................Stewart M. Lang, Laurel H. Maxwell, and Milton D. Burdick

The general physical properties of practically impervious porcelains within the beryllia (BeO) field of the system beryllia-alumina-zirconia ($BeO-Al_2O_3-ZrO_2$), whose base compositions approximate that of NBS Body No. 4811C, were found to be: maturing range, 1,500° to 1,600° C; apparent density, 2.9 to 3.4 g/cm^3; shrinkage, 17.8 to 20.5 percent; room-temperature compressive strength, 238,000 to 305,000 lb/in.^{2}; room-temperature transverse strength, 17,200 to 34,100 lb/in.^{2}; room-temperature transverse strength after thermal shocking, 17,800 to 31,900 lb/in.^{2}; transverse strength at 1,800° F (982° C), 15,100 to 25,100 lb/in.^{2}; approximate Young's modulus at 1,800° F, 28,000,000 to 38,000,000 lb/in.^{2}; relative thermal shock resistance, good; and Knoop hardness numbers (500-g load), 550 to 830. An admixture of 2 weight percent of calcia (CaO) to the base compositions of these porcelains (without which the specimens would not mature to an impervious structure) caused the appearance of unidentified isotropic phases. 8 p.

RP 2148. Some electrical relations in galvanic couples...........H. D. Holler

The electrical relations are developed for a galvanic couple (short-circuited cell) with and without polarization by externally applied current. Their significance in the derivation of criteria for cathodic protection is demonstrated. The mechanism of current flow between couples at different potentials is explained. The importance of galvanic-couple theory in governing current distribution over an electrode surface is indicated. 8 p.

RP2149. Study of the system barium oxide-aluminum oxide-water at 30° C Elmer T. Carlson, Thomas J. Chaconas, and Lansing S. Wells

A study has been made of the action of water and of barium hydroxide solutions on the following compounds: $BaO.Al_2O_3$, $3BaO.Al_2O_3$, $BaO.Al_2O_3.H_2O$, $BaO.Al_2O_3.2H_2O$, $BaO.Al_2O_3.4H_2O$, $BaO.Al_2O_3.7H_2O$, $7BaO.6Al_2O_3.36H_2O$, $2BaO.Al_2O_3.5H_2O$, and $Al_2O_3.3H_2O$. From this, together with a study of precipitation from supersaturated barium aluminate solutions, a diagram of phase equilibria (stable and metastable) at 30° C has been drawn. All the barium aluminates are hydrolyzed by water. The stable solid phases in the system $BaO-Al_2O_3-H_2O$ at 30° C are $Al_2O_3.3H_2O$ (gibbsite), $Ba(OH)_2.8H_2O$, and, over a narrow range, probably $2BaO.Al_2O_3.5H_2O$. With the exception of the two lowest hydrates, all the hydrated barium aluminates possess a range of metastable solubility. 18 p.

RP2150. Permeability of glass wool and other highly porous media
Arthur S. Iberall

An elementary treatment is developed for the permeability of fibrous materials of high porosities, based on the drag of the individual filaments. It is believed that the same treatment is valid for other highly porous media. A brief historical review is given of theories relating the permeability to the structure of porous media. The applicability of the currently accepted permeability theory, based on the hydraulic radius, only to media of low porosities is discussed. Both approaches may be extended to permit approximate correlation for intermediate porosities. For fibrous materials of high porosity, it is shown that the effect of fluid inertia results in a permeability that varies with flow even at low Reynolds number. The permeability to gaseous flow is also shown to vary with the absolute gas pressure. This variation is appreciable when the molecular mean free path is of the same order of magnitude as the separation between filaments or particles in the medium. Data suitable for the design of linear flowmeters utilizing fibrous materials of high porosity are given, including data on the useful porosity range of fibrous media. 9 p.

RP2151. Density, refractive index, boiling point, and vapor pressure of eight monoolefin (1-alkene), six pentadiene, and two cyclomonoolefin hydrocarbons...............Alphonse F. Forziati, David L. Camin, and Frederick D. Rossini

Density (at 20°, 25°, and 30° C), refractive index (at seven wavelengths at 20°, 25°, and 30° C), vapor pressure, and boiling point (from 48 to 778 mm Hg) of 16 highly purified samples of hydrocarbons of the API–NBS series were measured for 8 monoolefin (1-alkene), 6 pentadiene, and 2 cyclomonoolefin hydrocarbons.

The data on refractive index were adjusted by means of modified Cauchy and Hartmann equations, and values of the constants are given for each compound.

The data on vapor pressure were adjusted by means of the method of least squares and the three-constant Antoine equation. The values of the constants are given for each compound.

Values were calculated for the specific dispersions, $(n_F—n_C)/d$ and $(n_g—n_D)/d$. 5p.

RP2152. A study of the determination of the heat of hydration of portland cement...Edwin S. Newman

Three relatively inexperienced operators made six determinations each of the heat of hydration of a sample of portland cement. The results of their measurements were calculated by the method described in Federal Specification SS–C–158b and by two simpler reduced-observation methods. By statistical analysis, no significant differences were found among either operators or methods. The precision (standard deviation of a single determination) of the heat-of-hydration measurements was about 3 calories per gram at 7 days and 2 calories per gram at 28 days. Somewhat better precision can be expected from experienced operators. 7 p.

RP2153. pH standards of high acidity and high alkalinity and the practical scale of pH...................Roger G. Bates, Gladys D. Pinching, and Edgar R. Smith

The practical scale of pH is defined in terms of the electromotive force of the galvanic cell

$$\text{Pt}; H_2\ (g), \text{solution} \mid \text{satd. KCl} \mid \text{standard}, H_2\ (g); \text{Pt}.$$

This potential is usually obtained as the difference of two electromotive force values for a cell with glass and calomel electrodes, one of which is a calibration with a standard of known pH. Appropriate corrections must be applied if the glass electrode does not respond to changes in hydrogen-ion activity in exactly the same manner as the hydrogen electrode. However, there is no simple means of correcting pH measurements for the potential differences at the junctions of the solution and the standard with the solution of potassium chloride. These errors are sufficiently large in highly acid and highly alkaline solutions to render uncertain the interpretation of measured pH in these regions, in spite of the fact that reasonably accurate standards of hydrogen-ion activity are available at intermediate pH values.

The purpose of this study was twofold: (a) to determine the extent of aberration of the practical pH scale near its end, and (b) to select new standards that might improve the accuracy of pH measurements and facilitate their interpretation over the entire practical scale, with particular attention to the regions of high acidity and high alkalinity. The results indicate that pH obtained by adjustment of the meter with the present standards (phthalate, pH 4.01 at 25° C; phosphate, pH 6.86; borax, pH 9.18) will usually be low by at least 0.02 to 0.05 unit above pH 11, while errors as great as 0.03 unit, either positive or negative, are not uncommon below pH 2.5. The following additional standards were selected to supplement the three presently available: (1) 0.01-*M* potassium tetroxalate—pH 2.15 at 25° C; (2) potassium hydrogen tartrate (saturated at room temperature)—pH 3.56; (3) 0.025-*M* sodium acid succinate, 0.025-*M* sodium succinate—pH 5.40; (4) 0.025-*M* sodium bicarbonate, 0.025-*M* sodium carbonate—pH 10.02; and (5) 0.01-*M* trisodium phosphate—pH 11.72. The choice was based on a comparison of pH derived from cells with and without liquid junction in a study of 41 promising standard solutions. The pH on the practical scale was determined at 25° C, and electromotive force measurements of hydrogen-silver chloride cells without liquid junction were made at 0°, 10°, 25°, and 38° C. 12 p.

RP2154. Electrode function (pH response), hygroscopicity, and chemical durability of soda-lead oxide-silica glasses..........Donald Hubbard, Mason H. Black, and Gerald F. Rynders

The pH response, hygroscopicity, and chemical durability of a series of $Na_2O-PbO-SiO_2$ (soda-lead oxide-silica) glasses have been investigated. The results obtained are in complete accord with the data previously published for a series of $Na_2O-CaO-SiO_2$ glasses and show that: 1. Glasses of very low hygroscopicity yield electrodes whose pH responses fall appreciably below the theoretical 59 millivolts per pH at 25° C; 2. electrodes prepared from glasses of poor chemical durability also fail to develop the full theoretical voltage.

When the approximate compositions at which changes in the primary phase appear for the $Na_2O-PbO-SiO_2$ system are superimposed upon the pH response and chemical durability curves, the marked changes in these properties appear to reflect some of the critical compositions of the phase equilibrium diagram.

The chemical durability data obtained by the interferometer procedure indicate that the property of swelling in acid solutions is much more universal for silicate glasses than previously realized. 12 p.

RP2155. Mass spectra of the deuteromethanes.............Vernon H. Dibeler and Fred L. Mohler

The four deuteromethanes have been synthesized and their mass spectra obtained with a Consolidated mass spectrometer. The sensitivities of the molecule ions of CH_4 and CD_4 are equal within the estimated uncertainty. The total ionization is the same for CH_4, CH_3D, and CH_2D_2 but is significantly low for CD_4. The mass spectra of the deuteromethanes are not predictable from CH_4 by statistical considerations alone. In agreement with previously published data on CH_3D, probability factors of 1.18 and 0.45 were observed for the dissociation of an H atom or a D atom compared with the dissociation of an H atom from CH_4. Whereas these factors remain approximately constant for subsequent dissociations in the same molecule, they differ markedly for the three protiodeuteromethanes. Wide divergence is observed for some probability factors obtained in dissociations of two or more atoms. 4 p.

RP2156. First dissociation constant of succinic acid from 0° to 50° C and related thermodynamic quantities..............Gladys D. Pinching and Roger G. Bates

The first dissociation constant, K_1, of succinic acid was determined at intervals of 5 degrees from 0° to 50° C from measurements of the electromotive force between hydrogen and silver-silver-chloride electrodes in cells without liquid junction. In order to reduce the correction for "overlapping" of the two acid groups, which are of nearly equal strengths, the 10 solutions studied contained twice as much succinic acid as acid succinate ion. The residual correction of about 0.02 in log K_1 was made with the aid of values of the second dissociation constant from an earlier determination.

The first dissociation constant between 0° and 50° can be expressed by

$$-\log K_1 = 1206.25/t - 3.3266 + 1.011697T,$$

where T is the absolute temperature. The changes of free energy, heat content, entropy, and heat capacity for the first dissociation step of succinic acid in the standard state were calculated from the dissociation constant and its temperature coefficient. 6 p.

RP2157. Effects of prior static and dynamic stresses on the fatigue strength of aluminum alloys..........John A. Bennett and James A. Baker

Tests made on specimens of Alclad 24S–T sheet showed that prior static load had a marked effect on the fatigue strength in unidirectional bending when the stress amplitude was relatively small. From tests on bare 24S–T sheet, it was found that a few cycles at a stress amplitude of 17,000 lb/in.^{2} resulted in a large increase in the fatigue life at 20,000 lb/in.^{2} Damage tests for other combinations of stress amplitudes indicated that the damage was nearly a linear function of ratio of the number of cycles at a given stress to the number that would cause failure at that stress. A new design of specimen and a new form of stress versus number of cycles to fracture (S–N) diagram are described. 9 p.

RP2158. Boiling points of aqueous solutions of dextrose within the pressure range of 200 to 1,500 millimeters................John L. Torgesen, Vincent E. Bower, and Edgar R. Smith

By using twin ebulliometers of the Swietoslawski type, with water as the reference standard, data were obtained on the vapor-pressure–temperature relationship for aqueous solutions of dextrose. The pressures ranged from 200 to 1,500 millimeters and the concentrations of the solutions from 10 to 60 percent of dextrose by weight. The vapor-pressure–temperature relationship is expressed by equations of the form

$$\log_{10} p = \mathrm{A} - \frac{B}{C+t}$$

in which p is the vapor pressure in standard millimeters of mercury exerted by a solution of a given concentration at the temperature, t, in degrees Celius. A, B, and C are constants. The boiling-point elevations of aqueous dextrose solutions at a given pressure are expressed by equations of the form

$$\log_{10} \Delta t = \alpha + \beta c + \gamma c^2 + \delta c^3,$$

in which Δt represents the boiling-point elevation in degrees Celius at a given pressure, c is the concentration in weight percentage of dextrose, and α, β, γ, and δ are constants. 5 p.

RP2159. Wavelengths for calibration of prism spectrometers..Earle K. Plyler and C. Wilbur Peters

Several absorption bands of polystyrene, 1,2,4-trichlorobenzene, and other compounds have been measured in the infrared region from 1.5 to 24 μ on grating spectrometers. These bands have been determined with sufficient accuracy for use in calibration of prism instruments. A table is included that gives the cell thicknesses used in the measurements. The emission lines of mercury for the region from 0.5 to 2.4 μ are included. In order that the table may be of most value, a number of bands that have been determined by previous observers have also been included. 7 p.

RP2160. High-pressure apparatus for compressibility studies and its application to measurements on leather and collagen...Charles E. Weir

The design and construction of apparatus to be used to measure volume changes of solids (or liquids) between 1,000- and 10,000-atmosphere pressure is described in detail. Calibration of the equipment and its use in determining the compression ($-\Delta V/V_0$) of leather are discussed. The compression of leather between 1,000 and 10,000 atmospheres is reported. The compression between 2,000- and 10,000-atmosphere pressure is approximately 7 percent and appears to be relatively unaffected by moisture content, type of tannage, or sample variation. The compression of all leathers tested is described by the equation $-\Delta V/V_0 = 1.23 \times 10^{-5} (P-2000) - 5.60 \times 10^{-10} (P-2000)^2 + 1.35 \times 10^{-14} (P-2000)^3$. 9 p.

RP2161. Arc and spark spectra of technetium............William F. Meggers
and Bourdon F. Scribner

Four milligrams of highly purified technetium, loaned by the United States Atomic Energy Commission, were used to obtain a description of the arc and spark spectra characteristic of this fission product Solutions containing 50 to 200 micrograms of technetium were dried on copper electrodes and excited by electric arcs or sparks. A stigmatic concave grating of 22-feet radius was employed to photograph the spectra from 2200 to 9000 angstroms, within which limits more than 2,300 lines characteristic of Tc atoms or ions were recorded. Wavelengths were measured relative to iron standards, relative intensities were estimated on a scale of 1 to 1000, and almost every line was definitely assigned either to neutral Tc atoms or to singly charged (Tc^+) ions. The measured wavelengths range from 2261.30 to 8829.80 angstroms with average probable errors rarely exceeding ±0.01 angstrom. The average results of wavelength measurements and of intensity estimates for 2,121 lines in Tc I and Tc II spectra are presented. The strongest Tc I lines have wavelengths 4297.06, 4262.26, 4238.19, 4031.63, and 3636.10 angstroms. The strongest Tc II lines have wavelengths 2543.24, 2610.00, and 2647.02 angstroms. This description of Tc I and Tc II spectra will serve for spectro-chemical identification and for structural analyses of these spectra. 14 p.

RP2162. Dissociation constants of 4-aminobenzophenone calculated from ultraviolet spectra at several temperatures.......Elizabeth E. Sager
and Iris J. Siewers

Many of the physical-chemical properties of compounds of low solubility are difficult to determine because of the necessarily small concentrations of material. In many cases advantage may be taken of measurements of the absorption spectra if the bands occur in favorable ranges of the spectrum. The diphenyl ketones fall in this category and have been the subject of recent studies.

The ultraviolet absorption spectra of several concentrations of benzophenone, 4-aminobenzophenone, and 4,4′-diaminobenzophenone have been measured and their molar absorbencies determined. The dissociation of 4-aminobenzophenone, a weak base, has been carefully studied at temperatures from 10° to 40° C in 5-degree steps. Dissociation constants for each temperature, as well as activity coefficient terms, have been calculated. The heat of dissociation has also been determined. 8 p.

RP2163. A new method of radioactive standard calibration
Howard H. Seliger

By proper arrangement of experimental observations and statistical analysis it has been possible to make Geiger-counter measurements of different activity samples independent of intermittent disturbing effects. The results of 5,328 individual measurements, involving more than 1.4×10^8 counts made by using a Latin square arrangement, are shown to have an error distribution identical with that expected from the statistical nature of the disintegration process. A completely worked out example of a calibration procedure is given, in which it has been possible to achieve a higher degree of accuracy in only 30 percent of the original counting time. 7 p.

RP2164. A problem in precision cam design.....................Joseph Blum

This paper proposes an analytic method for determining the profile of a cam required in a device that demands high precision. The method is applicable whenever the equation for the profile can be obtained by making a less stringent assumption, namely, that the follower makes contact at a fixed point of its extremity. The true profile can then be determined numerically by considering it as the envelope of a family of curves. 3 p.

RP2165. Real roots of real dirichlet L-series................J. Barkley Rosser

In the theory of the distribution of primes in arithmetic series, in assigning bounds in the three prime theorem, and in studying the class number of quadratic fields, a knowledge of the location of the real zeros of $L(s, \chi)$ is of value. A long standing conjecture is that there are no positive real zeros for any k. If proved, this result would be of value in each of the fields mentioned above. By a certain computational procedure the conjecture has already been verified for each individual $k \leq 67$. In the present paper, this earlier computational procedure was tried for each $k \leq 227$ and failed for $k=163$. An improved computational procedure is given in the present paper, but still the case $k=163$ remained difficult. Finally, a new formula for $L(s, \chi)$ was discovered that made it possible to treat many values of k simultaneously. By means of this formula, the difficult case of $k=163$ was finally treated adequately. 10 p.

RP2166. Forced oscillations in nonlinear systems........Mary L. Cartwright

This paper shows how the approximate form of the solutions of a certain nonlinear differential equation occurring in radio work may be obtained from certain general results and gives the proof of the general results in detail. The proof of the general statement depends on a type of method that can be applied with minor modifications to any equation of the type $\ddot{x}+k f(x) \dot{x}+g(x)=kp(t)$, where $p(t)$ has period $2\pi/\lambda$, and $\int_0^t p(t)dt$ is bounded for all t, $f(x) \geq 1$ for $|x| \geq a$, and $g(x)/x \geqq 1$ for $|x| \geqq a$. 6 p.

TITLE PAGE AND CONTENTS TO VOLUME 45. 6 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 46, JANUARY—JUNE 1951

RP2167. Diaphragm-type micromanometer for use on a mass spectrometer
Vernon H. Dibeler and Fidel Cordero

A diaphragm-type micromanometer is described that is capable of measuring pressures in the range of 1 to 100 microns with a sensitivity of about 0.1 micron on the 50-micron scale. The displacement of the thin diaphragm is measured by the change in mutual inductance of two coils mounted above the center of the diaphragm. The capsule is easy to assemble, and the rugged construction reduces the effects of mechanical vibration. The value of the manometer is illustrated by a comparison of the sensitivites of the isomeric heptanes, octanes, and nonanes calculated from pressures measured in two ways: First by the conventional method of measurement with a mercury manometer of the pressure of a known volume of the vapors and expanding approximately 1,000 fold, and second, by measuring with the micromanometer the pressure of the expanded gases. 4 p.

RP2168. An electronic circuit for measuring the displacement of pressure-sensitive diaphragms........................Maurice L. Greenough
and William E. Williams

An instrument has been developed for indicating the position of thin pressure-sensitive diaphragms. As no appreciable load is placed on the diaphragm, the system is well adapted to the measurement of low absolute or differential pressures in the range from zero to 100 microns. The electronic instrument gives full-scale indication for motions of less than 5 x 10^{-4} inch. Five tubes are incorporated in a circuit based upon the principle of the mutual-inductance micrometer for the detection of diaphragm motion. The same instrumentation may be utilized in other applicatons requiring the indication of very small displacements. 6 p.

RP2169. Heat of polymerization of alpha-methylstyrene from heats of combustion of monomer and four polymer fractions
Donald E. Roberts and Ralph S. Jessup

Measurements have been made with a bomb calorimeter of the heats of combustion ($-\Delta Hc^\circ$) at 25° C to form gaseous carbon dioxide and liquid water, of liquid alpha-methylstyrene (1-methyl-1-phenylethylene) and four fractions of its sold polymer having number average molecular weights of (I) 5,400, (II) 3,750, (III) 2,200, and (IV) 1,300. The values of heat of combustion are: monomer, 1204.87 kcal/mole; fraction I, 1196.04; fraction II, 1195.83; fraction III, 1195.50; and fraction IV, 1194.74 kcal/C_9H_{10} unit. Values of heats of polymerization ($-\Delta Hp^\circ$) at 25° C of liquid alpha-methylstyrene to its solid polymers have been calculated from the heats of combustion. The values of heat of polymerization are: fraction I, 8.83; fraction II, 9.04; fraction III, 9.37; and fraction IV, 10.13 kcal/mole of monomer. The standard deviations of the mean for heat of combustion are not more than 0.30 kcal/mole, and for heat of polymerization, not more than 0.26 kcal/mole. The decrease in heat of polymerization with increasing molecular weight is discussed. The low values of heats of polymerization are ascribed in part to steric interference between the substituent groups of the polymer chain. 7 p.

RP2170. The McKee worker-consistometer with constant-speed drives
Samuel A. McKee and Hobart S. White

Two constant-speed drives have been developed for use with the McKee worker-consistometer for mechanically working a fluid and measuring its flow characteristics in the same series of operations. Previously, weights were used to provide various constant loads at which measurements were made at the rate of flow of the material under test. The modifications provide for measurements of the resultant forces when operating at constant rates of flow. They permit the determination of the effect of working at various constant rates of shear and also provide for a much greater range of loads.

Test data are given showing the effect of mechanical working upon the flow characteristics of some lubricating greases and some raw synthetic rubbers.

The results show that the apparatus provides a tool useful in the measurement of the apparent viscosity and the effect of mechanical working for non-Newtonian materials having thixotropic properties. The performance of the apparatus is adequate to cover consistencies of materials ranging from a light lubricating grease to 100 percent of raw rubber. 12 p.

RP2171. Oxide cathode base metal studies.....................Ralph Forman
and Glenn F. Rouse

A method for comparing the properties of two oxide cathodes, one with a high-purity-nickel base and the other with a nickel base containing a small percentage of magnesium, is discussed. Data are presented showing the effect of magnesium on the rate of electrolytic activation and life of an oxide cathode. The influence of the cathode and anode on pulsed current decay at high current densities is also discussed. 8 p.

RP2172. Effect of changes in crystalline structure on the infrared absorption spectrum of cellulose....Florence H. Forziati and John W. Rowen

The absorption spectra of native, mercerized, and amorphous celluloses are recorded for the region from 2 to 16 microns. Cellulose having the X-ray diffraction pattern of the native, or type I, crystal lattice is represented in this study by bacterial cellulose, cotton fibers, *Valonia* cell wall, and the residue from the hydrolysis of cotton linters. Cellulose having the X-ray diffraction pattern of the mercerized, or type II, crystal lattice is represented by regenerated cellulose, the residue from the methanolysis of mercerized cotton linters, and mercerized bacterial cellulose. Amorphous cellulose was obtained by milling the residue from the hydrolysis of cotton linters in a vibratory ball mill.

The spectra of the type I celluloses showed sharper and more clearly defined absorption bands than the spectra of the type II celluloses. The most striking differences were found in the 7- to 8- and 9- to 10-micron regions. In the former region of the spectrum of type I celluloses, definite absorption maxima of nearly equal intensity were found at approximately 7.0, 7.3, 7.4, and 7.5 microns. In the spectrum of type II celluloses, the maximum at 7.4 microns was lacking, while the absorption at 7.3 microns was considerably more intense than that at 7.0 and 7.5 microns. Observations in 7- to 8-micron region of the spectrum of the amorphous cellulose were prevented by the use of a suspending medium that absorbed in that region. In the 9- to 10-micron region, definite absorption maxima were found at approximately 9.0, 9.4, and 9.6 microns with the type I celluloses. When cellulose I was converted into cellulose II or amorphous cellulose, these maxima merged into a single broad band. Conversion of cellulose I into cellulose II or amorphous cellulose also resulted in an increase in the intensity of the absorption at 11.2 microns. Although factors other than decrease in type I crystallinity may contribute to these changes in absorption characteristics, the changes may prove useful in evaluating changes in crystalline structure of cellulose. 5 p.

RP2173. Analysis of mixtures of olefin hydrocarbons produced by codimerization of butenes..........................Augustus R. Glasgow, Jr.

This paper describes the analysis, with respect to individual components, of three mixtures of olefin hydrocarbons. These were produced by the combination to form dimers of mixed butenes in a tubular type reactor with phosphoric acid as catalyst. Products of such reactions are called "codimers" and the process "codimerization". The analyses were made by utilizing distillations performed at high efficiency with high reflux ratio, with accurately measured values of the boiling point and refractive index of the fractions of distillate, and with separation by adsorption of the paraffin portion of selected distillate. In the case of one codimer, use was made of the previous analysis of the corresponding mixture of paraffins produced by hydrogenation of the codimer. 8 p.

RP2174. Surface-area determination by adsorption of nitrogen from nitrogen-helium mixtures.......William V. Loebenstein and Victor R. Dietz

A new apparatus and technique, in which vacuum pumps and associated equipment are not required, have been developed for the determination of the adsorption of nitrogen from mixtures with helium for use in the determination of surface area. The sample is heated initially in a stream of helium. The adsorption of helium is negligible at the temperatures concerned. The gas mixture is cycled repeatedly over the adsorbent until no further change in pressure is observed. Temperature equilibration is attained rapidly. It is shown that thermomolecular pressure differences are negligible under the conditions of the experiment. Surface-area determinations by the simplified technique are in good agreement with results obtained by the conventional volumetric method when the same adsorbents are used with various residual helium pressures. 5 p.

RP2175. Transformations to speed the convergence of series

J. Barkley Rosser

Numerical instances are given of the speeding of the convergence of series by the Euler transformation. This is even applied advantageously to certain divergent series, and a rigorous justification is given. An example is given of a series for which use of the Euler transformation is not useful. Instances are given of several less widely known methods. Finally, the method of summation by transformation into a continued fraction is illustrated successfully in the case of certain divergent series. The possibility of applying two different methods in succession to a given series is exploited throughout the paper, in spite of the fact that this often requires summing a divergent series. 10 p.

RP2176. Random walks and the eigenvalues of elliptic difference equations

Wolfgang Wasow

This paper is concerned with the application of Monte Carlo methods to differential equations of the form, $\nabla^2 u+g(x,y)u=0$. It is shown that under suitable conditions the Monte Carlo solution converges and gives the solution of the difference analog of the above equation. 9 p.

RP2177. Checking and interpolation of functions tabulated at certain irregular logarithmic intervals

Herbert E. Salzer

Many functions $f(x)$ behave as polynominals in log x. When tabulated for arguments in geometric progression, $f(x)$ can be checked by ordinary differencing, and interpolation can be performed to a fine extent with existing tables of Lagrangian coefficients. But in practice, $f(x)$ is often known or calculated at some or all of the points 1, 2, 5, 10, 20, 50, 100, 200, 500, and 1000 (same theory for the points 0.001, 0.002, 0.005, 0.01, etc., or 0.01, 0.02, 0.05, 0.1, etc., or any constant multiple of 1, 2, 5, . . .).

The present tables have a twofold use: I. Checking the correctness of $f(x)$ when tabulated at some of the more frequently occurring combinations of points 1, 2, 5, etc. This also includes their use to estimate the least number of tabular entries for interpolation of given accuracy. II. Facilitation of Lagrangian interpolation by a generalization of a scheme given by W. J. Taylor. 9 p.

RP2178. Temperature variation of mass spectra of hydrocarbons

Robert M. Reese, Vernon H. Dibeler, and Fred L. Mohler

The temperature variations of the mass spectra of a variety of hydrocarbons have been measured by using a Consolidated mass spectrometer. Measurements have been made in the temperature range of 100° to 300° C on a number of selected mass peaks in the spectra of 21 compounds. The sensitivity (current per unit pressure) of the maximum peak and the ratio of other peaks to the maximum peak have been measured as a function of temperature of the ion source. The percentage change of sensitivity or of pattern per degree C at 250° C has been defined as the temperature coefficient. This changes very little with temperature. The temperature coefficients of sensitivity for A and N_2 are —0.23 and —0.18. Sensitivity coefficients of the maximum peaks of the hydrocarbons range from —0.2 to 0; and pattern coefficients of most of the peaks have small negative or positive values, but the molecule ions have larger negative coefficients up to —1.5 percent per degree. There is an inverse correlation between the size of the molecule ion peak relative to the sum of all the peaks and the temperature coefficients. Spontaneous dissociation of molecule ions because of thermal energy can account for this correlation between peak height and temperature coefficients. Spontaneous dissociation of molecule ions because of thermal energy can account for this correlation between peak height and temperature coefficient. Published appearance potential data for a few of these molecules give a basis for computing the stability of the ions and show that thermal dissociation is to be expected at 200° to 300° C. 6 p.

RP2179. Absorption and emission spectra of promethium

William F. Meggers, Bourdon F. Scribner, and William R. Bozman

Five milligrams of promethium ($^{147}_{61}$Pm) separated from fission products at the Oak Ridge National Laboratory, were loaned by the United States Atomic Energy Commission for this investigation. The absorption spectrum of this sample in solution was plotted between 3,500 and 10000 angstroms; the principal bands have wavelengths 494.5, 548.5, 568.0, 685.5, 735.5 millimicrons (±0.5 millimicrons). Small portions of the sample were dried on copper electrodes employed in photographing alternating-current arc and spark spectra with a concave grating of 22-foot radius. Excepting Sm, into which Pm decays, no other rare earths could be detected in this sample, but common chemical contaminants were troublesome. Between 2200 and 6900 angstroms the wavelengths and relative intensities of more than 2,200 new spectral lines were determined, but it was not possible to differentiate Pm I and Pm II lines with the light sources employed. The strongest Pm lines have wavelengths 3892.16, 3910.26, 3919.09, 3957.74, and 3998.96 ±0.02 angstroms. Hyperfine structure is suspected in some Pm lines, indicating that the nuclei of $^{147}_{61}$Pm atoms possess mechanical and magnetic moments. Confirming the findings of the Oak Ridge National Laboratory, both the absorption and the emission spectrum identify this fission product as a new element of rare-earth type; they provide positive proof that the long-sought element with atomic number 61 has been discovered. 14 p.

RP2180. A statistical solution of a problem arising in the sampling of leather

John Mandel and Charles W. Mann

The evaluation of the relative merits of different tanning procedures requires that a number of hides or sides[1] of each tannage be subjected to a variety of physical and chemical tests. The destructive nature of these tests makes it desirable to keep to a minimum the number of hides or sides required for test purposes. Moreover, the total number of test specimens for each property should be kept as small as practicable for reasons of economy in leather and labor. Because of the nature of a leather hide, a considerable saving can be realized through a judicious choice of the location on the side from which test specimens for any given property are cut. In this paper a criterion is developed for the evaluation of the suitability of any given side location as a source of test specimens for a given property. It is shown that the coefficient of correlation between the test result on a given location and the average of the test results, on the same property, over the entire side, determines the suitability of this location as sampling location, both from the viewpoint of economy in the number of hides or sides and in the number of specimens required. It is further shown that for any particular property, the number of sides required to detect a given difference between two tanning procedures is inversely proportional to the square of the coefficient of correlation corresponding to the block chosen as sampling location and directly proportional to the square of the coefficient of variation of side averages for the property considered. 7 p.

RP2181. Heats of combustion, formation, and insomerization of ten C_4 hydrocarbons

Edward J. Prosen, Frances W. Maron, and Frederick D. Rossini

The heats of combustion of ten C_4 hydrocarbons were measured by combustion of the gaseous hydrocarbon in a flame at constant pressure in a glass reaction vessel in a calorimeter. The calorimeter system was calibrated by means of electrical energy.

The experimental data yielded the following values for the standard heat of combustion, —ΔHc°, at 25° C and constant pressure, of the gaseous hydrocarbon and in gaseous oxygen to form gaseous carbon dioxide and liquid water, with all the reactants and products in their thermodynamic standard reference states, in kcal/mole: *n*-butane, 687.42±0.15; 2-methylpropane, 685.37±0.11; 1-butene, 649.33±0.18; *cis*-2-butene, 647.65±0.29; *trans*-2-butene, 646.90±0.23; 2-methylpropene, 645.19±0.25; 1,2-butadiene, 619.93±0.13; 1,3-butadiene, 607.16±0.18; 1-butyne, 620.64±0.20; 2-butyne, 615.84±0.23.

Values of heats of isomerization, formation, and hydrogenation were derived from these data. 7 p.

RP2182. Effect of a metal mast and guy wires on the performance of the 600-ohm multiple-wire delta antenna..............Harold N. Cones

This report describes the results of measurements made to determine the effect of a metal mast and guy wires on the radiation pattern and the effect of guy wires on the terminal impedance and the radiation efficiency of the 600-ohm multiple-wire delta antenna. Model techniques were used to obtain radiation patterns of identical antennas supported in various ways. Curves are presented showing the terminal impedance over the frequency range 1 to 25 megacycles of full-scale antennas with and without guy wires. A graph of the quasi-radiation efficiency of the antenna as a function of frequency is shown. 8 p.

RP2183. Heat of solution of zinc oxide in 2 *N* hydrochloric acid
Richard B. Peppler and Edwin S. Newman

The heat of solution of ZnO in 2 *N* hydrochloric acid was found to vary from 185 to 203 calories per gram, depending on the proportion of ZnO. For 1 gram of ZnO in 640 grams of 2 *N* hydrochloric acid, the heat of solution was found to be 185 calories per gram, in fair agreement with the value of 196 calories per gram calculated from the published heats of formation of ZnO, $ZnCl_2$(aq), and HCl(aq), and the measured heat of mixing of $ZnCl_2$(aq) with HCl(aq). 3 p.

RP2184. Bounds for characteristic roots of matrices II.........Olga Taussky

This is a continuation of an earlier note (Duke Mathematical Journal, volume 15, pages 1043–44 (1948). It deals with bounds for the characteristic roots of matrices with positive (nonnegative) elements, and with bounds for multiple roots. 2 p.

RP2185. Microhardness tester for metals at elevated temperatures
Abner Brenner

An apparatus has been devised for measuring the hardness of electrodeposited coatings at temperatures up to 900° C in an inert atmosphere. Coatings thicker than about 0.07 millimeter (0.003 inch) may be tested. The main parts of the apparatus are: (1) The indenting mechanism, consisting of a Vicker's diamond mounted on a shaft of fused silica; (2) a mechanical device for raising and lowering the indenter; (3) a micrometer device for orienting the specimen under the indenter; (4) the heating unit. The force on the indenter is varied either by dead-weight loading or by changing the gas pressure inside of the apparatus. Some typical measurements made with the apparatus are given. 6 p.

RP2186. Mechanisms for the mutarotation and hydrolysis of the glycosylamines and the mutarotation of the sugars.........Horace S. Isbell
and Harriet L. Frush

A study has been made of the kinetics of the mutarotation and hydrolysis reactions of L-arabinosylamine, and a mechanism has been devised to account for the striking sensitivity of the glycoslyamines to hydrolysis in a limted pH range. The concepts presented seem applicable for the interpretation of the reactions of other compounds of the aldehyde ammonia type. 13 p.

RP2187. Infrared studies of association in eleven alcohols..Francis A. Smith
and E. Carroll Creitz

This work provides information to facilitate the interpretation of the structures of carbohydrates in terms of their infrared absorption spectra and additional knowledge of the properties of alcohols as associated solvents. The spectra of methanol, 1-dodecanol, 2-methyl-2-propanol (*t*-butyl alcohol), 3-

pentanol, 3-methyl-3-pentanol, 2,2,4-trimethyl-3-pentanol, 2,4-dimethyl-3-ethyl-3-pentanol, 2,2,4-trimethyl-3-ethyl-3-pentanol, 2,2,4-trimethyl-3-isopropyl-3-pentanol, 2,2,4,4-tetramethyl-3-*n*-propyl-3-pentanol, and 2,2,4,4-tetramethyl-3-isopropyl-3-pentanol have been studied.

Some of the effects of dilution in nonpolar solvents, and of steric hindrance by branching, on their intermolecular association through the formation of hydrogen bridges have been determined.

Evidence is presented for the existence of a single-bridge type of dimer.

The assignment of the band at 2.86 microns to dimer has been given strong support.

An isobestic point, at which the molar absorbancy index (28.6) is independent of the degree of dissociation, was found at 8.82 microns in the spectrum of 3-pentanol. Others not so well marked appear in the spectra of some of the other alcohols. Such points facilitate the quantitative determination of such alcohols in favorable circumstances.

The absorptions of the monomer and the dimer, separately, appear to obey Beer's law.

Both the momomer and the single-bridge dimer appear to contribute to the free hydroxyl absorption; their relative contributions depend upon the concentration of the solution. 20 p.

RP2188. Refractive indices of maltose solutions..........Emma J. McDonald

The refractive indices of maltose hydrate solutions have been determined at 20° and at 25° C. Equations relating the refractive index to the percentage concentration of sugar have been prepared from the observed data by the method of averages. A table, giving the refractive indices of maltose solutions at 1-percent intervals over a range of 1 to 65 percent of maltose hydrate at both 20° and 25° C, is included. 3 p.

RP2189. Electrode function (pH response), hygroscopicity, and chemical durability of soda-potash-silica glasses.............Donald Hubbard, Mason H. Black, Sylvanus F. Holley, and Gerald F. Rynders

The pH response, hygroscopicity, and chemical durability of a series of Na_2O-K_2O-SiO_2 glasses have been investigated. The pH responses of electrodes prepared from these glasses are in accord with similar data previously reported for two other series of glasses, namely, Na_2O-CaO-SiO_2 and Na_2O-PbO-SiO_2, which showed that (1) glasses of low hygroscopicity produce electrodes whose pH response fall below the theoretical 59 millivolts per pH at 25° C predicted by the Nernst equation, and (2) electrodes prepared from glasses of poor chemical durability also fail to develop the full theoretical voltage.

Chemical durability determinations by an interferometer procedure indicate swelling of the glasses upon exposure to acid buffers and pronounced attack in alkaline solutions. During the investigation some limitations of the infereometer procedure for determining chemical durability of glass became evident. Glasses that had exhibited direct solution in the acid pH range were found to show swelling in the early stages of the exposure. This swollen layer then sloughed off giving the appearance of attack as previously interpreted.

Above 70 percent of SiO_2, glasses containing mixtures of Na_2O and K_2O have lower hygroscopicities than those having but a single one of these oxides.

The pH response-hygroscopicity curves appeared to reflect some of the critical compositions of the phase equilibrium diagram, with glasses in the composition range for alpha tridymite yielding electrodes with the optimum pH response characteristics. 7 p.

RP2190. Viscosity and density of molten optical glasses..........Leo Shartsis and Sam Spinner

The viscosities and densities of 22 optical glasses, representing all types produced at the National Bureau of Standards, were measured by a counterbalanced-sphere method. The densities agreed with those obtained by a volumeter method, and the viscosities showed good agreement with those obtained with a small rotation viscometer.

Expansivities calculated from density results in the temperature range 1,000° to 1,200° C showed that flints are low, 15 to 22, barium crowns are intermediate, 22 to 37, and borosilicate crowns are high, 34 to 40 (microns/meter)/°C. The expansivities showed a positive correlation with the slope of the viscosity temperature curve.

The superiority of the theoretically derived Faxen correction of Stokes law over that of the empirical Francis formula was established by means of a freely falling sphere apparatus. 19 p.

RP2191. Calorimetric properties of diphenyl ether from 0° to 570°K
George T. Furukawa, Defoe C. Ginnings, Robert E. McCoskey, and Raymond A. Nelson

The heat capacity, enthalpy, and entropy of diphenyl ether from 0° to 570° K are calculated from experimental heat capacities obtained by using an adiabatic vacuum calorimeter and a Bunsen ice calorimeter. The heat of fusion and the triple-point temperature are given as 17,216 ±17 absolute joules mole^{-1} and 300.03 ±0.01° K, respectively. Heat of combustion experiments in a bomb calorimeter gave the value —6,135.64 ±0.88 absolute kilojoules mole^{-1} for the standard heat of combustion of the liquid at 30° C. The standard heats of combustion and formation are computed for both liquid and solid at 25° C. The standard entropy and Gibbs free energy of formation for the solid at 25° C are given as —590.1 ±0.5 absolute joules deg^{-1} mole^{-1} and 143.8 ±0.9 absolute kilojoules mole^{-1}, respectively. 12 p.

RP2192. Compressibility of natural and synthetic high polymers at high pressures..Charles E. Weir

Compression data ($-\Delta V/V_0$) are reported between 1,000 and 10,000 atmospheres for the following materials: dry cellulose, polyvinylidene chloride (Saran), polyethylene, polymonochlorotrifluoroethylene (Kel-F), polytetrafluoroethylene (Teflon), a polyester (Selectron 5003), and raw rubbers, Hycar OR25, Hycar OR15, Neoprene, and Thiokol ST. All compression curves are smooth except that for polytetrafluoroethylene, which shows a transition at 5,500 atmospheres, resulting in a change in volume ($\Delta V/V_0$) of approximately 2 percent. Coefficients of the cubic equations, $-\Delta V/V_0=a(P-2000)+b(P-2000)^2+c(P-2000)^3$ fitted to the data are as follows: Cellulose: $a=9.26\times10^{-6}$, $b=-3.25\times10^{-10}$, $c=2.93\times10^{-15}$; polyvinylidene chloride (Saran): $a=2.17\times10^{-5}$, $b=-1.90\times10^{-9}$, $c=8.73\times10^{-14}$; polyethylene: $a=1.89\times10^{-5}$, $b=-1.45\times10^{-9}$, $c=6.10\times10^{-14}$; polymonochlorotrifluoroethylene (Kel-F): $a=9.89\times10^{-6}$, $b=-4.74\times10^{-10}$, $c=8.29\times10^{-15}$; polyester (Selectron 5003): $a=1.76\times10^{-5}$, $b=-1.23\times10^{-9}$, $c=4.82\times10^{-14}$; Hycar OR25: $a=2.26\times10^{-5}$, $b=-2.03\times10^{-9}$, $c=9.09\times10^{-14}$; Hycar OR15: $a=217\times10^{-5}$, $b=-2.03\times10^{-9}$, $c=9.42\times10^{-14}$; Neoprene: $a=2.04\times10^{-5}$, $b=-1.75\times10^{-9}$, $c=7.66\times10^{-14}$; Thiokol ST: $a=1.92\times10^{-5}$, $b=-1.41\times10^{-9}$, $c=6.07\times10^{-14}$. Compressibilities calculated from these equations show fictitious minima circa 10,000 atmospheres, although the equations represent the data satisfactorily to 10,000 atmospheres. The data given compare favorably with those obtained on similar materials by previous workers. 6 p.

RP2193. Formulas and graphs for representing the interchangeability of fuel gases..Elmer R. Weaver

When gas-burning appliances have been adjusted to give satisfaction with a gas of one composition, and are then supplied with gas of a different composition, changes are usually noted in the characteristics of the flames produced. When no change can be seen or measured, the gases are said to be "exactly interchangeable." When undesirable changes do not occur to a greater extent than the person using the term thinks permissible, the gases are usually still called "interchangeable" with the omission of the adverb. No entirely satisfactory method has ever been found for predicting or representing the extent to which different gases depart from exact interchangeability. In this paper a set of six "indexes" is given for specifying and predicting from the composition of any two fuel gases the extent of the effects that occur when one is substituted for another. Four of these indexes are new. Their derivation is given, and their application is shown by comparison with the results of extensive experimentation of the American Gas Association. They are shown to represent the results of observation somewhat better than any method previously proposed. 33 p.

RP2194. Absorption spectra of water vapor and carbon dioxide in the region of 2.7 microns..................W. S. Benedict and Earle K. Plyler

The absorption due to atmospheric H_2O and CO_2 in the region of 2.7μ has been remeasured under higher resolution than previously reported. By using a 15,000-line grating and a lead sulfide photoconductive cell, some 450 lines have been measured between 2.43 microns (4,090 cm^{-1}) and 2.87μ (3,500 cm^{-1}). A rotational analysis may be given for nearly all the lines. In addition to the known ν_3 fundamental of H_2O which causes the strongest absorption in the region, a number of lines due to the ν_1 fundamental of H_2O, and the $\left\{\begin{matrix}02^\circ\ 1\\10^\circ\ 1\end{matrix}\right\}$ combination bands of CO_2 may be recognized. The ν_1 analysis does not agree with one suggested previously. The following are the principal molecular constants derived from the new analyses:

Molecule	v_1 v_2 v_3	v_0	*A*	*B*	*C*
		cm^{-1}	*cm*$^{-1}$	*cm*$^{-1}$	*cm*$^{-1}$
H_2O	0 0 1	3755.79	26.64	14.40	9.16
H_2O	1 0 0	3657.05	27.13	14.29	9.11
CO_2	0 2 1	3612.91		0.3875_8	
CO_2	1 0 1	3714.59		$.3872_8$	

20 p.

RP2195. Analysis of symmetrical waveguide junctions........David M. Kerns

Previous theory of consequences of symmetry in waveguide junctions has made limited use of mathematical tools available in the theory of group representations and has been limited to the consideration of nondissipative junctions. In this paper group-theoretical technique is utilized more fully (in much the same way as in the analysis of the vibration of symmetrical molecules) in the formulation of an improved and general technique for the analysis of symmetrical waveguide junctions subject merely to the requirement of linearity.

A waveguide junction, for the purpose of this paper, is a linear electromagnetic system possessing ideal waveguide leads, and is considered to be subject to excitation solely through the effects of nonattenuated modes in the waveguide leads. Under the conditions of the problem, an arbitrary electric (or magnetic) field in a waveguide junction is expressible linearly in terms of a finite number of linearly independent electric (or magnetic) basis fields. From any given ordered pair of electric (or magnetic) basis fields one can in principle calculate a complex number—an element of the admittance (or impedance) matrix characterizing the junction (relative to the choice of basis fields). The geometric concept of rotation and reflection of fields (and structures) is discussed in terms of a rotation-reflection operator, and the symmetry of a junction is characterized by a group of rotation-reflection operations under which the structure is invariant. A general procedure is given for the construction of a basis in which the basis fields transform according to irreducible representations of the symmetry group involved. Such basis fields are said to be of particular symmetry species and from the special properties of such fields follow the physical results, of which perhaps the most conspicuous is the vanishing of the matrix element between two fields of distinct symmetry species. 16 p.

RP2196. Comparison of viscosities of rubbers from the McKee worker-consistometer and from the Mooney viscometer..........A. B. Bestul, G. E. Decker, and H. S. White

Viscosities of three GR–S rubbers and three GR–I rubbers were measured at 100° C with the McKee worker-consistometer, a piston-type capillary viscometer, and with the standard Mooney viscometer, a rotating disk instrument. Rates of shear from several tenths to several hundred sec^{-1} were covered with the consistometer and from 0.1 sec^{-1} to several sec^{-1} with the Mooney viscometer. The procedure for preparing the samples and taking the measurements with the Mooney viscometer was selected as giving the best possible simulation of the conditions of the standard Mooney measurement, consistent with a valid indication of the temperature of the sample and as nearly as possible a like state of degradation at all rates of shear. The viscosities from the consistomer were calculated, using the Weissenberg-Rabinowitsch differentiation method for reducing observed flow data to fundamental quantities. The agreement of the results from the two instruments in their common range varies for the different rubbers, being better for the GR–S's. The best agreement is within about 2 percent, the uncertainty of the measurements, and the worst is within about 20 percent. The results from both instruments for X–518 GR–S agree with results obtained by Treloar for a "Standard GR–S" with a Piper and Scott biconical rotor modification of the Mooney viscometer. As the disagreements shown are not the same for all the rubbers they cannot be the result of constant instrumental differences, but must involve factors such as hydrostatic pressure, elasticity, and slippage at instrument surfaces. 5 p.

RP2197. Spectrophotometric determination of carboxyl in cellulose
Florence H. Forziati, John W. Rowen, and Earle K. Plyler

A method that uses the intensity of the absorption of the oxidized celluloses at 5.8 microns as a measure of their carboxyl content is described. The analyses are carried out on mineral oil slurries of 1:1 mixtures of finely divided polystyrene and cellulose. The absorption of the polystyrene at 6.2 microns is used as a reference band, thus obviating the necessity of accurately controlling the thickness of the absorption cell. The method gives results that agree fairly well with those obtained by the calcium acetate method and can be used to detect as little as 0.1 millimole of carboxyl per gram of cellulose. 4 p.

RP2198. Static friction tests with various metal combinations and special lubricants...............................H. S. White and Dino Zei

An inclined-plane apparatus was used in obtaining static friction data for various lubricants with different metal combinations. Special lubricants, such as chlorinated and fluorinated hydrocarbons, were compared with a reference mineral oil. The effect of additives, such as graphite, molybdenum disulfide, zinc oxide, boron nitride, and an oxidized petroleum compound, was investigated. Metal combinations involving stainless steels, carbon steel, cast iron, aluminum alloy, and chromium plate were used.

It was found that the special chlorinated and fluorinated lubricants without additives gave higher friction than the Navy symbol 2110 reference oil. A lubricant containing the oxidized petroleum compound and one containing a silicone grease gave slightly less friction than the reference oil. With a mineral lubricating grease, with dry molybdenum disulfide, and with lubricants containing graphite or molybdenum disulfide, the friction was about 50 percent less than with the reference oil. The remaining lubricants gave higher friction than the 2100 reference oil.

In general, the heat-treated stainless-steel combinations gave the lowest friction, whereas the combinations involving cast iron or aluminum alloy gave relatively high friction. Friction was less with lapped and polished surfaces than with ground surfaces. 7 p.

RP2199. Apparatus for the preparaton of anhydrous titanium (III) chloride and titanium (III) bromide........................J. M. Sherfey

An improved method is described for the preparation of titanium (III) chloride or titanium (III) bromide from the corresponding tetrahalide. The apparatus consists essentially of a reaction kettle, in the upper half of which is suspended a hot tungsten filament. A mixture of hydrogen and the vapor of the refluxing tetrahalide reacts at the surface of the filament, and the resulting solid product collects at the bottom of the vessel. 2 p.

RP2200. An apparatus for studying autoignition of engine fuels: results with normal heptane and normal hexane...........William J. Levedahl and Frank L. Howard

A single-cylinder ASTM–CFR fuel-testing engine with a variable compression ratio has been modified to facilitate the study of compression-ignition of homogeneous fuel-air mixtures. An investigation of this type of combustion may lead to a better understanding of engine knock. A cylinder-pressure limiter is described that permits firing a small number of cycles, the first of which is uncontaminated by exhaust gases. Pressure-crank angle oscillograms of the process are shown. The combustion of *n*-heptane and *n*-hexane was found to take place in two distinct stages over a wide range of fuel-air ratios. The pressure at which the first-stage reaction begins is relatively unaffected by the mixture composition throughout the firing range. The second, or firing, stage occurs most readily at fuel-air ratios near stoichiometric, and ionization during firing is highest in this range of mixture compositions. No ionization was observed during the first stage of combustion with either fuel. 9 p.

RP2201. Creep of high-purity aluminum.................William D. Jenkins

A study was made of cold-drawn aluminum at 105° F, to determine the effects of variations of creep rate on the mechanism of deformation. Strain-hardening was found to decrease monotonically with increase in strain during first stage of creep. The extension on loading and the extension at the beginning of the third stage both increased with increase in stress. Cyclic temperature changes appeared to increase the ductility. Discontinuous flow was evidenced in constant-load creep tests at 105°F and in tensile tests conducted at 80°F. Conformance to Andrade's law of transient flow was found within a limited range of strain rates. Sigmoidal curves were produced that depicted the relationship between stress and creep rate. A mechanism of flow based on observed structural changes is proposed. 8 p.

RP2202. Standard X-ray diffraction patterns...........Howard E. Swanson and Eleanor Tatge

Improvement of the X-ray diffraction pattern file of the American Society for Testing Materials is the basis for work being done at the National Bureau of Standards with the cooperation of the Joint Committee on Chemical Analysis by X-ray Diffraction Methods of the American Society for Testing Materials, the American Crystallographic Association, and the British Institute of Physics. The equipment used in obtaining the data presented here comprises a Geiger-counter spectrometer with a 180° arc calibrated with the calculated patterns of substances whose lattice constants are known with high precision. Separate charts are prepared to obtain data for interplanar spacing and intensity measurements so that special attention can be paid to mounting the sample for the best results in each case. Tables are included to compare the patterns with those recorded in the literature.

Tables and discussion follow for X-ray diffraction data based on four compounds not listed in the American Society for Testing Materials file and on four represented there. The patterns of zinc borate, ZnB_1O_4; selenium oxide, SeO_2; magnesium silicate (forsterite), Mg_2SiO_4; and magnesium tungstate, $MgWO_4$, are recommended as additions to the file. The patterns of strontium nitrate, $Sr(NO_3)_2$; barium nitrate, $Ba(NO_3)_2$; lead fluochloride (matlockite), PbFCl; and mercuric chloride, $HgCl_2$, are recommended to replace the present patterns in the file. 10 p.

RP2203. The half-life of carbon 14.....George G. Manov and Leon F. Curtiss

The half-life of carbon 14 has been determined by gas counting of $C^*O_2+CS_2$ mixtures (where C^*O_2 is used to designate inert carbon dioxide containing some $C^{14}O_2$) by using pairs of counters that are identical in construction except for the length of the cathodes. The suitability of various equations proposed for calculating the true counting rate, C_T, from the resolving time, t_r, and the observed counting rate, C_o, is evaluated from experimental measurements of C_o and t_r and is presented graphically. A value of 5,370±200 years for the half-life of C^{14} is obtained from the measurements. By comparison with the results of other workers, it is estimated that the most probable value for the half-life of carbon 14 is 5,400±200 years. 6 p.

RP2204. Heat capacity of liquid mercury between 0° and 450° C; calculation of certain thermodynamic properties of the saturated liquid and vapor..........................Thomas B. Douglas, Anne F. Ball, and Defoe C. Ginnings

The enthalpy of liquid mercury was measured from 0° to 450° C by the "drop" method. These and other precise published data were used to calculate a number of thermodynamic properties of liquid and gaseous mercury at the vapor pressures from the triple point, —38.88°, to +500° C. The entropy calculated from data on the vapor and liquid was compared with that derived from published low-temperature heat-capacity data for the solid. The calculated values of vapor pressure, also using data on the vapor and liquid, were found to agree over a wide temperature range with certain published experimental values when independently derived gas-imperfection and published temperature-scale corrections were applied. 5 p.

RP2205. Acidic dissociation constant and related thermodynamic quantities for monoethanolammonium ion in water from 0° to 50° C
Roger G. Bates and Gladys D. Pinching

Twenty-three buffer solutions composed of approximately equal molal amounts of monoethanolamine (2-aminoethanol) and monoethanolammonium chloride in water were studied by electromotive-force methods at 11 temperatures from 0° to 50° C. The values obtained for the acidic dissociation constant, K_{bh}, of the ethanolammonium ion are given in this range of temperatures by

$$-\log K_{bh}=2677.9/t+0.3869+0.0004277T,$$

where T is the temperature on the Kelvin scale. The changes of free energy, heat content, entropy, and heat capacity that accompany the dissociation of 1 mole of ethanolammonium ion in the standard state were calculated from the dissociation constant and its temperature coefficient. Dissociation of a mole of ethanolammonium ion results in a small decrease of heat capacity. In this respect ethanolammonium ion resembles ammonium ion rather than the methyl-substituted ammonium ions, for which rather large increases of heat capacity on dissociation have been found. 4 p.

RP2206. Ultraviolet spectral distribution of radiant energy from the sun
Ralph Stair

This paper gives the results of some preliminary measurements on the ultraviolet spectral energy distribution of direct solar radiation at Washington, D. C. Data are given for wavelengths extending below 300 millimicrons for air masses approximating $M=1.4$. The new equipment and method employed in this work permit the rapid acquirement of a prismatic ultraviolet spectral energy curve at sea level showing greater Fraunhofer structure than previously obtained even at desert and mountain stations.

Other applications of this equipment, for example, in the study of total ozone and in sky-light spectral-energy distributions are suggested. 5 p.

RP2207. Wind tides in small closed channels..............Garbis H. Keulegan

In addition to the generation of waves, a wind produces a mass transport in a body of water resulting in the lowering of the level at the windward side and rise at the leeward side, which is called wind tide or set-up. Two effects of the wind are involved: the surface traction on the water, and the form resistance of the waves. This paper presents the theoretical background of the subject and experimental results. It was discovered that formation of waves in an experimental channel could be inhibited by adding small amounts of soap or detergent to the water. This made it possible to study the surface traction effect separately. The effect was studied for both laminar and turbulent motion of the drift and gravity currents produced by the wind. The set-up computed from measured wind and water surface velocities agreed with theory. Regardless of the flow regime, the set-up was unaffected by viscosity and independent of the depth-length ratio of the channel. The additional set-up due to presence of waves could be correlated only by introducing a characteristic velocity. This additional set-up appears to vary as the square root of the depth-length ratio. The relation of the characteristic velocity to the critical velocity for wind generation is discussed. The derived empirical formula for set-up is compared with observations in Lake Erie. 24 p.

RP2208. Infrared spectrum of bromochlorofluoromethane.....Earle K. Plyler and Mary A. Lamb

The spectrum of bromochlorofluoromethane has been measured in order to compare the wave numbers of the fundamental bands with those of other substituted methanes containing the halogens. The positions of the absorption bands have been determined for the liquid and vapor states and all fundamental bands except one at 220 cm^{-1} have been observed. The position of this band has been predicted from other bands that are classified as combinations of two fundamental bands, one of which was the 220 cm^{-1} band. Many of the bands of low or medium intensity have been classified as combinations or overtones of the nine fundamentals. 3 p.

RP2209. Surface tension of molten alkali silicates.............Leo Shartsis and Sam Spinner

The surface tensions of a series of lithium, sodium, and potassium silicate melts were measured by a maximum-pull-on-cylinder method. The order $Li > Na > K$ was established for surface tension as well as for the algebraic value of the temperature coefficient of surface tension. Lithia and soda raised the surface tension, and potash lowered it. The surface tension curves of different alkali content converged with increasing temperature for lithium and sodium, but diverged for potassium silicates. Liquids containing less than 33 mole percent of lithia had positive temperature coefficients of surface tension. Correlation was observed between alkali content, volume expansivity, and temperature coefficient of surface tension. 6 p.

RP2210. Mechanism of the degradation of polyamides
Bernard G. Achhammer, Frank W. Reinhart, and Gordon M. Kline

Films of polyamides were exposed to heat, ultraviolet radiant energy, and different atmospheric conditions. The degradation products were collected in some cases and analyzed by mass spectrometric techniques. The unexposed and exposed specimens were examined by the following techniques to obtain information concerning the changes in chemical and physical structure of the polymer: infrared absorption, ultraviolet absorption, viscosity of solutions, measurement of dielectric constant and dissipation factor, photomicrography, X-ray diffraction, electron microscopy, electron diffraction, and effect of organic liquids. In addition, pyrolysis studies were made and some physical properties were determined. The results of the investigation show clearly that no single method gives a complete picture but that the results from several of the methods give an insight into the mechanism of degradation of polyamides.

Polyamide molecules are relatively unaffected by exposure to moderate temperature (60° C). However, loss of water and other volatile materials may cause changes in physical properties. The effects of exposure to ultraviolet materials may cause changes in physical properties. The effects of exposure to ultraviolet radiant energy are more pronounced, and degradation of the polyamide molecule occurs with accompanying loss of water and other volatile materials that act as plasticizers.

The results of this investigation show that the general course of the degradation of polyamides is as follows:

1. The polymer molecules break at the C—N bond of the peptide group creating smaller polymer molecules with the same unit of chemical structure. The fragments broken out are evolved as carbon dioxide, carbon monoxide, water, and hydrocarbons.

2. The degree of crystallinity or local order changes, including alterations in hydrocarbon packing, dipole rearrangement, and hydrogen bridging.

3. The amount of strongly bound water and/or organic liquids changes. These materials are probably bound by hydrogen bridging to the oxygen of the peptide group. They act as plasticizers for the polyamides. 31 p.

RP2211. Radiation properties of spherical antennas as a function of the location of the driving force........................Philip R. Karr

A theoretical analysis is made of the radiation properties of a perfectly conducting sphere excited as an antenna by a driving force that acts in the θ direction in a narrow strip around the circle of colatitude $\theta=\theta_0$ on the surface of the sphere. As the location θ_0 is varied, the radiation pattern, together with the current distribution and the input admittance, change. In the present paper some of these effects are analyzed, it is believed for the first time. In previous work only the case of center feed is treated.

Unless θ_0 equals 90 degrees, the radiation pattern is not symmetrical with respect to the equatorial plane. Some interesting features of this asymmetry are discovered in the course of the analysis that have also been found experimentally in certain classes of antennas driven asymmetrically. The radiation conductance, which is proportional to the amount of power radiated for a given applied voltage, varies in a complicated way with θ_0. However, for a sphere whose radius is not too large compared with the wavelength, this trend is approximately as $\sin^4\theta_0$. In some cases the radiation conductance is not a maximum for $\theta_0=90$ degrees, but is greater when the feeding strip is somewhat to one side of the equatorial plane. Other features of the radiation are analyzed. Reasons are given for believing that the idealization of the feed conditions does not prevent the theory from giving experimentally pertinent results for the radiation properties. 15 p.

RP2212. Photoelectric spectroradiometry and its application to the measurement of fluorescent lamps..............................Ralph Stair

This paper describes new equipment and its applications in the precise determination of the spectral radiant energy emission of light sources having low intrinsic brightness, in particular fluorescent lamps. The evaluation of the spectral radiant energy distribution of light sources having superimposed bright lines is discussed in detail. Data are given on a number of commercially available fluorescent sources. Applications are noted in other problems, for example absolute spectral emissivity measurements on tungsten, spectral reflectivities, spectral transmittance measurements on dark shade welding glass, total ozone studies, or measurements in other situations where low intensities may be involved. 9 p.

RP2213. Penetration and diffusion of X-rays. Calculation of spatial distributions by polynomial expansion......Lewis V. Spencer and U. Fano

The expansions of the spatial distribution of X-rays in suitable systems of polynomials appear to converge rapidly. Calculations are performed for various source geometries in an infinite homogeneous medium. The surprisingly good convergence of this method of calculation is discussed with a view to its possible use in a variety of problems. 11 p.

RP2214. A study of fatigue in metals by means of X-ray strain measurement..John A. Bennett

X-ray determinations of lattice strain were made on steel specimens under a series of static bending moments. These series of determinations were made on the specimens as normalized and after various amounts of fatigue stressing. The slope of the line relating the bending moment to the lattice strain was found to decrease with increasing numbers of cycles of alternating stress. However, the decrease was of approximately the same magnitude for specimens stressed above and below the fatigue limit, showing that the change was not associated with fatigue damage. 5 p.

RP2215. On the mean duration of random walks............Wolfgang Wasow

The mean duration of a discrete random walk in a bounded domain is studied for general transition probability functions. The mean duration satisfies an integral equation which, for small mean step length, can be approximated by an elliptic differential equation. This leads to explicit inequalities for the mean duration in an important special case. 10 p.

RP2216. Effect of chromium plating on the plastic deformation of SAE 4130 steel..Hugh L. Logan

The effects of chromium plating on the plastic deformation of SAE 4130 steel, hardness Rockwell C40, have been evaluated from the results of tensile, tensile impact, bending and crushing tests. Chromium plating materially reduces the percentage of elongation, true stress at beginning of fracture, and the ratio of the original cross-sectional area to the area at beginning of fracture. Values of these properties decreased with increased plating thickness. Baking after plating generally increased the ductility of the plated steel. The tensile and yield strengths in tensile tests and the elongation and reduction in area of tensile impact tests were generally reduced less than 10 percent by chromium plating and were changed only slightly by baking after plating. 8 p.

RP2217. Stochastic processes and dispersion of configurations of linked events ....Chan-Mou Tchen

By the use of a function for the transition probability, as introduced by Kolmogoroff in diffusion problems with continuous motion (the so-called continuous stochastic processes), the dispersion of the configurations of linked events is studied. A long-chain molecule of irregular configurations, representing configurations of events linked in a time sequence, is chosen as a model. Attention is given in particular to the inversion of the dispersion law of stochastic processes, and to the interactions between nearest neighbors. A very elementary application is given to the perturbance on the distribution function for the configurations of a chain molecule, as a result of interactions by other neighbor chains. 9 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 47, JULY—DECEMBER 1951

RP2218. Heat of combustion and formation of cyanogen..John W. Knowlton and Edward J. Prosen

Calorimetric measurements were made of the heat of combustion of cyanogen in oxygen in a flame at constant pressure. The data yielded the following value for the reaction of combustion:

$$C_2N_2 \text{ (gas)} + 2O_2 \text{ (gas)} = 2CO_2 \text{ (gas)} + N_2 \text{ (gas)},$$

$$\Delta Hc^\circ \text{ at } 25^\circ\text{ C} = -1095.97 \pm 1.80 \text{ kj/mole}$$

$$= -261.94 \pm 0.43 \text{ kcal/mole.}$$

Utilizing the value for the heat of formation of carbon dioxide, the following value is given for the reaction of formation:

$$2C \text{ (solid, graphite)} + N_2 \text{ (gas)} = C_2N_2 \text{ (gas)},$$

$$\Delta Hf^\circ \text{ at } 25^\circ\text{ C} = 308.94 \pm 1.80 \text{ kj/mole}$$

$$= 73.84 \pm 0.43 \text{ kcal/mole.}$$

7p.

RP2219. Behavior of bromophthalein magenta E (tetrabromophenolphthalein ethyl ester) with organic bases and its bearing on the Brønsted-Lowry and Lewis concepts of acidity........Marion Maclean Davis
and Hannah B. Hetzer

In a continuation of spectrophotometric studies of its indicator properties in benzene, bromophthalein magenta E (tetrabromophenolphthalein ethyl ester) has been shown to react with 1,3-diphenylguanidine and with 1,2,3-triphenylguanidine in two steps that correspond to the equations: (1) $R_3N+HX \rightleftarrows R_3NH^+ \ldots X^-$(magenta); (2) $R_3NH^+ \ldots -X^- + R_3N \rightleftarrows (R_3NHNR_3)^+X^-$ (blue). The association constants K_1 and K_2 for these reactions with diphenylguanidine are 2.2x10^5 and 15.5, respectively. For the reactions with triphenylguanidine, K_1 is 525 and K_2 is of the same order as the K_2 for the reaction with diphenylguanidine. Replacing benzene by ethanol or pyridine produces the same kind of effect as increasing the concentration of di- or triphenylguanidine. The results indicate that the Brønsted-Lowry formulation of an acid-base reaction should be modified, and that hydrogen acids should be regarded as a special class of Lewis acids. 16 p.

TITLE PAGE AND CONTENTS TO VOLUME 46. 6 p.

RP2220. The role of current distribution in cathodic protection
Homer D. Holler

The paper outlines a procedure for determining current distribution over an electrode surface, as required in cathodic protection or in electroplating when the electrode potential bears a known relation to current density; and shows the relation of current distribution to resistance of current path and counter electromotive force. The primary current distribution (without polarization) is also computed. A method is suggested for determining the electrode potential-current density relation over an extensive surface in a uniform medium. In a nonuniform medium, the determination of current density by measurement of electrode potential becomes complex. In such a case the potential criterion of cathodic protection must be relied upon. 5 p.

RP2221. Multiplets and terms in technetium spectra.....William F. Meggers

Multiplets and terms of the quartet, sextet, and octet systems are reported for the first spectrum of Tc. The combinations of 20 terms composed of 63 atomic energy levels account for 200 Tc I lines and 66 percent of the total observed intensity summed for 1,300 lines.

The ground state of neutral Tc atoms is represented by $4d^5\ 5s^2\ {}^6S_{2\frac{1}{2}}$, and the first metastable state by $4d^6 5s\, {}^6D_{4\frac{1}{2}}$, only 2573 cm^{-1} higher. A Rydberg series of ^8S terms yields absolute term values from which a Ritz-corrected limit of 60070 cm^{-1}, or ionization potential of 7.45 electron volts, is derived.

In the second spectrum of Tc the principal S and P terms of the quintet and septet systems are identified and fixed relative to each other. Evidence is presented that $4d^6\ {}^5D$ represents the normal state of Tc^+ ions, but to confirm this further observations of the Tc II spectrum are necessary. 8 p.

RP2222. Properties of beryllium-barium titanate dielectrics
Elmer N. Bunting, George R. Shelton, Ansel S. Creamer,
and Bernard Jaffe

Dielectrics having compositions in the system BeO-$BaTiO_3$-TiO_2 were matured at 1,240° to 1,525° C. Data are given for the compositions, heat-treatments, absorption, and shrinkage. At 25° C the dielectric constant (K) and the reciprocal of the power factor (Q) were determined at frequencies of 50, 130, 1,000, and 20,000 kilocycles per second and at 3,000 megacycles per second when K is not greater than 50. At 1 megacycle per second K was determined at temperatures between —60° and +85° C and at 130 kilocycles per second, K and Q were determined at temperatures between 25° and 200° C. The linear thermal expansion was measured over the temperature range 25° to 700° C. It varied from 0.58 to 0.77 percent. The electrical resistivities of a few specimens were measured at 200° C, using a direct-current potential constantly applied for several days. In some cases the resistivity decreased by a factor of 10^5 over a few days. For specimens of some compositions, K and Q changed with time. 10 p.

RP2223. Refractivity of lithium fluoride with application to the calibration of infrared spectrometers....Leroy W. Tilton and Earle K. Plyler

The refractivity of lithium fluoride was measured from 0.4 to 5.9 microns and expressed for 23.6° C by a four-constant dispersion formula by which an interpolation table was prepared for included wavelengths. The temperature coefficient was determined as -1.63×10^{-5} (constant within ±0.05) for the visible region and a table of indices made for 20° to 60° C at equal intervals of λ from 0.4 to 0.7 micron. Most of the observed indices agree with the tabulated values within $\pm3\times10^{-6}$ for the visible region and $\pm3\times10^{-5}$ in the infrared. In calibrating an infrared spectrometer simple empirical relationships between drum reading, D, and wavelength are not entirely reliable. Three steps are recommended: (1) the expression of D in terms of E, the emergent angle of energy from the prism; (2) expression of E in terms of refractive index; and (3) the obtaining of the indices or their expression as a function of λ. The first step requires at least two constants, one for angular equivalent of the screw and another for the particular Littrow-mirror orientation for $D=0$. The second requires knowledge of the refracting angle of the prism and its orientation with respect to the incident energy. The adequate expression of index as a function of wavelength usually requires four constants. 6 p.

RP2224. Preparation and purification of hydrogen deuteride
Abraham Fookson, Philip Pomerantz, and Edwin H. Rich

In an investigation of the physical properties of hydrogen isotopes it was necessary to prepare 10 liters of high-purity hydrogen deuteride. This was done by reacting lithium aluminum hydride with deuterium oxide, giving hydrogen deuteride, in two batches, of 98.1- and 97.0-percent purity, respectively. This material was then fractionated at liquid hydrogen temperature in three batches, yielding the desired amount of hydrogen deuteride in a purity of 99.8 percent. 4 p.

RP2225. Linear thermal expansion of artificial graphites to 1,370° C
Milton D. Burdick, Benson Zweig, and R. Eugene Moreland

In connection with creep studies of graphite, the need arose for accurate thermal expansion data on the three grades of graphite being investigated. Therefore, the linear thermal expansion of specimens of the three grades, cut in three directions with respect to the direction of extrusion or of molding pressure, was determined at various temperatures between 20° and 1,370° C in vacuum. Results show that specimens cut perpendicular to the extrusion direction or parallel to the direction of molding pressure had greater expansions than specimens cut parallel to the extrusion direction or perpendicular to the molding pressure. The data obtained are tabulated. 6 p.

RP2226. The absolute standardization of radioisotopes by 4π counting
H. H. Seliger and L. Cavallo

The absolute counting of beta particles, using 4π proportional flow counters, is described. This method of absolute counting has been adopted in the Radioactivity Section of the National Bureau of Standards for the primary calibration of radioisotope solution standards. Pillbox, cylindrical, and spherical 4π flow counters have been used in the measurements, and excellent results have been obtained for each. A simple method of source mounting has been developed, and a formula is derived that determines the absorption in the source mounting regardless of knowledge of the thickness of the mounting or energy spectrum of the beta rays. Results are given of intercomparisons of P^{32} and I^{131} with other laboratories in the United States, Canada, and Great Britain that employ different types of absolute counting techniques. The applicability of the 4π counting method to the standardization of practically all beta emitting radiosotopes is discussed. 4 p.

RP2227. A method of gradients for the calculation of the characteristic roots and vectors of a real symmetric matrix.......Magnus R. Hestenes and William Karush

Let A be a real symmetric matrix, $\mu(\bar{x})$. The Rayleigh quotient formed with a vector x, and $\xi(x)$ the gradient vector of $\mu(x)$. The method of gradients consists in an infinite iteration of the operation $x = x - \alpha(x)\xi(x)$. The convergence of the procedure is proved for several choices for $\alpha(x)$, and the rate of convergence is studied extensively for one particular $\alpha(x)$. The directions of the vectors in the sequence are seen to tend to that of the characteristic vector belonging to the lowest characteristic value. The method can be used for a numerical determination of all characteristic vectors and values. 17 p.

RP2228. Vapor pressures of hydrogen, deuterium, and hydrogen deuteride and dew-point pressures of their mixtures.........Harold J. Hoge and Robert D. Arnold

The vapor pressures of H_2, HD, and D_2 have been measured from near their triple points to their critical points. The H_2 and D_2 samples were catalyzed to ortho-para equilibrium at 20.4° K. Tables suitable for interpolation have been prepared to represent the results both in centimeter-gram-second and in engineering units.

Measurements of dew-point pressures of several binary mixtures have been made at several pressures below atmospheric. Observed pressures were about 3 percent above those predicted by the law of ideal solutions. 12 p.

RP2229. Critical temperatures, pressures, and volumes of hydrogen, deuterium, and hydrogen deuteride...................Harold J. Hoge and James W. Lassiter

The critical temperatures, pressures, and volumes of H_2, HD, and D_2 have been determined by measuring short sections of P–V isotherms in the neighborhood of the critical points. The H_2 and D_2 samples were catalyzed to ortho-para equilibrium at 20.4° K and are designated e-H_2 and e-D_2. For e-H_2 the values found are $T_c = 32.9_{94}$° K, $P_c = 12.7_{70}$ atm, and $V_c = 65.5$ cm^3 mole^{-1}. For HD the corresponding values are 35.9_{08}° K, 14.6_{15} atm, and 62.8 cm^3 mole^{-1}; for e-D_2 the values are 3.28_{62}° K, 16.2_{82} atm, and 60.3 cm^3 mole^{-1}. A method of correlating isotherm data for different substances, based on the use of graphs of log P versus log V, is described. 5 p.

RP2230. A photoelectric recording interferometer for measurement of dimensional changes.................................Richard N. Work

A method is given for the photoelectric recording of light intensity at a reference point in an image of an interference pattern for the automatic plotting of fringe count versus thermocouple electromotive force in interferometric dilatometry. Application of the technique to the measurement of coefficients of expansion and to the determination of transition temperatures in rubber-like materials over a temperature range of —185° to +185° C is given. Transitions can be located to a precision of ±0.5 degree C and coefficients of expansion found to a precision of ±5 percent. 7 p.

RP2231. A fiftyfold momentary beam intensification for a high-voltage cold-cathode oscillograph.................................John H. Park

A method for obtaining a momentary increase (up to 50 times the steady value) in the intensity of the electron beam obtained from a high-voltage cold-cathode discharge tube has been developed. Its application for increasing the recording speed of a high-voltage cathode-ray oscillograph is described. Oscillograms have been obtained in which the writing speed is about three-fourths the speed of light.

The intensification is caused by superposing a steeply rising voltage pulse on the normal steady voltage across the electrodes of the discharge tube serving as the electron beam source. The voltage pulse momentarily disrupts equilibrium conditions in the discharge and produces an intense discharge that lasts for about 2 microseconds. Measurements of the magnitude and duration of the superposed pulse and of the changes in discharge current have been made. A tentative explanation of the mechanism of intensification based on these measurements is given. 7 p.

RP2232. Annealing of platinum for thermometry........Robert J. Corruccini

Experiments are described on the annealing of platinum wire in which the coefficient of resistance and thermal electromotive force were used as criteria of the physical state of the metal. It was found that platinum wire of the highest available purity almost completely recovers its electrical properties at a temperature as low as 300° C, although a slight further recovery occurs with increase of annealing temperature up to 1,450° C. On quenching heated wires in various gaseous media, changes in the electrical properties occur that are greater the more rapid the quenching and that are similiar to the effect of strain.

The electrical properties of dilute alloys of gold, silver, and copper in platinum were measured. Contrary to prediction, the copper and silver alloys were thermoelectrically positive to platinum at ordinary temperatures. Thus far, no impurity other than gold has been found to lower the thermoelectric power of platinum.

It is apparently not possible to represent the kinetics of annealing in terms of a temperature activated process having a single value of activation energy. This result is interpreted in terms of the diffusion of dislocations. 10 p.

RP2233. Potential and current requirements for the cathodic protection of steel in soils............W. J. Schwerdtfeger and O. N. McDorman

Potentials of steel in 20 air-free soils varying in pH from 2.9 to 9.6 were determined in the laboratory. These data and the potential-pH relation for the hydrogen electrode were used in fixing the optimum potential for the cathodic protection of the steel against corrosion. The effectiveness of this potential for the cathodic protection of steel in soils was confirmed by weight-loss measurements on electrodes that were maintained at the selected potential in five corrosive soils. Cathodic polarization curves are interpreted in terms of the potential and current requirements for the cathodic protection of steel in soils. 9 p.

RP2234. A monte carlo method for solving a class of integral equations
R. E. Cutkosky

This note describes a random walk equivalent to the Neumann series solution of an integral equation. A diffusion analogy and the problem of importance sampling are discussed briefly. 3 p.

RP2235. Study of degradation of polystyrene, using infrared spectrophotometry.................Bernard G. Achhammer, Mary Jane Reiney, and Frank W. Reinhart

Since polystyrene is a widely used plastic and styrene is an integral part of the most widely used synthetic rubber (GR–S), it appears necessary to know something of the process of degradation of polystyrene to assist in interpreting the degradation of these materials in service. Polystyrene films were exposed to heat at 100° C in a forced-draft air oven and to ultraviolet radiant energy at 60° C in air. Chemical structural changes in the polymer as a result of these treatments were analyzed by study of the infrared spectra between 2 and 16 microns, obtained with a Baird recording infrared spectrophotometer. Ultraviolet exposure for 200 hours resulted in absorptions at 2.9 and 5.8 microns, which are attributed to hydroxyl and carbonyl groups, respectively. Heating of the film for 270 hours at 100° C produced no significant change in the infrared spectrum. Prolonged heating at 125° C resulted in the destruction of the films by flow. The literature and theory on the degradation of polystyrene are discussed. Several mechanisms are postulated to account for the production of hydroxyl and carbonyl products in the polymer. 10 p.

RP2236. First dissociation constant of phosphoric acid from 0° to 60° C; limitations of the electromotive force method for moderately strong acids..Roger G. Bates

An accurate determination by the electromotive-force method of the dissociation constant of an acid as strong as the first acidic group of phosphoric acid requires that the hydrogen-ion concentration be established with greater accuracy than is usually attainable. The uncertain quantity is the activity coefficient of hydrochloric acid in the particular mixture under study. It is shown that the calculation of this coefficient by the Debye-Hückel equation, which affords an adequate estimate of the small hydrogen-ion correction in buffer solutions composed of weak acids, fails to yield the desired accuracy for mixtures in which the acid is dissociated to an appreciable extent. In order to determine the common logarithm of the first dissociation constant of phosphoric acid with an accuracy believed to be ±0.005 unit, the hydrogen-ion concentration of some of the buffer mixtures studied was kept at low levels by use of a large excess of potassium dihydrogen phosphate. Other solutions contained formic acid instead of hydrochloric acid, thereby lowering the hydrogen-ion concentration still further. In addition, particular attention was given to a choice of reasonable values for the activity coefficient used to estimate the hydrogen-ion correction.

By these means the first dissociation constant, K_1, of phosphoric acid was calculated from emf measurements of 71 phosphate buffer solutions, together with supplementary data from the literature for 18 additional solutions. The result from 0° to 60° C is given by

$$-\log K_1 = \frac{799.31}{T} - 4.5535 + 0.013486\ T,$$

where T is the temperature in °K. The changes of heat content, entropy, and heat capacity for the dissociation of 1 mole of aqueous phosphoric acid in the standard state were found to be —7,650 j, —66.8 j deg^{-1}, and —154 j deg^{-1}, respectively, at 25° C. 8 p.

RP2237. Determination of ash in GR–S synthetic rubbers and latices
Frederic J. Linnig, Lewis T. Milliken, and Ralph I. Cohen

Rapid methods are described for the determination of the ash content of GR–S synthetic rubbers and latices. Filter paper and filter pulp are used to prevent either material from overrunning the edge of the crucible when introduced into the furnace at the ashing temperature. Water is used to facilitate the burning of the carbonaceous residue obtained in ashing GR–S latex. These procedures have been put into use in the control testing of GR–S production. They are precise as older methods of ashing and far less time-consuming. The techniques employed should be applicable to other organic materials. 4 p.

RP2238. Glass spheres for the measurement of the effective opening of testing sieves......................Frank G. Carpenter and Victor R. Dietz

It is shown that the "effective" opening of testing sieves is generally somewhat larger than the average opening or the nominal opening. A method of measuring the effective opening by means of a calibrated mixture of glass spheres is described. Glass beads of the type used for highway markings were a suitable source of glass spheres for sizes from 80 to 1,000 microns (U. S. Sieves No. 170 through 18). Details are given for the selection of the spheres, the preparation of the desired mixture of spheres, subdivision of the samples, the measurement of the diameters, and the calculation of the weight-size distribution. From a statistical analysis of the calibration data, both the reproducibility and accuracy of the method were found in general to be about 1 percent. 9 p.

RP2239. Precise topography of optical surfaces...........James B. Saunders

The unit of length usually used in measuring optical surface features, by interference of light, is one-half the wavelength of the monochromatic light that is used. A method is described in which the unit of length is a much smaller fraction of the wavelength. Topographic maps of optical surfaces are made in which the contour interval is less than one-thirtieth the wavelength. The smallness of the unit depends upon the quality of the surfaces. Irregularities, too small to be detected with the Fizeau or two-beam fringes, are made to appear very prominent. Surface markings, caused by the final polishing actions, can be made to stand out in bold relief. 8 p.

RP2240. Hydrodynamics of cathode films................Garbis H. Keulegan

A hydrodynamical theory of the cathode diffusion layer based on the assumption of a uniform density reduction at the cathode surface is presented. By means of an approximate solution for the flow and the diffusion equations, the layer dimensions, the velocity distributions, and the densities are determined. Further derivations from the solutions directly applicable to results obtained by the freezing method are effected. The data of Brenner on copper and nickel baths are considered. Using the observed values of the density reductions at the cathode surface, the maximum width of the layer, the average densities for a given distance from the cathode, and the mobilities of the cations are determined and compared with the observations. The agreement between observed and computed values is regarded as fairly satisfactory. 14 p.

RP2241. Absorption spectra of thioindigo dyes in benzene and chloroform
Wallace R. Brode and George M. Wyman

The spectral absorption curves of 10 purified thioindigo dyes, containing mostly methyl and ethoxyl groups or halogens as substituents, in benzene and chloroform solution were determined over the ultraviolet and visible parts of the spectrum. The existence of an equilibrium between *cis* and *trans* isomers was indicated by the study of the effect of light on the absorption spectra. Some of the results of this investigation have been published. The present paper supplements the earlier paper and contains the spectral absorption curves that have not previously been published, along with the data on the purification of the three dyes that had not been reported there. In general, the first (long-wave) absorption band of the *cis*-form of each dye occurs at a shorter (by approximately 60 $m\mu$) wavelength than that of the corresponding *trans* isomer. The spectra are displaced slightly toward longer wavelengths in chloroform solutions than in benzene. Substituents in the five and seven positions cause a bathochromic shift in the spectra of both isomers of each dye in each solvent without affecting the shape of the spectral absorption curves. The introduction of substituents in the four or six positions results in a change in the shape of the absorption curves and a shift of the absorption to shorter wavelengths. 9 p.

RP2242. A sonic-flow pyrometer for measuring gas temperatures
George T. Lalos

Evaluation of the performance of gas turbines and jet engines requires knowledge of the temperature of the working medium. Although conventional temperature-measuring instruments are adequate for some purposes, they possess a number of disadvantages that become more serious with increasing gas velocity and temperature. The most troublesome sources of error are the directed motion of gas and the loss of heat to the surroundings by radiation and conduction. An instrument that is relatively free of these errors is described and evaluated. It has been called a sonic pyrometer because the measuring element is located in the throat of a nozzle through which the gas, whose temperature is to be measured, is caused to flow at sonic velocity. In accordance with theory and experiment, the total temperature of the gas is obtained by multiplying the temperature indicated by the measuring element by an essentially constant correction factor. Tests on experimental units indicate that these have many advantages over conventional instruments when used in the evaluation and control of gas turbines and jet engines. 12 p.

RP2243. Covergence of Cauchy-Riemann sums to Cauchy-Riemann integrals
Otto Szasz and John Todd

Two general theorems giving conditions to insure the truth of the relation

$$\lim_{h\to 0}\sum_{n=1}^{\infty} f(nh)=\int_0^{\infty} f(x)\,dx$$

are established. In addition, several cases involving Bessel functions are discussed. 6 p.

RP2244. Maximum likelihood estimates of position derived from measurements performed by hyperbolic instruments........Eugene Lukacs

Certain electronic surveying instruments—referred to as hyperbolic instruments—determine the difference between the distances from two fixed stations to a moving object. Data obtained from a single observation yield one relation between the three coordinates of the moving object and restrict it to a hyperboloid of revolution. To locate a position in space, observations from at least three pairs of stations are needed. If more than three observations are taken, more than three equations for the three coordinates are obtained. In general these equations will not be compatible; it is then a statistical problem to find an estimate for the unknown position. In this paper maximum likelihood estimates are obtained for positions in space derived from such hyperbolic data. 5 p.

RP2245. Infrared spectra of eighteen halogen-substituted methanes
Earle K. Plyler and W. S. Benedict

In order to study how the vibrational frequencies of methane vary with halogen substitutions, the infrared spectra of the following halogen-substituted methanes have been studied with a prism spectrometer between 2 and 38 microns: Carbon tetrafluoride, chlorotrifluoromethane, dichlorodifluoromethane, trichlorofluoromethane, carbon tetrachloride, trichlorobromomethane, dichlorodibromomethane, fluoroform, difluorochloromethane, dichlofluoromethane, choloroform, dichlorobromomethane, chlorodibromomethane, bromoform, iodoform, methylene fluoride, methylene chloride, and methylene iodide. Spectra are presented as obtained at room temperature in the vapor and liquid states, and in a few cases in solution. The bands are interpreted as fundamentals, overtones, combination, and difference bands. Tables and graphs display the regularities existing among the various fundamentals of these molecules and other halogen-substituted methanes. Force-constant calculations, using an approximate potential function with general constants transferred from one molecule to another are reported. 19 p.

RP2246. Spectrochemical analysis of bronze by a porous electrode method
Bourdon F. Scribner and John C. Ballinger

A modification of Feldman's porous electrode method is described for the spectrochemical analysis of bronze (3 Sn, 3 Zn, 2 Pb, 2 Ni, 90 Cu). A 1-gram sample of bronze drillings is dissolved by the addition of 4 milliliters of hydrochloric acid and 16 milliliters of nitric acid, and after dilution to 40 milliliters with water, the solution is transferred to the hollow electrode for spark excitation. The analysis is made with reference to standard solutions prepared in a similar manner. Studies of the effect of electrode shape on the reproducibility of excitation led to the adoption of a porous electrode having a tip in the shape of a truncated cone. With this electrode the precision was greater by a factor of 1.2 to 2.1 over that obtained with a flat-tipped electrode. The precision of the method, determined as the coefficient of variation of a group of duplicate runs on 50 samples, ranged from 1.6 percent for nickel to 4.3 percent for lead. On the average, the results of routine spectrochemical determinations agree with the results of chemical determinations on the same samples to within ±5 percent. 6 p.

RP2247. Correcting for density and viscosity of incompressible fluids in float-type flowmeters..........Montgomery R. Shafer, Ernest F. Fiock, Harry L. Bovey, and Ross B. Van Lone

The theory of the flow of incompressible fluids through float-type flowmeters is developed by the methods of dimensional analysis. The relations thus derived have been verified experimentally for the specific cases of five flowmeter tubes with 11 liquid hydrocarbons of different physical properties. Parameters that are suggested to describe the performance of any float-type flowmeter may be evaluated by measuring the float density and the mass rate of flow of fluids of known density and viscosity. Procedures are described whereby, after calibration of a metering tube with a few fluids of known physical properties, accurate corrections may be calculated for any fluid whose properties lie within the range embraced by the calibration fluids. Application of the proposed method of calibration and correction to the five metering tubes studied gave corrected values of flow that were always within one-quarter percent of the true values of flow. 12 p.

RP2248. Mutarotation, hydrolysis, and structure of D-galactosylamines
Harriet L. Frush and Horace S. Isbell

Of the two previously described galactosylamines, one has been shown to be a mixture. A pure compound has now been isolated from it, thus making available for the first time two pure modifications of a glycosylamine. The structure and properties of these compounds and of certain derivatives have been determined. The new substances constitute a group of reference compounds useful for the assignment of structure in this field. The mutarotation and hydrolysis of the two galactosylamines were studied and found to be in harmony with mechanisms previously advanced by us. 8 p.

RP2249. Near infrared absorption spectra of deuterated acetylene
Earle K. Plyler and Norman Gailar

The bands of C_2D_2 at 1.96 and 2.39 microns have been measured under high resolution so that the moments of inertia of this molecule could be compared with that of C_2H_2 and C_2HD. From the measurement of the rotational structure the ground rotational constant, B_0, is found to be 0.8471 cm^{-1}. The center of the $\omega_1+\omega_3$ band is 5097.07 cm^{-1}, and the center of the $\omega_2+\omega_3$ is 4190.46 cm^{-1}. 5 p.

RP2250. Spectrophotometric determination of bismuth in lead-base and tin-base alloys..................Bruce B. Bendigo, Rosemond K. Bell, and Harry A. Bright

A method is described for the determination of bismuth in lead-base and tin-base alloys. Tin, arsenic, and antimony are volatilized as the bromides from a perchloric acid solution. The bismuth is then precipitated as the oxychloride in a perchloric-nitric acid solution. The precipitate is dissolved in nitric acid, and the bismuth is treated with thiourea to form a yellow complex. The absorbancy of the colored solution is measured with a filter photometer at approximately 425 millimicrons, and the amount of bismuth is read from a curve prepared by treating known amounts of bismuth with thiourea. An accuracy of ±0.002 percent of bismuth is indicated for lead-base and tin-base alloys containing from 0.02 to 0.10 percent. 4 p.

RP2251. Calorimetric properties of benzoic acid from 0° to 410° K
George T. Furukawa, Robert E. McCoskey, and Gerard J. King

Heat capacity, enthalpy, and entropy of benzoic acid (C_6H_5COOH) are tabulated from 0° to 410° K, using experimental heat capacities obtained by means of an adiabatic vacuum-type calorimeter. The heat of fusion was measured to be 18,000 ±100 abs j $mole^{-1}$. The standard entropy, heat, and free energy of formation of benzoic acid at 298.16° K are calculated. 6 p.

RP2252. Infrared emission spectrum of calcium.........Curtis J. Humphreys

The spectrum of neutral calcium excited in alternating-current and direct-current arcs, using carbon electrodes cored with CaO, has been observed with high resolution, in the interval between 12816 and 22655 Angstroms. A total of 36 lines has been observed, of which all but one have been classified. The long-sought term, $3d^2\ ^3F$, has been found and established on the basis of two complete multiplets, $3d{\cdot}4p\ ^3F^\circ - 3d^2\ ^3F$, and $3d{\cdot}4p\ ^3D^\circ - 3d^2\ ^3F$, and two intersystem lines $3d{\cdot}4p\ ^1D^\circ - 3d^2\ ^3F_{2,3}$. Most of the infrared energy is radiated in the multiplet $4p\ ^3P^\circ - 3d\ ^3D$. These lines are suggested for use as wavelength standards for the 2-micron region. 7 p.

RP2253. Crystallization of aluminum chloride in the hydrochloric acid process for production of alumina from clay........Lewis Jesse Clark,
Willard D. Hubbard, and James I. Hoffman

When roasted clay is treated with dilute hydrochloric acid, a solution is obtained that contains aluminum and other soluble constituents of the clay in the form of chlorides. Crystallization as the hydrated chloride, $AlCl_3{\cdot}6H_2O$, serves to separate the aluminum from the other soluble chlorides. A process is described for this crystallization on a large scale. 3 p.

RP2254. Creep of annealed and cold-drawn high-purity copper
William D. Jenkins and Thomas G. Digges

A study was made of the effect of temperature and stress on the creep behavior at 110°, 250°, and 300° F of high-purity oxygen-free high-conductivity copper initially as annealed and as cold-drawn 40-percent reduction of area. The resistance to creep and to fracture at all these test temperatures was increased by cold-drawing the copper prior to testing in creep; however, this superiority in creep properties was accompanied by a decrease in ductility and time to rupture. Dissociation of parent grains into crystals of microscopic dimensions and the presence of strain markings were evidenced in all specimens carried to complete fracture in creep. Correlations are made of these changes in structure with time, stress, temperature, and the discontinuous flow, as evidenced by the creep rate-extension curves. 16 p.

RP2255. Tables of the functions

$$\int_0^\phi \sin^{1/3} x\,dx \text{ and } (4/3)\sin^{-4/3}\phi\int_0^\phi \sin^{1/3} x\,dx$$

Milton Abramowitz

This article concerns itself with the tabulation of the functions

$$\int_0^\phi \sin^{1/3} x\,\mathrm{dx} \text{ and } 4/3\sin^{-4/3}\phi\int_0^\phi \sin^{1/3} x\,dx,$$

which are important in the theory of condensation of vapor at rest on cylindric surfaces. The series expansion for the latter function is given, and certain functional relations useful for interpolation are mentioned. Instructions for interpolation with Lagrangian interpolations are given for the user. 3 p.

RP2256. Separation of close eigenvalues of a real symmetric matrix
J. B. Rosser, C. Lanczos, M. R. Hestenes, and W. Karush

In order to test two methods, one proposed by C. Lanczos and the other by M. R. Hestenes and W. Karush, for the numerical calculation of eigenvalues of symmetric matrices, an 8 by 8 matrix is constructed that has several sets of eigenvalues close together. The application of the two methods to this test matrix is described, and in addition, a third method for dealing with such problems is proposed. 7 p.

RP2257. Viscosity of dilute and moderately concentrated polymer solutions
S. G. Weissberg, Robert Simha, and S. Rothman

The viscosities of solutions of three polystyrene fractions in three solvents of varying solvent power were measured at two temperatures. The relative viscosities of the systems investigated ranged from 1.03 to 43.

The applicability of two empirical expressions for the concentration depedence, namely the Martin equation and the Baker relation, is examined. In addition, the results are represented by means of polynomials of suitable degree. The numerical procedures for the evaluation of the coefficients are discussed in detail. In the concentration range investigated, the introduction of a reduced concentration scale $S=[\eta]c$, places the viscosity-concentration curves for different molecular weights in the same solvent on a more nearly common scale. This scale, S, is simply related to another reduced scale c/c_0. Here c_0 represents the concentration at which the equivalent spheres of the coiling molecules, as defined at infinite dilution, would just begin to overlap. At $c/c_0 \leq 1$, the concentration dependence can be described in terms of hydrodynamic interaction. This interaction involves single molecules and can also involve the intrinsic viscosity and interactions of aggregates of low order. An attempt is made to deduce from the viscosity data and on the basis of certain hydrodynamic results, the equilibrium constants and relative populations of such aggregates. Reasonable values are obtained. On approaching c_0, the average volume available to a chain molecule in a good solvent is reduced because of the cage formed by its nearest neighbors. The effective pressure is just the internal osmotic pressure. This leads to an expression for the concentration dependence of the viscosity, in terms of the virial coefficients of osmotic pressure, molecular weight, and size. These equations are shown to be in satisfactory agreement with the experimental data. In particular, in the neighborhood of c_0 one obtains reasonable values for the molecular extension factors of the chain. 7 p.

RP2258. An analysis of the effect of the discontinuity in a bifurcated circular guide upon plane longitudinal waves...............Louis L. Bailin

The problem of theoretically accounting for the scattering of sound by a semi-infinite circular tube with a small diameter inserted axially, as a measuring probe, into a larger tube of infinite length, is solved in a rigorous and explicit manner when the incident plane waves are restricted to the lowest propagating mode.

The investigation follows the methods outlined by J. Schwinger and consists in solving Helmholtz's equation subject to boundary conditions on the acoustic velocity potential at rigid walls. With the aid of Green's theorem and the Green's function for a point source in the large guide, an integral representation of the desired velocity potential is obtained. The imposition of the boundary conditions leads directly to a homogeneous integral equation of the Wiener-Hopf type, which is solved by transform techniques. The results of this solution are shown to be related to a distance d, which is the length the inner guide must be extended to account for the disturbance occurring in the immediate vicinity of the discontinuity caused by the excitation of higher mode fields.

Another satisfactory method of representing the effect of the discontinuity is by the use of equivalent circuits, by means of which a discontinuity in a wave guide is replaced by a lumped parameter network in a set of transmission lines. The equivalent circuit for this network is derived, and the one essential circuit parameter is related to d and to the explicit solution of the integral equation.

Numerical results for d are given as a function of several different guide ratios and driving frequencies of the incident waves. The results are in considerable disagreement with approximation methods previously reported and indicate that these methods are unsatisfactory in the present problem. 21 p.

RP2259. Mass spectra of some organo-lead and organo-mercury compounds
Vernon H. Dibeler and Fred L. Mohler

Mass spectra of tetramethyl and tetraethyl lead and of dimethyl, diethyl, and di-*n*-butyl mercury were obtained with a Consolidated 21–102 mass spectrometer. Monoisotopic spectra were calculated by using the isotopic abundance derived from each spectrum. A variation in the lead isotope abundance was observed in the commercially available lead alkyls. No variation was observed among the mercury alkyls and good agreement was obtained with previously published measurements on mercury vapor. There was no indication of voltage discrimination. The mass spectra of the lead alkyls are qualitatively similar. The principal portion of the total ionization is contributed by the dissociation of one and three alkyl groups. Ions resulting from the dissociation of one or more hydrogen atoms are small, as are the hydrocarbon ions. Hydrides and hydrocarbon ions resulting from intramolecular rearrangement were observed. The principal part of total ionization in the mercury alkyl spectra was contributed by hydrocarbon ions. Hydrides and other rearrangement peaks were observed. A preliminary experiment on a leaded gasoline, using a model 21–103 spectrometer, indicated that sensitivity is sufficient to analyze for a few hundredths of a mole percent of tetraethyl lead with a precision of about 2 percent of the value. 6 p.

RP2260. Resolution of the dissociation constants of *d*-tartaric acid from 0° to 50° C..................Roger G. Bates and Richard G. Canham

The ratio of the first thermodynamic dissociation constant, K_1, of tartaric acid to the second, K_2, is only 20 to 23 at temperatures between 0° and 50° C. The two dissociative steps therefore overlap to a considerable extent. The greater the amount of overlapping, the more difficult it is to resolve the two equilibria and to determine each individual dissociation constant.

Electromotive-force measurements of the cell

$$\text{Pt; } H_2 \text{ (g, 1 atm), } d\text{-tartrate solution, } Cl^-\text{, AgCl; Ag}$$

were made at intervals of five degrees from 0° to 50° C. Thirty-two tartrate solutions were studied. All but 5 of the 22 solutions of series 1 were composed of sodium hydrogen tartrate, sodium tartrate, and sodium chloride in the molar proportions 1:3:1. The other 17 contained sodium hydrogen tartrate, sodium tartrate, and potassium chloride in the molar proportions 1:1.3411:0.5853. The 10 solutions of series 2 were 1:1 mixtures of sodium hydrogen tartrate and sodium chloride.

The calculation of the second dissociation constant by the conventional method requires not only a knowledge of the concentration of hydrogen ion but also that of the free tartaric acid formed as a result of the overlapping. Neither can ordinarily be evaluated exactly from the emf. However, the 1:3 buffer ratio of series 1 reduced the hydrogen-ion concentration and at the same time lowered the ratio of the concentrations of tartaric acid and hydrogen tartrate ion to about 0.03. Hence, an adequate correction for the amount of acid could be made with an approximate value of the first dissociation constant. However, it is impossible to lower the K_2 correction for the determination of K_1 without increasing the hydrogen-ion concentration. Accordingly, a method developed earlier, utilizing emf data for solutions of the acid salt (series 2), was employed. Thus the hydrogen-ion concentration was kept relatively low, and the emf became a function of the product of K_1 and K_2 rather than substantially independent of K_2.

The two dissociation constants of tartaric acid from 0° to 50° C are given by the equations

$$-\log K_1 = 1525.59/T - 6.6558 + 0.015336T$$

and

$$-\log K_2 = 1765.35/T - 7.3015 + 0.019276T,$$

where T is the temperature in degrees K. The standard thermodynamic quantities for the two dissociation steps were calculated. 6 p.

RP2261. Effect of SO_3 on the alkali compounds of portland cement clinker Terry F. Newkirk

This investigation shows that the compound $Na_2O.8CaO.3Al_2O_3$, which is known to be one of the forms in which Na_2O may occur in portland cement clinker, is unstable at clinkering temperatures in the presence of SO_3. This compound reacts with SO_3 to form Na_2SO_4 and $3CaO.Al_2O_3$. Any excess of Na_2O will remain as $Na_2O.8CaO.3Al_2O_3$, become a constituent of the clinker glass, or enter into solid solution with one of the other clinker components.

In clinker compositions containing both soda and potash together with SO_3, an alkalisulfate phase is produced that contains both of the alkalies. For molecular ratios R_2O/SO_3 greater than unity, a preferential reaction of the SO_3 with K_2O is indicated. Empirical relationships between the alkalies and the SO_3 of the cement mixture indicate that the alkalies first combine with the SO_3 in the approximate molecular ratio $K_2O/Na_2O=3$ to the extent that the composition limits of the mixture permit. The composition of the alkalisulfate phase for mixtures of varying soda-potash contents with R_2O/SO_3 molecular ratios equal to 1, 2, and 3 have been determined. Equations are developed for calculating the approximate composition of the alkali sulfate and the potential phase composition of clinker-type mixtures having other R_2O/SO_3 ratios. 8 p.

RP2262. Resin bonding of offset papers containing mineral fillers
Martin J. O'Leary, Bourdon W. Scribner, and Joshua K. Missimer

Papermaking studies at the National Bureau of Standards have shown that melamineformaldehyde resin used as a binding agent in offset lithographic papers containing no mineral fillers has the beneficial effects of improved printing quality, decrease in the beating time of the fibers, and large increase in permissible content of hardwood fibers. The last is desirable for the conservation of the scarcer softwood fibers.

The previous work has shown that as little as 1½ hours of beating gives satisfactory results with the usual 50 percent of hardwood fibers increased to 75 percent, when 1 to 3 percent of melamine resin is added.

Further investigation has been made to determine whether these beneficial effects occur when the mineral fillers, clay and titanium dioxide, are used. With 1½ hours of beating of a fiber furnish consisting of 75 percent of soda pulp (hardwood fibers) and 25 percent of sulfite pulp (softwood fibers) 15 percent of clay made the papers too soft for lithographic papers, lowering all of their desirable physical properties. The addition of the melamine resin had little or no beneficial effect on these papers. However, with a 50-percent-sulfite, 50-percent-soda, 15-percent-clay furnish, the physical properties were improved by the addition of 3 percent of melamine resin, resulting in good lithographic papers. The clay retention was lowered slightly by the addition of 3 percent of melamine resin, and more so with 1 percent of melamine resin. When the stock was given 5½ hours of beating, the melamine resin was of assistance in producing improved lithographic papers made from 75 percent of soda pulp and 25 percent of sulfite pulp.

When 3 percent of titanium dioxide was added to both 50-percent soda, 50-percent sulfite, and 75-percent soda, 25-percent sulfite furnishes with 5½ hours of beating and 1 or 3 percent of melamine resin added, satisfactory offset papers were produced. The retention of the titanium dioxide was decreased somewhat by the resin.

As reported in an earlier publication, the retention of both fillers was improved by using an excess of aluminum sulfate and adjusting the stock to the desired pH with sodium carbonate. 6 p.

RP2263. A method for corn-sirup analysis involving selective adsorption
Emma J. McDonald and Roger E. Perry, Jr.

A chromatographic method is described for the separation of corn sirups into dextrose, maltose, and dextrin fractions. The sample is adsorbed on a Darco column; separation of the components is effected by using water, a 5-percent-ethanol-in-water solution and a 15-percent-ethanol-in-water solution as eluting media. Pressure is used to increase the flow rate. 4 p.

RP2264. Effect of exposure to soils on the properties of asbestos-cement pipe......................Irving A. Denison and Melvin Romanoff

This report summarizes the results of study made on two varieties of asbestos-cement pipe involving the exposure of 15 different soils for periods up to 11 years. The soils range from well-aerated types deficient in water soluble salts to very poorly aerated ones containing high concentrations of soluble material. The effects of exposure to the soils on the mechanical and physical properties of asbestos-cement pipe are indicated by measurements of hydrostatic bursting pressure, crushing strength, water absorption, apparent specific gravity and by observations of the condition of the surface of the specimens removed. Bursting and crushing strengths of the pipe samples, after exposure, were without exception higher than the requirements of the Federal specifications for this class of material. 13 p.

RP2265. Photometric determination of copper in iron and steel with diethyldithiocarbamate......................John L. Hague, Eric D. Brown, and Harry A. Bright

A method is described for the direct photometric determination of copper in steel and iron. An 0.1- to 0.25-gram sample is dissolved in diluted nitric acid, and a sulfuric-phosphoric-perchloric acid mixture is added. The solution is evaporated to fumes of sulfuric acid, diluted, and the sodium salt of dimethylglyoxime or ethylenediaminetetraacetic acid added as a complexing reagent. The copper diethyldithiocarbamate complex is then formed, and extracted with butyl acetate. The butyl acetate extract is washed with diluted sulfuric acid, and the absorbancy of the copper complex is measured at 560 to 600 millimicrons. An accuracy of about 0.005 percent of copper or better is indicated for steels containing 0.05 to 0.25 percent of copper, and of about 0.001 percent of copper for steels containing less than 0.05 percent of copper. 5 p.

RP2266. Description and analysis of the second spectrum of chromium, Cr II
Carl C. Kiess

The analysis of Cr II presented in this paper is based on new wavelength measurements and estimated intensities, and on new observations of the Zeeman effect. Of approximately 2,100 lines listed in the tables, 89 percent have been classified as combinations of the levels of 48 even terms with levels of 51 odd terms. The even terms arise from the electron configurations $3d^5$, $3d^4\ 4s$, and $3d^3\ 4s^2$, the odd terms from the configuration $3d^4\ 4p$. No odd terms from the configuration $3d^3\ 4s\ 4p$ have been established. High even terms from the excited configurations $3d^4\ 4d$ and $3d^4\ 5s$ have been found that form Rydberg series with terms from the low even configurations. From them an ionization potential of 16.49 electron volts has been derived for the work required to convert a singly ionized Cr atom in the $a\ {}^6S_{2\frac{1}{2}}$ state to a doubly ionized atom in the $a\ {}^5\mathrm{D}_0$ state. The terms of the $3d^3\ 4s^2$ configuration lie high in the energy scale, and only a few relatively faint combinations between them and the odd terms have been found. 42 p.

RP2267. Harmonic output of the synchronous rectifier............Paul Selgin

If a sine-wave current or voltage of generic frequency f is admitted into a switching device that inverts its polarity with frequency F, the output will contain all the positive frequencies $\pm f + NF$, with N an odd integer. This fact, as well as the amplitude and phase of each component, results from the expansion of the output in a complex Fourier series. Application to particular cases illustrates the behavior of the synchronous rectifier in cases when the input contains nonsynchronous components. In particular, the selectivity and damping associated with the synchronous rectifier are made the object of comparative considerations. 6 p.

RP2268. pH of solutions of potassium hydrogen *d*-tartrate from 0° to 60° C
Roger G. Bates, Vincent E. Bower, Richard G. Miller, and Edgar R. Smith

Although it is impossible to establish a thermodynamic scale of hydrogen-ion activity, a_{H}, the NBS pH standards are assigned pH values that approach as closely as possible & $-\log a_{\mathrm{H}}$ in dilute buffer solutions. In order to avoid the uncertainties of the liquid junction, electromotive-force measurements of hydrogen-silver chloride cells without liquid junction were used to obtain the standard pH. To assign pH values to four standard tartrate buffer solutions in the temperature range 0° to 60° C, electromotive-force data were obtained for 30 aqueous mixtures of potassium hydrogen tartrate and sodium chloride. One of the proposed standards is a saturated solution of potassium hydrogen tartrate at 25° (pH 3.56), and the others are 0.03-, 0.02-, and 0.01-molar with respect to this salt.

Directions for the preparation and preservation of tartrate buffer standards are given. 6 p.

RP2269. Heats of formation of some barium aluminates........R. B. Peppler and E. S. Newman

The heats of solution in HCl, 26.61 H_2O of eight compounds in the system BaO-Al_2O_3-H_2O were determined. From these data and data taken from the literature, the heats of formation of the compounds at 25° C were calculated. 4 p.

RP2270. Thickness of glass electrodes....J. J. Diamond and Donald Hubbard

A nondestructive magnetic method has been developed for the measurement of the thickness of glass electrode bulbs. It involves the use of the Brenner Magne-Gage as the measuring instrument and carbonyl iron powder as the backing material. Each of the four glasses investigated was found to have a characteristic "departure thickness," ranging from 54 to 130 microns. A glass electrode whose minimum thickness was equal to or less than this departure thickness was found to give the full 59 millivolts per pH unit electrode response. Bulbs of increasingly greater thickness showed increasing departures from this theoretical response. The departure thicknesses of the glasses investigated were found to be a function of their hygroscopicities. 6 p.

RP2271. Some characteristics of Stedman packing in the distillation of hydrogen and its isotopes.........Abraham Fookson, Philip Pomerantz, and Simon Rothberg

Apparatus was designed and constructed in which some characteristics of Stedman packing in the distillation of hydrogen isotopes were measured. The average still hold-up and the hold-up at various boil-up rates were measured using both hydrogen and deuterium as still charge. Mixtures of hydrogen–hydrogen-deuteride of known composition were distilled at boil-up rates of 454 milliliters per hour and 1,90 milliliters per hour, respectively. From the distillation data the height equivalent to a theoretical plate was calculated and found to be 1.0 inch for the 12-inch packing used in these experiments. 7 p.

RP2272. Use of radiation from incandescent particles as an indication of flame temperature.......Earle K. Plyler and Curtis J. Humphreys

This study was undertaken to determine if the radiation from incandescent carbon particles could be utilized in the measurement of the temperature of flames. This is a preliminary investigation of the measurement of flame temperatures by using the intensities in the ultraviolet continuum at two wavelengths chosen in regions comparatively free from molecular bands and comparing these energies with the continuous emission at the same wavelengths of a calibrated tungsten ribbon lamp containing a quartz window. Fuel-rich oxyacetylene flames were used because they contain the desired incandescent particles. The ratios of intensities in the chosen spectral regions were determined photographically and photoelectrically. Interpretation of the observed ratio for a given flame, in terms of temperature has been made, and flame temperatures from 1,900° to 2,400° C have been determined. 5 p.

RP2273. Electron-optical bench....L. Marton, M. M. Morgan, D. C. Schubert, J. R. Shah, and J. A. Simpson

A versatile electron-optical bench has been constructed for the extensive study of electron-optical elements. Three carriages for magnetic lenses and four holders for apertures, objectives, and meshes are arranged appropriately in the vacuum chamber, while provision is made for external positioning with 3 degrees of freedom for each element. The design and experimental technique are discussed in detail. A set of measurements of the focal length of a magnetic lens is presented to illustrate the practical employment of the bench and to indicate the limits of accuracy that can be attained. 4 p.

RP2274. Random determinants.......................................R. Fortet

Determinants whose elements involve random variables are discussed and expressions derived for the first and second moments. Applications are made to n-dimensional geometry, especially, to finding limiting probabilities for the event: "a given point lies above a random hyperplane", under fairly general hypotheses. The random variable $A_n h - B$ is considered, where A_n and B are certain minors of the determinantal equation of the random hyperplane, and h is a coordinate of the given point.

An asymptotic expression for $E\{A_n^2\}$ is obtained, and it is shown that $E\{B^2\}$ is of the order of $(1/n)$ $E\{A_n^2\}$. 6 p.

RP2275. Solutions of $Ax=\lambda Bx$................ M. R. Hestenes and W. Karush

The problem is to determine characteristic numbers and vectors for the problem $Ax=\lambda Bx$, where A, B are $n \times n$ Hermitian matrices. A generalized gradient η is defined. From a first approximation x_0, a second approximation $x_1=x_0+\alpha\eta$ is determined. Successive approximations, with appropriate alphas, converge to a solution. 8 p.

RP2276. Proposed revision of the conventional method of wave-filter design
Paul J. Selgin

A modification of the conventional "classical" method of electrical filter design is proposed. The change consists of the use of new parameters, "frequency numbers", which permit the design to be made from specification of peak and cut-off attenuation rather than idealized cut-off frequency, as in the conventional method.

The method is extended to cover the dissipative, as well as the nondissipative, or lossless case. Suitable design curves and tabulations are included. 12 p.

RP2277. On the derivation and accuracy of certain formulas for sample sizes and operating characteristics of nonsequential sampling procedures..Uttam Chand

Formulas are given that are needed for the computation of number of observations and operating characteristics of single sample acceptance sampling procedures based on tests of statistical hypotheses. Some of the same results may be obtained by reference to existing tables and curves located in widely scattered places. The hypotheses considered concern the means and standard deviations of certain populations (that is, binomial, Poisson, normal) where the test is made against a one-sided alternative. The comparison of two means or two variances as well as the test of a single mean or variance is discussed. The accuracy of the formulas is considered, and where approximations are involved, the results are compared with existing tables. 11 p.

RP2278. Asymmetries of Zeeman patterns and g-values for neutral manganese...Miguel A. Catalán

Spectrograms of manganese made at the Massachusetts Institute of Technology with fields in excess of 84,000 oersteds show many lines that exhibit various degrees of distortion in both the positions and the intensities of the magnetic components. The interpretation of these asymmetric patterns has been made by the approximate theory of the partial Paschen-Back effect. The g-values that have been derived for several energy levels of Mn I are found to conform, in most cases, with those required for *LS*-coupling. A few exceptions to this rule have been considered in some detail. General tables have been computed, which will permit explanation of the distortions in other spectra. 22 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 48, JANUARY—JUNE 1952

RP2279. Absolute viscosity of water at 20° C.................J. F. Swindells, J. R. Coe, Jr., and T. B. Godfrey

An accurate knowledge of the viscosities of liquids in absolute units is of fundamental importance in many scientific fields. The measurement of these viscosities is almost universally based upon the absolute viscosity of water at 20° C as a primary standard. During the past 50 years there has been an increasing need for a more accurate determination of this standard. Consequently, with the cooperation of the Society of Rheology and some financial assistance from the Chemical Foundation, this project was undertaken by the National Bureau of Standards and has now been completed.

The determination was made by the method of capillary flow. By means of a calibrated injector, various known constant rates of flow were produced in capillaries of measured dimensions, and observations were made of the corresponding pressure drops through the capillaries. The effects of the ends of the capillaries were rendered negligible by the simultaneous treatment of data obtained with pairs of capillaries having essentially the same diameters but different lengths.

The value found for the viscosity of water is 0.010019 poise as compared with 0.01005 poise, which has generally been accepted for the past 30 years. The estimated accuracy of the new determination is ±0.000003 poise.

As a result of this work, beginning on July 1, 1952, the National Bureau of Standards is planning to use the value 0.01002 poise for the absolute viscosity of water at 20° C as the basis for the calibration of viscometers and standard-sample oils. It is recommended that other laboratories adopt this value as the primary reference standard for comparative measurements of viscosity. 31 p.

RP2280. On some functionals of Laplacian processes................R. Fortet

Let $X(t)$ be a random function derived, in a sense that is explained in the paper, from a Poisson process. It is proved that, under certain assumptions, the distribution of the functional $\int_t^{t+T} V(u, X(u))\,du$ tends to a Laplacian (i. e. normal) distribution as $T \rightarrow \infty$. This result is extended to the case that $X(t)$ is itself a Laplacian process by means of a theorem stating that, under certain assumptions, every Laplacian process is the limit of some random function derived from a Poisson process. 8 p.

RP2281. Solubility of carbon in 18-percent-chromium–10-percent-nickel austenite...................Samuel J. Rosenberg and Carolyn R. Irish

A series of high-purity iron-chromium-nickel alloys, made to a base analysis of 18 percent of chromium and 10 percent of nickel, and with carbon ranging from 0.007 to 0.30 percent, was melted and solidified in vacuum. The presence or absence of carbides in these alloys after various mechanical and thermal treatments was determined by metallographic examination. The practical limit of solubility varied from less than 0.007 percent of carbon at 1,300° F to slightly more than 0.077 percent at 1,975° F, the highest temperature studied.

The presence of ferrite and/or sigma as stable phases in many of the alloys was established. 10 p.

RP2282. Uniformly best constant risk and minimax point estimates
Raymond P. Peterson

In this paper several types of point estimates are compared on the bases of their corresponding expected risk. It is shown that constant risk minimax estimates (which are always uniformly best constant risk estimates) exist, under certain conditions, for several frequently occurring types of parameters and general methods are obtained for constructing these minimax estimates. 5 p.

RP2283. Sensitive mercury-level detecting unit for manometers
W. E. Williams, Jr.

An electronic instrument has been developed to determine the differential height of the two arms of a mercury manometer. The instrument has a sensitivity corresponding to 0.0005-inch height differential, and the pickup units are designed to provide this performance at absolute pressures up to 35,000 pounds per square inch. Use is made of a high-frequency mutual-inductance micrometer, with the tops of the mercury columns serving as the reference surfaces. 5 p.

RP2284. A note on bounds of multiple characteristic roots of a matrix
P. Stein

If $A=(a_{1s})$ is an $n \times n$ matrix, and if C_i are the circles, center a_{ii} and radii $\sum_{\substack{s=1 \\ s \ddagger i}}^{n} |a_i|$, and if λ is a characteristic root with m independent characteristic vectors, Olga Taussky proved the following two results:
(1) If λ lies outside all but one circle C_i, then m cannot be greater than 1.
(2) If $m=n-1$, then λ is an inner or boundary point of at least M circles C_i.
In this note the gap between these two results is closed, and it is shown that λ lies in at least m circles C_4, for all finite values of m and n, $\leqq n$. 2 p.

RP2285. Binding energies for electrons of different types
Charlotte E. Moore and Henry Norris Russell

The binding energy of an electron of given type in any state of a neutral or ionized atom may be defined as that required to remove it along successive terms of a spectral series to its limit. The data regarding electron configurations and limits collected in Atomic Energy Levels, Volumes I and II, permit the calculation of these in a great number of cases.

The present tables give the maximum energy resulting from the addition of an electron of given type (such as $4p$) to the ground states of singly or doubly ionized atoms of the elements H through Nb; and, when desirable, to one other low state (two in the cases of Sc and Y). These increase smoothly with atomic number except for a remarkable break after a shell of ten d-electrons has been half filled. 7 p.

RP2286. On the estimation of an eigenvalue by an additive functional of a stochastic process, with special reference to the Kac-Donsker method .... R. Fortet

A "Monte Carlo" method is described for the determination of the eigenvalues and the Fredholm determinant of certain Fredholm integral equations with positive kernel $\Gamma(t,\tau)$. The method is based on a theorem by Kac and Segert. An appropriate stochastic process is constructed from a Poisson process, for the case that $\Gamma(t,\tau)$ depends on $t-\tau$ only.

The second part of the paper contains a discussion of the various errors inherent in the method of Donsker and Kac for the determination of the lowest eigenvalue of Schrodinger's equation. 8 p.

RP2287. Synethesis and physical properties of n-heptane and 2,2,4-trimethylpentane .... Philip Pomerantz

High-purity samples of n-heptane and 2,2,4-trimethylpentane have been prepared by synthetic methods and purified by fractional distillation for use as standards in the certification of primary reference fuels. One lot of n-

heptane was used to prepare standard samples for the comparison of precision heat-capacity calorimeters. The details of the syntheses are presented, and the physical properties of these compounds are reported. 6 p.

RP2288. Some general theorems on iterants........................P. Stein

If B is a square matrix, then it is known that a necessary and sufficient condition that $\lim_{n \to \infty} B^n = 0$, is that the characteristic roots of B are all of modulus less than unity. An alternative condition is given in this paper, in terms of Hermitian matrices. Further, a generalization of the result is obtained that covers cases of matrices. B, whether B^n does or does not converge to 0, except for very special matrices. 2 p.

RP2289. Ionization constant of 5-5′-diethylbarbituric acid from 0° to 60° C
George G. Manov, Kathryn E. Schuette, and Floyd S. Kirk

Measurements are reported for the ionization constant and for related thermodynamic quantities from 0° to 60° C for 5-5′-diethylbarbituric acid.

Two series of solutions corresponding to molal ratios of barbituric acid: sodium barbiturate:sodium chloride (or iodide) of 1:0.5:1.667, 1:1:1.667, and 1:2:1.667 were investigated. The values obtained for the ionization constant of the acid using these three ratios of acid to sodium salt and two types of reference electrodes were found to agree within the experimental error of the measurements. Two other series of solutions in which both the ratio and the concentration of the buffer materials were maintained at a fixed value and that of the halide ion was diminished were also studied. The effect of sodium iodide on the pK' of the buffers was normal, whereas that for the sodium chloride was anomalous but could be explained in terms of a demonstrated interaction at low concentrations of sodium chloride, between the soluble barbiturate ion and the silver–silver-chloride electrode used in the cell.

The variation of pK for 5-5′-diethylbarbituric acid with the absolute temperature T, where $T = 273.16 + t\,^\circ\mathrm{C}$, can be expressed by the equation

$$\mathrm{p}K = 2324.47/T + 0.0118562T - 3.3491$$

over the range 0° to 60° C. 8 p.

RP2290. Infrared absorption spectra of five halomethanes....Earle K. Plyler and Nicolo Acquista

The infrared absorption spectra of five halomethanes, bromodifluoromethane, dibromodifluoromethane, bromochlorodifluoromethane, bromotrifluoromethane, and iodotrifluoromethane have been studied from 2 to 38 microns. Fundamental, combination, overtone, and difference bands have been identified. Many unobserved fundamentals have been predicted by comparisons with related molecules and with Raman spectra. The fundamentals have been classified as to the type of motion and the principal atom involved. Four tables are included to show the relationships among the fundamentals of the molecules compared. 6 p.

RP2291. Film-rupture mechanism of stress corrosion..........Hugh L. Logan

The atmospherically formed protective films were removed by abrasion in an argon atmosphere from surfaces of an aluminum alloy, two brasses, a magnesium alloy, and low-carbon and stainless steels. The resulting surfaces were 0.12 to 0.76 volt more negative with respect to a calomel electrode than surfaces prepared and measured under normal atmospheric conditions. Appreciable changes in electrochemical solution potentials of notched specimens, stressed in tension, occurred at or just above stresses at which the true stress-true strain curves deviated from the modulus lines. These changes in potential were caused by rupturing of the protective films at the roots of the notches and were of the order of 0.16 to 0.70 volt at failure, depending on the material. Stress corrosion is postulated to occur in corrosive media, at stresses sufficient to rupture the protective film, by electrolytic action between the filmed (cathodic) and film-free (anodic) areas. 7 p.

RP2292. A note on the bounds of the real parts of the characteristic roots of a matrix..P. Stein

Two theorems are given for the bounds of the real parts of the characteristic roots of an $n \times n$ matrix, depending on the use of an arbitrary set of n positive numbers. The set is then specialized in several ways so as to lead to theorems for the bounds in terms of the elements of the matrix. 3 p.

RP2293. Chart for the TE_{11} mode piston attenuator........Charles M. Allred

A nomogram is given and described that expedites the determination of the dependence of attenuation on frequency, conductivity, and radius in a cylindrical waveguide, TE_{11} mode, piston attenuator. 2 p.

RP2294. Table of the zeros and weight factors of the first twenty hermite polynomials...Herbert E. Salzer, Ruth Zucker, and Ruth Capuano

The chief use of this table of the zeros and weight factors of the Hermite polynomials is in the calculation of integrals over the interval $[-\infty, \infty]$, when the integrand is either the product of e^{-x^2} and a polynomial, or may be closely approximated by e^{-x^2} times a polynomial. The zeros and weight factors, $x^{(n)}$ and $a_i^{(n)}$, respectively, together with the auxiliary quantities $\beta_i^{(n)}=a_i^{(n)}\exp[x_i^{(n)2}]$, which are useful in computation, are all tabulated here for the first twenty Hermite polynomials. The zeros $x_i^{(n)}$ *and* $\beta_i^{(n)}$ are given to 13 or more decimals, and the weight factors $a_i^{(n)}$ to 13 significant figures. Although other shorter tables have appeared, this present table will enable one to cope with problems requiring much higher degree and accuracy, both in problems involving direct quadratures and those arising in the numerical solution of linear integral equations for the range $[-\infty, \infty]$. Thus the use of this table in any direct quadrature can give exact accuracy as far as the 39th degree (the only inexactitude arising from the use of rounded values of $x_i^{(n)}$ and $a_i^{(n)}$). 6 p.

RP2295. Film dosimetry of electrons in the energy range 0.5 to 1.4 million electron volts.....................J. Freeman and F. S. Frantz, Jr.

Two types of films were exposed to electrons in the energy range 0.5 to 1.4 million electron volts. The film response was found to be linearly proportional to the dosage received and independent of the energy of the incident electrons in the measured energy range. The photographic density is further shown to be dependent on the amount of paper absorber surrounding the film. A step-wedge filter is suggested that would permit extrapolation of densities to zero filter thickness. 4 p.

RP2296. Thermal converters as ac-dc transfer standards for current and voltage measurements at audio frequencies....Francis L. Hermach

Thermal converters and associated equipment that are used as ac-dc transfer standards at the National Bureau of Standards for the precise measurement of current and voltage at power and audio frequencies are described. The standards and the equipment are primarily used to standardize a-c ammeters and voltmeters submitted to the Bureau for certification. The ac-dc transfer may be made with these thermal converters at currents from 1 milliampere to 50 amperes, voltages of 0.2 to 750 volts, with an accuracy of 0.01 percent at frequencies from 25 to 20,000 cycles per second.

The special tests to insure the required accuracy of the transfer standards are described, and the results are presented. A number of factors that limit the transfer accuracy of thermal converters have been discovered, and the results of special tests and theoretical work to evaluate these factors are discussed. The solutions, by an approximation method, of certain pertinent nonlinear differential equations governing the heating of a conductor by an electric current are given. 18 p.

RP2297. Some nonnegative trigonometric polynomials connected with a problem in probability................Eugene Lukacs and Otto Szász

Let $0<b_1<b_2< \ldots <b_n$ be integers and let $g(\theta)$ be the Vandermonde determinant formed from $b_1^2, b_2^2, \ldots b_n^2$ with the first row replaced by $\sin^2 (b_i\theta/2)$ $(i=1, \ldots, n)$. The function $g(\theta)$ is then a cosine polynomial. In connection with a problem in probability, the question arose as to when $g(\theta)$ is a nonnegative trigonometric polynomial. This question is answered for six classes of such trigonometric polynomials. 8 p.

RP2298. Measurement of cesium-137 and cobalt-60 gamma radiation with a pressure ionization chamber.................................G. R. Grove

The characteristics of the pressure ionization chamber at the National Bureau of Standards have been studied for the gamma radiation from a cesium-137 source (0.6614 Mev) and from a cobalt-60 source (1.1715 and 1.3316 Mev). The dosage rates produced in air by these sources were measured with this chamber with an accuracy of about 2 percent. Dosage rates obtained with an extrapolation chamber and a Victoreen thimble chamber agreed with the values measured by the pressure chamber within the limits of the experimental errors. 5 p.

RP2299. Techniques for growing and mounting small single crystals of refractory compounds..................................Fred Ordway

An apparatus is described for growing single crystals in a small droplet of melt at temperatures up to 1,600° C. The droplet, held by capillarity at the junction of a thermocouple, can be observed during the process through a binocular microscope. The heating is by means of a high-frequency current that can be separated by a filter from the thermocouple electromotive force, allowing the electromotive force to be measured continuously. The apparatus is therefore suitable also for determining melting points.

The process of mounting and grinding the single-crystal specimens for X-ray diffraction and a simple but versatile micromanipulator to facilitate these procedures are described. 6 p.

RP2300. Crystal forms of chromium orthophosphate....Barbara M. Sullivan and Howard F. McMurdie

There is no evidence for the existence of any crystalline hydrate of chromium orthophosphate other than the hexahydrate. This breaks down near 130° C to an amorphous material. If the unstrained and coarse hexahydrate is heated, it recrystallizes at 1,014° C to an unstable, fine-grained compound (βCrPO^4). If the original hydrate is ground and thus strained, it will form a stable compound (αCrPO^4) at 972° C. X-ray diffraction powder patterns are given for the three crystalline forms, and the general relation of chromium orthophosphate hexahydrate to other hydrates is discussed. 4 p.

RP2301. Synthesis of D-glucose-1-C^{14} and D-mannose-1-C^{14}.......H. S. Isbell, J. V. Karabinos, H. L. Frush, N. B. Holt, A. Schwebel, and T. T. Galkowski

Heretofore, radiochemical yields of sugars position-labeled with carbon-14 have been only 5 to 10 percent. This paper reports an improved cyanohydrin synthesis, and the preparation of D-glucose-1-C^{14} and D-mannose-1-C^{14} from D-arabinose in yields of about 50 percent. Low yields in prior syntheses appear to have been due to several inefficient steps, and to the fact that extension of the carbon chain yields a pair of epimeric sugar derivatives, the proportion of which may not favor the desired epimer. In the classical cyanohydrin synthesis of glucose from D-arabinose only 30 percent of the product goes to the gluconic epimer. To increase the yield of glucose, a systematic study was made of the proportions of the epimers formed from D-arabinose under a variety of conditions. It was found that the ratio of the epimers depends upon the conditions under which the reaction of the sugar with cyanide takes place. Thus, D-arabinose and cyanide, in the presence of sodium bicarbonate and carbon dioxide, yield about three parts of mannonic nitrile to one part of gluconic nitrile, but, in the presence of sodium carbonate the proportion is approximately reversed. 9 p.

RP2302. Effects of Maxima Suppressors on Polarographic Diffusion Currents.....John Keenan Taylor and Roberta E. Smith

The influence of maxima suppressors on the polarographic diffusion current has been reinvestigated. Abnormally large values for the diffusion current are found in the absence of suppressor. The amount required to suppress maxima is less for large electrodes at longer drop-times. The depressive action of large excesses of suppressor also has been studied. Agar is shown to be an effective suppressor of maxima and a sufficient amount can dissolve in a short period of time, when using H-cells containing agar plugs, to completely suppress maxima. As a result, quantitative studies of suppressor action with this type of cell are of doubtful significance. 7 p.

RP2303. Heat Capacity of gaseous carbon dioxide...........Joseph F. Masi and Benjamin Petkof

The heat capacity (C_p) of gaseous carbon dioxide has been measured at $-30°$, $0°$, $+50°$, and $+90°$ C and at 0.5-, 1.0- and 1.5-atmosphere pressure, with an accuracy of 0.1 percent. The flow calorimeter used was a modification of the one previously described by Scott and Mellors [1][2] and Wacker, Cheney, and Scott [2]. In order to test the accuracy of the calorimeter, the heat capacity of oxygen was measured at 1 atmosphere at $-30°$, $0°$, and $+50°$ C. The measured values of C_p for oxygen were combined with an equation of state to give C_p°; these differed from the statistically calculated values by $+0.03$, -0.06 and -0.01 percent at the three temperatures.

The experimental values of C_p for carbon dioxide have been used to calculate new values of C_p° and values of the pressure coefficient of heat capacity at the four temperatures of measurement. The theoretical values of C_p° calculated in 1949 [8] were found to be too low by 0.2 to 0.3 percent; the results of a new calculation are in substantial agreement with the experiments. The pressure coefficients are in agreement with those obtained from the recent pressure-volume-temperature work of MacCormack and Schneider [7]. 9 p.

RP2304. Mass Spectra of deuteroacetylenes, monodeuterobenzene, and deuteronaphthalenes.........Fred L. Mohler, Vernon Dibeler, Laura Williamson, and Helen Dean

Mass spectra at 70-volt ionizing voltage have been measured for C_2H_2, C_2HD, C_2D_2, C_6H_6, C_6H_5D, $C_{10}H_8$, $C_{10}H_7D$, and for a mixture of $C_{10}D_8$ and $C_{10}HD_7$. In acetylene, benzene, and naphthalene it is possible to measure the isotopic purity at ionizing voltages below the appearance potential of any fragment ions and to correct the observed spectra of monodeutero compounds for isotopic impurity.

For C_2HD the probability of removing the H atom is nearly twice as great as that of removing the D atom. In monodeutero benzene and naphthalene, on the other hand, there is no such selectivity, and it is possible to compute the spectra of the monodeutero compounds on the basis of equal *a priori* probability of removing a single H or D atom. By assuming that equal probability holds for doubly charged ions, the complete doubly charged ion spectra can be computed from the observed half-integer peaks. Similarly, the spectra of $C_{10}D_8$ and $C_{10}HD_7$ are computed from a spectrum of a mixture of the two compounds. 5 p.

RP2305. Influence of nitrogen on the notch toughness of heat-treated 0.3-percent-carbon steels at low temperatures.... Glenn W. Geill, Nesbit L. Carwile, and Thomas G. Digges

Charpy impact tests were made at temperatures ranging from $-196°$ to $+100°$ C on fully hardened and tempered specimens of 0.3-percent-carbon steels with variable nitrogen.

The transition from ductile to brittle fractures was affected by both the amount and forms of the nitrogen in the steels. Fixation of the nitrogen as aluminum nitride was beneficial, as the aluminum-treated steels had considerably lower transition temperatures than those of the steels not treated with aluminum. 8 p.

RP2306. Determination of metallic beryllium and beryllium carbide in beryllium metal................................Walter A. Bergholz

A method is described for the determination of metallic beryllium and beryllium carbide in beryllium metal. The beryllium metal is dissolved in potassium hydroxide solution at a controlled rate of solution. The liberated hydrogen and methane are burned with copper oxide in an atmosphere of nitrogen. The water and carbon dioxide formed are absorbed in magnesium perchlorate and ascarite, respectively, and determined by weighing. The metallic beryllium is calculated from the water, corrections being made for any calcium or aluminum present as impurities that also liberate hydrogen in caustic solution; in case beryllium carbide is determined, a correction may also be made for the water formed by the combustion of methane. The beryllium carbide is calculated as Be_2C from the carbon dioxide formed. 5 p.

RP2307. Heats of Combustion and Formation of Liquid Ethylenimine
Raymond A. Nelson and Ralph S. Jessup

The heat of combustion of ethylenimine was measured at 28° C in a bomb calorimeter. The experimental data yielded the value $-\Delta H_c^\circ = 1591.36 \pm 0.57$ kilojoules per mole for the heat of combustion at 25° C, the reactants being liquid ethylenimine and gaseous oxygen and the products being gaseous carbon dioxide, gaseous nitrogen, and liquid water. By combining this value with data on the heats of formation of gaseous carbon dioxide and liquid water, the value $\Delta H_f^\circ = 91.90 \pm 0.59$ kilojoules per mole was obtained for the heat of formation of liquid ethylenimine at 25° C. 3 p.

RP2308. Thermal Expansion of Aluminum and Some Aluminum Alloys..............................Peter Hidnert and H. S. Krider

Data are given on the linear thermal expansion of aluminum and some aluminum-beryllium, aluminum-copper, aluminum-silicon, aluminum-copper-iron, aluminum-copper-magnesium, aluminum-copper-nickel, aluminum-silicon-copper, aluminum-silicon-magnesium, aluminum-copper-nickel-magnesium, aluminum-copper-tin-zinc, aluminum-silicon-copper-manganese, aluminum-silicon-copper-nickel, aluminum-silicon-nickel-copper-manganese, and aluminum-silicon-nickel-copper-molybdenum alloys for various temperature ranges between —50° and +400° C. The addition of beryllium, copper, or silicon to aluminum causes a decrease in the coefficients of expansion. Copper has a greater effect than beryllium, and silicon has the greatest effect of these three alloying elements. Ternary diagrams are shown that indicate the effects of composition on the coefficients of expansion of aluminum-copper-nickel and aluminum-silicon-copper alloys. The effects of additions of two or three elements (copper, nickel, manganese, and molybdenum) on the coefficients of expansion of aluminum-silicon alloys are indicated in a figure. 12 p.

RP2309. Some accurately measured infrared wavelengths for calibration of grating spectrometers............Earle K. Plyler, Norman Gailar, and Thomas A. Wiggins

The measured values of the wavelengths of 60 lines in the 1.1- to 2.3-micron spectral region are reported. The absorption lines of the bands of methane and water vapor were used in the calibration. The methods of measurement are discussed. Also discussed are the methods of superimposing the well-known emission lines of several sources on the absorption lines that were measured. The values obtained for some lines are compared with values reported by other workers. 7 p.

RP2310. A method of summing infinite series.................Samuel Lubkin

This paper describes a new method of obtaining an equivalent series from a given infinite convergent or divergent series. In many cases the new series is more convenient for summing than the original and, moreover, the same method may usually be repeated indefinitely to obtain an entire sequence of series each equivalent to the original and each better than its predecessor in summing properties. The new method differs from most summing methods heretofore employed in that terms of the transformed series are not linear functions of terms of the original series. The paper includes proofs of theorems indicating the scope of the new method and comparisons of results with various other methods for many specific examples. 24 p.

RP2311. Properties of certain statistics involving the closest pair in a sample of three observations......................Julius Lieblein

Triplicate readings are of wide occurrence in experimental work. Occasionally, however, only the closest pair of a triad is used, and the outlying high or low one discarded as evidencing some gross error. The present paper presents a mathematical investigation leading to precise determination of some of the biases that result from such selection. This project was suggested by certain experiments involving random sampling numbers and analysis of published chemical determinations. The theoretical findings agree closely with the empirical results and imply that selected pairs not only tend to overestimate considerably the precision of the experimental procedure, but also result in less accurate determinations. 14 p.

RP2312. Pressure-humidity apparatus.......................Arnold Wexler and Raymond D. Daniels, Jr.

An apparatus for producing atmospheres of known relative humidity, based on the "two-pressure principle", is described. It has a working space (test chamber) of 1 cubic foot, in which the relative humidity may be varied and controlled from 10 to 98 percent, the temperature from —40° to +40° C, the air flow up to 150 liters per minute, and the test-chamber pressure from ½ to 2 atmospheres. The humidity in the test chamber may be set and maintained to an accuracy of at least ½- to 1-percent relative humidity. 6 p.

RP2313. Heats of copolymerization of butadiene and styrene from measurements of heats of combustion..................Raymond A. Nelson, Ralph S. Jessup, and Donald E. Roberts

The heats of combustion of two samples of polybutadiene and four copolymers of butadiene and styrene prepared at 50° C (122° F), and one sample of polybutadiene and four copolymers polymerized at 5° C (41° F) were measured in a bomb calorimeter. The styrene contents in the copolymers varied from approximately 8 to 55 weight percent.

A value for the heat of polymerization (or copolymerization) was calculated for each sample by combining the experimental value for the heat of combustion with other known thermochemical data. The mean value obtained for the heat of polymerization ($-\Delta_p°$) of polybutadiene is 17.4 kcal per monomer unit, and the values obtained for the heat of copolymerization varied from 17.1 to 17.7 kcal per monomer unit. No appreciable difference was found between the heats of copolymerization of the 5° C and 50° C polymers. The heat of copolymerization can be represented as a function of styrene content of the polymer by an equation of a form derived theoretically by Alfrey and Lewis, although the conditions under which the polymers were formed were such that some of the assumptions underlying the derivation of the equation were not satisfied. 6 p.

RP2314. Infrared spectra of methanol, ethanol, and *n*-propanol Earle K. Plyler

The infrared absorption spectra of methanol, ethanol, and *n*-propanol have been measured with prism instruments. Studies have been made of the vapors and of several dilute solutions. The methanol spectra, between 2 to 15 microns, provided a direct comparison with the other two alcohols and confirmed earlier work on the existence of a number of low-intensity bands. The two other alcohols were studied from 2 to 36 microns. The bands have been classified in relation to the O—H, C—H, C—O, and C—C vibrations within the molecules. The long-wave absorption, in the region beyond 30 microns, for each alcohol, is attributed to the hindered rotation of OH. The object of the present study was to confirm the assignments for methanol and to study and assign the vibrational spectra of ethanol and *n*-propanol. 6 p.

RP2315. Pigmentation in bristle and horsehair...........Sanford B. Newman

Bristles for use in brushes are normally imported in large quantities for domestic consumption. Horsehair is also commonly used in brushes, often blended with bristle in paint brushes. To determine compliance with material specifications and to enforce labeling laws it is necessary to be able to distinguish between the two fibers. The need of a reliable method for identifying the two fibers became more critical after the start of hostilities in Korea, which increased the difficulty of obtaining bristle from Chinese sources.

The use of pigment distribution in bristle and horsehair has been recommended for their differentiation. However, the use of this characteristic has been challenged on the grounds of technical difficulty in the preparation of mircoscopic specimens and the possibility of variations in pigmentation at different levels in the fiber, in animals from different geographical locations, and in different types of hairs from the same animal.

As little previous attention has been given these points, a series of observations was made that show clearly that pigment distribution in fiber cross sections permits the detection of horsehair in bristle and bristle products. The test is, of course, applicable only to fibers that contain sufficient natural pigment to establish a distribution pattern. In addition, the medullation in the two fibers is sufficiently distinctive to constitute another aid in identification. 11 p.

RP2316. The system beryllia-alumina-titania: phase relations and general
physical properties of three-component porcelains.....S. M. Lang,
C. L. Fillmore, and L. H. Maxwell

The data obtained in the investigation of the phase equilibria in the systems beryllia-alumina, beryllia-titania, and alumina-titana suggest that the equilibrium diagrams of these systems need to be revised: the system BeO-TiO_2 shows no compounds, an eutectic at about 85 weight percent of TiO_2 and 1,670° ±3° C, and an area of TiO_2 solid-solution. The system BeO-Al_2O_3 has three eutectics: (1) at 1,890° ±10° C and about mole ratio $1BeO{:}\ 4Al_2O_3$ (94.2% Al_2O_3); (2) at 1,850° ±10° C and about mole ratio $2BeO{:}3Al_2O_3$ (85.9% Al_2O_3); and (3) at 1,835° ±10° C and abcut 75 weight percent of Al_2O_3, and two congruently melting compounds, $BeO.3Al_2O_3$ (92.4% Al_2O_3) at 1,910° ±10° C and chrysoberyl ($BeO.$-Al_2O_3—80.3% Al_2O_3) at 1,870° ±10° C. The system Al_2O_3-TiO_2 has two eutectics: (1) at 1,705° ±5° C and about 20 weight percent of Al_2O_3; and (2) at 1,840° ±10° C and about mole ratio $5Al_2O_3{:}4TiO_2$ (61.5% Al_2O_3), and a high- and low-temperature form (alpha and beta) of aluminum titante ($Al_2O_3.TiO_2$—56.1% Al_2O_3); the alpha form is stable from the alpha-beta inversion temperature of 1,820° ±10° C and melts congruently at 1,860° ±10° C, and the beta form seems to be stable for periods up to 100 hours from room temperature to about 750° C and from about 1,300° C to its inversion temperature. The equilibria for the system BeO-Al_2O_3-TiO_2 was found to contain four invarient points: (1) at 1,572° ±5° C and about mole ratio $2BeO{:}1Al_2O_3{:}2TiO_2$ (16.1% BeO, 32.7% Al_2O_2, 51.2% TiO_2); (2) at 1,577° ±5° C and about mole ratio $2BeO{:}1Al_2O_3{:}4TiO_2$ (10.6% BeO, 21.6% Al_2O_3, 67.8% TiO_2); (3) at 1,580° ±5° C and about mole ratio $1BeO{:}1Al_2O_3{:}1TiO_2$ (12.1% BeO, 49.3% Al_2O_3, 38.6% TiO_2); and (4) probably at about 1,755° ±10° C and about mole ratio $2BeO{:}5Al_2O_3{:}2TiO_2$ (7.0% BeO, 79.8% Al_2O_3, 22.2% TiO_2). No ternary compounds were found in this system.

The general physical properties of practically impervious porcelains of this system were found to be: maturing range, usually 1,525° to 1,575° C, but with some of the high-alumina-containing bodies maturing between 1,600° and 1,700° C; apparent density, 3.3 to 3.7 g/cm_3; shrinkage, 11 to 19 percent; room-temperature compressive strength, 187,000 to 280,000 $lb/in.^2$; room-temperature transverse strength, 13,700 to 25,000 $lb/in.^2$; Young's modulus at room temperature, 42,000,000 to 47,000,000 $lb/in.^2$; transverse strength at

1,800° F (982° C), 10,500 to 17,000 lb/in.^{2}; approximate Young's modulus at 1,800° F, 22,000,000 to 41,000,000 lb/in.^{2}; relative thermal-shock resistance, poor; and the linear thermal expansion of a few selected bodies, in the range 25° to 950° C, usually was regular and ranged from 0.81 to 0.89 percent. 15 p.

RP2317. Effect of temperature on the tensile properties of high-purity nickel
William D. Jenkins and Thomas G. Digges

Tension tests were made at temperatures ranging from —320° to 1,500° F on high-purity nickel in the annealed condition. Exceptions to the usual trend exhibited by metals of decreasing strength and increasing ductility with increasing test temperature were observed and discussed. Strain aging occurred in specimens tested in the temperature range of about 80° to 300° F, but recrystallization and recovery predominated in specimens fractured at 1,200° and 1,500° F. 9 p.

RP2318. Thiophosphation of 2-methyl-2-nitro-1-propanol and the preparation of monothiophosphoric acid........J. V. Karabinos, R. A. Paulson, and W. H. Smith

The thiophosphation of a nitroalcohol was studied in ether and in pyridine solution. When 2-methyl-2-nitro-1-propanol was refluxed with phosphorus pentasulfide in ether, the corresponding dithiophosphate was formed. In pyridine solution, however, a pyridine salt of the secondary dithiophosphate was formed. A pyridine salt of metatrithophosphoric acid was also isolated from the latter reaction, and this salt was hydrolyzed to pyridinium monothiophosphate. Monothiophosphoric acid monohydrate itself was obtained, for the first time, by application of ion-exchange and lyophilizing techniques to its pyridine salt. 3 p.

RP2319. Surface changes in an original and activated bentonite
Juan de Dios Lopez-Gonzalez and Victor R. Deitz

The physical adsorption of nitrogen was used to study a bentonite activated by a treatment with hydrochloric acid. The Brunauer-Emmitt-Teller equation, the Huttig equation, and a so-called "summation" equation were used in the calculation of the surface areas available to nitrogen. The changes in surface area at different temperatures have been related to the quantity of adsorbed water and the amount of constitutional hydroxyl groups. The surface area is a measure of only the external boundary (nonswelling surface) of the bentonite, and this is increased significantly by the activation process. The ratio of surface areas (activated to original) is about four. A maximum in the surface area was found to exist when all of the adsorbed water was eliminated. However, the surface area decreased with the removal of water formed by decomposition of the constitutional hydroxyl groups. Chemical analyses, dehydration curves, thermal differential analyses, X-ray patterns, and electron micrographs were employed to characterize the materials. 9.

RP2320. Arc spectra of gallium, indium, and thallium....William F. Meggers and Robert J. Murphy

The arc spectra of gallium, indium, and thallium have been systematically investigated photographically in the octave 6500 to 13000 Angstroms. The spectra were excited in direct-current arcs and recorded on infrared sensitive photographic emulsions with a concave diffraction grating 22 feet in radius. In the designated spectral range, 37 new lines were photographed in Ga I, 35 lines in In I, and 25 lines in Tl I. All the observed lines are explained as combinations of doublet terms arising from the axial and orbital momenta of a single-valence electron. The new data led to a revision of Ga I terms, and extension from $n=9$ to 12 for $ns\ ^2S$, from $n=7$ to 11 for $nd\ ^2D$, and to the discovery of $nf\ ^2F^\circ$ terms from $n=4$ to 7. Besides confirming many terms already known for In I and Tl I, two new $nf\ ^2F^\circ$ terms were found for each of these spectra. 11 p.

RP2321. On the truncation error in the solution of Laplace's equation by finite differences.................................Wolfgang Wasow

The difference between the solution of the Laplace differential equation and the Laplace difference equation, defined in the same rectangle and assuming the same boundary values, is estimated under the assumption that the boundary function possesses a bounded third derivative. The bound obtained is of the order magnitude of the square of the mesh length. 3 p.

RP2322. Influence of temperature and moisture on the electrical properties of leather...Charles E. Weir

Apparent, or bulk, dielectric constants and power factors of chrome and vegetable leather and untanned hide are reported for moisture contents up to 30 percent, at temperatures of 23° C, 0° C, and —70° C over the frequency range 0.75 to 96 kilocycles. Dielectric constants of fibers determined on dry material at 3 kilocycles and 22° C are: chrome 5.4; vegetable 6.4; and kangaroo tendon 5.1. Apparent direct-current resistivity decreases from values $>10^{16}$ ohms when dry to values $<10^{9}$ ohms at 30-percent moisture. Apparent dielectric constant decreases with frequency and temperature at all moisture contents, the frequency dependence increasing with moisture content. Apparent power factors generally exhibit similar behavior. At —70° C at high moisture contents, a diffuse absorption maximum observed may be due to ice or to permanent dipoles of collagen which are freed by moisture. Observed behavior is interpreted as probably arising from a combination of interfacial polarization at surfaces existing in the fibrous leather and dipolar polarization. Results indicate electrical measurements in this frequency range are probably not reliable for precise quantitative moisture analyses. 11 p.

RP2323. Synthesis of mica.........Alvin Van Valkenburg and Robert G. Pike

A synthetic fluorophlogopite mica ($KMg_3AlSi_3O^{10}F_2$), in which the (OH) ions that are normally found in normal micas were completely replaced by fluorine, has been synthesized. This material has essentially the same physical and electrical properties as natural phlogopite mica, except with somewhat lower flexibility. To grow large, usable sheets of mica, it is necessary to obtain preferred crystal orientation, which depends primarily on controlled thermal gradients, batch composition, and rate of cooling. Platinum crucibles were found to be the best material for holding the batch during the melt. Data on the physical, electrical, thermal, and chemical properties of the synthetic mica are given. 10 p.

RP2324. pH response of nonhygroscopic glasses.........Richard G. Goldman and Donald Hubbard

Electrodes prepared from glasses of low hygroscopicity, high electrical resistance, and unsatisfactory pH response in aqueous solutions have been investigated in an effort to determine if their failure to develop the full pH response is due merely to a lack of sensitivity of the indicating instrument or to a real failure of these glasses to respond to hydrogen-ion activity. By increasing the sensitivity of the indicating instrument and decreasing the thickness of the electrode membrane in order to lower the electrical resistance, many of these glasses have been shown to develop the full pH response of 59 millivolts per pH at 25° C. However, theoretical and experimental evidence indicates that glasses below a limiting hygroscopicity probably do not develop full pH response regardless of the thickness of the glass membrane, the resistance of the electrode, or the sensitivity of the indicating instrument. In fact, glass electrodes for which the thickness, electric resistance, and surface are retained essentially unaltered throughout the experiments exhibit large departures from the hydrogen electrode upon the progressive removal of water. 7 p.

RP2325. Wavelengths of rotational lines in the water-vapor bands at 0.93 and 1.13 microns...C. C. Kiess

The infrared water-vapor bands at 0.93 and 1.13 microns have been photographed with the grating spectrographs of the National Bureau of Standards. These bands appear in absorption in the continuous spectrum of white-light sources, part or all of the optical path being in air. They appear also in emission in the spectra of flames containing hydrogen and oxygen compounds. In relatively short light-paths, the rotational lines of these bands are sharp and show little or no tendency toward diffuseness, even in air for which the relative humidity is 90 percent. Their wavelengths may be measured with accuracy on high-dispersion spectrograms. Wavelengths, estimated intensities, and wave numbers, as derived from the spectrograms, are presented. The wavelengths are recommended for use in calibrating infrared spectrometers. 4 p.

RP2326. Comparative strengths of four organic bases in benzene
Marion Maclean Davis and Hannah B. Hetzer

Spectrophotometric studies have shown that the reaction of the base 1,3-di-*o*-tolyguanidine with the acidic indicator dye bromophthalein magenta E (tetrabromophenolphthalein ethyl ester) in benzene at 25° C, like the reactions of 1,3-diphenylguanidine and 1,2,3-triphenylguanidine with the same indicator, can be represented by the following two equations:

$$\underset{\text{(colorless base)}}{B} + \underset{\text{(yellow acid)}}{HA} \qquad \underset{\text{(magenta salt)}}{BH^{+}\cdot A^{-}}$$

$$BH^{+}\cdot A^{-} + B \rightleftharpoons \underset{\text{(blue salt)}}{(BHB)^{+}A^{-}}$$

For ditolylguanidine, the equilibrium constants K_1 and K_2 for the first and second reactions, respectively, are estimated to be 1.1×10^6 and 6.4. These values are compared with values for K_1 and K_2 previously found for di- and triphenylguanidine and the value of K_1 found for triethylamine.

The values for K_1, which measure the relative tendencies of the bases to form salts with the indicator acid in benzene, would be expected to parallel the ionic dissociation constants of the bases in water. However, the parallelism is not good. Diphenylguanidine and ditolylguanidine, which are presumed to be weaker bases in water than triethylamine, are much more reactive in benzene. The results demonstrate how misleading the aqueous dissociation constants may be as a gage of the relative reactivities of bases in a nonaqueous solvent such as benzene. Steric and solvation effects are discussed. 11 p.

RP2327. The $3_{\nu3}$ bands of carbon disulfide and carbon dioxide
Norman M. Gailar and Earle K. Plyler

The $3_{\nu3}$ bands of carbon disulfide and carbon dioxide are described. This band of CS_2 is complex, containing two transitions from excited states and two transitions attributed to the isotopic molecule $CS^{32}S^{34}$ in addition to the primary transition 000→003 of CS_2^{32}. A multiple-reflection cell of 6-meter path length, 20-cm optics, and negligible loss of aperture is described. Molecular constants are checked for CO_2 and found for CS_2. These latter constants are $B_0=0.1089$ cm$^{-1}\pm0.0004$, $\alpha_3=0.0007$ cm$^{-1}\pm0.00003$, $X_{33}=-5.2$ cm^{-1}, and $X_{23}=-3.3$ cm^{-1}. 3 p.

RP2328. On Cauchy-Riemann equations in higher dimensions.......E. Stiefel

The *n* linear partial differential equation with constant complex coefficients

$$1j=\sum_{iu}^{n} a_{jk}^{\ 1}\frac{\delta u_k}{\delta x_\iota}=0,$$

($j=1, \ldots, n$) are said to form a system of generalized Cauchy-Riemann equations, if there exist constants f_{jk} such that

$$\Delta u_j=\sum_{h,k}^{n} f_{jk}^{\ h}\frac{\delta 1_k}{\delta x_h}$$

It is proved that such systems exist for $n=1,2,4,8$ only. In the cases $n=2,4$

there are three essentially inequivalent systems; $n=8$, only two. If the coefficients are required to be real, there exist only the classic system of two equations, the two systems of Dirac-Fueter equation, and two systems of eight equations. 4 p.

RP2329. Effect of strain-temperature history on the flow and fracture of ingot iron at low temperatures......................Glenn W. Geil and Nesbit L. Carwile

The effect of the strain-temperature history of ingot iron on the true stress-strain relationship for tensile specimens extended at temperatures ranging from —196° to +100° C is reported. Specimens of ingot iron in various initial conditions were extended to a specified strain at a selected temperature and subsequently extended to fracture at a different temperature. The deviation of the true stress-strain values for the second stage of these tests from corresponding values for a single-stage test generally increase at a decreasing rate as the prestrain of the specimen increases.

The "rheotropic embrittlement" and work hardening (strain hardening plus strain aging) vary with the heat treatment and prestrain history of the ingot iron. The brittleness at or below —78° C of normalized or hot-rolled ingot iron is partially curable by prestraining in tension at room temperature. However, prestraining in tension of annealed ingot iron at room temperature decreases the ductility retained at —154° and —196° C. The predominance of strain aging at the higher temperatures and strain hardening at the lower temperatures causes the total work hardening of the specimen during deformation to maximum load to increase as the test temperature is either increased or decreased from about —120° C. 8 p.

RP2330. Gradient methods in the solution of systems of linear equations Marvin L. Stein

The results of various experiments with iterative methods for solving systems of linear algebraic equations are discussed. Modifications of the optimum gradient method are compared, and the rather interesting self-acceleration properties of a class of methods here named "almost optimum" gradient methods are pointed out. 7 p.

RP2331. An alkaline solution of potassium chromate as a transmittancy standard in the ultraviolet............................G. W. Haupt

The need for a means of testing the reliability of the photometric scale of spectrophotometers in the ultraviolet region (where glasses are unsuitable) has led to the study of an aqueous solution of potassium chromate having the composition 0.0400 g/liter of K_2CrO_4 in 0.05 N KOH. Based on extensive measurements, using photographic, photoelectric, and visual spectrophotometry, standard values of special transmittancy have been determined for 1.000 and 2.000 cm of solution at 25° C from 220 and 500 mμ. These values have been tabulated along with derived values of absorbancy, molar absorbance index a_M, and $\log_{10}a_M$. The latter values have been compared graphically with those of other observers. Changes in spectral transmittancy with changes in temperature have been determined. The work has also included a study of the effects due to the container bottle and to age of solutions over periods up to 8 years, and a comparison of results obtained with the solution prepared either from K_2CrO_4 or from $K_2Cr_2O_7$ as one of the reagents. 10 p.

RP2332. Two applications of group characters to the solution of boundary-value problems..E. Stiefel

It is shown that the numerical work involved in solving a boundary-value or eigenvalue problem by finite difference methods in a domain with many symmetries can often be reduced by applying the theory of group characters to the group of symmetries of the domain.

In the second part the author considers the problem of solving $\Delta u=0$ in a cube when the prescribed boundary values are invariant under the group of rotations of the cube. In the series representation of the solution in terms of harmonic polynomials only a subset of these polynomials actually occurs, and the theory of group characters facilitates considerably the determination of this subset. 4 p.

RP2333. Heterogeneous equilibria at the glass electrode-solution-interface
Donald Hubbard and Richard G. Goldman

Heterogeneous equilibria at the glass-solution interface were investigated in connection with the pH response of glasses. The preferential leaching of alkali and other cations from the glass surface by acid aqueous solutions, leaving a silica-rich layer to act as a nonmigratable negatively charged ion, causing an uneven distribution of the migratable ions of the system in accordance with the dictates of the Donnan membrane equilibria and the "equation of products." The uneven distribution of $Ag(NH_3)_2^+$, and Br^- ions for various experimental conditions was readily followed potentiometrically for Corning 015, a series of Na_2O-CaO-SiO_2, and a series of Na_2O-SiO_2 glasses. The Donnan membrane theory is compatible with the various experimentally observed phenomena such as the swelling of the glass surface, repression of swelling by high concentrations of electrolytes, voltage departures in alkaline and hydrofluoric-acid solutions, voltage departures in the "superacid" region, and asymmetry potentials. However, the Donnan membrane considerations do not account for the preferential voltage response of the glass electrode to hydrogen ions with a complete or partial exclusion of other ions. 10 p.

RP2334. Preparation of D-mannitol-C^{14} and its conversion to D-fructose-1-(and 6)-C^{14} by acetobacter suboxydans............Horace S. Isbell and J. V. Karabinos

Methods are described for the production of D-mannitol-1-C^{14} and D-fructose-1-(and 6)-C^{14}. These materials are powerful new tools for research in biology and chemistry. D-Mannitol-1-C^{14} was prepared in 80-percent yield from D-mannono-γ-lactone. D-Fructose-1-(and 6)-C^{14} was produced in 54-percent yield by growth of Acetobacter suboxydans on a D-Mannitol-1-C^{14} substrate. 8 p.

RP2335. Analysis of goniophotometric reflection curves.....Isadore Nimeroff

Surface appearance, apart from texture, is defined by the goniophotometric curve giving the angular distribution of the reflected light, but a summary of current goniophotometric techniques shows that essential parts of these fundamental data have been neglected. An established method of statistics is applied to the problem of goniophotometric-curve analysis and interpretation whereby such data are reduced to dispersion, skewness, and kurtosis indexes. The kurtosis index is shown to correlate better with subjective estimates of the distinctness of the reflected images than the conventional measure, 60° specular gloss. The kurtosis index is applied to one problem in the selection of optimum glossmeter geometry. 8 p.

TITLE PAGE AND CONTENTS TO VOLUME 48, 6 P.

RP2336. Fine structure in some infrared bands of methylene halides
Earle K. Plyler and W. S. Benedict

The infrared absorption spectra of methylene chloride, methylene bromochloride, and methylene bromide have been studied with a high-resolution grating spectrometer in the region from 1.6 to 2.3 microns. The purpose of these measurements was to determine the molecular constants of these molecules from their spectra. Using the saturated vapor in a cell 60 centimeters long, it was possible to resolve the fine structure in three to five bands of each molecule. All the resolved bands are overtones and combinations of fundamental vibrations localized in the methylene radical, and hence appear at nearly the same frequencies for each molecule. Bands with Q branches (symmetry types B and C) and without that feature appear. Application of combination relations to all bands of a given molecule yield rotational spacings of the ground state agreeing within 0.5 percent. The spacings, $[A''-(B''+C'')/2]$, are, respectively, for CH_2Cl_2, 0.955 cm^{-1}; CH_2BrCl, 0.898 cm^{-1}; and CH_2Br_2, 0.821 cm^{-1}.

The molecular dimensions cannot be uniquely determined from these data alone, but if tetrahedral angles are assumed, they lead to improbably low values of the C—halogen distance, namely, 1.70 A for C—Cl and 1.83 A for C—Br. If the halogen—C—halogen angle is increased to 112°, as found by electron diffraction, the C—Cl distance is in good agreement with the electron diffraction distance 1.766 A, and C—Br becomes 1.907 A in CH_2Br_2 and 1.911 in CH_2BrCl. 6 p.

RP2337. Overlapping dissociation constants of 4,4′-diaminobenzophenone from spectral-absorbancy measurements....Elizabeth E. Sager and Iris J. Siewers

Dissociation constants and related thermodynamic quantities can be calculated directly from spectral-absorbancy measurements and known hydrogen-ion concentrations, when the compound, whether base or acid, has only one group capable of accepting or donating a proton. When two groups are present, one may also calculate the constants of the reaction directly if the ratio of the two constants is large, that is, if the pK values are separated by several units. If the two reactions closely overlap, the ratio is small, and a complicated series of approximations is necessary.

An example of the latter type of reaction is the overlapping dissociation of the ions of 4,4′-diaminobenzophenone. The spectral-absorbancy curves of the undissociated and of the completely dissociated species can be obtained experimentally. The spectral curve representing the one-group dissociated species cannot be measured. The bands of the three species are superimposed upon one another and, during the overlapping reactions, each of the three species contributes to the observed absorbancy values. Using a series of solutions with very small differences in hydrogen-ion concentrations, the two constants were first calculated from measurements at the very beginning and at the very end of the reactions. Equations were developed, using the constants, activity-coefficient terms following the simple Debye-Hückel relationships for the first constant, and the hydrogen-ion concentrations, to determine the relative amounts of each species at any stage during the dissociation. The validity of the method was proved by its application to all intermediate data where the two reactions overlap. The agreement of the calculated sums of absorbancy with the observed values is well within experimental error. The method will be useful for many substances where electromotive-force methods cannot be applied. 6 p.

RP2338. Calibrating wavelengths in the region from 0.6 to 2.6 microns
Nicolo Acquista and Earle K. Plyler

The wavelengths of twenty absorption bands have been measured on a grating spectrometer in the region from 0.6 to 2.6 microns. Also, several emission lines of krypton have been measured in the near infrared region. The purpose of this investigation was to make available additional calibration points for prism instruments.

The bands which were selected for calibration are parts of the absorption spectra of didymium glass, carbon disulfide, 1,2,4-trichlorobenzene, carbon disulfide, and polystyrene. Five graphs of the measured spectra are included, and the calibrated wavelengths are marked on the bands in order to facilitate identification. 4 p.

RP2339. Long-tube method for field determination of sound-absorption coefficients........Earle Jones, Seymour Edelman, and Albert London

A method has been developed that makes it possible to measure the sound-absorption coefficient of acoustic materials that have been installed. The method uses a portable version of the familiar impedance tube, in which measurements on the standing sound-wave pattern are used to obtain the sound-absorption coefficient for normally incident sound. The sound-absorption coefficient for randomly incident sound may be determined from the tube measurements by reference to an extensive table given in the paper. The tube is coupled to the acoustic material without defacing its surface so that the test is nondestructive. It is useful for acceptance testing; the determination of the effects of aging, staining, and redecoration of acoustic materials; and for quality-control purposes in the manufacture of acoustic materials. The results of laboratory measurements on a large number of acoustic tiles and plasters were compared with the results obtained with the standard reverberation-room techniques. Field measurements were made on acoustic plasters. Large variations in the absorption coefficient were observed and ascribed to faulty application and painting procedures. Measurements were made at 512 cycles per second only. 4 p.

RP2340. Refractive uniformity of a borosilicate glass after different annealing treatments
Leroy W. Tilton, Fred W. Rosberry, and Florence T. Badger

In order to investigate claims that only low holding temperatures are adequate when annealing optical glass for a highly homogeneous product, interferometric tests were made on ten 2-inch cubes of borosilicate glass after an annealing at 515° C, and then the tests were repeated after the cubes were reannealed, five at 490° and five at 530° C. For each of three presentations of the cubes with respect to light paths, contours of differences in refractive index were drawn at intervals of 5×10^{-7}. It was found that index variations seldom exceeded $\pm1\times10^{-6}$ in this annealed glass. From analyses of the data, it was concluded that there need be little, if any, difference in degree of homogeneity, even if the holding temperature during annealing is 30 or 40° C above the lowest feasible value. 12 p.

RP2341. Solution of systems of linear equations by minimized iterations
Cornelius Lanczos

A simple algorithm is described which is well adapted to the effective solution of large systems of linear algebraic equations by a succession of well-convergent approximations. 21 p.

RP2342. Heats of hydration and pozzolan content of portland-pozzolan cements
Edwin S. Newman and Lansing S. Wells

Methods are described for the measurement of the approximate heat of solution in acid of portland-cement-pozzolan mixtures. Examples are given of the estimation of the heat of hydration of portland-pozzolan cements. Determinations of the amount of material undissolved in the calorimeter, as well as the heats of solution, were applied to the problem of determining the composition of mixtures of portland cement and pozzolan. Data are presented for the calculation of the heat capacity of the vacuum-flask calorimeter with amounts of hydrofluoric acid other than the 8-milliliter quantity used in measuring the heat of hydration of portland cement by the standard method. 6 p.

RP2343. Infrared properties of cesium bromide prisms
Earle K. Plyler and Nicolo Acquista

A prism of cesium bromide has been installed in a Perkins-Elmer spectrometer, and spectra have been observed in the region from 15 to 38 μ. This prism is of better optical quality than those of KRS–5, which makes it possible to obtain sharp images at the second slit of the spectrometer. Measurements have been made with this cesium bromide prism, which has a refracting angle of 55°, and the results have been compared with those obtained with a 26° KRS–5 prism. The dispersion of cesium bromide from 15 to 38 μ is about equal to KRS–5, but the effective resolution is about twice as great. A group of rotational lines of water vapor at 28.4 μ is now clearly resolved into three components, the two narrow ones being separated by 1.8 cm^{-1}. The long wavelength bands of carbon disulfide and chloroform have been measured in the vapor state, and it is possible, with the good definition available, to observe the *P*, Q, and *R* branches. In the spectral region beyond 33 μ, the stray radiation produces a considerable amount of the total deflection. The stray radiation was reduced to one-tenth of its value by the use of a roughened silver mirror located in the source box of the spectrometer. 3 p.

RP2344. Titanium dioxide rectifiers......R. G. Breckenridge and W. R. Hosler

A new type of metal rectifier is described which utilizes a film of semiconducting titanium dioxide produced on titanium metal. These rectifiers, which have been prepared either by a two-step process involving a heating of the metal in oxygen followed by a reduction of the oxide in hydrogen or by a single heating of the metal in water vapor, are shown to have properties comparing favorably with existing types, particularly for high temperature applications. The properties of the units in regard to the nature of the counter electrode, and relation to theories of rectification are discussed. 8 p.

RP2345. Infrared spectra of noble gases (12000 to 19000 A)
Curtis J. Humphreys and Henry J. Kostkowski

The first spectra of helium, neon, argon, krypton, and xenon, excited by discharges in Geissler tubes, operated by direct connection to a transformer, have been explored in the infrared (12000 to 19000 A). A high-resolution, automatically recording, infrared spectrometer, employing a 15000-lines-per-inch grating and lead-sulfide photoconducting detector, was used as the dispersing instrument. A new set of wavelength values is reported for all these spectra. New data include 18 previously unreported lines of neon and 36 of krypton, all of which have been classified. The descriptions of the spectra of argon, krypton, and xenon represent essentially a repetition of the observations of Sittner and Peck. Several previously missing classifications are supplied, also a few amended interpretations. The analysis of these spectra may be regarded as complete. Use of selected lines as wavelength standards is suggested. 12 p.

RP2346. A viscometric study of the micelles of sodium dodecyl sulfate in dilute solutions
Lawrence M. Kushner, Blanton C. Duncan, and James I. Hoffman

The viscosities of solutions of sodium dodecyl sulfate of concentrations up to 0.8 percent in distilled water and in 0.01- to 0.12-*M* sodium chloride have been measured. By introducing the concept of a monomer saturation concentration it is possible to determine the intrinsic viscosity of the micelles at each concentration of sodium chloride. A method for the experimental determination of the monomer saturation concentration is presented. The dependence of the intrinsic viscosity on the salt concentration is discussed in terms of electroviscous and hydration effects. The data indicate the presence of spherical micelles in the solutions investigated. 6 p.

RP2347. Absorption spectrum of water vapor between 4.5 and 13 microns
W. S. Benedict, H. H. Claassen, and J. H. Shaw

The absorption spectrum of water vapor has been measured from 4.5 to 13 microns with a 3,600 line per inch replica echelette grating as the dispersing element. Various absorbing path lengths and concentrations of water vapor at atmospheric pressure were used up to 8 meters of steam near 110° C. Almost all of the previously unreported lines that have been found are also present in the solar spectrum. A rotational analysis shows that most of the lines can be assigned either to rotational transitions or to rotation-vibration transitions of the ν_2 fundamental of the water-vapor molecule. In addition, a few lines have also been assigned to the transitions $(2\nu_2-\nu_2)$, $(\nu_1-\nu_2)$, and $(\nu_3-\nu_2)$. 42 p.

RP2348. On calculating the zeros of polynomials by the method of Lucas
Herbert E. Salzer

When $f(x)$ is a polynomial of degree n and x_i, $i=0, 1, \ldots, n$, are any $n+1$ points at which $f(x_i)\neq 0$, the zeros of $f(x)$ are known to be identical with the zeros of $\Sigma a_i/(x-x_i)$, where $a_i=f(x_i)/\Pi'\ (x_i-x_i)$. Lucas proposed this principle for use in an electric analogue device for finding zeros. The present note evaluates this principle in digital comptuation for both real and complex zeros when the coefficients of $f(x)$ are given exactly (integral or rational) so that the zeros of $f(x)$

are identical with the zeros of $\Sigma A_i/(x-i)$, A_i integral. The chief advantages are (1) the saving of labor in tabulating $\Sigma A_i/(x-i)$ instead of $f(x)$ in the neighborhood of the zero, especially for complex zeros, and (2) somewhat less work in the inverse interpolation for the zero. Three examples in locating a real root, and one example in locating a complex root were worked out in support of these findings. 2 p.

RP2349. Effect of moisture on compressibility of natural high polymers
C. E. Weir

Studies are reported of the effect of sorbed moisture on compressibilities of leather, cellulose, wool, and silk fibroin. The general behavior of all materials is similar. For low moisture contents, compressibility is essentially independent of moisture content. For high moisture contents, compressibility increases markedly. It is suggested that these data are consistent with the concept that moisture exists in hydrogen bonded form at low and as liquid water at high moisture contents. Empirical compression equations are: for dry wool, $-\Delta V/V_0=1.37\times10^{-5}\ (P-2000)-6.79\times10^{-10}\ (P-2000)^2+1.55\times10^{-14}\ (P-2000)^3$; for dry silk fibroin $-\Delta V/V_0=1.24\times10^{-5}\ (P-2000)-7.00\times10^{-10}\ (P-2000)^2+2.68\times10^{-14}\ (P-2000)^3$, where P is expressed in atmospheres. 5 p.

RP2350. Thermodynamics of some simple sulfur-containing molecules
William H. Evans and Donald D. Wagman

The thermodynamic functions $(F^\circ-H_0^\circ)/T$, $(H^\circ-H_0^\circ)/T$, S° $(H^\circ-H_0^\circ)$, and C_p° are calculated to high temperatures for gaseous sulfur (monatomic and diatomic), sulfur monoxide, sulfur dioxide, sulfur trioxide, and hydrogen sulfide from molecular and spectroscopic data. Values of the heats of formation of the various atomic and molecular species are selected from published experimental data, and certain industrially important equilibria are calculated. 8 p.

RP2351. A correlation of polarized light extinctions with crystal orientation in 70 nickel-30 copper alloy............................H. C. Vacher

After etching 70 nickel-30 copper alloy to produce an optically anisotropic surface, the orientations of 12 crystals were determined by the twin-boundary method, and the positions of polarized light extinctions (obtained at normal incidence with crossed nicols) were measured. A comparison of the orientations with the positions of the extinctions showed that one was near the cubic pole farthest from the surface normal. Little or no extinction was obtained when a (100) or (111) plane was nearly parallel to the surface. Study of the results indicated that the optical anisotropy probably was caused by parallel furrows formed by the tendency of the etching reagent to develop etch pits whose facets were parallel to cubic planes. 5 p.

RP2352. Magnesium-rich side of the magnesium-zirconium constitution diagram
J. H. Schaum and H. C. Burnett

The magnesium-rich side of the magnesium-zirconium constitution diagram has been studied for the purpose of improving the previous work on this subject. A diagram has been developed that is similar in form to that found by previous investigators, but the phase boundaries differ as to temperatures and alloy compositions. The peritectic reaction was found to take place at 654° C, beginning at 0.58 percent of zirconium. 8 p.

RP2353. A study of the diphenylamine test for aliphatic nitrocompounds
Kivi Grebber and J. V. Karabinos

A study has been made of the diphenylamine test for aliphatic nitrocompounds. It is not given by all nitroparaffins. However, the test is at least a thousand times more sensitive than previously supposed. Structural factors are discussed.

Spectroscopic measurements indicate that the blue color in the diphenylamine test with nitrosating agents is similar to that produced by oxidizing agents. It is probably caused by colored phenazine and benzidine derivatives. A possible free radical mechanism for the reactions involved is presented. 4 p.

RP2354. Influence of prior strain history on the tensile properties and structures of high-purity copper....William D. Jenkins and Thomas G. Digges

Tensile tests were made at room temperature on oxygen-free high-conductivity (OFHC) copper initially as annealed, as cold-drawn different amounts, and as prestrained in creep at 110°, 250°, and 300° F.

The shape of the true stress-strain curves obtained on copper cold-drawn 34-, 40-, and 70-percent reduction in area indicate a strain aging effect in the specimens when subjected to stresses in the vicinity of the maximum load. This phenomenon of strain aging is usually more closely associated with alloys of the ferrous type than with a high-purity nonferrous metal. The present results show that the strength, ductility, and hardness of the copper is markedly affected by its prior strain history. The test conditions are correlated with the tensile properties, hardness, necking characteristics, formation of microcracks, and substructures. 20 p.

RP2355. A description of the arc and spark spectra of rhenium
William F. Meggers

For purposes of chemical identification and of structural analysis, a more complete and accurate description of the atomic emission spectra of rhenium was required. Such a description was obtained by using solid metal electrodes of rhenium in conventional arcs or sparks, photographing the spectra with the aid of large spectrographs containing concave gratings, and measuring the wavelengths of spectral lines relative to secondary standards in the spectrum of iron. Relative intensities were carefully estimated for all lines, and the total widths of many broad lines were measured. Results are presented for approximately 6,000 lines ranging in wavelength from 2000.47 A in the ultraviolet to 11788.9 A in the infrared. A comparison of the estimated intensities in arc and spark spectrograms provides a separation of the spectral lines arising from neutral rhenium atoms from those originating in ionized atoms. In this description the Re I spectrum is represented by about 4,200 lines and the Re II spectrum by nearly 1,800 lines. 30 p.

RP2356. Hydraulic resistance effect upon the dam-break functions
Robert F. Dressler

The dam-break solution, a known centered simple-wave when resistance is neglected, is studied with the Chezy resistance formula added to the nonlinear shallow-water equations. Resistance transforms the wavefront from a characteristic curve into an envelope of characteristics. The flow near the tip differs from the other parts, due to a distinct boundary-layer type of region adjacent to the wavefront envelope. Then a perturbation leads to a system of partial differential equations with variable coefficients. Initial conditions are derived for the singularity at the origin. By studying its characteristic equations, this system is solved explicity for the correction functions. Except at the tip, resistance raises the water surface and lowers velocities. These functions, no longer simple-waves, possess concurrent straight characteristic lines that map into another set of the same type. The critical flow locus moves downstream, faster for more resistance, and discharge rates are reduced. The method fails in the tip layer because the asymptotic expansions for the first derivatives lose validity there. Estimates are made indirectly for the wavefront velocity by observing where the boundary-layer effect becomes predominant. 9 p.

RP2357. Ultraviolet radiant energy from the sun observed at 11,190 feet
Ralph Stair

This paper gives the results of some measurements on the ultraviolet and short wavelength visible spectral energy distribution of direct solar radiation, made in September 1951, at Climax, Colo., altitude 11,190 feet. Data are given for wavelengths extending from 535 to 299.5 millimicrons for a number of air masses from 0 to 3.0. A determination of atmospheric transmittance as a function of wavelength results in calculated amounts of ozone approximating 0.21 centimeter (*ntp*) for several days during September. This value is in good agreement with previous determinations by other methods, for the season of the year and the geographical latitude of Climax. 8 p.

RP2358. Mass spectra of the tetramethyl compounds of carbon silicon, germanium, tin, and lead. . . . . Vernon H. Dibeler

Mass spectra of $C(CH_3)_4$, $Si(CH_3)_4$, $Ge(CH_3)_4$, $Sn(CH_3)_4$, and $Pb(CH_3)_4$ were obtained with a Consolidated 21-103 mass spectrometer. Isotopic abundances of carbon, silicon, germanium, tin, and lead were obtained from the observed spectra and used to calculate the monoisotopic spectra. The mass spectra of the Group IV tetramethyls are qualitatively similar. The principal ion in each case results from the dissociation of one methyl group. The molecule ion and ions resulting from the dissociation of hydrogen atoms are rare. Hydrides of the atom ions and the mono-, di-, and tri-methyl ions were observed. Some evidence is pointed out for the possible formation of the CH_3^+ ion and the $C_2H_5^+$ ion in neopentane as hydrides of the central carbon atom. 5 p.

RP2359. Determination of planeness and bending of optical flats
Walter B. Emerson

The true contours, undistorted by gravitational bending, were determined for four 10⅝-inch-diameter standard optical flats of fused quartz. The bending deflections of these flats were determined by a method based upon the differential bending with thickness of the flats. Bending deflection curves of a flat supported at three points equidistant from the center of the flat and equidistant from each other were obtained. The locus of the bending deflections at the center of a flat, similarly supported but with supports at different distances from the center, approximates a straight line. This paper describes the method used to obtain the true contours and the bending deflection curves of the flats, and compares the bending values so determined with theoretically derived values. 7 p.

RP2360. Index of refraction of magnesium oxide
Robert E. Stephens and Irving H. Malitson

The index of refraction of magnesium oxide crystal has been measured for wavelengths from 0.36 to 5.35 microns. In the visible region, measurements were made at three temperatures, close to 20°, 30°, and 40° C. Thermal coefficients were computed for this range of temperatures for nine wavelengths. 4 p.

RP2361. Refractivity of potassium bromide for visible wavelengths
Robert J. Spindler and William S. Rodney

Values of the index of refraction of potassium bromide were determined independently on two high-precision spectrometers by the method of minimum deviation for 11 spectral lines at temperatures near 17°, 24°, and 27° C. The instruments are described, and the methods used in obtaining results valid in the sixth decimal place of index are discussed. Temperature coefficients of index were determined, and a small linear variation was found with respect to wavelength. With the values of dn/dt so obtained, the experimental data were reduced to a common temperature, averaged, and a four-constant Ketteler-Helmholtz dispersion equation fitted to the data and adjusted by least squares. The refractive indices of potassium bromide for the particular prism used are intermediate between the values reported by Harting and Forrest. Reduced to 23° C for comparison, the results for sodium light are Harting, 1.55983; National Bureau of Standards, 1.55978; and Forrest, 1.55971. Another prism measured at NBS yielded 1.55983, and an obviously defective prism gave 1.55889. Small differences in dispersion were also detected. 10 p.

RP2362. On approximate solutions of systems of linear inequalities
Alan J. Hoffman

Let $Ax \leqq b$ be a consistent system of linear inequalities. The principal result is a quantitative formulation of the fact that if x "almost" satisfies the inequalities, then x is "close" to a solution. It is further shown how it is possible in certain cases to estimate the size of the vector joining x to the nearest solution from the magnitude of the positive coordinates of $Ax-b$. 3 p.

RP2363. Deuterium and hydrogen electrode characteristics of lithia-silica glasses
Donald Hubbard and Given W. Cleek

The pH and pD responses of a series of lithia-silica glasses have been investigated and compared with the hygroscopicity, deuteroscopicity, and chemical durability of the glasses in aqueous and deuterium oxide buffers. The curves for pH and pD response as a function of composition pass through an optimum electrode response that is limited on the low percentage of silica end by poor chemical durability and a strong tendency to devitrify upon reheating the glasses for the purpose of blowing the electrodes. The optimum also falls off on the high-silica end where opalescence appears and the hygro- and deuteroscopicities decrease.

The pH and pD response, hygroscopicity, and deuteroscopicity, as well as the chemical durability in aqueous and deuterium oxide solutions, appear to reflect some of the critical features of the Li_2O-SiO_2 phase equilibrium diagram, with the optimum electrode response occurring in the composition range in which tridymite is the primary phase.

Indices of refraction and expansion data for these Li_2O-SiO_2 glasses exhibit breaks at the same compositions indicated by the physicochemical properties. 6 p.

RP2364. Calorimetric properties of polytetrafluoroethylene (teflon) from 0° to 365° K
George T. Furukawa, Robert E. McCoskey, and Gerard J. King

The thermal properties of polytetrafluoroethylene (teflon) samples were investigated, using an adiabatic-vacuum calorimeter. The effect of the annealing and quenching processes on the heat capacity of a molded Teflon sample was studied. The heat-capacity data were used to compute the heat capacity, enthalpy, and entropy of the polymer samples at 5-deg intervals from 0° to 365° K. The heat-capacity results with the molded, annealed, and quenched samples of Teflon show the possibility of a glass transformation at about 160° K. The lack of a more definite glass-transformation effect is attributed to inter- and intramolecular hindrances to configurational changes in the Teflon polymer. The existence of first-order transitions at 293° and 303° K, previously reported by Quinn, Roberts, and Work, was confirmed. 6 p.

RP2365. Analytical and experimental studies with idealized gas turbine combustors....................Fillmer W. Ruegg and Howard J. Klug

Problems of flow, heat release, and mixing in gas turbine combustion chambers are discussed and analyzed. The analysis is based on an idealized or equivalent chamber in which the end result is the same as in the conventional chamber, but in which the functions are separate and distinct. A large primary zone is advantageous, but the combustion process still is burdened by an inverse relationship between primary air and fuel. Conditions favorable to combustion in the primary zone over the whole range of operation are realized by means of a mechanical control. Agreement between analysis and experiment was demonstrated by tests of a chamber with a mechanical control. Comparison of the field of mixing of primary flame gas and secondary air with other studies of mixing revealed a general similarity, but a slower rate of mixing that is ascribed to the effects of a large difference of temperature or density in these experiments. 20 p.

RP2366. Corrosion of galvanized steel in soils...........Irving A. Denison and Melvin Romanoff

The results of measurements of the corrosion of galvanized steel and of bare steel and zinc as reference materials after exposure to different soil conditions for a maximum of 13 years are reported. The magnitude and progress of corrosion of galvanized steel as determined by weight loss and pitting is interpreted in terms of the environmental conditions to which the specimens were exposed. From analysis of data on the corrosion of galvanized specimens having different weights of coating, minimum coating requirements for different environmental conditions are suggested. 16 p.

RP2367. Corrosion of low-alloy irons and steels in soils..Irving A. Denison and Melvin Romanoff

The results of measurements of the corrosion of 10 low-alloy irons and steels exposed to 14 soils for periods up to 13 years are given. The magnitude and progress of corrosion as determined by weight-loss and pit-depth measurements are correlated with the composition of the materials and the nature of the environmental conditions to which the test specimens were exposed. 10 p.

RP2368. Loading of quartz oscillator plates . . . . Leland T. Sogn and
Philip A. Simpson

The effects of physically loading the surface of two types of piezoelectric quartz oscillator plates have been experimentally investigated. Various amounts of Wood's metal were applied to different parts of the crystal surfaces. Thickness-shear-mode plates were benefited only when the metal was applied on or near the active central area of the plate, but X-cut crystals employing an extensional mode of vibration responded favorably only when the metal was applied near the periphery of the plate.

In both types of oscillator plates loading increased the crystal unit Q several fold. Activity-frequency characteristics over a temperature range $-60°$ to $+90°$ C were greatly improved. 6 p.

RP2369. Effects of moderate biaxial stretch-forming on tensile and crazing properties of acrylic plastic glazing
B. M. Axilrod, M. A. Sherman, V. Cohen, and I. Wolock

The effects of biaxial stretch-forming to approximately 50-percent strain on the tensile and crazing properties of polymethyl methacrylate were investigated. The materials used were commercial cast polymethyl methacrylate sheets, nominally 0.15 in. thick, of both general-purpose and heat-resistant grades. Portions of the sheets were biaxially stretch-formed by means of a vacuum-forming vessel, which had been designed to produce flat uniformly stretched disks of 10-in. diameter. Specimens from the formed pieces, as well as from the unformed portions of the same sheets, were subjected to various tests, including standard tensile, stress-solvent crazing with benzene, long-time tensile loading, and accelerated weathering.

The results indicate that biaxially stretch-forming polymethyl methacrylate approximately 50 percent does not affect its tensile strength or secant modulus of elasticity in tension. However, the total elongation and the stress and strain at the onset of crazing in the short-time tests were greatly increased by the stretch-forming. The forming also increased the threshold stress of stress crazing about 40 percent for loading times up to 7 days and increased the threshold stress of stress-solvent crazing with benzene about 70 to 80 percent. It was observed in the long-time tensile tests that the crazing cracks were more closely spaced and finer on formed as compared to unformed specimens. 12 p.

RP2370. Mass spectra of fluorocarbons . . Fred L. Mohler, Vernon H. Dibeler, and
R. M. Reese

Mass spectra of 22 fluorocarbons have been measured on a 180° Consolidated mass spectrometer, and the results are presented in six tables of spectral data. These include seven normal paraffins from methane to heptane; isopentane and isohexane; three pure cyclics and methylcyclohexane; four olefins; three C_4F_6 isomers; a dicyclic; and a tricyclic. These spectra are very different from the hydrocarbon analogs. In all the paraffins the most abundant ion is CF_3^+, and the molecule ions are very small or absent. Spectra of the unsaturated compounds and the cyclics are more distinctive than the normal paraffins. In the paraffins, ions of formula C_nF_{2n+1} tend to be largest, except that when one carbon is removed the largest ion is C_nF_{2n-1}. In cyclics, C_nF_{2n-1} ions tend to be largest; in the dicyclic, C_nF_{2n-3} ions are largest; and in the tricyclic, C_nF_{2n-5} ions tend to be largest. The tricyclic C_8F_{12} is probably a fused cyclobutane structure. The dicyclic is completely fluorinated methylnapthalene, $C_{11}F_{20}$, and is the heaviest compound ever run on the Bureau's mass spectrometer. In the perfluoroparaffins there is a progressive increase in the current per unit pressure for the CF_3^+ ion with increasing molecular weight of the fluorocarbon. In incompletely fluorinated molecules containing an H atom the larger ion peaks containing H will correspond with the larger peaks in the perfluoro spectrum, with H substituted for a fluorine atom. 5 p.

RP2371. A method of computing exact inverses of matrices with integer coefficients . . . . J. Barkley Rosser

In theory, the problem of computing the exact inverse of a matrix A with integer coefficients is completely solved by solving exactly the simultaneous equations $Ax=y$, in which both x and y are variable vectors. This solution can be carried out by any one of numerous well-known procedures, resulting in expressions for the components of x as linear combinations of the components of y. The coefficients of these linear combinations are just the components of A^{-1} because we have $x=A^{-1}y$.

In actual practice, if the order of A is at all large, the exact components of A^{-1} will be fractions whose numerator and denominator each have a large number of digits, and the usual methods of solution become extremely laborious due to the necessity for carrying an even larger number of significant digits throughout most of the computation. In the method presented herein, the number of significant digits involved builds up gradually, and only the final stages of the computation involve a large number of digits. Moreover, the method can be readily adapted to use on IBM equipment, and so all but the final stages (in which many significant digits must be carried) can be readily mechanized. 10 p.

RP2372. Effect of water on the induction period of the polymerization of methyl methacrylate...I. C. Schoonover, G. M. Brauer, and W. T. Sweeney

The effect of water in monomer on the length of the induction period of the polymerization of methyl methacrylate was investigated for varying concentrations of water, catalyst, and inhibitor. For the benzoyl peroxide catalyzed polymerization, the induction period is markedly shortened by small quantities of water in the monomer. It is inversely proportional to the water concentration and directly proportional to the hydroquinone content. In the absence of inhibitor it is inversely proportional to the square root of the catalyst concentration. This acceleration effect is caused by the more rapid decomposition of benzoyl peroxide in water-containing monomer, with a subsequent slight increase in free radical concentration, which is sufficient to shorten the induction period. Water in the monomer does not alter appreciably the reaction rate after the induction period. 6 p.

RP2373. Transmittancy of commercial sugar liquors: dependence on concentration of total solids
V. R. Deitz, N. L. Pennington, and H. L. Hoffman, Jr.

The dependence of the transmittancy of a commercial sugar liquor on the concentration of total solids does not in general follow Beer's law. This behavior is attributed to the presence of appreciable light-scattering material in the solution. A linear dependence has been found to relate the concentration with the reciprocal of a^*_c, the latter being defined as equal to $(-\log T_s)/bc$, where T_s is the transmittancy, b the cell length, and c the concentration of total solids. The intercept at $c=0$ in a plot of $1/a^*_c$ versus c is equal in magnitude to the limiting slope of the Beer's law plot. 5 p.

RP2374. Extension of the first spectrum of rhodium (Rh I)....Robert J. Murphy

The arc spectrum of rhodium has been investigated photographically in the region 6300 to 12000 A. The spectrum was excited in conventional direct-current arcs and photographed on infrared sensitive emulsions with the aid of concave diffraction gratings. Wavelengths have been measured for 238 Rh I lines, including 90 new lines, of which 53 have been classified. Two new even levels have been added to the list of known term values; these two new levels account for 18 of the 53 newly classified Rh I lines. 5 p.

RP2375. Heat generation in the setting of magnesium oxychloride cements
Edwin S. Newman, John V. Gilfrich, and Lansing S. Wells

The heats of hardening of magnesium oxychloride pastes and flooring cements were determined by three methods. Two direct methods limited to 18 hours in duration gave heats of hardening of about 190 cal/g of MgO. Temperatures up to 147° C were obtained in the interior of the samples. A heat-of-solution method, applicable only to the pastes, gave 60-day values for the heat of hardening ranging from 135 to 320 cal/g of MgO, depending on the relative concentrations of MgO, $MgCl_2$, and H_2O in the pastes. A sample stored for 4 years gave a heat of hardening of 240 cal/g of MgO, as compared with the 60-day value of 215 cal/g of MgO for a different sample of similar composition. The low heats of hardening, corresponding to high heats of solution, obtained for certain of the pastes support the conclusion that free MgO may remain in such pastes. 7 p.

RP2376. Stiffness of paper.............F. T. Carson and Vernon Worthington

An instrument to determine the stiffness of paper is described. The specimen is bent through a given angle, and the bending moment is measured as the torque in two lengths of piano wire, between which the clamp that holds the specimen is suspended.

Stiffness of paper is defined as the bending moment per unit of width of specimen producing unit curvature. This quantity was evaluated for eight types of paper, for various lengths and widths of specimen, and for bending angles from 5° to 30°. The stiffness value for a given specimen remained substantially constant when the width and bending angle were varied, but increased somewhat as the length of the specimen was increased. 7 p.

RP2377. A convenient small osmometer......G. A. Hanks and S. G. Weissberg

A small, rugged osmometer that is relatively easy to assemble and use is described. Typical data obtained with polystyrene solutions are presented. Performance in comparison with other osmometers is discussed. 4 p.

RP2378. Low even configurations of the first spectrum of molybdenum (Mo I)
Richard E. Trees and Marion M. Harvey

The analysis of the first spectrum of molybdenum has been extended by the classification of approximately 3,000 additional lines arising from combinations including 44 new even levels and 190 new odd levels that have been located. The identification of those levels that belong to the three low even configurations, $4d^4\ 5s^2$, $4d^5\ 5s$, and $4d^6$, is given. Some unpublished levels found earlier by C. C. Kiess are included.

Assignment of the terms to the three low even configurations has been aided by a theoretical calculation. Over-all agreement is very good, as indicated by a mean deviation of ± 168 cm^{-1} between theory and experiment. The calculation is presented in a simplified and detailed form, which may help in applying the theory to future analyses.

The theoretical calculation assumes *LS*-coupling and takes into account the electrostatic interaction between the three configurations. Excellent confirmation of the theory of configuration interaction is obtained because the interaction is very strong in Mo I. Difficulties in assigning a term to a configuration are discussed and tentatively resolved by the use of the calculation.

In the $3d^5\ 4s$ configuration of Fe III, Trees has shown that polarization can be accounted for by an empirical correction proportional to $L(L+1)$. The applicability of this correction in the $4d^5\ 5s$ configuration of Mo I is demonstrated. The correction is only about half as important in Mo I as it is in Fe III, so that Mo I is not well suited for a detailed study of polarization effects. However, the agreement obtained is some confirmation of Racah's assumption that polarization can be treated linearly.

Magnetic interactions are considered briefly in an effort to explain disagreements between theory snd experiment, and to illustrate additional difficulties that arise in the assignment of term designations. 12 p.

RP2379. Methods of conjugate gradients for solving linear systems
Magnus R. Hestenes and Eduard Stiefel

An interative algorithm is given for solving a system $Ax=k$ of n linear equations in n unknowns. The solution is given in n steps. It is shown that this method is a special case of a very general method which also includes Gaussian elimination. These general algorithms are essentially algorithms for finding an n dimensional ellipsoid. Connections are made with the theory of orthogonal polynomials and continued fractions. 28 p.

TITLE PAGE AND CONTENTS TO VOLUME 49, 5 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 50, JANUARY-JUNE 1953

RP2380. The sixth series in the spectrum of atomic hydrogen
Curtis J. Humphreys

The first member of the sixth series ($6h\ ^2H^\circ - 7i\ ^2I$) in the spectrum of atomic hydrogen has been observed at 12.37μ, in agreement with the predicted position. Other newly observed lines include the second line of the Pfund series and the third, fourth, and fifth lines of the Brackett series. The source was a water-cooled discharge tube drawing 640 milliamperes at 5,000 volts. The tube was fitted with a KBr lens, which served also as a window for end-on observation. An atomic-hydrogen discharge was maintained by admitting water vapor through a Hopfield leak and pumping continuously. A conventional dispersing and recording system was used, consisting of a Perkin-Elmer model 12 spectrometer with a d-c breaker amplifier and Speedomax recorder. Relative-intensity measurements are included. 6 p.

RP2381. National Bureau of Standards mobile low-level sounding system
P. D. Lowell, W. Hakkarinen, and D. L. Randall

The National Bureau of Standards Mobile Low-level Sounding System is a combination of an improved wiredsonde and an Army SCM–1A mobile weather station. Its purpose is to measure temperature and moisture distributions and their associated gradients and heights from near the ground up to a maximum height of 2,000 feet over different types of terrain. The system has six distinguishing features: 1. Balloon-level heights can be determined at all times during a flight by data recorded at the ground level by an electric altimeter. 2. Humidity data recorded with this system, which is energized with 60-cycles-per-second alternating current, are reliable for longer periods of time than those obtained by direct-current sounding systems. 3. The system can be operated from within the heated truck body and is suitable for use in dense fog, at night, or during very cold weather. 4. The air-borne unit is of lighter construction because switching and ventilating of the circuit measuring elements are done by a gravity motor instead of a battery-driven motor. 5. The system provides a condition of radio silence during operation. 6. The system is designed to operate into recorders requiring up to 500 microamperes of direct current. The intelligence from the system can therefore be recorded directly on the equipment in a standard radiosonde receptor installation. 11 p.

RP2382. A simple calculation of dielectric loss from dielectric dispersion for polar polymers.......................................Paul Ehrlich

For polar polymers undergoing orientation polarization it is possible to calculate dielectric losses from dielectric constant data by use of a single approximation already familiar from its application to mechanical properties, if this approximation is applied to the real part of the dielectric constant only and if data over a sufficiently wide frequency range are available. Data obtained at frequencies from 10^2 to 10^8 cycles per second for Butvar and for a copolymer of styrene and methyl methacrylate are analyzed and it is found that observed and calculated values of the dielectric losses agree within 10 percent or better. 2 p.

RP2383. Struve function of order three-halves

The Struve function $h_{3/2}(x)$, where $h_\nu(x)=\left(\frac{2\pi}{x}\right)^{1/2} H_\nu(x)$, for $x=0(.02)15$ to ten decimal places. The values are correct to within one unit of the last place. Central differences, modified where necessary, are provided. 9 p.

RP2384. Spectral energy distribution of the International Commission on Illumination light sources A, B, and C
Raymond Davis, Kasson S. Gibson, and Geraldine Walker Haupt

Standard light sources A, B, and C were adopted by the International Commission on Illumination (CIE) in 1931 for the colorimetry of materials. Source A is an incandescent lamp operated at 2,854° K. Sources B and C, representative of average noon sunlight and average daylight, respectively, are produced by passing radiant flux from source A through specified Davis-Gibson filters described in Bureau Miscellaneous Publication M114 (1931).

The CIE published relative energy data only from 370 to 720 mμ. The present paper gives data for these sources in the ultraviolet and extends the data in the red to 780 mμ. The new data were reported through the U. S. Secretariat Committee to the CIE at its 1951 meeting. 7 p.

RP2385. The constants in the equation for atmospheric refractive index at radio frequencies...........Ernest K. Smith, Jr., and Stanley Weintraub

Recent improvements in microwave techniques have resulted in precise measurements at the National Bureau of Standards, the National Physical Laboratory, and elsewhere, which indicate that the conventional constants $K_1=79°$ K/mb and $K_2'=4{,}800°\ K$ in the expression for the refractivity of air, $N=(n-1)10^6=(K_1/T)\ [p+K_2'(e/T)]$ should be revised. Various laboratories appear to have arrived at this conclusion independently, with the result that there are several different sets of constants in current use. In much of propagation work the absolute value of the refractive index of the atmosphere is of small moment. However, in some work it is important, and it seems highly desirable to decide upon a particular set of constants.

Through consideration of the various recent experiments a relation $N=(77.6/T)[p+4810(e/T)]$ is derived, where p is the total pressure, in millibars, e is the partial pressure of water vapor, in millibars, and T is absolute temperature (°C+273). This expression is considered to be good to 0.5 percent in N for frequencies up to 30,000 megacycles and normally encountered ranges of temperature, pressure, and humidity. 3 p.

RP2386. Tables of complete elliptic integrals..............J. M. Hammersley

The complete elliptic integrals

$$K=\int_0^{\pi/2}(1-k^2\sin^2\phi)^{-\frac{1}{2}}d\phi, \qquad E=\int_0^{\pi/2}(1-k^2\sin^2\phi)^{\frac{1}{2}}d\phi$$

and the associated function

$$M=\frac{\pi}{2K}$$

are tabulated for $1/k=1.00(.01)1.30(.02)2.00$ to nine decimal places. The last significant figure is doubtful. 1 p.

RP2387. Assembled polygon for the calibration of angle blocks
Clyde E. Haven and Arthur G. Strang

A method is described for constructing and calibrating an assembled, multiple-sided, angular standard of exceptional accuracy. Although designed as a master for the 30- and 45-degree angle blocks of a series made in this country, the polygon is equally suitable for the test or calibration of circular dividing equipment. Simpler forms may be easily and economically constructed as masters for a variety of applications in the mechanical and optical industries. 6 p.

RP2388. On the spectrum of energy in turbulent shear flow........C. M. Tchen

A turbulent flow with a given spatial pattern of mean motion invariant with time is treated. No solid boundary is considered. By means of the Fourier analysis of the Navier-Stokes equation, it is possible to obtain an equation of energy balance in spectral terms. This involves the following functions: Viscous dissipation, transfer, production, convection, and diffusion. The first two functions are common to the isotropic and homogeneous turbulence without mean motion. Assuming that eddies controlled by inhomogeneity are much larger than those controlled by anisotropy, stationary spectral laws are obtained for small eddies in the viscous and nonviscous ranges. The agreement between theory and experiment is shown. 12 p.

RP2389. Beryllium-uranium system..........................R. W. Buzzard

The phase diagram of the system beryllium-uranium was constructed from data obtained by thermal analysis, metallographic examination and X-ray diffraction. The system is characterized by one intermetallic compound, UBe^{13}, melting at about 2,000° C, a eutectic having a composition of approximately 0.12 weight percent of beryllium, occurring between uranium and UBe^{13}, at 1,090° C, and a monotectic occurring at 1,550° C and 60-weight-percent of beryllium. The solid solubility of beryllium in uranium is slight; no solid solubility of uranium in beryllium was detected. The transformation temperatures of uranium are not affected by additions of beryllium. 5 p.

RP2390. Pulsed light system for multiple-cell ultracentrifuge rotor
M. Wales, P. G. Sulzer, and L. C. Williams

A system for photographing any spot on a moving rotor is described. A pulsed light, triggered by a signal obtained from a small alternator on the rotor shaft, is used. By shifting the phase of the light, any desired location on the rotor may be kept in view. This system is used to record data from an ultracentrifuge having four symmetrically placed cells on the rotor. A scaler-counter circuit is included for speed measurement. 2 p.

RP2391. Damping of elastically supported element in a vacuum tube
S. Levy, E. V. Hobbs, W. D. Kroll, and L. Mordfin

It is shown that it is possible to damp the motion of an element in a vacuum tube by making the tube part of a two-degree-of-freedom system. The equations of motion of this system are presented. The optimum values of the parameters are determined on SEAC, the National Bureau of Standards electronic automatic computer, for a particular set of design requirements. In carrying out this computation, SEAC is used not only to compute the displacements of the system for given values of the parameters, but also to choose that set of parameters for which the performance is optimum. A description is given of a tube mount built in accordance with the computations and of the degree of damping achieved. 4 p.

RP2392. Calorimetric determination of the half-life of polonium
D. C. Ginnings, Anne F. Ball, and D. T. Vier

The heats of radioactivity of four samples of polonium have been measured with a Bunsen ice calorimeter over a period of about seven months. With samples ranging in initial powers from 0.17 to 1.4 watts, the half-life values calculated from these measurements were found to agree within 0.1 percent, or the equivalent of 0.0003 watt, whichever was the larger. The results with the sample with the largest power gave a half-life value of 138.39 days, with an uncertainty of 0.1 percent (0.14 day). This is in agreement with the value of 138.3 days (±0.1 percent) reported by Beamer and Easton, who used a different calorimetric method. 5 p.

RP2393. Determination of molecular weights of dextrans by means of alkaline copper reagents........................H. S. Isbell, C. F. Snyder,
N. B. Holt, and M. R. Dryden

Reducing values were determined for samples of clinical dextrans, gentiobiose, and isomaltose with several alkaline copper reagents. The results for the dextrans were converted to number-average molecular weights on the assumption that equimolecular quantities of dextran, isomaltose, and gentiobiose have approximately the same reducing power. The molecular weights, thus obtained, are in fair agreement with values obtained by the recently developed radioactive cyanide method. The results show that copper-reducing methods are suitable for the determination of the number-average molecular weights of clinical dextrans. 6 p.

RP2394. An interferometer procedure applied to the study of the chemical durability of silicates, enamels, and metals......Robert G. Pike and
Donald Hubbard

The chemical durability of quartz, fused silica, obsidian, flint, opal, and glass were determined by the interferometer method and the results interpreted in the light of the Donnan theory of membrane equilibria. A more sensitive test of the same phenomena is the uneven distribution of migratable ions, as shown by the Ag^+Br^- titration. The tests used are sensitive enough to differentiate between the different types of silica and may be applicable to the study of the chemical weathering characteristics of all natural silicates. Results of preliminary experiments on enamels and metals show that these tests may serve as indicators of the corrosive resistance of these materials under a wide range of conditions. 7 p.

RP2395. Transitions and phases of polytetrafluoroethylene (Teflon)
Charles E. Weir

Transitions in polytetrafluoroethylene (Teflon) have been studied as a function of pressure and temperature. A high-pressure transition (5,000 atm) and a lower pressure transition were studied. These are believed to result from three polymorphic forms. The pressure of the high-pressure transition decreases and that of the low-pressure transition increases with increasing temperature. A triple point is indicated at approximately 70° C, and a third equilibrium line is found to proceed to higher pressures with increasing temperature from this point. Experimental errors involved render tests of all thermodynamic conditions at the triple point indeterminate. 3 p.

RP2396. Hydrodynamic effects of gales on Lake Erie.......Garbis H. Keulegan

The coefficients of wind stress and the sea roughness are derived from records of water levels and wind intensities relating to gales passing over Lake Erie during the past fifty years. The reduction of wind velocities measured at various elevations in four cities on the lake shore to a single "effective wind velocity" over the lake is explained. A theoretical determination of the wind tides agrees well with the observations. The coefficient of wind stress derived from the observations is nearly the same as that obtained by Neumann from observations in the Gulf of Bothnia. Both the coefficient of wind stress and the sea roughness are found to decrease with increasing wind velocities. 11 p.

RP2397. Twisted square plate method and other methods for determining the shear stress-strain relation of flat sheet........Walter Ramberg and James A. Miller

A method is presented for determining the stress-strain relation in shear for isotropic flat sheet. The method requires measurements of deflection or of extreme fiber bending strain in the center portion of a twisted square plate. The octahedral stress derived from the stress-strain curve in shear for a twisted plate of aluminum alloy agreed within about 5 percent with the octahedral stress derived from tensile and compressive tests of the same material. The difference was much greater for specimens of mild steel with a definite yield point. Unfortunately, the method is difficult to perform on thin sheet because of the small size of the specimen. An examination of alternate methods indicates particular promise for the use of an annulus of constant thickness. 13 p.

RP2398. Stress-strain relation in shear from twisting test of annulus
Walter Ramberg and James A. Miller

It is shown that the stress-strain relation in shear of isotropic thin sheet can be determined from a test of an annular specimen. The annulus must be clamped uniformly along the inner and the outer edge, and the relative twist of two circles concentric with the edges must be measured. The shear strain at the inner circle can be computed from the shear strain at the outer circle and the slope of the torque-twist curve. Tests were made on 0.032-inch aluminum alloy 75S–T6 sheet well beyond the elastic range to a shearing stress of 48,000 lb/in.^{2} EPON adhesive VI was used to bond the sheet to a clamping ring at the outer edge of the annulus and between the sheet and the end of a cylinder through which the torque was applied. 6 p.

RP2399. An intersystem transition in the first spectrum of beryllium
W. R. Bozman, C. H. Corliss, W. F. Meggers, and R. E. Trees

The intersystem line from the transition $2s^2\ {}^1\mathrm{S}_0$—$2s2p\ {}^3\mathrm{P}^\circ_1$ has been observed in the first spectrum of beryllium. Wavelength measurements give 4548.538 ± .002 A, which agrees with the predicted value of 4548.29 ± .4 A. The energy of the ${}^3\mathrm{P}^\circ_1$ level is thus determined to be 21,978.92 ± .01 K above the ground state, and the value, x to be added to all of the triplet terms of Be I tabulated in "Atomic Energy Levels" is —1.18 K. Intensity measurements show that the intensity ratio of the singlet resonance line Be I 2348.61 A, to the intersystem line is about 3×10^7. 2 p.

RP2400. Synthesis of lactose-1-C^{14} and lactobionic-1-C^{14} delta lactone from 3-β-D-galactopyranosyl-α-D-arabinose..........Harriet L. Frush and Horace S. Isbell

Lactose-1-C^{14}, which has been prepared for the first time, was obtained in 38-percent radiochemical yield by the cyanohydrin synthesis with 3-(β-D-galactopyranosyl)-D-arabinose. The latter substance was prepared in crystalline form and its reaction with NaC^{14}N was studied under a variety of conditions. Acid catalysts favor production of the epimer having the mannose configuration. An improved procedure is given for the lactonization of lactobionic acid; by slow crystallization from methyl cellosolve, large crystals of high-purity lactobionic-1-C^{14} delta lactone were obtained. The lactone was reduced to lactose by sodium amalgam in the presence of sodium acid oxalate with a yield (by analysis) of 84 percent. A modification of the process in which the separation of the epimeric acids or lactones is omitted, was also found to be practicable for the production of lactose-1-C^{14}. 5 p.

RP2401. Surface areas of cottons and modified cottons before and after swelling as determined by nitrogen sorption

Florence H. Forziati, Robert M. Brownell, and Charles M. Hunt

Surface areas of cottons differing in variety and maturity, and cottons that had been subjected to various physical and chemical treatments were measured before and after swelling. Swollen cottons were prepared by immersing air-dried cottons in water at room temperature for 24 hours, displacing the water with methanol and the methanol with pentane, and finally drying the fibers. Surface areas were calculated from the quantity of nitrogen adsorbed at −195.8° C.

The specific surfaces of unswollen fibers were less than 1 square meter per gram; those of the swollen fibers ranged from 4 to 148 square meters per gram. Purification and mercerization produced increases in the surface available after swelling; methylenation produced a decrease; ethylamine treatment had no effect. In the early stages of methanolysis, a decrease in the surface available after swelling occurred; in the later stages, an increase.

Although surface area measurements were probably in no instance made on completely swollen fiber, the procedure employed is believed to be useful in evaluating the effects of various treatments on cottons and other cellulose fibers. 7 p.

RP2402. Measurement of multimegohm resistors.............. Arnold H. Scott

The method by which multimegohm resistors are measured at the National Bureau of Standards is a null method using an electrometer as the null detector. The charge flowing through the resistor during the time of measurement is obtained from a variable air capacitor maintained at a fixed potential. The potentials across the variable air capacitor and thus across the specimen are maintained constant as indicated by the null reading of the electrometer by decreasing the capacitance of the air capacitor at just the right rate. The capacitance of the capacitor is varied by a small direct-current motor geared to the shaft of the capacitor and whose speed can be controlled. Several multimegohm resistors of two different makes have been studied over a period of about three years. Although these are the most stable multimegohm resistors available, it was found that they had arratic fluctuations of 0.5 to 1 percent and were generally voltage sensitive. With the impressed voltage varied from 1.5 to 180 volts, various resistors showed resistance changes ranging from 0.4 to 26.9 percent. 6 p.

RP2403. Temperature dependence of compression of natural rubber-sulfur vulcanizates of high sulfur content.................. Charles E. Weir

Measurements are reported of the compression of rubber-sulfur vulcanizates in the temperature range 10° to 81.5° C between pressures 1,000 and 10,000 atmospheres. Sulfur contents varied from 10 to 28 percent. Empirical isothermal compression equations are derived. Empirical isobaric equations are derived for specific volume. From the isobars empirical equations of state (pressure-volume-temperature) are derived. 8 p.

RP2404. On a recursion formula and on some tauberian theorems

N. G. de Bruijn and P. Erdös

The paper is concerned with two sets of positive numbers, c_k and f_k, connected by a linear recursion formula. Under certain assumptions there exists an asymptotic relation between the partial sums $\sum_1^n c_k$ and $\sum_1^n f_k$.

The assumptions on the c_k are of Tauberian type. The method is based on discussing the associated power series $\sum_1^\infty c_k x^k$ and $\sum_1^\infty f_k x^k$. 4 p.

RP2405. Pyrolysis of styrene, acrylate, and isoprene polymers in a vacuum

S. Straus and S. L. Madorsky

Pyrolysis was carried out in a vacuum in the temperature range 250° to 400° C. The volatile products were collected and fractionated. The more volatile products were analyzed in the mass spectrometer, whereas the less volatile products were tested for their average molecular weights.

In the styrene group of polymers, poly-alpha-methylstyrene yielded practically 100 percent of monomer, and poly-meta-methylstyrene and poly-alpha-deuterostyrene yielded about 52 and 70 percent, respectively, of monomer or similar products, the other volatiles consisting of dimer, trimer, and some tetramer. Hydrogenated polystyrene yielded volatiles consisting of 6 percent of small molecules and a mixture of products of average molecular weight of 602.

In the acrylate group of polymers, benzoyl peroxide polymerized polymethyl methacrylate, molecular weight 150,000, and thermally prepared polymethyl methacrylate, molecular weight 5,100,000, yielded almost 100 percent of monomer. Polymethyl acrylate yielded carbon dioxide, methanol, and a mixture of various fragments, of average molecular weight of 686.

In the isoprene group of polymers, synthetic polyisoprene, natural rubber (*cis*-polyisoprene), and gutta hydrocarbon (*trans*-polyisoprene), yielded isoprene, dipentene, and mixtures of large molecules of average molecular weight of about 600. 12 p.

RP2406. Tabulation of an integral arising in the theory of cooperative phenomena
Michael Tikson

The paper deals with the tabulation of

$$\mathrm{I}(b)=\frac{1}{\pi^3}\int_0^\pi\int_0^\pi\int_0^\pi\frac{dxdydz}{3b-(\cos x+\cos y+\cos z)}$$

for $b^{-1}=\mu=.01(.01)1$. 2 p.

RP2407. A new method for determining linear thermal expansion of invar geodetic surveying tapes..............Peter Hidnert and Richard K. Kirby

In the new method an invar tape is heated by passing direct current through it while the ambient temperature is held constant. Observations of changes in length and electrical resistance are taken at different constant temperatures of the tape. The temperature coefficient of resistance of each tape is obtained experimentally or from a relationship, derived by the authors, between temperature coefficients of resistance and mass resistivities. The actual temperatures of the tape are determined from its different resistances and temperature coefficient of resistance. Coefficients of expansion determined by this method from 15° to 35° C are in good agreement with those obtained by the method used previously at the Bureau. With the new method greater precision is obtained in a much shorter time than with the old method, and the observers are not subjected to widely different ambient temperatures. 7 p.

RP2408. Transmission of near-infrared energy by some two- and three-component glasses....Jack M. Florence, Francis W. Glaze, and Mason H. Black

Most silicate glasses have a region of absorption for radiant energy at wavelengths longer than 2.7 microns. This absorption has been found to be caused by the presence of water and CO_2 in the glass. Means for removing much of this absorption from some glasses have been developed. Also, it has been found that glasses containing lead oxide or barium oxide, or combinations of the two, do not appear to retain as much water as most other glasses. A soda-lead oxide-silica glass and a barium oxide-lead oxide-silica glass with high transmission for near-infrared energy have been developed. 10 p.

RP2409. Refinements in radioactive standardization by 4π beta counting
W. B. Mann and H. H. Seliger

The corrections due to backscattering and film absorption for radioactive sources in 4π proportional flow counters have been investigated. The low-field effect arising from the use of thin, but nonconducting, Formvar-polystyrene films has also been investigated, and the results have been compared with those obtained in experiments carried out with such supporting films rendered conducting by the evaporation thereon of an approximately 15-microgram-per-square-centimeter layer of gold. Sandwiches of such conducting films have been used to determine the absorption due to the supporting film. It has been shown that the simpler nonconducting source-mounting film technique may still be used to calibrate radioactive sources to within the limits of accuracy currently in demand. 4 p.

RP2410. A new technique for the mass spectrometric study of the pyrolysis products of polystyrene
Paul Bradt, Vernon H. Dibeler, and Fred L. Mohler

Polystyrene was placed in a small tube furnace and the degradation products evaporated directly into the ionization chamber of a mass spectrometer. At about 330° C a fairly complicated mass spectrum was observed, extending to about mass 520. Major features of the spectrum are accounted for by a mixture of monomer, dimer, trimer, tetramer, and pentamer, with the first two by far the most abundant. The nonvolatile liquid fraction recovered from pyrolysis of polystyrene when heated to 80° C in the tube furnace gave a spectrum nearly identical to the above pyrolysis spectrum except that the styrene contribution is absent. The technique should be applicable to a wide range of polymers. 2 p.

RP2411. Contributions to the theory of Markov chains........Kai Lai Chung

The fundamentals of the theory of denumerable Markov chains with stationary transition probabilities were laid down by Kolmogorov, and further work was done by Doblin. The theory of recurrent events of Feller is closely related, if not coextensive. Some new results obtained by T. E. Harris turn out to tie up very nicely with some amplifications of Doblin's work. Harris was led to consider the probabilities of hitting one state before another, starting from a third one. This idea of considering three states, one initial, one "taboo", and one final, is more fully developed in the present work. The notion of first passage time to the "union" or "intersection" of two states is also introduced here. The interplay between these notions is illustrated. 6 p.

RP2412. Titanium-uranium system in the region 0 to 30 atomic percent of titanium..............R. W. Buzzard, R. B. Liss, and D. P. Fickle

The tentative titanium-uranium phase diagram has been amplified by thermal, microscopic, and X-ray analyses of alloys in the range 0 to 30 atomic percent of titanium. The system is characterized by a peritectic reaction which occurs at 1,180° C, and by two solid-solution phases which decompose eutectoidly, one at 718° C and 5 atomic percent of titanium, the other at 830° C and 18.3 atomic percent of titanium. The alpha-beta transformation in uranium is increased from 657° to 667° C by titanium and the beta-gamma transformation is lowered from 768° to 718° C. 6 p.

RP2413. Nonquantized frequency-modulated altimeter
Henry P. Kalmus, John C. Cacheris, and Herbert A. Dropkin

A new principle that makes possible nonquantized altitude information so that the accurate range of altimeters can be extended to include low-level operation is described. A frequency shifter is inserted between the local oscillator and the mixer in order to remove the inherent error in conventional altimeters that makes them objectionable for low-altitude operation. The authors show how the characteristic of the amplifier can be shaped differently and point out that the strength of the return signal and the inherent amplitude modulation determine the most suitable characteristic for any particular operating condition. 7 p.

RP2414. Infrared spectra of pentachlorofluoroethane, 1,2-dichlorotetrafluoroethane, and 1-bromo-2-fluorethane
Delia Simpson and Earle K. Plyler

The infrared absorption spectra of pentachlorofluoroethane and 1,2-dichlorotetrafluoroethane have been measured from 2 to 40 μ. Several bands were found in the region from 25 to 40 μ, which had not been previously investigated. The spectrum of 1-bromo-2-fluoroethane has also been measured in the spectral region from 2 to 40 μ, and many bands were observed. A list of the observed bands and the frequency assignments for the three molecules are given. 5 p.

RP2415. Modified 1913 reference tables for iron-constantan thermocouples
Robert J. Corruccini and Henry Shenker

An investigation was made of the characteristics of iron-constantan thermocouples typical of those being supplied to reproduce the standard temperature-electromotive force relationship that was established commercially in 1913. Using the calibration of the thermocouple that most nearly matched the 1913 reference table over the range to which iron-constantan thermocouples usually are limited (32° to 1,400° F), a slightly different temperature-electromotive force relationship was derived which is more nearly realizable by commercially available materials. The new relationship is presented in four mutually consistent tables covering the range, −320° to +1,600° F (−196° to +871° C), in both Fahrenheit and Celsius units and with both temperature and electromotive force as arguments. 20 p.

RP2416. Epitaxial deposits of metals evaporated on salt substrates
Olive G. Engel

Experimental data and theoretical considerations relating to the process of epitaxy are reviewed. The case of epitaxy resulting from vapor phase deposition of metals on rock salt is considered in detail and it is concluded that a factor other than best fit determines the orientation. A model for epitaxy in metal-rock salt pairs is advanced which involves ionization of the metal atoms on the surface. The epitaxial temperature is found to be related to the ionization potential of the metal for the ionization state to be expected. It is found that the observed orientations of metals on rock salt are those that would be expected if such an ionization process occurred, that is, if the orientation involved charged ions rather than neutral atoms. 13 p.

RP2417. Torsion of anisotropic elastic cylinders by forces applied on the lateral surface..Harold Luxenberg

The classical Saint-Venant theory of torsion presents a method for the determination of the elastic behavior of an orthotropic elastic beam of uniform arbitrary cross section twisted by forces applied on the end sections, with the lateral surface free of stress. In the present paper the theory is extended to include a more generally anisotropic beam (possessing only a single plane of elastic symmetry, rather than three mutually orthogonal planes of elastic symmetry, as in the case of orthotropic materials) built in at one end and twisted by forces uniformly distributed along the lateral surface.

The stresses in a beam of elliptic cross section twisted by constant tangential traction are obtained as an application of the theory. 14 p.

RP2418. On methods for obtaining solutions of fixed end-point problems in the calculus of variations.............................Marvin L. Stein

Two methods for constructing solutions to the problem of minimizing an integral in a certain class of arcs joining a pair of fixed points are proposed. One of these procedures is a generalization of Newton's method, while the other is a "gradient" method. Conditions for convergence to a strong relative minimum are given in both cases. 21 p.

RP2419. Electron microscopy of synthetic elastomer latices
Robert R. Stromberg, Max Swerdlow, and John Mandel

The effects on the apparent particle size and its frequency distribution arising from the method of specimen preparation, shadowcasting, distortion of shape, and other artifacts inherent in the electron microscopy of synthetic elastomer latices are described. The possibility of applying a single, reproducible method of examination to four latices involving three copolymers (butadiene-styrene, butadiene-acrylonitrile, and butadiene-styrene-acrylonitrile) is statistically evaluated. These copolymers contain particles ranging in size from approximately 100 to 2100 A, and their average particle diameters are about 600, 800, and 1700 A, respectively. 11 p.

RP2420. Second-order transitions of rubbers at high pressures..Charles E. Weir

Pressure-volume-temperature data on rubber-sulfur vulcanizates are analyzed in connection with their bearing on the second-order, or glass, transition in rubber. The results show no measurable change in transition temperature with increasing pressure nor any noticeable discontinuity in compressibility at the transition. No evidence is found for an isothermal transition produced by pressure. Possible explanations for the absence of the pressure transition are discussed. 9 p.

RP2421. Thermodynamics of the rubber-sulfur system at high pressures
Charles E. Weir

From previously reported *PVT* data on rubber-sulfur vulcanizates in the ranges 10° to 80° C, 1,000 to 10,000 atm, and 10 to 28 percent of sulfur, calculated values are given for work, heat, internal-energy change, and difference in specific heats. These values are given at 10-deg-C and 1,000-atm intervals for three representative rubbers containing 10, 18, and 28 percent of sulfur. Implications of the results are discussed. 7 p.

RP2422. Laboratory measurement of the corrosion of ferrous metals in soils
W. J. Schwerdtfeger

A method is described for setting up soil-corrosion cells using a soil-wetting procedure that gives reproducible results. By measuring the weight losses on cell electrodes made of steel and of cast iron after exposure to various soils for 6 months, it was possible to compare the effects of corrosion on the two materials. It was also found that the electrode weight losses correlated with the weight losses and maximum pitting on wrought ferrous specimens exposed for 10 years at the field test sites. Because the laboratory soils covered the range of corrosivity peculiar to soils, it was possible to derive empirical equations for predicting weight loss and pitting at the end of 10 years for presumably any soil. It is also shown how reasonable adjustments can be made for areas other than that of the field specimens and for exposure periods other than 10 years. 8 p.

RP2423. Effect of temperature on the electrical resistance and voltage departures (errors) of glass electrodes, and upon the hygroscopicity of glass
Donald Hubbard

The effect of temperature upon the electrical resistance and pH response has been studied on electrodes prepared from three types of glasses: Pyrex 7740, commercial soft-glass tubing, and Corning 015; glasses of low, intermediate, and high hygroscopicity, respectively. The results show that electrical resistance is not the determinant in most cases of voltage departure from the theoretical, and in the inherent failure of many glasses to act as satisfactory indicators of hydrogen-ion activity of aqueous solutions. For example, the electrodes prepared from Pyrex glass gave no significant pH response even when the resistance was as low as 12 megohms. The results of electrodes from glasses of intermediate hygroscopicity gave a pseudo-correspondence of pH response with resistance, whereas electrodes of Corning 015 gave voltage departures that could in no way be attributed to the electrical resistance of the electrode. 6 p.

RP2424. On the numerical solution of parabolic partial differential equations
Gertrude Blanch

The numerical results presented here relate to a two-dimensionsl parabolic partial differential equation containing a nonlinear term. Denoting the independent variables by t and x, a lattice is introduced, with intervals k and h in the t-and x-directions, respectively. Much attention has been devoted recently to the study of the conditions on the mesh ratio, k/h^2, under which an approximation by a difference equation converges to the solution of the differential equation for sufficiently small h. Some known results are summarized in sections 1 and 2, and three approximation formulas are given, one of order two, and two of order four. The feasibility of using approximation formulas of order higher than the differential equation is studied in later sections. The primary objective of this paper is to seek the *most economical* mesh ratio for a given approximation formula, that is, of all mesh ratios that will lead to a preassigned upper bound of error in the approximation, to choose that mesh ratio that will lead to the least amount of work. It is shown in section 3 that the largest admissible mesh ratio is not necessarily the most economical one and that a great deal depends on the form of the differential system and the boundary conditions.

In section 4 a generalization is given of the method of Hartree and Womersley (1937) for improving a solution from two difference approximations. The method is shown to be very effective for suitable boundary conditions. Five numerical examples are presented and analyzed in section 5. An appendix, with detailed derivations of the formulas used, is given for the benefit of those who may want to apply the formulas to specific studies. 14 p.

RP2425. Thermal properties of some butadiene-styrene copolymers
George T. Furukawa, Robert E. McCoskey, and Gerard J. King

The thermal properties of 41° and 122° F butadiene-styrene copolymers containing 8.58 percent of bound-styrene were investigated by means of an adiabatic calorimeter from 16° to 330° K. The 41° F copolymer was found to crystallize in the temperature range from 210° to 285° K. The 122° F copolymer did not exhibit any crystallization. The glass-transformation temperatures of the 41° and 122° F copolymers were 200° and 193° K, respectively. The effects of heat treatment upon the heat capacity and the glass-transformation temperature have been studied. The results of the heat-capacity measurements were used to compute heat capacity, enthalpy, and entropy from 0° to 330° K at 5-deg intervals. 9 p.

TITLE PAGE AND CONTENTS TO VOLUME 50, 5 P.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS VOLUME 51, JULY—DECEMBER 1953

RP2426. Fabrication of radio-frequency micropotentiometer resistance elements

Lewis F. Behrent

Disk resistors between 1 and 10^3 milliohms needed for the radio-frequency micropotentiometer were not available. Therefore, considerable research was necessary on a wide variety of processes for forming thin-film elements. Those methods whereby resistors stable to within plus or minus 1 percent were consistently produced are described in detail, and the various limitations, fabrication problems, and solutions to these problems are discussed. 9 p.

RP2427. Properties of some masonry cement

D. N. Evans, A. Litvin, A. C. Figlia, and R. L. Blaine

Seventeen brands of masonry cement were tested for soundness, strength, consistency, fineness, time of setting, shrinkage, water repellency, water retention, autoclave expansion, air entrainment, and resistance to freezing and thawing. Mortars were proportioned both by weight and by volume. Autoclave tests indicated potential unsoundness in some of the cements. Air entrained in the mortar was effective in increasing the ability to withstand freezing and thawing. The shrinkage of these cements differed greatly. The results of tests indicated also that the properties of these masonry cements were appreciably different from those previously reported in 1934. 6 p.

RP2428. Subsieve particle-size measurement of metal powders by air elutriation

Rolla E. Pollard

Particle-size measurements of spherical metal powders by means of the Roller air analyzer, using samples up to 40 grams of powder, were found to be reproducible within approximately ±1 percent of the original weight of the sample for particle diameters up to 120 microns. The separation limits closely approximated those required by Stokes law ($V=Kd^2$) for particle diameters of 5 to 20 microns. For particle diameters of 20 to 70 microns, the size limits of fractions conformed approximately to the formula $V=K''d^{1.4}$. With particles larger than 70 microns, the accuracy of separation was uncertain.

Reproducible results also were obtained with irregularly shaped particles, such as those of electrolytic copper powder. However, the accuracy of calculated size limits was uncertain, no attempt being made to check them by other methods of measurement. 15 p.

RP2429. Eigenvectors of matric polynomials

Murray Mannos

It is the object of this paper to compare the eigenvectors of an arbitrary $n \times n$ matrix A over the complex field with those of the matric polynomial $f(A)$. While it is well known that each eigenvector of A is an eigenvector of $f(A)$, it is not, in general, true that A and $f(A)$ have identical eigenvectors. In this regard a necessary and sufficient condition that A and $f(A)$ have identical eigenvectors is given. The condition is that both (1) and (2) hold:

(1) $f'(\lambda \neq 0$ for all eigenvalues λ of the matrix A corresponding to nonlinear elementary divisors.

(2) The values of $f(\mu)$ are distinct for all eigenvalues μ of the matrix A corresponding to linear elementary divisors.

When either (1) or (2) fails to hold, then $f(A)$ has eigenvectors that are not eigenvectors of A. This situation is also discussed. 4 p.

RP2430. The system barium oxide-boric oxide-silica

Ernest M. Levin and George M. Ugrinic

A phase equilibrium diagram for the system $BaO\text{-}B_2O_3\text{-}SiO_2$ has been constructed from data, obtained essentially by the quenching method, on 178 ternary compositions. One new compound, $3Ba{\cdot}O3B_2O_3{\cdot}2SiO_2$, melting at 1,009° C and possessing an extremely flat primary field appears, and its optical properties and

X-ray diffraction data are given. The $BaO \cdot 4B_2O_3$ and SiO_2 primary phase areas include almost 70 percent of the diagram, and over these areas exists a large region of two-liquid immiscibility. Limited data indicates that the immiscibility gap decreases with increasing temperature. The solid solution region between $2BaO \cdot 3SiO_2$ and $BaO \cdot 2SiO_2$ extends into the interior of the diagram and is complex in nature. An isofract diagram for the quenched glasses is shown. For precise temperature control of a quenching furnace, a self-adjusting, bridge-type controller is described briefly. 20 p.

RP2431. Errors introduced by finite space and time increments in dynamic response computation........Samuel Levy and Wilhelmina D. Kroll

An investigation is made of the accuracy and stability of numerical integration methods when applied to the computation of the dynamic response of structures to impact loads. The effect of finite time increments is studied both by obtaining analytical solutions for a single-degree-of-freedom system and by carrying out numerical integrations for many-degree-of-freedom systems; the effect of finite space increments is studied by replacing a continuous beam by a discrete number of elastically connected point masses. It is found that: (1) Of the methods investigated, only Houbolt's is stable when the time increments are large compared with the natural periods of the system. Errors are introduced by Houbolt's method, in this case, which result in the damping out of the responses in the higher modes of vibration. All of the methods give good results when the time increment is less than about 1/30 of the period in the highest frequency mode. (2) The distributed mass of a beam can be considered to be concentrated at relatively few mass points for computational purposes; using a five mass idealization, the bending moment at the center of a uniform beam is determined with good accuracy. 12 p.

RP2432. Heat capacity, heats of fusion and vaporization, and vapor pressure of tetrafluoroethylene
George T. Furukawa, Robert E. McCoskey, and Martin L. Reilly

The heat capacity of tetrafluoroethylene of 99.99_0-mole-percent purity was measured in an adiabatic calorimeter from 16° to 210° K. A smoothed table of heat capacity at 5-degree intervals from 0° to 210° K was constructed from the data. The average heat of fusion of three experiments gave 7,714.5 ±7 abs j $mole^{-1}$ at the triple-point temperature of 142.00 ±0.01° K. The three heats of vaporization measurements at the normal boiling temperature of 197.53 ±0.01° K gave an average value of 16,821 ±10 abs j $mole^{-1}$. The results of the vapor-pressure measurements from 142° to 208° K can be represented by the equation

$$\log_{10} p_{\mathrm{mmHg}} = 4.71241 - \frac{972.9810}{T} + 4.816562 \times 10^{-2} T - 2.427347 \times 10^{-4} T^2 + 3.958793 \times 10^{-7} T^3.$$

The entropy of the ideal gas tetrafluoroethylene at 197.53° K and 1 atm was computed from the calorimetric data to be 270.06 ±0.37 abs j deg^{-1} $mole^{-1}$ or 64.55 ±0.09 cal deg^{-1} $mole^{-1}$(1 cal=4.1840 abs j). The entropy was computed from molecular and spectroscopic data to be 64.54 cal deg^{-1} $mole^{-1}$. 4 p.

RP2433. Hydrothermal preparation of some strontium silicates
Elmer T. Carlson and Lansing S. Wells

A study was made of the formation of hydrated strontium silicates under hydrothermal conditions. Seven hydrated compounds, believed to have the following compositions, were prepared: $SrO \cdot 2SiO_2 \cdot H_2O$, $SrO \cdot SiO_2 \cdot H_2O$, $2SrO \cdot 2SiO_2 \cdot 3H_2O$, $3SrO \cdot 2SiO_2 \cdot 3H_2O$, $3SrO \cdot 2SiO_2 \cdot 4H_2O$, $2SrO \cdot SiO_2 \cdot H_2O$, and $3SrO \cdot SiO_2 \cdot 2H_2O$. The anhydrous compounds $SrO \cdot SiO_2$ and $2SrO \cdot SiO_2$ were obtained by hydrothermal synthesis at temperatures as low as 124° and 142°C, respectively. No evidence was found that the anhydrous strontium silicates possess hydraulic binding properties. X-ray powder diffraction patterns and some optical data are given for the various hydrates, and possible relationships with the calcium silicates are discussed. 8 p.

RP2434. Ultraviolet spectral radiant energy reflected from the moon
Ralph Stair and Russell G. Johnston

Results are given of some measurements on the ultraviolet and short-wavelength visible spectral radiant energy reflected from the surface of the full moon, made from October to December 1952, at Washington, D. C. Although the reflected lunar spectrum contains all the Fraunhofer bands as found in direct sunlight with approximately the same relative intensities in the visible spectrum, intense absorption occurs for some of the ultraviolet wavelengths. Selective absorption for wavelengths in the spectral regions of 380 to 390 millimicrons and less than 360 millimicrons indicates the possibility of a lunar reflecting surface similar to that of powdered glassy silicates. 4 p.

RP2435. Phase equilibria in the system $MgO-TiO_2$
L. W. Coughanour and V. A. DeProsse

The phase relations in the system $MgO-TiO_2$ were studied by means of solid-phase reactions between the components and by observing the fusion characteristics of specimens within the system. The existence of three binary compounds in the system was confirmed. From the data obtained, an equilibrium diagram for the system is suggested. 4 p.

RP2436. Pairs of normal matrices with property *L*........... Helmut Wielandt

A short proof is given, under weaker assumptions, of the following theorem first proved by N. Wiegmann: If the eigenvalues α_i, β_i of two normal $n \times n$ matrices *A*, *B* may be numbered in such a way that the eigenvalues $\gamma_i(z)$ of $C(z)=a+zb$ are given by $\gamma_i(z) = \gamma_i + z\beta_i$ (for $i=1, \ldots, n$ and all complex values of z), then $AB=BA$. 2 p.

RP2437. Heat capacity of gaseous hexafluoroethane
John S. Wicklund, Howard W. Flieger, Jr., and Joseph F. Masi

An accurate flow calorimeter has been used to measure the heat capacity (C_p) of gaseous hexafluoroethane (C_2F_6) at $-50°$, $-20°$, $+10°$, $+50°$, and $+90°$ C and at 0.5-, 1.0-, and 1.5-atmosphere pressure. The results are believed to be accurate to ± 0.1 percent.

The values of C_p have been extrapolated to zero pressure at each temperature; the ideal-gas heat capacities thus obtained at the five temperatures are, respectively, 20.99, 22.79, 24.43, 26.45, and 28.24 calories $mole^{-1}$ $degree^{-1}$. Calculated results, using recent frequency assignments and molecular data, were 0.4 to 0.7 percent higher than the experimental results.

The values of the pressure coefficient of heat capacity at the five temperatures have been used in conjunction with literature data to obtain an equation of state for hexafluoroethane at low pressures. 2 p.

RP2438. Effective circuit bandwidth for noise with a power-law spectrum
Philip R. Karr

The effective bandwidth of tuned circuits for noise with a power-law spectrum is derived and discussed. Comparison is made with the usual case of "flat" noise. 2 p.

RP2439. Penetration of X- and gamma rays to extremely great depths. . U. Fano

Earlier work on the asymptotic trend of the X-ray intensity at great distances from a source is reviewed and completed in various aspects. The asymptotic law is shown to be the same as in the "straight-ahead" approximation (which disregards deflections) whether the primary energy is higher or lower than the energy of minimum absorption, provided a constant is replaced by the eigenvalue of a suitable Wick equation. The penetration in directions oblique to the source direction hardly ever attains its asymptotic trend when the source energy is lower than the energy of minimum absorption. This situation raises a difficult problem regarding the penetration law in the range of great depths where the asymptotic trend is being approached very slowly. 28 p.

RP2440. Refractive index of cesium bromide for ultraviolet, visible, and infrared wavelengths....... William S. Rodney and Robert J. Spindler

The index of refraction of cesium bromide was measured at 37 wavelengths from 0.365 to 39.22 microns. The minimum deviation method was used, and the entire range was covered with a single instrument. The index changes approximately two units in the first decimal place over the wavelength range. The dispersion compares favorably with that of KRS–5 beyond 20 microns; and when the effects of inhomogeneity and reflection losses are considered, the resolving power of CsBr is probably better. 4 p.

RP2441. An expansion method for parabolic partial differential equations
J. W. Green

The aim of this paper is to adapt to certain parabolic partial differential equations an expansion method of solution developed by S. Faedo for hyperbolic equations. In order to make possible a moderately compact presentation, the equations treated are not the most general to which the method is applicable, but are the simplest nontrivial relatives of the heat equation. Similarly, the boundary values and initial conditions are not the most general, but are assumed to be in a canonical form to which others, if sufficiently smooth, can be reduced. The method of solution not only shows the existence of a solution, but describes a definite procedure for approximating it. Some remarks are made on the possibility of estimating the error. 6 p.

RP2442. Characteristics of internal solitary waves.........Garbis H. Keulegan

This is an application of the method of approximations initiated by Boussinesq to the disturbances of the interface points for waves of permanent form and the internal solitary wave. The system considered is a layer of liquid on another layer of greater density, the liquids of the layers being initially at rest and of constant total depth. The form of the wave is established. The dependence of wave velocity on wave height, on density differences and on layer thickness is determined. 8 p.

RP2443. Becker value of manila rope by photoelectric reflectometry
Sanford B. Newman, Harry K. Hammond, III, and Helen F. Riddell

Becker value, or reflectance under specified conditions, has been used for more than 20 years as an index of fiber quality in the purchase of manila cordage. The accepted method for determining Becker value requires a visual reflectometer. Previous attempts to use photoelectric reflectometers were unsuccessful because the instruments lacked sensitivity, attributable in part to the low transmittance of the chosen filter combination. Properly selected filters used with a sensitive reflectometer permit photoelectric determinations to be made with greater speed and precision than visual determinations. The results obtained photoelectrically agree well with the averages of visual determinations. 3 p.

RP2444. Dielectric relaxation in a styrene-acrylonitrile copolymer during and after its polymerization......Paul Ehrlich and Nicholas J. De Lollis

Dielectric relaxation in plasticized copolymers of styrene and acrylonitrile is studied during their formation as well as in the fully polymerized copolymers by measurements of dielectric constant and loss factor at several frequencies from 100 c/s to 100 kc/s. In the polymerizing mixture, there occur, at an early stage of the reaction, sigmoid decreases in the dielectric constant at each frequency, accompanied by maxima in the loss factor, when these variables are plotted as a function of reaction time. These changes are interpreted as resulting from the relaxation of the nitrile groups. The electrical properties of the fully polymerized copolymer, as it goes through its glass transition, are in semiquantitative agreement with those of the polymerizing mixture at the stage of the reaction referred to, demonstrating the occurrence of similar phenomena in each case. 10 p.

RP2445. Study of degradation of polystyrene, using ultraviolet spectrophotometry........Mary Jane Reiney, Max Tryon, and B. G. Achhammer

The role of ultraviolet radiant energy and effect of presence of monomer on degradation of polystyrene were studied by means of ultaviolet absorption techniques. It was found that exposure of pure polystyrene to ultraviolet radiant energy resulted in increased absorption in the ultraviolet region of 280 to 400 millimicrons, which advanced progressively as exposure time increased. The presence of monomer increased the rate of degradation without altering the general type of absorption. A post-radiation effect was noted in both the purified polymer and polymer containing monomer styrene. Again, the presence of monomer increased the rate of progress of the post-radiation effect. Possible mechanisms are postulated for the ultraviolet degradation, and the concept of entrapped free radicals is considered as a possible explanation for the post-radiation effect observed. 11 p.

RP2446. Determination of carbon 14 in the terminal positions of sugars: Preparation of D-arabinose-5-C^{14} from D-fructose-1,6-C^{14}

Harriet L. Frush and
Horace S. Isbell

Methods are described for the determination of carbon 14 in the terminal positions of reducing sugars. The sugar in alkaline solution is oxidized by means of molecular oxygen to the next lower aldonic acid, and the acid is separated in the form of a convenient derivative. The loss in radioactivity coincident with the removal of carbon 1 is a measure of the activity located at this carbon. The activity of the carbon at the nonreducing end of the molecule is determined by periodate oxidation of the aldonic acid, followed by formation and radioactivity assay of the dimedone compound of the resulting formaldehyde.

The method was applied to the labeled D-fructose prepared from D-mannitol-1-C^{14} by the action of *Acetobacter suboxidans*, and the D-arabonic acid formed from the D-fructose was isolated as potassium D-arabonate. It was found that all of the activity of the labeled D-fructose was located equally at carbons 1 and 6.

Potassium D-arabonate-5-C^{14} was also prepared from D-mannitol-1-C^{14} in 52-percent yield (26-percent radiochemical yield) without the intermediate separation of crystalline D-fructose-1,6-C^{14}; it was then converted to D-arabinose-5-C^{14} in an over-all radiochemical yield of 18 percent of the original D-mannitol-1-C^{14}. 4 p.

RP2447. Measurement of variations in atmospheric refractive index with an airborne microwave refractometer........... Howard E. Bussey and
George Birnbaum

A microwave refractometer for aircraft use is described, and some of the sources of error in the measurement of variations of atmospheric refractive index with this instrument are discussed. Observations were made up to 10,000 feet on 2 days near Washington, D. C. Two refractive-index soundings taken 1½ hours apart showed changes that, in the coarser aspects, resembled changes shown by radiosonde data. The fluctuation intensity changed erratically with time and place, but was usually greatest where the vertical gradient was changing. A rough analysis of the data showed that the larger fluctuations occurred over distances of several hundred meters, whereas over distances less than 5 meters the fluctuations were negligible (the response of the instrument would have allowed the detection of fluctuations occurring within 0.5 meter). Large increases in index were observed on entering cumulus clouds and intense fluctuations were noted within the clouds. 8 p.

RP2448. Studies in the system magnesia-silica-water at elevated temperatures and pressures........... Elmer T. Carlson, Richard B. Peppler, and
Lansing S. Wells

The reactions between magnesia and silica under hydrothermal and pneumatolytic conditions were investigated. Chrysotile and talc were produced, depending on the ratio of the reacting oxides. The chrysotile was submicroscopic but was shown by the electron microscope to have a fibrous structure. Chrysotile and talc were likewise prepared from mixtures of magnesium carbonate and silica. The same products were obtained by the action of silica in the vapor phase on solid magnesia. A detailed study of this method was made, and the effects of temperature, pressure, time, pH, and oxide ratio on the amount of silica transported were determined. The overall rate of transport was found to increase with temperature, pressure, and pH. 6 p.

RP2449. Dielectric properties of Teflon from room temperature to 314° C and from frequencies of 10^2 to 10^5 c/s.................... Paul Ehrlich

The dielectric constant and dissipation factor of Teflon were measured at frequencies from 10^2 to 10^5 c/s and from room temperature to temperatures just below the first-order transition point occurring at 327° C. Measurements of the d-c conductivity were made over the same temperature interval. Results show that the dielectric constant decreases somewhat with increasing temperature. The relation between thermal-expansion coefficient and temperature coefficient of the dielectric constant is roughly as predicted by the Clausius-Mossotti equation. Values of dissipation factor and d-c conductivity at all temperatures are very low (less than 2×10^{-4} and 2×10^{-15} mho/cm, respectively), and the dielectric constant is independent of frequency at all temperatures. 4 p.

RP2450. pH of solutions of potassium tetroxalate from 0° to 60° C
Vincent E. Bower, Roger G. Bates, and
Edgar R. Smith

The National Bureau of Standards conventional activity scale of pH is defined in terms of a series of standard buffer solutions prepared from certified materials issued as NBS Standard Samples. In order to increase the accuracy of measurements at low and high pH, standards of high acidity and high alkalinity are needed to supplement the four now available, which cover adequately the intermediate range from 3.5 to 9.2.

Potassium tetroxalate dihydrate, chosen as the fifth pH standard, is a stable, crystalline substance composed, in addition to water, of equal molar amounts of oxalic acid and potassium acid oxalate. Its solutions are therefore well buffered in the concentration range 0.01 to 0.1 *M* and are highly acidic, with pH ranging from 1.5 to 2.2. Electromotive-force data were obtained for 12 mixtures of potassium tetroxalate and potassium chloride at 13 temperatures from 0° to 60° C, and pH values were assigned to 0.1-, 0.05-, 0.025-, and 0.01-*M* solutions of potassium tetroxalate without added chloride. The 0.05-*M* solution, which has a pH value of 1.68 from 15° to 35° C, is recommended as a standard for measurements at low pH. 6 p.

RP2451. On small disturbances of plane Couette flow........Wolfgang Wasow

The Orr-Sommerfeld equation for the function $\phi(y)$, which appears in the component $\phi(y)\exp\{i\alpha(x-ct)\}$ of the stream function, is analyzed in detail for the case of plane Couette flow. A set of solutions is found whose asymptotic behavior as $\alpha R\rightarrow\infty$ can be calculated in the whole complex y-plane (R is the Reynolds number). A disturbance with given α is proved stable, for any α, if αR is sufficiently large. In addition, an investigation is made of the asymptotic propties of an allied equation for which, in contradistinction to the singular Couette case, an inner friction layer does exist. 8 p.

RP2452. Diffusion length of thermal neutrons in water..James A. DeJuren and
Hyman Rosenwasser

The thermal-neutron diffusion length in a hydrogenous medium can be simply determined by measuring the variation of the thermal-neutron density at large radii from the center of a photoneutron source. The necessary requirement is that the relaxation length of the source in a medium be less than the diffusion length, so that diffusion dominates at large radii. Using a Ra-Be photoneutron source, the diffusion length of thermal neutrons was determined by indium-foil measurements at large radii. A value of 2.763 ± 0.015 cm was obtained. This result was confirmed in a second experiment with an Sb^{124}-Be source. 5 p.

RP2453. Metal ultrasonic delay lines..........Russell W. Mebs, John H. Darr,
and John D. Grimsley

A study was made of the applicability of a number of metals and alloys for thermally stable ultrasonic delay lines.

A preliminary investigation was made of different types of pressure holders and adhesives for use in crystal transducer attachments and of the influence of specimen length on attenuation for various metals and alloys. The effect of coldwork, annealing, and specimen cross section on attenuation was also determined for a representative isoelastic alloy.

Measurements of temperature variation of signal attentuation, distortion, and delay time on a number of assembled delay lines indicated that an isoelastic alloy employing overcured epoxy-resin crystal attachments gave best over-all transmission characteristics. No correlation was obtainable between strength and sound-transmission characteristics with various cemented joints. 12 p.

RP2454. A radio-frequency permeameter......................Peter H. Haas

An instrument is described, which, in connection with commercially available impedance measuring devices, is capable of measuring the permeability and losses in ferromagnetic toroidal cores. The measurement is made by inserting a toroidal core into the short-circuited secondary of a transformer whose primary is attached to a radio-frequency bridge or Q meter. Equations are derived for the measurements, the accuracy and sensitivity are discussed, and typical construction details are given. Finally, a modification of the device enabling the measurement of permeability temperature coefficients is discussed. 8 p.

RP2455. On mildly nonlinear partial difference equations of elliptic type
Lipman Bers

The use of the finite differences method is in solving the boundary value problem of the first kind for the nonlinear elliptic equation $\Delta\phi = F(x,y,\phi,\phi_x,\phi_y)$ is justified by first showing that the problem of the corresponding difference equation has a unique solution, and then that the solution of the difference equation tends to that of the differential equation when the net unit tends to zero. Also a numerical method of the Liebmann type for the computation of the solution of the difference equation is developed, and these results are extended to more general nonlinear elliptic equations. 8 p.

RP2456. Determination of glucose by means of sodium chlorite
Herbert F. Launer, William K. Wilson, and Joseph H. Flynn

The oxidation of several aldoses with acid sodium chlorite solution was investigated in order to obtain a method for the determination of aldehyde groups in sugars and their polymers.

The kinetics of the oxidation of glucose and cellobiose were studied over the experimental ranges 3.4 to 4.4 pH, 30° to 65° C, 0.005- to 0.15-M sodium chlorite, and 0.00006- to 0.0016-M aldose, both by the determination of the change in chlorite concentration by iodometric titration and by the photometric measurement of ClO_2 formed. The rate of oxidation was found to be approximately first order with respect to aldose and chlorous acid. The measurement of the oxidation was complicated by the second-order decomposition of chlorous acid. This decomposition was corrected for by a calibration curve and an approximate formula derived from the reaction kinetics. Use of either of these corrections gave experimental values for glucose within a few percent of the theoretical value.

Melibiose, maltose, and lactose were oxidized at about the same rate as glucose and cellobiose. Nonreducing sugars and sugar acids were not appreciably oxidized under the experimental conditions used. 9 p.

RP2457. Description and analysis of the first spectrum of chromium, Cr I
Carl C. Kiess

Wavelengths and estimated intensities are presented for about 4,400 lines of Cr I recorded photographically between 11610 A in the infrared and 1880 A in the ultraviolet. Zeeman patterns, measured in magnetic fields of 35000 and 85000 oersteds for approximately 10 percent of the lines, are presented also. Analysis of the spectrum with these observational data has yielded classifications for about 80 percent of the Cr I lines, as combinations among the terms that arise from the various configurations assumed by the valence electrons of the atom in its excited and unexcited states. Of these terms 53 have been found due to the even electron configurations $3d^5\,ns$, $3d^4\,ns^2$, $3d^6$, and $3d^5\,nd$; and 115 due to the odd configurations $3d^5\,np$ and $3d^4\,4s\,np$. Among both even and odd terms several series of two or more members have been found converging to the ground state $a\ {}^6\mathrm{S}$ and to the metastable state $a\ {}^6\mathrm{D}$ of Cr II.

The ${}^7\mathrm{S}$, ${}^5\mathrm{S}$, and ${}^7\mathrm{P}^\circ$ series, of three or more members, that converge to $a\ {}^6\mathrm{S}$ are in remarkable accord in fixing the separation of the ground states of the neutral and singly ionized Cr atoms as 54570 cm^{-1}. This corresponds to an ionization potential of 6.764 electron volts. 59 p.

RP2458. Preparation of D-arabinose-1-C^{14} and D-ribose-1-C^{14}
Harriet L. Frush and Horace S. Isbell

By application of the cyanohydrin synthesis to D-erythrose, D-arabinose-1-C^{14} and D-ribose-1-C^{14} have been prepared in overall radiochemical yields of 30 and 8.5 percent, respectively. General acid catalysts in the cyanohydrin reaction appear to favor formation of the arabonic epimer. The epimeric acids resulting from the reaction of labeled cyanide and D-erythrose, and subsequent hydrolysis, were separated as crystalline potassium D-arabonate-1-C^{14} and cadmium D-ribonate-1-C^{14}, respectively. The salts were converted to the corresponding lactones, and these were reduced to the sugars by use of sodium amalgam in the presence of sodium acid oxalate. 5 p.

RP2459. Corrosion of nickel cast irons in soils...........Irving A. Denison and Melvin Romanoff

The results of measurements of the corrosion and of the strength of nickel cast irons after exposure to different soil conditions for a maximum of 14 years are reported. The magnitude and progress of corrosion, as determined by weight-loss and pit-depth measurements, are correlated with the composition of the materials and the nature of the environmental conditions to which the specimens were exposed. The residual strength of the corroded cast iron that had been removed from the more corrosive soils was evaluated by subjecting the pipe specimens to hydraulic pressures up to 500 lb/in^2. 8 p.

RP2460. Calorimetric properties of 41° and 122° F polybutadienes
George T. Furukawa and Robert E. McCoskey

The heat capacity of 41° and 122° F polybutadienes was measured from 15° to 330° K. The 41° F polybutadiene was found to have a higher (195° K) glass-transformation temperature than the 122° F polymer (187° K). Also, the 41° F polymer exhibited a higher degree of crystallizability than the 122° F polymer. The crystallization temperature range of the 41° F polymer was found to be 200° to 295° K and that of the 122° F polymer 200° to 270° K. The data were used to construct a smoothed table of heat capacity, enthalpy, and entropy from 0° to 330° K. 6 p.

RP2461. Thermal degradation of tetrafluoroethylene and hydrofluoroethylene polymers in a vacuum
S. L. Madorsky, V. E. Hart, S. Straus, and V. A. Sedlak

Teflon and tetrafluoroethylene photopolymers, on pyrolysis in a vacuum at 423.5° to 513.0° C, yield almost 100 percent of monomer. The rate of formation of monomer at any given temperature follows a first-order reaction and is independent of the method of preparation of polymer or its initial average molecular weight. The activation energy was determined by a pressure method and a weight method, and a value of 80.5 kcal was found by both methods. A preliminary heating of Teflon in air at 400° to 470° C did not change appreciably its rate of degradation into monomer when it was subsequently heated in a vacuum. Polyvinyl fluoride, 1,1-polyvinylidene fluoride, and polytrifluoroethylene were pyrolyzed in the range 372° to 500° C. The volatiles consisted in all cases of HF and a wax-like material consisting of chain fragments of low volatility. Polyvinyl fluoride and polytrifluoroethylene degrade to complete volatilization, whereas 1,1-polyvinolidene fluoride becomes stabilized at about 70-percent loss of weight. The rate-of-volatilization curves indicate a first-order reaction for polyvinyl fluoride a zero-order reaction for trifluoroethylene, and an undetermined order for 1,1-polyvinylidene fluoride. The order of thermal stability for these polymers, as compared with polymethylene, is as follows: Polyvinyl fluoride$<$polymethylene$<$ polytrifluoroethylene$<$1,1-polyvinylidene fluoride $<$ polytetrafluoroethylene. 7 p.

RP2462. An analogue computer for the solution of the radio refractive-index equation...Walter E. Johnson

The solution to the radio refractive-index equation provides information necessary to the research worker studying tropospheric radio propagation in the very high and ultrahigh regions. Present means of computation are either time consuming or of low accuracy. An analogue computer is developed to solve this equation by utilizing basic computation circuits incorporated into a null-balance bridge circuit. A unique feature of this computer is the modification of a linear 10-turn potentiometer so that its output to input voltage ratio versus rotation closely approximates the exponential-type curve of the saturated water-vapor term in the refractive-index equation.

This computer is now in use at the Central Radio Propagation Laboratory, of the National Bureau of Standards, Boulder, Colo., and has superseded other methods of calculating the radio refractive index. 8 p.

RP2463. On the accuracy of the numerical solution of the Dirichlet problem by finite differences........................J. L. Walsh and David Young

This paper derives numerical bounds for the error, in certain closed regions, of the difference analog of the Dirichlet problem. It is concerned only with the difference between the exact solution of the difference equation and the solution of the Dirichlet problem. The error bounds obtained involve quantities which can actually be computed, such as the mesh size, and the oscillation and modulus of continuity of the given function on the boundary. So far as the method is concerned, the chief novelty is the use of the difference analogs of harmonic measure and the Schwarz Alternating Process. 21 p.

TITLE PAGE AND CONTENTS TO VOLUME 51, 4 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 52, JANUARY—JUNE 1954

RP2464. Apparatus for the determination of minor components of a gas mixture
Martin Shepherd

The apparatus is primarily for the determination of the components occurring in low partial pressures in a gas mixture, and which ordinarily cannot be determined with satisfactory accuracy because of the significant sorption and desorption of major components in the reagents intended for the removal of the minor ones. Small amounts of solid and liquid reagents are used in the apparatus, and combustions, as well as absorptions, can be performed. The apparatus can be made a separate unit or part of a standard apparatus for volumetric chemical gas analysis. 6 p.

RP2465. Mismatch errors in the measurement of ultrahigh-frequency and microwave variable attenuators..........................R. W. Beatty

The mismatch error in the measurement of ultrahigh-frequency and microwave variable attenuators is analyzed and expressions are derived. An example is given to show that the mismatch error in measuring the difference in attenuation between two attenuators is less than the sum of the mismatch errors obtained when measuring each attenuator individually. 3 p.

RP2466. Heat capacity, heats of transitions, fusion, and vaporization, and vapor pressure of octafluorocyclobutane
George T. Furukawa, Robert E. McCoskey, and Martin L. Reilly

The heat capacity of octafluorocyclobutane of 99.98_9 mole-percent purity was determined in an adiabatic calorimeter from 17° to 270° K. The heat of fusion is 2768.2 ± 2.0 abs j mole^{-1} at the triple-point temperature of $232.96 \pm 0.05°$ K. The three heat-of-vaporization experiments at the vapor pressure of 590.9 mm Hg and 261.25° K gave an average value of 2371 ± 20 abs j mole^{-1}. Four solid-solid transitions were observed with the heat-capacity peaks at $141.3 \pm 0.2°$, $174.6 \pm 0.2°$, $214.84 \pm 0.05°$, and 216.99 ± 0.05 K. The anomalous behavior in the heat capacity at about 97° K, where the heat capacity changes its slope abruptly, is attributed to glass transformation. The vapor pressure was measured from 177° to 274° K. The results of this measurement from the triple-point temperature to 274° K can be represented within ± 0.5 mm Hg in most cases by the equation

$$\log_{10}p(\text{mm Hg}) = 6.70267 - \frac{1315.906}{T} + 8.778482\times10^{-3}T - 1.739691\times10^{-5}T^2$$

The entropy of octafluorocyclobutane in the ideal gas state at 261.25° K and 1 atm was computed from the experimental data to be 380.52 ± 0.71 abs j deg^{-1} mole^{-1} or 90.95 ± 0.17 cal deg^{-1} mole^{-1} (1 cal=4.1840 abs j). The entropy computed from the spectroscopic assignments by Claassen and the molecular constants based on the D_{4h} model amounted to 87.83 cal deg^{-1} mole^{-1}. 6 p.

RP2467. A characterization of normal matrices..........Alan J. Hoffman and Olga Taussky

A matrix A is called normal if $AA^* = A^*A$, where A^* is the transposed and conjugate matrix of A. It is known that for a pair of commuting matrices, A, B, there exists an ordering of the characteristic roots $\alpha_1, \ldots, \alpha_n$ of A and $\beta_1, \ldots,$

β_n of B, such that every polynomial $p(A,B)$ has as characteristic roots the numbers $p(\alpha_i,\beta_i)$. This property is, in general, weaker than commutativity, but does imply it if $B=A^*$. It is shown that this property already implies commutativity of A and A^* if it is assumed to hold for only one polynomial, provided the latter is suitably chosen. Polynomials of first and second degree are examined for their suitability. 3 p.

RP2468. Prediction of the likelihood of interference at frequencies of 30 to 42 megacycles in Alaska..........T. N. Gautier, Jr., and C. J. Sargent

The likelihood of interference with very-high-frequency networks in Alaska from stations operating on similar frequencies in other parts of the world, as a function of season, sunspot number, and time of day, is presented. This example serves as a model for similar computations for other communication links. Calculations are based upon regular reflection from the *F*2 layer, and data are supplied for estimating the probability of interference for sporadic-*E* reflections. 11 p.

RP2469. Tables for use in the interpretation of paramagnetic behavior below 1° K; for the chromic alums (J=3/2).........Ralph P. Hudson and Charles K. McLane

The method of interpreting susceptibility and entropy data, obtained in adiabatic demagnetization experiments, by means of the theory of Hebb and Purcell in order to derive absolute temperatures is recounted briefly. This forms an introduction to tables that enable one to carry out this procedure for the case of the chromic alums. 3 p.

RP2470. Phase equilibrium relations in the systems lime-titania and zirconia-titania.........L. W. Coughanour, R. S. Roth, and V. A. DeProsse

The systems CaO-TiO_2 and ZrO_2-TiO_2 were studied by means of solid-state reactions and by the observation of fusion characteristics. The existence of two binary compounds in the CaO-TiO_2 system was confirmed. One compound was found to exist in the ZrO_2-TiO_2 system. This compound, $ZrO_2 \cdot TiO_2$ has been found to have orthorhombic symmetry with the following parameters at room temperature: $a=4.806$ A, $b=5.032$ A, $c=5.447$ A. Solid-solution development was observed in the ZrO_2-TiO_2 system, but not in the CaO-TiO_2 system. From the data obtained, an equilibrium diagram is suggested for each system. 6 p.

RP2471. Conrady's chromatic condition.....................Donald P. Feder

Nearly fifty years ago Conrady published a simple and ingenious formula for determining the state of chromatic correction of an optical system. This method, called the "*D-d* achromatism", depends upon the variation of the optical path as a function of wavelength. It can be used to evaluate both axial and lateral color, chromatic variation of spherical aberration, and secondary chromatic aberration. Unfortunately, this method is not as well known or as widely used as it deserves to be.

This paper proves the exact equation and discusses an extension of it which is approximate. A numerical example illustrates the accuracy obtainable with the approximation. The principal applications are presented and formulas derived giving the relations between the "*D-d* method" and conventional means of expressing the chromatic aberration. 7 p.

RP2472. Synthesis and physical properties of several acetylenic hydrocarbons Philip Pomerantz, Abraham Fookson, Thomas W. Mears, Simon Rothberg, and Frank L. Howard

As a part of researches conducted on hydrocarbons as jet-fuel components under the auspices of the National Advisory Committee for Aeronautics, a number of acetylenic hydrocarbons and their intermediates have been prepared. The details of these syntheses and the physical constants measured on the compounds are presented. 8 p.

RP2473. Synthesis and physical properties of several aliphatic and alicyclic hydrocarbons...............Philip Pomerantz, Abraham Fookson, Thomas W. Mears, Simon Rothberg, and Frank L. Howard

The synthesis and purification of four paraffins, three cycloparaffins, six olefins, and five diolefins, and their intermediates are described. These compounds were prepared by standard reactions or modifications thereof, and purified by fractional distillation. Physical properties of the hydrocarbons are presented, and purity data are given for some of them. 7 p.

RP2474. Vibrational spectra of tetrafluoroethylene and tetrachloroethylene
D. E. Mann, Nicolo Acquista, and Earle K. Plyler

The infrared spectra of gaseous tetrafluoroethylene from 22 to 52 μ and liquid tetrachloroethylene from 3 to 52 μ have been determined. Several hitherto unobserved bands were found. New and satisfactory assignments, for which a detailed discussion is given, have been achieved. The out-of-plane force constants are discussed and used to predict the wagging and torsion frequencies of tetrabromoethylene. Tables of the thermodynamic functions for tetrafluoro- and tetrachloroethylene are presented. 6 p.

RP2475. Preparation of nickel chloride of high purity.....W. Stanley Clabaugh,
John W. Donovan, and Raleigh Gilchrist

A method is described for the preparation of cobalt-free nickel chloride, which consists in the repeated precipitation by hydrogen chloride of nickel chloride dihydrate from a mixture of a saturated aqueous solution of nickel chloride with acetone. Methods are also given for determining cobalt, aluminum, iron, copper, and combined phosphorus and silicon in nickel salts. 2 p.

RP2476. The system of lime, alumina, and water from 50° to 250° C
Richard B. Peppler and Lansing S. Wells

The system CaO-Al_2O_3-H_2O has been investigated over the range 50° to 250° C. At equilibrium, only two stable ternary compounds exist in the system, namely, $3CaO \cdot Al_2O_3 \cdot 6H_2O$ up to 215° C and $4CaO \cdot 3Al_2O_3 \cdot 3H_2O$ from 215° to 250° C. Hexagonal hydrated calcium aluminates occur as metastable phases with decreasing stability with increasing temperature until at temperatures over 100° C they exist only momentarily. There are only two stable alumina hydrates, namely, gibbsite ($Al_2O_3 \cdot 3H_2O$) up to 150° C, and boehmite ($Al_2O_3 \cdot H_2O$) thereafter. A stable phase throughout the temperature range is $Ca(OH)_2$. The equilibria curves of these solid phases maintain the same general relationships to each other throughout. As the temperature increases to 250° C, the solubility fields are compressed into the water apex of the diagram. 18 p.

RP2477. Absolute calibration of the NBS standard thermal neutron density
James A. DeJuren and Hyman Rosenwasser

A moderating geometry providing a constant thermal neutron flux from two radium-beryllium (α,n) sources has been constructed. The flux at the center of the geometry has been calibrated by absolute alpha counting from boron films exposed in pulse ionization chambers. The boron capture cross section has been obtained by comparison of the NBS boron with the Argonne "standard" boron, and a value of $n\hat{v}=3918$ (± 2 percent) n/cm^2 sec has been determined for the flux. 4 p.

RP2478. Electron-optical shadow method of magnetic-field mapping
L. Marton, J. Arol Simpson, and S. H. Lachenbruch

The essential features of the electron-optical shadow method for the quantitative mapping of magnetic fields are presented in unified form. The processes of obtaining and analyzing the shadowgrams are given in some detail. Iterative procedures of analysis, which have proved successful in practice, are illustrated by the mapping of an otherwise inaccessible ferromagnetic domain field. Sections 5 and 6 give an analytical method, involving inversion of integral operators. The method, although it has not yet been applied to the analysis of shadowgrams, is given because of its generality and applicability to the equivalent problem of interpretation of fluid dynamic interferograms. 8 p.

RP2479. Precise measurements with Bingham viscometers and Cannon master viscometers.....J. F. Swindells, R. C. Hardy, and R. L. Cottington

A critical study has been made of the techniques used at the National Bureau of Standards with Bingham viscometers and Cannon kinematic viscometers. All corrections applicable to measurements with these instruments were critically examined. Instruments of each type were calibrated using the viscosity of water at 20° C as the primary viscosity standard. The viscometers were used to determine the viscosities of four hydrocarbon liquids in the range of 0.4 to 40 centipoises. With each liquid, the values obtained in the two types of viscometers were in agreement by 0.05 percent or better, indicating that no gross error was involved in the use of either instrument. It is considered, however, that the inherent relative simplicity of operation of the kinematic viscometer makes it a preferable instrument for this type of measurement. 16 p.

RP2480. Coaxial radio-frequency connectors and their electrical quality
M. C. Selby, E. C. Wolzien, and R. M. Jickling

The widely accepted manner of evaluating the quality of coaxial radio-frequency connectors was in the past limited to a single case, namely, to the condition when the load terminating the system was equal to the characteristic impedance of the line on the output end of the connector. The quality was expressed as the voltage standing-wave ratio in the input line.

To broaden this method of evaluation a "connector" is redefined, and several methods are given to find the corrections of various types of connectors with any termination. Typical results of measurements made by these methods are given for frequencies from 100 to 900 megacycles. Application of these methods are also indicated in determining the quality of transmission lines in general. 12 p.

RP2481. Continuous measurement of atmospheric ozone by an automatic photoelectric method
Ralph Stair, Thomas C. Bagg, and Russell G. Johnston

An automatic photoelectric instrument and method for the continuous measurement of the ozone in the earth's atmosphere at low altitudes are described. The method is physical rather than chemical in character and is based upon the optical absorption characteristics of ozone in the Hartley and Huggins ultraviolet bands. The instrument makes use of a low-pressure mercury arc, which is situated at a distance of 1,450 feet from the recording station that employs a 1P28 photomultiplier as a detector. The light beam is modulated, at 510 cycles per second, so that the output of the photomultiplier is fed into a tuned alternating-current amplifier and amplified to the recorder level. By means of a Geneva mechanism, which changes the glass filters, the radiant energy from the map is separated into bands primarily at wavelengths 253.7, 365.5, and 405.0 millimicrons. From the ratios of the deflections for the different spectral regions it is possible to determine ozone concentration in the range from a few tenths of 1 part to many parts per 100 million. 7 p.

RP2482. Applications of dimensional analysis to spray-nozzle performance data
Montgomery R. Shafer and Harry L. Bovey

Some possible applications of dimensional analysis in studies of the performance of continuous fuel-spray nozzles of the centrifugal type are presented. Equations are developed showing the relations among nozzle capacity, mean drop diameter, spray angle, nozzle size, the density, viscosity, surface tension, and pressure of the fuel. Using experimental data available at the National Bureau of Standards and in the literature, good correlation is shown in considerations of nozzle capacity, and fair correlation in those involving mean drop diameter and spray angle. 7 p.

RP2483. Silver-uranium system....R. W. Buzzard, D. P. Fickle, and J. J. Park

The phase diagram of the system silver-uranium was constructed from data obtained by thermal analysis, metallographic examination, and X-ray diffraction. The system is characterized by a eutectic having a composition of approximately 5 weight percent of uranium occurring at 950° C, and a monotectic occurring at 1,132° C, and 0.23 weight percent of silver. The solid solubility of uranium in silver appeared to be between 0.1 and 0.4 weight percent at the eutectic temperature; no appreciable solubility of silver in uranium was noted. The temperatures of the gamma-beta and the beta-alpha transformation of uranium apparently were unaffected by silver. 4 p.

RP2484. Nonnegative trigonometric polynomials and certain rational characteristic functions....................Eugene Lukacs and Otto Szász

Let $0<b_1<b_2< \dots <b_n$ be n integers and $0<d_1<d_2< \dots <d_m$ be $m(m\leqq n)$ real numbers (not necessarily integers). Denote by $g(\theta)$ the Vandermonde

determinant formed from the $b_1^2, b_2^2, \ldots, b_n^2$ with the first row replaced by $1-\lambda_j \cos b_j\theta$, where $\lambda_j = \prod_{k=1}^{m} (1-b_j^2/d_k^2)$ for $j=1, 2, \ldots, n$. The question whether $g(\theta)$ is nonnegative for all values of θ is closely connected with the problem whether certain rational functions are characteristic functions. Four configurations of the $b_1, \ldots, b_n$, and $d_1, \ldots, d_m$ are studied, which lead to nonnegative trigonometric polynomials. 8 p.

RP2485. Flame-emission spectrum of water vapor in the 1.9-micron region
W. S. Benedict, Arnold M. Bass, and Earle K. Plyler

The emission of hydrogen-oxygen and acetylene-oxygen flames has been studied by using a 15,000-lines-per-inch grating spectrometer with a lead-sulfide photoconductive detector. The water-vapor band, which in room-temperature absorption extends from about 1.80 to 1.96 microns, is broadened in emission to 1.7 to 2.2 microns. Nearly 1,000 lines have been measured, and a rotational analysis has been given for many of them. Many lines of the (011–000) band agree with those found in laboratory and atmospheric absorption, and many additional lines from higher energy levels may be identified. The principal series $J_{-J} \longleftrightarrow (J+1)_{-(J+1)}$ may be followed out to $J=23$ in both P and R branches. Corresponding lines in the upper-state bands (021—010) and (031–020) have also been identified. A smaller number of lines may be assigned to the (041–030), (051–040), (012–001), (022–011), (032–021), (111–100), and (121–110) bands. 16 p.

RP2486. Use of Callendar's "radio-balance" for the measurement of the energy emission from radioactive sources.................... W. B. Mann

In 1910 H. L. Callendar described a calorimeter for measurement of radiant energy in which the quantity of heat to be measured is balanced against the cooling from a Peltier couple. He called this thermal-balance device a "radio-balance." The operation of the radio-balance has been extensively investigated to see whether it could be used for the accurate determination of the energy emission from radioactive sources. In the present experiments, measurements have been confined solely to radium preparations. For an absorption equivalent to 0.126 cm of lead a heat emission of 128.9 cal g^{-1} hr^{-1} has been found for radium in equilibrium with its products down to radium D. The estimated accuracy of this result is ±0.7 percent. 8 p.

RP2487. Some factors affecting the dimensional stability of the silver-tin-(copper-zinc) amalgams
J. A. Mitchell, I. C. Schoonover, George Dickson, and H. C. Vacher

An investigation of the X-ray diffraction characteristics and of the dimensional changes of silver-tin-(copper-zinc) amalgams during and after their hardening period indicated that uncombined mercury was present in the amalgams after the initial solidification and that this uncombined mercury disappeared during the period when greatest dimensional changes occur. On the basis of the data obtained, it is postulated that the expansion during the hardening of the amalgam results from diffusion of uncombined mercury throughout the material; the subsequent shrinkage then results from combination of this mercury with existing phases or with residual alloy. 9 p.

RP2488. A colorimeter for pyrotechnic smokes
Isadore Nimeroff and Samuel W. Wilson

A tristimulus photoelectric colorimeter has been designed to measure the chromaticities of pyrotechnic smokes having highly saturated colors. To minimize edge effects and rear-wall reflection, the smoke chamber was designed as a 36-inch cube. Three filters were designed to approximate the daylight CIE standard observer functions for the source-filter-phototube combinations of the instrument. As the CIE $\bar{y}$- and $\bar{z}$-functions are unimodal, little difficulty was encountered in designing filters to approximate these functions. The CIE x-function, which is bimodal, required a divided filter to approximate its two lobes. The filter constructed was composed of two sectors, one approximating the "blue lobe" the other approximating the "red lobe" of the $\bar{x}$-function. Satisfactory results have been obtained with this colorimeter, using Munsell papers as standards. 5p.

RP2489. Simplification of calculations in routine density and volumetric determinations. . . . . Charles T. Collett

In density and volumetric determinations, certain methods of weighing have encouraged the use of approximations. These can be avoided by minor changes in procedure that simplify claculations. The use of counterpoises is shown to eliminate some buoyancy corrections. 4 p.

RP2490. Infrared spectrum of hydrogen sulfide in the 6,290-cm^{-1} region
Harry C. Allen, Jr., and Earle K. Plyler

The absorption of hydrogen sulfide in the region 6,100 to 6,500 cm^{-1} has been measured under high resolution. The rotational fine structure has been analyzed through the use of published energy tables for the rigid rotor. A classical centrifugal-distortion correction was applied to the rigid energy levels. It is found that there are two overlapping bands in this region, a normally strong, A-type band, the $(n_1, n_2, n_3)=(1,1,1)$, and a normally weak, B-type band, which becomes strong enough to be observed by borrowing intensity from the A-type band through a Coriolis interaction. The B-type band is the lower component of the resonating pair (2,1,0) and (0,1,2). The excited state inertial parameters giving the best fits are (1,1,1) band, $A=10.398$, $B=8.935$, $C=4.548$, $\mu_0=6289.26$ cm^{-1}; (0,1,2) band, $A=10.394$, $B=8.918$, $C=4.547$, $\mu_0=6288.28$ cm^{-1}. 6 p.

RP2491. New formulas for facilitating osculatory interpolation . . Herbert E. Salzer

Hermite's n-point osculatory interpolation formula for equally spaced arguments at intervals of h, employing the function and its derivative is very much more accurate than the corresponding n-point Lagrangian formula and considerably more accurate than even the $2n$-point Lagrangian formula at intervals of h. Also it is specially suited for interpolation in many functions (e. g., Bessel, probability) that are tabulated with their derivative. To avoid the tremendous amount of labor in calculating the coefficients of f_i and f_i' in the forms that they are usually given, Hermite's formula is expressed as

$$f(x_0+ph)=\sum_i(\alpha_i f_i+\beta_i h\, f_i')/\sum_i \alpha_i+R_{2n}(p),$$

where

$$\alpha_i\equiv \alpha_i/(p-i)^2+b_i/(p-i),\ \beta_i\equiv a_i/(p-i),$$

and where

$$a_i=k(n)/\left\{\prod_{j=-[(n-1)/2]}^{[n/2]}{}' (i-j)\right\}^2,\ b_i=-2L_i^{(n)\prime}(i)a_i,\ L_i^{(n)}(p),$$

being

$$\prod_{j=-[(n-1)/2]}^{[n/2]}{}' (p-j)/\prod_{j=-[(n-1)/2]}^{[n/2]}{}' (i-j).$$

The constant $k(n)$, which may be picked arbitrarily, is here chosen to make a_i and b_i integers. The exact values of a_i and b_i are given for $n=2(1)11$, $i=-[(n-1)/2]$ to $[n/2]$ so that this formula can be applied exactly for any polynomial up to the 21st degree. A schedule gives approximate upper bounds for the coefficients of $f^{(2n)}(\xi)h^{2n}\sim\Delta^{2n}f(x)$ in $R_{2n}(p)$. 6 p.

RP2492. Apparent specific volume of polystyrene in benzene, toluene, ethylbenzene, and 2-butanone
Maurice Griffel, Ralph S. Jessup, Joseph A. Cogliano, and Rita P. Park

Measurements have been made at temperatures near 27° and 30° C of the densities of purified benzene, toluene, ethylbenzene, and 2-butanone (methylethylketone), and of solutions of a purified sample of polystyrene in these solvents. Within the precision of the measurements (about 1 or 2 in 10^5 density) the apparent specific volume of the polystyrene is a constant independent of the concentration in any one solvent, but depends to some extent upon the solvent. The lowest values, which were obtained with 2-butanone, are about 1 percent lower than the highest values, which were obtained with ethylbenzene. The values are all lower than those of the virtual liquid polymer, obtained by extrapolation of data on specific volume above the glass transition temperature, although the data of other observers indicate that this is not true for all solvents. In all four solvents the change of the apparent specific volume with temperature is less than for the liquid polymer.

The changes in volume upon mixing of polystyrene with the solvents are shown to have a significant effect on such thermodynamic properties as heat, free energy, and entropy of mixing. 6 p.

RP2493. A cryoscopic study of the solubility of uranium in liquid sodium at 97.8° C.......................................Thomas B. Douglas

The equilibrium temperatures, at various stages of melting, of three samples of sodium were measured with a standard deviation of 0.001 degree. One sample contained uranium in compact form, and one contained finely divided uranium. Impurities lowered the freezing points of all the samples by approximately 0.035 degree, but the sodium containing finely divided uranium was found to have a freezing point higher than those of the other two samples by 0.005 degree, an effect that may be due to a partial purification of the sodium by the uranium. After extrapolation to no impurity, the freezing points of the three samples agree within 0.001 degree. Allowing for errors, it is concluded that the solubility of uranium in liquid sodium at 97.8° C probably does not exceed 0.05 percent by weight and may actually be many times smaller. 4 p.

RP2494. Multirange, audiofrequency thermocouple instruments of high accuracy
F. L. Hermach and E. S. Williams

Two new types of thermocouple instruments developed at the National Bureau of Standards are described. The first, called a volt-ampere converter, is used with a direct-current potentiometer to make measurements of alternating-current voltage and current over wide ranges with an accuracy of 0.05 percent at frequencies up to 20 kc/s. The second is a 0.5-percent multirange thermocouple volt-ammeter incorporating simple circuits so that the thermal converter may be checked with the indicating instrument normally connected to it. 8 p.

RP2495. Fatigue notch sensitivity of some aluminum alloys
J. A. Bennett and J. G. Weinberg

The notch sensitivity in fatigue was determined for 24S–T4, 61S–T6, and 75S–T6 aluminum alloys. Specimens having thereotical stress-concentration factors of 1.0, 1.4, and 1.8 were used, and the fatigue-strength reduction factor was based on the number of cycles required to initiate the fatigue crack. The values of notch sensitivity for 61S–T6 in the small radius specimens and for 24S–T4 were close to unity, whereas that for 75S–T6 was much lower. The data also provide information on the dispersion of fatigue results for the different alloys and the portion of the total life required for a fatigue crack to grow to fracture. 11 p.

RP2496. Compressibilities of crystalline and glassy modifications of selenium and glucose..Charles E. Weir

Data are reported for the compression of selenium and α-glucose in both glassy and crystalline modifications at 21° C between 1,000 and 10,000 atmospheres. The compressibilities of the glassy form were found to be considerably larger than those of the crystals. A transition of unknown origin was observed to occur in glassy glucose between 7,000 and 8,000 atmospheres. 3 p.

RP2497. Atypical pH response of some nonsilicate glasses. Herman F. Shermer, Gerald F. Rynders, Given W. Cleek, and Donald Hubbard

It is generally believed that a glass, in order to yield electrodes whose voltage characteristics serve as a satisfactory indicator of the hydrogen-ion activity of aqueous solutions in accord with the dictates of the Nernst equation, must possess at least a minimum hygroscopicity and an adequate chemical durability, uniform over an extended pH range. Three series of nonsilicate glasses, $Na_2O-MgO-P_2O_5$, Na_2-O-GeO, and $BaO-B_2O_3$, were investigated for these three properties. In accord with the fact that all of the members of these series exhibited very poor chemical durability and many of them possessed very low hygroscopicity, none of them produced electrodes that had a satisfactory pH response. All of the series confirmed the generally accepted fact that hygroscopicity cannot be directly correlated with chemical durability of glasses. For example, some members of the

$BaO-B_2O_3$ series possessed hygroscopic properties that compared favorably with Pyrex 7740, yet had unusually poor chemical durability. 8 p.

RP2498. A numerical solution of Schrödinger's equation in the continuum
W. Futterman, E. Osborne, and David S. Saxon

Continuum solutions of Schrödinger's equation for two particles that interact according to a central Yukawa potential are obtained by numerical integration. The resulting wave functions are tabulated, as are the phase shifts which determine the asymptotic behavior of the solutions. 6 p.

RP2499. Electrical measurements in the selection of bolt materials for service underground.............................W. J. Schwerdtfeger

Electrical measurements made in the laboratory are useful in generally predicting the relative behavior of bolt materials underground as pertaining to the corrosive effect of the soil. Some arbitrarily chosen low-alloy ferrous materials are shown to be superior to plain cast iron or steel commonly used for the fabrication of bolts. The effect of exposure on the potentials of cast iron and galvanized iron as components of galvanic couples is described. 10 p.

RP2500. Heat capacity of gaseous perfluoropropane......Joseph F. Masi,
Howard W. Flieger, Jr., and John S. Wicklund

An accurate flow calorimeter, previously described, has been used to measure the heat capacity of gaseous perfluoropropane (C_3F_8) at three pressures up to 1.5 atmospheres at each of the temperatures −30°, +10°, +50°, and +90° C. The results, believed accurate to 0.1 percent, have been extrapolated to zero pressure at each temperature, in order to obtain the ideal-gas heat capacity (C_p°) and the pressure coefficient of heat capacity. Values of C_p° are 31.10, 34.22, 37.02, and 39.49 calories $mole^{-1}$ degree C^{-1}, respectively, at the four temperatures of measurement. 4 p.

RP2501. Discussion of current-sheet approximations in reference to high-frequency magnetic measurements..........Bohdan Kostyshyn and
Peter H. Haas

The problem of violations of thin, uniform current-sheet assumptions in toroidal coils of rectangular cross section is investigated from the viewpoint of high-frequency magnetic measurements. The errors resulting by neglecting leakage flux and by assumptions as to the location of effective current sheets are investigated experimentally as a function of permeability, core dimensions, wire spacing, and wire size. Conclusions are reached as to the adequacy of at least two attempts at calculations of these errors. Finally, conclusions are drawn as to the limitations of measurements on toroidal coils by high-frequency considerations. 9 p.

RP2502. Thermodynamic functions for carbon dioxide in the ideal gas state
Harold W. Woolley

The thermodynamic functions C_p°/R, $(H^{\circ}-E_0^{\circ})/RT$, $-(F^{\circ}-E_0^{\circ})/RT$, and S°/R for carbon dioxide in the ideal gas state are given from 50° to 5,000° K, based on the latest spectroscopic data. 4 p.

RP2503. Optical spectroscopic determination of hydrogen isotopes in aqueous mixtures. Herbert P. Broida, Harold J. Morowitz, and Margaret Selgin

Extension of the optical spectroscopic method of iostope analysis of gaseous mixtures of hydrogen and deuterium to mixtures of water and heavy water provides a direct method for determining the total water content of materials. A determination can be made on a sample of less than 0.1 milliliter in less than 10 minutes to an accuracy of a few percent. Using a sample of at least 1 milliliter, an accuracy of the order of 0.1 percent is obtained in an hour or less. This paper describes the system and the investigation of optimum operating conditions and effect of variations in operating conditions on precision and accuracy of measurement, as well as limitations of the technique. A sample of blood or serum can be measured directly almost as easily as one of distilled water. The optical spectroscopic method can be used to determine the water content of most materials, whether in the solid, liquid, or gas phase. 9 p.

RP2504. Refractive indices of five selected optical glasses. . Robert E. Stephens and William S. Rodney

The refractive indices of typical samples of five optical glasses made at the National Bureau of Standards were measured over a range of wavelengths from 0.35 to 2.32 microns. This was done in such a way that the values obtained in the visible and invisible portions of the spectrum are consistent with one another. The results are expressed for each glass by a six-constant dispersion formula. 2 p.

RP2505. Spectral transmissive properties of five selected optical glasses
Harry J. Keegan, Marion A. Belknap, and Dorothy J. Cordrey

Measurements of the spectral transmittance and internal transmittance of five optical glasses for the wavelength region 200 to 1,000 millimicrons are reported. 4 p.

RP2506. Densities of five selected optical glasses. . . . . Charles T. Collett

Densities of five optical glasses were determined by the hydrostatic weighing method. Values are presented by type of glass, index of refraction, and Abbe value. 1 p.

RP2507. Thermal expansion of five selected optical glasses. . . . Peter Hidnert

Coefficients of linear thermal expansion of five optical glasses were determined by a strain gage method for the range between room temperature and 60° C. The coefficients of expansion of two crown glasses are 7.6×10^{-6} per deg C. A rare-earth glass was found to have a slightly lower coefficient of expansion, but the coefficients of expansion of two flint glasses are 10 percent larger than the other glasses. 2 p.

RP2508. Evaluation of the exponential integral for large complex arguments
John Todd

Two methods of evaluating the exponential integral for (large) complex arguments are discussed. It is shown that the Laguerre quadrature method is more efficient than the asymptotic expansion. Examples are given to show the practicability of the Laguerre method. 5 p.

RP2509. On nearly triangular matrices. . . . . A. M. Ostrowski

A discussion is presented of the change in the inverse of a triangular matrix if on one side the zeros are replaced by sufficiently small numbers and on the other side the nonvanishing elements are varied by sufficiently small amounts. 27 p.

TITLE PAGE AND CONTENTS TO VOLUME 52, 5 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 53, JULY—DECEMBER 1954

RP2510. Correlation of polarized light phenomena with the orientation of some metal crystals. . . . . C. J. Newton and H. C. Vacher

A photometric study was made of the reflection of plane polarized light normally incident in a metallographic microscope upon specimens of tin, aluminum, and monel, with various surface treatments. A high degree of correlation was found in most cases between the extinction position and the projection of the optic axis or of the cubic axis making the greatest angle with the surface normal. Moreover, a fourth power sine relationship was observed between the change of intensity and the angle between the surface normal and the optic axis in tin. The intensity correlation in the case of the cubic metals was not so clear, but a slight indication of position dependence was observed for aluminum. The results indicate that the optically anisotropic effects observed with cubic metals can be caused both by anisotropic films and by oriented surface contours, but that the latter is the source of those effects that are correlated with the crystallographic orientation of the grain. 12 p.

RP2511. Separation of iodide, bromide, and chloride from one another and their subsequent determination. Thomas J. Murphy, W. Stanley Clabaugh, and Raleigh Gilchrist

A method is described for separating iodide, bromide, and chloride from one another. First, the iodide ion is oxidized to elementary iodine by hydrogen peroxide in weakly acid solution and the iodine removed by distillation. Next, bromide is oxidized to bromine without affecting the chloride ion by use of a controlled concentration of nitric acid as oxidizing agent. After removal of bromine by distillation, chloride remains in the residual solution.

Determination of the individual halides depends on the quantity of each. If in trace amounts, a turbidimetric method is used; if in larger amounts, potentiometric titration with silver nitrate is used.

A description of the apparatus used is also given. 6 p.

RP2512. Relative humidity-temperature relationships of some saturated salt solutions in the temperature range 0° to 50° C. . Arnold Wexler and Saburo Hasegawa

The relative humidity-temperature relationships have been determined in air in equilibrium with saturated salt solutions of lithium chloride, $LiCl \cdot H_2O$; magnesium chloride, $MgCl_2 \cdot 6H_2O$; sodium dichromate, $Na_2Cr_2O_7 \cdot 2H_2O$; magnesium nitrate, $Mg(NO_3)_2 \cdot 6H_2O$; sodium chloride, $NaCl$; ammonium sulfate, $(NH_4)_2SO_4$; potassium nitrate, KNO_3; and potassium sulfate, K_2SO_4, over a temperature range of 0° to 50° C, using the dewpoint method. The relative humidity is a continuous function of temperature, and, except for sodium chloride, is monotonic. The curve for sodium chloride increases from 74.9-percent relative humidity at 0° C to a maximum of 75.6 percent at 30° C and then gradually decreases to 74.7 percent. The maximum change in relative humidity with temperature, about 15-percent relative humidity as the temperature increases from 0° to 50° C, occurs with saturated salt solutions of sodium dichromate and magnesium nitrate. 8 p.

RP2513. Disintegration rate of carbon-14. . R. S. Caswell, J. M. Brabant, and A. Schwebel

The energy emission rates of C^{14} samples have been measured with an extrapolation ionization chamber. From the energy emission rates, the disintegration rates are determined through knowledge of the average beta-ray energy emitted per disintegration. From earlier data on the iostopic abundance, a value for the half-life of C^{14} of 5,900 ±250 years is obtained. 2 p.

RP2514. Testing of large optical surfaces with small test plates James B. Saunders

A procedure for testing large optical surfaces with relatively small optical standards is described. Simplified formulas are used to apply a statistical method for obtaining increased precision. A practical example is used to illustrate the procedure for testing surfaces that may be assumed to have revolution symmetry. 6 p.

RP2515. Bacher and Goudsmit theory of complex spectra. . . . . R. E. Trees

The Bacher and Goudsmit theory expresses the energy of a state of an atom in terms of a linear combination of energies of states of other ions of the same atom. This theory is tested in the spectra with *d*- and *s*-electrons and general conclusions drawn about its accuracy.

In deriving their theory, Bacher and Goudsmit formally introduced many-particle interactions. They showed (to a limited extent) that this was equivalent to a second procedure in which the zero-order wave functions were assumed to be independent of the ionization and successive orders of perturbations were included.

Recently it has been shown that a linear theory, which is a combination of the Slater theory and an empirically derived correction, predicts the separations of terms in any one configuration with about the same accuracy as the Bacher and Goudsmit theory; in this theory, the wave functions are allowed to depend on the degree of ionization. It is shown that the Bacher and Goudsmit theory can be interpreted in a third way that is consistent with this linear theory.

In the light of this latter interpretation, Racah has suggested an empirical modification of the Bacher and Goudsmit theory that often leads to better results; this suggestion has been incorporated in the present paper. 14 p.

RP2516. Self-ignition temperatures of combustible liquids. . Nicholas P. Setchkin

The methods previously used for determination of the ignition temperatures of liquids are briefly reviewed, and the large discrepancies in reported values noted.

Various factors which affect the determined values of ignition temperature are discussed. A practical ignition apparatus consisting in part of an insulated spherical flask, designed to provide conditions favorable to low ignition temperature values, is described, and data obtained with this apparatus on a considerable number of combustible liquids are presented. The usefulness of time-temperature curves of a thermocouple junction placed in mixtures of combustible liquid and air, as a means of studying the preignition reactions in such mixtures is illustrated. 18 p.

RP2517. Delta ferrite-austenite reactions and the formation of carbide, sigma, and chi phases in 18 chromium-8 nickel-3.5 molybdenum steels
H. C. Vacher and C. J. Bechtoldt

Three 18 Cr-8 Ni-3.5 Mo steels of slightly different compositions were given "solution treatments" at 2,500°, 2,000°, and 1,800° F, and samples of each were reheated at 1,700°, 1,500°, and 1,200° F. Ferrite residues, remaining after dissolving the austenite in the solution-treated steels were analyzed chemically and given the reheat treatments, along with the parent steels. A metallographic study of the effect of chemical composition of the delta ferrite and austenite phases, and of the amount of delta ferrite, on the formation of carbide, sigma, and chi phases, was made. It was found that the products formed at a certain reheating temperature were influenced by the amount and composition of the delta ferrite phase present in the solution-treated steels, the amount and composition of the delta ferrite being determined by the solution-treatment temperature. Distribution ratios for Cr, Ni, Mo, and Mn in the delta ferrite and austenite phases of the solution-treated steels were 1.2, 0.5, 1.7, and 0.9, respectively. 10 p.

RP2518. Determination of hydrogen by slow combustion over platinum in excess oxygen........Shuford Schuhmann and Martin Shepherd

The accuracy and reproducibility of the determination of hydrogen by combustion with excess oxygen over a hot platinum helix (slow combustion) have been experimentally measured. The combustion of a pure hydrogen gave the observed stoichiometric relationship, $H_2 + 0.4996\ O_2 \rightarrow 1.4996$ contraction. The ideal relationship, corrected for the deviations of hydrogen and oxygen, is $H_2 + 0.4994\ O_2 \rightarrow 1.4994$ contraction. Uncorrected, the method gave these results: Hydrogen calculated from the contraction, 99.98 ±0.03 percent; hydrogen from oxygen consumed, 99.91 ±0.13. Corrected, these results became 100.02 ±0.03 and 100.03 ±0.13, respectively. 4 p.

RP2519. Anhydrous sodium hydroxide: The heat content from 0° to 700° C, the transition temperature, and the melting point
Thomas B. Douglas and James L. Dever

Samples of sodium hydroxide, whose purity as indicated by analyses was approximately 99.3 percent, were sealed in pure silver. Cryoscopic measurements indicated a transition temperature of 293° C. Using a "drop" method and a Bunsen ice calorimeter, the enthalpy change between 0° and each of 11 temperatures up to 700° C was measured. With reasonable simplifying assumptions, the thermal measurements near the freezing point were used to correct for the impurity, giving for pure sodium hydroxide a melting point of 319° C and the same value, 159 absolute joules per gram, for the heat of fusion and the heat of transition. The heat capacity derived for the liquid is estimated to be correct within 2 percent, whereas the derived heats of fusion and transition may be in error by as much as 5 percent. Values of heat capacity, entropy, relative enthalpy, and relative free energy are tabulated at regular intervals from 298° to 1,000° K. 10 p.

RP2520. Heat content of molybdenum disilicide from 0° to 900° C
Thomas B. Douglas and William M. Logan

The heat content relative to 0° C of a sample of molybdenum disilicide ($MoSi_2$) was measured at 100-degree intervals up to 900° C, using a nichrome-V container for the sample, a silver-core furnace, and a precision ice calorimeter. Corrections were applied for the impurities (approximately 2 percent) reported to be in the sample. The equation

$$H_t - H_0 = 0.48560t + 3.586(10^{-5})t^2 - 41.78 \log_{10}[(t+273.16)/273.16],$$

giving between 0° and 900° C the heat content in absolute joules per gram at t° less that at 0° C, represents the unsmoothed corrected mean values, with an average deviation of 0.24 absolute joule gram $^{-1}$. This equation is believed to have an absolute accuracy within 2 percent between 100° and 800°. Values of the relative heat content, heat capacity, and relative entropy derived from this equation are formulated and tabulated at even temperatures. 3 p.

RP2521. Precise comparison method of testing alternating-current watthour meters .... A. W. Spinks and T. L. Zapf

A brief description of the basic method of testing alternating current watthour meters at the National Bureau of Standards is given, followed by a description of equipment for a faster and less laborious method.

Equipment with several novel features has been assembled for making precise tests of alternating-current watthour meters by a comparison method employing a group of carefully selected alternating-current watthour meters, which serve as a secondary standard group. One of this group, designated the "Standard Watthour Meter", is used with multirange instrument transformers as a reference standard to test other watthour meters with good precision. The testing procedure is explained, and the formulas used in computing the results of the tests are derived.

An analysis of the possible errors of measurement and data from numerous tests indicate that the measurement of energy applied to a watthour meter under test can be relied upon to better than 0.06 percent. 11 p.

RP2522. Mass spectra of the deuteroethylenes .... Vernon H. Dibeler, Fred L. Mohler, and M. de Hemptinne

Samples of all of the deuteroethylenes have become available in satisfactory purity, and mass spectra have been measured and corrected for isotopic impurities. The mass spectra of *cis* and *trans* dideuteroethylene are nearly identical, and the spectrum of the asymmetrical dideuteroethylene is similar to the symmetrical molecules in the mass range 24 to 30. The probability of removing an H atom from the deuteroethylenes relative to the probability in C_2H_4 is equal to the a priori probability times 1.10, $(1.10)^2$, and $(1.10)^3$ in molecules containing 1, 2, and 3 D atoms, and the relative probability of removing a D atom is 0.90 in C_2D_4 and is nearly equal to the a priori probability times $(0.90)^2$, $(0.90)^3$, and $(0.90)^4$ in molecules C_2HD_3, $C_2H_2D_2$, and C_2H_3D, respectively. As the factors 1.10 and 0.90 are nearly reciprocals, these ratios can be expressed as positive and negative powers of 1.10. The probabilities of removing 2, 3, or 4 atoms are powers or products of the probability of removing single atoms, and thus are also positive and negative powers of 1.10. Similar relations are found in the previously published data on deuteroacetylenes. 5 p.

RP2523. Spectral distribution of energy from the sun .... Ralph Stair, Russell G. Johnston, and Thomas C. Bagg

Measurements on the spectral energy distribution of direct solar radiation, made in July 1953, at Sacramento Peak, New Mexico, altitude 9,200 feet are described. Spectral data are given for wavelengths extending from 299 to 535 millimicrons for air masses 0, 1.0, 2.0, and 3.0. A determination of atmospheric transmittance as a function of wavelength results in calculated total amounts of ozone approximating 0.21 centimeter (ntp) as a mean for 4 days during July. Preliminary measurements, employing a lead sulfide photoconducting cell, in the visible and infrared spectrum are discussed. On the basis of the spectral ultraviolet data obtained, an estimate of a value slightly exceeding 2.00 langleys per minute for the solar constant is indicated. 7 p.

RP2524. Factors affecting the thermal stability of polytetrafluoroethylene R. E. Florin, L. A. Wall, D. W. Brown, L. A. Hymo, and J. D. Michaelsen

The structure and kinetics of thermal decomposition of polytetrafluoroethylene suggested several methods for improvement of its stability: (a) polymerization in the presence of fluorocarbon catalysts or photochemically to eliminate labile centers for initiation, (b) inclusion of foreign structural units in the polymer to promote chain transfer of the free radicals active in depolymerization, (c) inclusion of foreign molecules capable of promoting chain transfer. The catalysts tried included perfluorodimethylmercury, perfluoromethyl iodide, and fluorine gas, as well as conventional catalysts. The foreign structural units and additives included sulfur, selenium, and a variety of hydrocarbon and fluorocarbon groups, mainly aromatic, added usually as dibromides to the polymerizing mixture. None of the experimental catalysts or additives brought about any change in the rate of thermal decomposition. 10 p.

RP2525. Optical rotations, refractive indices, and densities of dextran solutions
C. F. Snyder, H. S. Isbell, M. R. Dryden, and N. B. Holt

Clinical dextrans obtained from commercial sources, using different strains of *Leuconostoc mesenteroides*, were found to vary in optical rotation ($[\alpha]^{20^\circ\,\mathrm{C}}_{5893\,\mathrm{A}}$) from +194.6° to +211.0°. Samples derived from the same strain of bacteria, however, did not differ widely. With few exceptions, all samples of clinical dextran derived from the Northern Utilization Research Branch of the Agriculture Research Service (formerly Northern Regional Research Laboratory), B512 strain of *Leuconostoc mesenteroides*, have values in water solutions of $[\alpha]^{20^\circ\,\mathrm{C}}_{5893\,\mathrm{A}} = +199^\circ \pm 2^\circ$ and $[\alpha]^{20^\circ\,\mathrm{C}}_{5461\,\mathrm{A}} = +235^\circ \pm 1^\circ$. The specific rotation was found to vary with temperature, in the range 15° to 30° C, according to the equation

$$[\alpha]^{20^\circ\,\mathrm{C}}_{5893\,\mathrm{A}} = [\alpha]^{t}_{5893\,\mathrm{A}}\ (1 + 0.00033(t - 20)).$$

The presence of 0.9 percent of sodium chloride or less than 10 percent of methanol did not alter the optical rotation of aqueous dextran appreciably; 40-percent methanol solution caused an increase of about 1 percent.

The factor for converting quartz-wedge-saccharimeter readings of dextran solutions to angular degrees and sodium light was determined and found to agree with the factor (0.3462) ordinarily used for sugar solutions.

Measurements of refractive index and of apparent density in air gave the following equations: $n^{20^\circ\,\mathrm{C}}_{5893\,\mathrm{A}} = 1.33299 + 0.00151p + 0.0000064p^2$, and $d_{20^\circ\,\mathrm{C}} = 0.99717 + 0.00398p + 0.000016p^2$, where p is the number of grams of dextran in 100 g of aqueous solution (weights in air). Tables of refractive indices and apparent densities are given for aqueous solutions and for solutions containing 0.9 and 0.3 percent W/V of sodium chloride. 7 p.

RP2526. Calorimetric properties of normal heptane from 0° to 520° K
Thomas B. Douglas, George T. Furukawa, Robert E. McCoskey, and Anne F. Ball

Precise measurements of the heat capacity of solid and liquid *n*-heptane from 20° to 523° K are described. An adiobatic calorimeter, with which were determined also the triple point and the heat of fusion, was used from 20° to 370° K, whereas a drop method was used with a Bunsen ice calorimeter from 273° to 523° K. These two series of heat-capacity measurements and three other series of independent values show a maximum difference of approximately 0.25 percent in the range 50° to 370° K. Besides the heat capacity, the enthalpy, entropy, and Gibbs free energy of the solid and liquid at saturation pressures from 0° to 520° K are derived and tabulated. The same properties of the ideal gas from 298° to 470° K also are derived by making use of published precise measurements of gaseous heat capacity, heat of vaporization, and the normal boiling point. Interconsistency in the values of the various thermal properties is shown by the fact that the vapor pressures calculated from these values agree with those precisely measured by other investigators between 299° and 372° K to within ±0.1 percent. 15 p.

RP2527. Sensitivity—a criterion for the comparison of methods of test
J. Mandel and R. D. Stiehler

In the evaluation of many methods of test, the two usual criteria—precision and accuracy—are insufficient. Accuracy is only applicable where comparisons with a standard can be made. Precision, when interpreted as degree of reproducibility, is not necessarily a measure of merit, because a method may be highly reproducible merely because it is too crude to detect small variations.

To obtain a quantitative measure of merit of test methods, a new concept—sensitivity—is introduced. If M is a measure of some property Q, and σ_M its standard deviation, the sensitivity of M, denoted ψ_M, is defined by the relation $\psi_M = (dM/dQ)/\sigma_M$. It follows from this definition that the sensitivity of a test method may or may not be constant for all values of the property Q. A statistical test of significance is derived for the ratio of sensitivities of alternative methods of test. Unlike the standard deviation and the coefficient of variation, sensitivity is a measure of merit that is invariant with respect to any functional transformation of the measurement, and is therefore independent of the scale in which the measurement is expressed. 5 p.

RP2528. Infrared emission spectra of cyanide and dicarbon radicals
W. S. Benedict and Earle K. Plyler

The infrared region from 1 to 1.3 microns has been studied for low-intensity radiation in an oxyacetylene flame with a rich fuel mixture. When the inner cone was focused on the slit of the spectrometer, two regions of the spectrum showed rotational structure that has been identified as arising from C_2 and CN. The lines have been classified, and from their intensities the flame temperature has been found to be $2,600° \pm 200°$ K. 4 p.

RP2529. Refractivity measurements on thick plates.........James B. Saunders

An interferometer is described that permits measurement on refractive gradients in thick transparent bodies. The order of interference does not depend upon the thickness of the specimen. Any monochromatic light source may be used to test plates of any thickness. A 10-inch aperture interferometer of this type has been constructed and used successfully to measure index gradients in thick glass disks. 7 p.

RP2530. Installation for adiabatic demagnetization experiments at the National Bureau of Standards...............D. de Klerk and R. P. Hudson

A description is given of the National Bureau of Standards equipment for the production and measurement of very low temperatures by the method of adiabatic demagnetization. The construction of the cryostat and that of the mutual-inductance bridge are described in detail and the relative advantages of iron-cored electromagnets and iron-free solenoids are discussed. 12 p.

RP2531. Index of refraction of fused-quartz glass for ultraviolet, visible, and infrared wavelengths.....William S. Rodney and Robert J. Spindler

The index of refraction of fused-quartz glass was determined for 24 wavelengths from 0.34669 to 3.5078 microns, using the minimum-deviation method. The whole range was covered with a single instrument. The variation in index between samples was determined; no definite variations in dispersion were observed. Possible relations between purity and index are discussed. 5 p.

RP2532. New experimental designs for paired observations
W. J. Youden and William S. Connor

There are many experimental situations in which observations naturally occur in pairs. From v quantities to be compared, $v(v-1)/2$ distinct pairs can be formed, so that for even moderately large v, the accompanying number of observations may be prohibitively large. Or, even if the work can be done, the precision of the estimates of the effects of the quantities and the experimental error may be greater than is needed. In either event, a subset of the pairs should be used. If the arithmetic is to be manageable, this subset must be chosen with care. Such a subset is described and its analysis is given in detail. 6 p.

RP2533. Application of infrared spectroscopy to the determination of impurities in titanium tetrachloride...Rolf B. Johannesen, Charles L. Gordon, James E. Stewart, and Raleigh Gilchrist

The infrared spectrum of pure titanium tetrachloride was measured in the range of 2 to 15 microns, and, by adding known amounts of certain substances, it was possible to identify the common impurities likely to be found in refined titanium tetrachloride and to establish their limits of detection. The application of infrared spectroscopy made possible a sensitive method of following the process of purification of the tetrachloride. 4 p.

RP2534. Some properties of porcelains and phase relations in the ternary systems of beryllia and zirconia with titania, ceria, and chromia
S. M. Lang, R. S. Roth, and C. L. Fillmore

The following physical properties were determined for some $BeO\text{-}TiO_2\text{-}ZrO^2$ and $BeO\text{-}CeO_2\text{-}ZrO_2$ porcelain specimens of less than 0.10 percent equivalent water absorption: Maturing range, 1,450° to 1,750° C; shrinkage, 13.9 to 18.7 percent; bulk density, 3.0 to 5.8 g/cm^3; room-temperature sonic elastic properties—Young's modulus, 18.7 to 43.6×10^6 lb/in.^{2}, shear modulus, 8.0 to 18.1×10^6 lb/in.^{2}, Poisson's ratio, 0.17 to 0.28, and bulk modulus, 5.3 to 12.1×10^6 lb/in.^{2}—for each specimen tested for transverse strength; room-temperature static strength properties—transverse, 12.0 to 23.4×10^3 lb/in.^{2}, and compressive, 112 to 271×10^3 lb/in.^{2}—and Young's modulus, 18.7 to 46.8×10^6 lb/in.^{2}; and, at 1,800° F (982° C), static transverse strength, 9.1 to 18.1×10^3 lb/in.^{2}, Young's modulus, 21.5 to 38.3 $\times 10^6$ lb/in.^{2}, and strain rates under various stresses. Because of the loss of chromia from the samples during preliminary heating trials, no specimens of BeO-Cr_2O_3-ZrO_2 mixtures were prepared for these tests. The conjecture is made that porous oxide porcelains with requisite strength properties may prove of considerable interest in the search for materials of greater thermal-shock resistance than that associated with dense, practically impervious oxide porcelains with high-strength properties.

It is proposed that the phase diagram of the BeO-TiO_2-ZrO_2 system includes an invariant point at about 20-BeO, 35-TiO_2, and 45-ZrO_2 (wt %) and 1,630° C; an invariant point at about 20-BeO, 55-TiO_2, and 25-ZrO_2 (wt %) and 1,610° C; and primary crystallization fields of BeO, tetragonal ZrO_2 solid solution, $ZrO_2 \cdot TiO_2$ solid solution, and TiO_2 solid solution.

The limited X-ray data indicate that the BeO-CeO_2-ZrO_2 system is a simple one with an invariant point at approximately 40-BeO, 30-CeO_2, and 30-ZrO_2 (wt %) and 1,845° C, and primary crystallization fields of BeO, tetragonal ZrO_2 solid solution, and CeO_2 solid solution.

Based upon extremely limited data and considerable amount of speculation, a suggested configuration of the liquidus surfaces of the BeO-Cr_2O_3-ZrO_2 system would be one that contains three invariant points and primary crystallization fields of BeO, tetragonal ZrO_2, $BeO \cdot Cr_2O_3$, $BeO \cdot 3Cr_2O_3$, and Cr_2O_3. Beryllium chromate ($BeO \cdot Cr_2O_3$), the chromia analog of chrysoberyl, was identified; crystallographic parameters of this orthorhombic compound were tentatively determined as being $a=10.0$ A, $b=3.8$ A, and $c=4.5$ A. 10 p.

RP2535. Effects of recent knowledge of atomic constants and of humidity on the calibrations of the National Bureau of Standards thermal-radiation standards.................... Ralph Stair and Russell G. Johnston

The National Bureau of Standards thermal-radiation standards, as established and maintained since 1913, are based primarily upon the emission of a blackbody, using the Stefan-Boltzmann constant of total radiation $\sigma = 5.70 \times 10^{-12}$ watt/(cm^2 deg^4).

The present status of this constant is reviewed in relation to the recent experimental evidence for more accurate values of the velocity of light and for the other atomic constants effecting the value of σ. It is concluded that any change in the Stefan-Boltzmann constant is unimportant at this time.

An investigation is reported on the effect of the atmospheric water vapor on the transmitted radiant intensities of these lamps at the working distance of 2 meters. The usual variations in laboratory humidities will affect the certified calibrations of these standard lamps less than 0.3 percent and hence may be neglected in all radiometric work wherein they are employed.

One section of the paper is given to general instructions for the use of these standards in precision work. 5 p.

RP2536. Synthesis of D-galactose-1-C^{14} and D-talose-1-C^{14}.... Horace S. Isbell, Harriet L. Frush, and Nancy B. Holt

An efficient procedure is presented for the preparation of α-D-galactose-1-C^{14} and α-D-talose-1-C^{14} from D-lyxose and C^{14}-labeled cyanide. The epimeric acids from the cyanohydrin synthesis were separated as calcium D-galactonate-1-C^{14} pentahydrate and D-talono-γ-lactone-1-C^{14} in yields of 67 and 28 percent, respectively. The calcium D-galactonate-1-C^{14} was converted quantitatively to D-galactono-γ-lactone-1-C^{14} and this was reduced, in 86-percent yield, to D-galactose-1-C^{14}. The over-all radiochemical yield of D-galactose-1-C^{14} from NaC^{14}N was thus 57 percent. D-Talono-γ-lactone-1-C^{14} was reduced to α-D-talose-1-C^{14} in 56-percent yield, an over-all radiochemical yield of 16 percent. 4 p.

RP2537. Determination of carbon-14 in solutions of C^{14}-labeled materials by means of a proportional counter........ A. Schwebel, H. S. Isbell, and J. D. Moyer

A study is reported of the determination of carbon-14 in C^{14}-labeled substances by counting, with a proportional gas-flow counter, the radioactive disintegrations arising from a material that is dissolved in a suitable solvent. A number of solvents were found to be satisfactory. Formamide is recommended for the assay of carbohydrates and other materials with which it is a compatible solvent. Ethylene glycol is suitable for the assay of highly alkaline substances, and, in conjunction with sequestering agents, for the assay of alkaline earth carbonates. Other useful solvents are dimethyl formamide and 90-percent phosphoric acid. The counting efficiency in different solvents was found to be inversely proportional to the density of the solution and highly reproducible. The study shows that solutions of C^{14}-labeled materials can be counted easily and precisely with a proportional counter. 4 p.

RP2538. Extension of the arc spectra of palladium and platinum (6500 to 12000 A)
Karl G. Kessler, William F. Meggers, and Charlotte E. Moore

The arc spectra of palladium and platinum have been reinvestigated photographically in the red and infrared, and extended approximately 2000 angstroms beyond the former limit of observation. The spectra were excited in conventional direct-current arcs between pure-metal electrodes and recorded by modern sensitized emulsions with the aid of diffraction gratings of 640-cm radius. Improved wavelength values and intensity estimates are given for 63 Pd I lines between 6508.42 and 11556.27 A, and for 74 Pt I lines between 6648.32 and 10757.78 A. All of the observed Pd I lines have been explained as transitions between known atomic energy levels, but only 42 of the 74 Pt I lines can be explained in like manner. It is concluded that further progress in the structural analysis of the Pt I spectrum is dependent on making an improved description in the visible and ultraviolet. 4 p.

RP2539. Influence of molecular shape on the dielectric constant of polar liquids
F. Buckley and A. A. Maryott

The Onsager theory of the static dielectric constant of polar liquids has been modified to allow for the influence of molecular shape. Equations have been derived for both prolate and oblate spheroids in which the permanent dipole is directed along the axis of symmetry. These equations have been applied to a number of pure polar liquids, exclusive of the hydrogen bonded liquids, where reliable data were available over extended ranges of temperature. A satisfactory interpretation of the variation of dielectric constant with temperature is obtained provided the volume of the molecular cavity is maintained fixed and independent of temperature rather than allowed to expand in proportion to the molar volume as assumed by Onsager. The required molecular shapes are in general accord with the actual molecular geometries. The behavior of dilute solutions and mixtures with a nonpolar solvent are also satisfactorily correlated using the same shape parameters. It appears to be unnecessary to consider specific interactions between neighboring molecules in order to account for the static dielectric behavior of these systems. 16 p.

RP2540. Temperature dependence of compression of linear high polymers at high pressures .... Charles E. Weir

Pressure-volume-temperature data for polyethylene, polytetrafluoroethylene, polymonochlorotrifluoroethylene, polyvinyl fluoride, polyvinylidene fluoride, polyvinyl alcohol, a copolymer of ethylene-tetrafluoroethylene (1:1), and a polyester are reported over the range 20° to 80° C and 1 to 10,000 atmospheres. Empirical equations of state for some of the polymers are derived. Internal-energy changes were calculated for most of the polymers studied. 8 p.

RP2541. Turbulent flow in shock tubes of varying cross section
Robert F. Dressler

The unsteady escape flow of a compressible gas is investigated subject to the influences of varying duct cross section and mechanical retardation due to turbulence and frictional dissipation. This study is applicable to shock tubes, intermittent wind tunnels, and general pneumatic-control systems, such as airbrakes. Wave-front velocities and trajectories are obtained by direct integration along the bounding Mach lines. In the general case, calculation of first-order approximations is reduced to a set of independent ordinary differential equations for easy stepwise integration. For the special cases of constant resistance or exponentially converging-diverging ducts, first-order solutions are obtained analytically. An error estimate is derived. Local Mach number variations are presented throughout the flow. 8 p.

RP2542. Separation of titanium, tungsten, molybdenum, and niobium by anion exchange......John L. Hague, Eric D. Brown, and Harry A. Bright

The results of a systematic study of the elution behavior of titanium, tungsten, molybdenum, and niobium in various hydrochloric-hydrofluoric acid media are given. These data demonstrate the behavior of the anion complexes of these elements on an anion-exchange resin column. The possibility of several interesting quantitative separations is evident, and experiments are described that demonstrate that these elements can be separated from each other. 2 p.

RP2543. Vapor pressure of nitrogen....................George T. Armstrong

The vapor pressure of nitrogen has been measured in the liquid range below the normal boiling point and can be represented by $\log P\ (\text{mm}) = 6.49594 - 255.821/(T - 6.600)$. The normal boiling point calculated from this equation is 77.364° K. Nitrogen vapor densities along the saturation line are represented by $\log \rho T = 3.39858 - 282.953/(T - 3.83)$. The fugacity function $\ln f/p$ for the saturated vapor is tabulated. 4 p.

RP2544. Comparison of four national radium standards. Part 1. Experimental procedures and results..............T. I. Davenport, W. B. Mann, C. C. McCraven, and C. C. Smith

The two United States primary radium standards have been compared with the British primary radium standard and the Canadian national radium standard (1) by an ionization method, using the NBS standard electroscope, (2) calorimetrically, using the Peltier-cooling radiation balance, (3) by means of a Geiger-Müller counter, and (4) using a scintillation counter. Where there is little or no difference in gamma-ray source self-absorption, the four methods should, and in fact do, give good agreement. In the case of the Canadian national radium standard the difference in the results obtained is an indication of a difference in source self-absorption. 6 p.

Part 2. Statistical procedures and survey..........W. S. Connor and W. J. Youden

The statistical analysis of the observations on the four national radium standards is discussed. The readings made with the electroscope, Geiger-Müller counter, and scintillation counter were adjusted by one formula, and the readings made with the radiation balance by a different formula. In each case the adjusted values of the standards satisfy a consistency criterion. Finally, the adjusted values were improved by making use of the proportional relationship between the masses and the radioactive effects of the standards. 3 p.

RP2545. A radiation balance for the microcalorimetric comparison of four national radium standards..................................W. B. Mann

The design of a radiation balance, a twin microcalorimeter utilizing the Peltier effect, to accommodate three Hönigschmid radium standards is described. The rate of energy production of radium and its daughter products down to radium D, for unit mass of radium element in terms of all three Hönigschmid standards, was found to be equal to 138.6 cal g^{-1} hr^{-1}. 5 p.

RP2546. Standard potential of the silver–silver-chloride electrode from 0° to 95° C and the thermodynamic properties of dilute hydrochloric acid solutions..................Roger G. Bates and Vincent E. Bower

From electromotive-force measurements of the cell without liquid junction:

$$\text{Pt; } H_2,\ \text{HCl}\ (m),\ \text{AgCl; Ag}$$

through the range 0° to 95° C, calculations have been made of (1) the standard potential of the silver–silver-chloride electrode, (2) the activity coefficient of hydrochloric acid in aqueous solutions from m (molality) $= 0$ to $m = 0.1$ and from 0° to 90° C, (3) the relative partial molal heat content of hydrochloric acid, and (4) the relative partial molal heat capacity of hydrochloric acid.

The extrapolations were made by the method of least squares with the aid of punch-card techniques. Data from at least 24 cells were analyzed at each temperature, and 81 cells were stuied at 25° C. The value of the standard potential was found to be 0.22234 absolute volt at 25° C, and the standard deviation was 0.02 millivolt at 0° C, 0.01 millivolt at 25° C, and 0.09 millivolt at 95° C.

The results from 0° to 60° C are compared with earlier determinations of the standard potential and other quantities derived from the electromotive force. 8 p.

RP2547. The gold-uranium system.............. R. W. Buzzard and J. J. Park

The phase diagram of the gold-uranium system was constructed from data obtained by thermal analysis, metallographic examination, and X-ray diffraction. The system is characterized by two intermetallic compounds, one forming peritectically at 1,216° C and having an apparent composition of U_2Au_3, and the other melting congruently at approximately 1,450° C and having an apparent composition of UAu_3. There are two eutectics, one between UAu_3 and gold at 855° C and 87.5 atomic percent of gold, and the other between uranium and U_2Au_3 at 1,105° C and 10.5 atomic percent of gold. The solubility of uranium in gold appeared to be about 0.6 atomic percent at 855° C, and the solubility of gold in uranium was approximately 3.2 atomic percent at 1,105° C. Gold lowered the gamma-beta transformation temperature of uranium from 762° to 738° C, and the beta-alpha transformation from 653° to 647° C. 6 p.

RP2548. A study of absolute standards of mutual inductance and in particular the three-section National Bureau of Standards type
Frederick W. Grover

The results of a study of the number and location of the circles of zero field surrounding a multisection coil are presented. The configuration of the field surrounding the equatorial region of several three-section coils has been partially mapped out. One arrangement yields a design in which the mutual-inductance contribution of any secondary turn differs but little from that of the median turn. By locating the secondary symmetrically about the circles of zero field, the correction for winding distribution can be made small, and the effect of uncertainties in location of individual secondary turns minimized. 24 p.

RP2549. The deuterium-sulfide band at 4,590 cm^{-1}........ Harry C. Allen, Jr., Robert E. Naylor, and Earle K. Plyler

The absorption of deuterium sulfide has been observed and measured under high resolution in the region from 4,513 cm^{-1} to 4,675 cm^{-1}. The rotational structure has been analyzed through the use of published energy and line-strength tables for the rigid asymmetric rotor. A classical centrifugal-distortion correction was applied to the rigid energy levels. The absorption is attributed to the vibrational band having an excited state with the quantum number $(n_1,n_2,n_3)=(1,1,1)$. The inertial parameters giving the best fit to the observed absorption are:

Ground state.....................	$A=5.473$ cm^{-1}	$B=4.490$	$C=2.444$
Excited state.....................	$A=5.465$ cm^{-1}	$B=4.482$	$C=2.383$

Using the ground-state inertial constants, the D–S distance is calculated to be 1.345 A, and the D–S–D–angle 92°16′, in excellent agreement with similar structural parameters determined for hydrogen sulfide from infrared studies. 3 p.

RP2550. Synthesis of α-D-xylose-1-C^{14} and β-D-lyxose-1-C^{14}....... H. S. Isbell, H. L. Frush, and N. B. Holt

Methods are presented for the preparation of α-D-xylose-1-C^{14} and β-D-lyxose-1-C^{14} from D-threose and C^{14}-labeled sodium cyanide. The xylonic epimer from the cyanohydrin synthesis was separated in 34-percent yield by means of the lead salt; the lyxonic epimer, in 49-percent yield by means of the lactone. Lead D-xylonate-1-C^{14} was converted quantitatively to D-xylono-γ-lactone-1-C^{14}, and this was reduced by sodium amalgam to α-D-xylose-1-C^{14} in 61-percent yield. D-Lyxono-1-lactone-1-C^{14} on reduction, gave β-D-lyxose-1-C^{14} in 64-percent yield. Thus, the over-all yields of α-D-xylose-1-C^{14} and β-D-lyxose-1-C^{14}, based on the C^{14}-labeled cyanide used in the cyanohydrin synthesis, were 21 and 31 percent, respectively. The methods reported greatly facilitate the preparation of α-D-xylose-1-C^{14} and β-D-lyxose-1-C^{14}. 3 p.

RP2551. Creep of high-purity nickel.... William D. Jenkins, Thomas G. Digges, and Carl R. Johnson

A study was made of the creep behavior in tension at 300°, 700°, 900°, and 1,200° F of initially annealed high-purity nickel. Discontinuous flow was observed in each of the three stages of creep, and it was affected by temperature, strain rate, and prior-strain history. The phenomenon of strain aging was especially prominent at 300° F as manifested by the attainment of an appreciable creep life in specimens stressed in excess of the tensile strength at this temperature. The experimental results are analyzed in terms of the past and present theories of deformation of metals. Strain hardening, recovery, and the initiation, propagation, and types of fractures obtained during creep are further evaluated by means of true-stress–true-strain and hardness data obtained at room temperature and by metallographic examination of the fractured specimens. 24 p.

RP2552. Determination of nickel, manganese, cobalt, and iron in high-temperature alloys, using anion-exchange separations........John L. Hague, Edwin E. Maczkowske, and Harry A. Bright

A procedure is given for the determination of nickel, manganese, cobalt, and iron in a high-temperature alloy. Niobium, tantalum, tungsten, and silicon are rendered insoluble by hydrochloric acid dehydration after solution of the alloy in aqua regia. Molybdenum and copper are precipitated with hydrogen sulfide, and the solution is filtered. The filtrate is evaporated several times with hydrochloric acid and hydrogen peroxide to obtain a chloride solution of these elements in the proper valence. The resulting solution is transferred to an anion-exchange column containing Dowex-1. The nickel and manganese, with chromium and some other elements, are collected in the first fraction by elution with 9 *N* hydrochloric acid. Cobalt is collected in a second fraction by elution with 4 *N* hydrochloric acid, and iron in a third by elution with 1 *N* hydrochloric acid. The cobalt is determined by electrolysis from a weakly ammoniacal chloride solution containing hydroxylamine hydrochloride, and the other elements are determined by conventional methods. 7 p.

RP2553. Thermal degradation of polymers as a function of molecular structure
S. L. Madorsky and S. Straus

When heated in a vacuum at temperatures of about 200° to 500° C, polymer chains break up into volatile fragments of various sizes, depending on the nature the polymer. Some polymers, like poly-alpha-methylstyrene, yield the monomer exclusively. Other polymers, like polymethylene, yield a whole spectrum of fragments consisting of 2 carbon atoms in the chain to about 50 or more. Intermediate between these two types of polymers are those like polyisobutylene, which yield partly monomer and partly large fragments. The rates at which these fragments are formed and vaporized also vary for different polymers. On comparing rates of volatilization of a series of polymers at 350° C, we find that polytetrafluoroethylene is the most thermally stable polymer, having an initial rate of volatilization of 0.0000016 weight percent per minute, whereas poly-alpha-methylstyrene is the least stable, having a rate of volatilization of 230 percent per minute. These differences in the thermal behavior of polymers can be correlated with the molecular structure of the polymer chains and with the nature and frequency of side groups. 10 p.

RP2554. Some properties of strontium hydroxide and its monohydrate
Elmer T. Carlson

Strontium hydroxide, $Sr(OH)_2$, was prepared by hydration of strontium oxide under pressure at 400° C. The monohydrate was prepared by hydration of the oxide at 168° C and also by evaporation of a boiling solution of strontium hydroxide. Optical properties and X-ray powder diffraction patterns are given. 2 p.

RP2555. Refractivity measurements on Canada balsam by interferometry
James B. Saunders

The index of refraction of three different samples of Canada balsam, each obtained from a different source, was measured for thirteen spectral lines in the visible range by means of the Fabry-Perot interferometer. This instrument permits absolute measurements when the method of coincidence (or method of exact fractions) is applied to fringes produced in thin films of the material being tested. High accuracy may be obtained by applying the method to fringes produced in films of successively increasing thickness. 3 p.

RP2556. Bounds on a distribution function that are functions of moments to order four . . . . Marvin Zelen

Explicit expressions are presented for bounds on a distribution function when moments to order four are known. These inequalities are given in a form suitable for applications. 5 p.

RP2557. Aerological sounding balloons . . . Gordon M. Martin, John Mandel, and Robert D. Stiehler

A low-temperature patch test for sounding balloons is described. In this test a circular piece is cut out of the rubber film, clamped around its circumference, and inflated until it bursts. Equations applying to the patch test and to the flight of sounding balloons are developed. The important properties in determining the flight elevation are found to be the flaccid length of the balloon and the elongation of the rubber film. The effective elongation is defined as the average elongation of the entire balloon film at the pressure at which the weakest part of the balloon will fail. A method of estimating this effective elongation from patch test data is given. Correlation was found between patch-test data and night-flight elevations. On the basis of flights made with thermistors both inside and outside the balloon, the temperature of the balloon film at burst is estimated to be 0 to 4 Celsius degrees colder than the surrounding air at night and 20 to 30 Celsius degrees warmer than the surrounding air in the daytime. 10 p.

RP2558. Plate-separation requirements for standard free-air ionization chambers Frank H. Attix and LeRoy DeLaVergne

A method is described for measuring ionization losses resulting from inadequate separation of the parallel plates in free-air chambers. The ionization produced by X-rays scattered out of the collimated beam was measured separately and subtracted from the total to obtain the ionization contribution of only the electrons from the beam. Losses of this electron ionization are tabulated for plate separations from 6 to 36 centimeters, with moderately and heavily filtered X-rays from 50- to 250-kilovolt constant tube potential. Results are also converted into cylindrical coordinate form for application to chambers other than the parallel-plate type. A method is suggested for measurement, in other free-air chambers, of the contribution of ionization by scattered X-rays. Ionization-loss results are compared with previous experiments. 10 p.

TITLE PAGE AND CONTENTS TO VOLUME 53, 5 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 54, JANUARY—JUNE 1955

RP2559. Calibration of meter line standards of length at the National Bureau of Standards . . . . Benjamin L. Page

The results of intercomparisons of the total lengths of several meter bars and of calibrations of the subintervals of some of these bars for the past twenty years are reported. Information both on the degree of stability of these standards and on the precision with which such measurements can be repeated was obtained. The results are critically analyzed and comments made as to the precautions necessary in the precision comparisons of line standards of length. 14 p.

RP2560. Enthalpy and specific heat of four corrosion-resistant alloys at high temperatures . . . . Thomas B. Douglas and James L. Dever

Specific heats that are believed to be accurate in general to within ±2 percent are reported for four alloys: from 0° to 900° C for 80 Ni-20 Cr and two stainless steels (type 347, containing 18 percent of chromium, 11 percent of nickel, and 1 percent of niobium, and type 446, containing 26 percent of chromium); and from 0° to 300° C for Monel, containing 67 percent of nickel and 30 percent of copper. These values were calculated from enthalpies measured with a drop method and a precision Bunsen ice calorimeter. The relatively small amounts of heat lost by the alloys as they dropped from the furnace to the calorimeter were estimated and corrections were applied therefor. Discontinuities in specific heat were found only in the case of 80 Ni-20 Cr and the stainless steel type 446. 5 p.

RP2561. Effect of temperature on the tensile properties of a commercial and a high-purity 70-percent-nickel–30-percent-copper alloy
William D. Jenkins, Thomas G. Digges, and Carl R. Johnson

Short-time tensile tests were made at temperatures ranging from 75° to 1,700° F on two 70-percent-nickel–30-percent-copper alloys. The experimental evidence showed that discontinuous flow occurred in specimens of both alloys fractured in tension at temperatures ranging from 300° to 1,700° F. This phenomenon was attributed to strain-aging at the lower temperatures and to recrystallization accompanied by grain growth at the higher temperatures. Variations in chemical composition of the two alloys also affected the degree of strain-aging, strength and ductility properties, and fracture characteristics. 16 p.

RP2562. The system lime-water at 21° C and high pressures....Charles E. Weir

Compression measurements on the binary system $Ca(OH)_2$-H_2O at 21° C and high pressures show a large discontinuity in volume at 2,800 atmospheres which involves both components. Evidence is presented that the transition is the result of formation of a hydrate of lime, $Ca(OH)_2 \cdot n\ H_2O$, where $4 \leq n \leq 6$. A pressure composition diagram for the system $Ca(OH)_2$-H_2O at 21° C is given. 4 p.

RP2563. Absorption of radiant energy by solid particles in suspension
James E. Stewart

A simple theory is developed to describe the absorption of radiant energy by particles suspended in a transparent medium and also by an absorbing medium containing transparent suspended particles. It is found that in both cases transmittance increases as particle size increases. Apparent deviations from Beer's law and other effects that might introduce difficulties in experimental work are discussed. 6 p.

RP2564. Branching ratio in the decay of polonium-210........R. W. Hayward
D. D. Hoppes, and W. B. Mann

Using a micro-calorimeter to determine the alpha-particle activity and a sodium-iodide scintillation counter of high efficiency to measure the gamma-ray intensity, the branching ratio of polonium-210 has been found to be equal to $(1.22 \pm 0.06) \times 10^{-5}$. This value is based on the assumption that the energy of the main alpha-particle group from polonium-210 is 5.301 Mev. In the calibration of the scintillation counter the angular anisotropy of the gamma rays from cobalt-60 was found to be 1.164 ± 0.002. 4 p.

RP2565. Mechanism of high-speed-waterdrop erosion of methyl methacrylate plastic..Olive G. Engel

A mechanism for the high-speed-waterdrop erosion of methyl methacrylate plastic is postulated as a result of a parallel study of the damage that is done by the impacts of steel spheres and of deforming lead pellets. Results of the parallel study are described. The mechanism can be extrapolated with safety only to other brittle materials of low tensile strength, the other characteristic properties of which are closely similar to those of methyl methacrylate plastic. 9 p

RP2566. Geometric factors in electrical measurements relating to corrosion and its prevention..........W. J. Schwerdtfeger and Irving A. Denison

The "electrical boundary" of a galvanic couple immersed in an aqueous medium, when corroding normally and also when corrosion is stopped by cathodic protection, is discussed in the light of present theory. Experimental data, consisting of potential measurements made on bimetallic couples in an unrestricted medium producing relatively little polarization and also one producing considerable polarization, are compared with theoretical data. The electrical boundary is theoretically defined and experimentally verified for model galvanic couples having bimetallic electrodes, one couple simulating line electrodes and the others having electrodes made of longitudinal cylindrical segments arranged in three anode-to-cathode area ratios. The effect on potential measurements as a result of interference to the normal flow of galvanic and external currents is also shown by experimental data. The results of this study indicate that geometric factors should be given consideration in making potential measurements on subsurface structures of similar configuration, such as cylindrical tanks and pipelines. 11 p.

RP2567. Pore-size distribution in collagen and leather by the porosimeter method
Robert R. Stromberg

The pore-size distribution in collagenous tissue and a number of leathers, in the range 100 to 20000–A in radius, has been determined by means of a mercury-pressure porosimeter. The sources of error incurred in such measurements, the reliability of the measurements, and experimental and "actual" pore-size distributions are considered. The geometry of the fine and gross structure of leather, and the process of water-vapor transmission through leather are interpreted from the data. 9 p.

RP2568. Collagen pores determined by electron microscopy.....Max Swerdlow and Robert R. Stromberg

The existence and morphology of pores of the order of 150 A, in radius, within collagen fibrils is delineated. Structural features of collagen from air-dried kangaroo tail tendon, impregnated with mercury at a pressure of 10,800 psi., are compared with those of fibrils not exposed to mercury. A helical configuration of subfibrillar elements is suggested by the electron micrographs of individual fibrils. The possible use of mercury under hydrostatic pressure as a technique in staining and preserving the structure of biological materials for electron microscopy is advanced. These findings constitute a visual confirmation of the presence and probable size of small pores deduced from theoretical considerations of pore-size distributions in collagen and leather, and provide additional information about the shape, location, and arrangement of such pores in collagen fibrils. 8 p.

RP2569. Effect of low temperatures on the mechanical properties of a commercially pure titanium..........Glenn W. Geil and Nesbit L. Carwile

Notched and unnotched tensile specimens of annealed commercially pure titanium were slowly strained to fracture in single-stage tests at −196° to +100°C. Unnotched tensile specimens also were strained in two-stage tests (strained at one temperature until just after the maximum load was reached and then strained to fracture at a different temperature) to reveal the effect of prior-strain-temperature history on the tensile properties of the titanium. Impact tests were made on Charpy V-notch specimens at −196° to +300° C for a determination of the impact notch-toughness of the metal. True-stress–true-strain relations were determined for the titanium in tension, and a study was made of the effects of test temperature and the stress distribution on the rates of work-hardening of the metal. 11 p.

RP2570. Reactions at wet-dry interfaces on fibrous materials....Robert Schaffer, Wm. D. Appel, and Florence H. Forziati

The "brown-line" reaction on cellulosic materials at the boundary between areas wet with water and dry areas has now been found to be an example of a general phenomenon. Other fibers and liquids participate in oxidation reactions at wet-dry interfaces. Examples of the reactions are given, the conditions necessary for them are demonstrated, and the nature of the reactions is discussed. 4 p.

RP2571. Scintillation spectrometry of low-energy bremsstrahlung
Margarete Ehrlich

A method was devised to measure bremsstrahlung spectra from commercial X-ray tubes on an absolute scale, using a thallium-activated sodium-iodide crystal-scintillation spectrometer. The method was used to study bremsstrahlung spectra between 20- and 100-kilovolts exciting potentials from a beryllium window tube having a thick tungsten target. Fully corrected, absolute experimental spectra were obtained at exciting potentials of 50 and 100 kilovolts.

In order to compare the experimental results with theory, a calculation was made yielding the thick-target bremsstrahlung spectrum derived from Sommerfeld's theory. Experiment and theory showed order-of-magnitude agreement. However, a characteristic difference in spectral shape was observed, the experimental spectra showing a more pronounced peak. This peak is near 30 kilo electron volts and gives the impression of being superimposed on the spectral shapes expected from theory.

Finally, a point of interest to the practical user of the X-radiation from beryllium window tubes was brought out, namely, that a considerable portion of the low-energy radiation, at least in the region between 12 and 30 kilo electron volts, is strongly absorbed in the tungsten target of a conventional X-ray tube. 12 p.

RP2572. A method for the numerical integration of differential equations of second order without explicit first derivatives.....Rene de Vogelaere

This is a fourth-order step-by-step method based on difference formulas. The case of a single equation is discussed in detail. The use of this method for automatic computer is considered. 7 p.

RP2573. Selected positive and negative ions in the mass spectra of the monohalomethanes.............Vernon H. Dibeler and Robert M. Reese

Ionization potentials of the molecule ions and appearance potentials of the methyl and halogen positive ions and of the halogen negative ions have been measured for CH_3F, CH_3Cl, CH_3Br, and CH_3I and compared with previously reported spectroscopic and electron-impact data. A value is obtained for the ionization potential of HF by graphical comparison of the ionization potentials of the hydrogen and methyl halides. Carbon-halogen bond-dissociation energies are computed from appearance potentials of the methyl ion and of the halogen ion. A simple relation between bond-dissociation energy and bond distance is observed for the methyl halides. 8 p.

RP2574. Variation in distortion with magnification...........Arthur A. Magill

The distortion introduced in the image by a lens for a given axial inclination of the chief ray is a linear function of the magnification. Specifically, if D_0 represents the distortion with parallel light incident on one side of the lens (zero magnification) and D_∞ the distortion with parallel light incident on the other, then the distortion D_m at any magnification m is given by $D_m=D_0-{}^{m}D_\infty$. This equation has been experimentally verified for examples of three types of symmetrical lenses. 8 p.

RP2575. Heats of combustion and isomerization of six pentadienes and spiropentane..............Frances Maron Fraser and Edward J. Prosen

The heats of combustion of six pentadienes and spiropentane were measured by combustion of the hydrocarbon vapors, carried by helium gas, in a flame at constant pressure; the reaction was carried out in a glass reaction vessel contained in a calorimeter. The calorimeter system was calibrated by means of electric energy.

The experimental data yielded the following values for the standard heat of combustion, $-\Delta Hc°$, at 25° C and constant pressure, of the gaseous hydrocarbon in gaseous oxygen to form gaseous carbon dioxide and liquid water, with all the reactants and products in their thermodynamic standard reference states, in kilocalories per mole, where 1 kcal=4.1840 kj: 1,2-pentadiene, 777.14 ±0.15; 1,*cis*-3-pentadiene, 763.30 ±0.21; 1,*trans*-3-pentadiene, 761.64 ±0.15; 1,4-pentadiene, 768.94 ±0.30; 2,3-pentadiene, 775.32 ±0.16; 2-methyl-1,3-butadiene (isoprene), 761.62 ±0.23; spiropentane, 787.77 ±0.17.

From the above data the heats of isomerization to isoprene in kilocalories per mole were calculated to be 2-methyl-1,3-butadiene (isoprene) = 0; 1,2-pentadiene = −15.52 ±0.23; 1,*cis*-3-pentadiene = −1.68 ±0.27; 1,*trans*-3-pentadiene = −0.02 ±0.22; 1,4-pentadiene = −7.32 ±0.34; 2,3-pentadiene = −13.70 ±0.23; spiropentane = −26.14 ±0.24.

Values of the heats of formation and hydrogenation were also derived from these data. 6 p.

RP2576. Solid-state reactions and dielectric properties in the system magnesia-lime-tin oxide-titania...L. W. Coughanour, R. S. Roth, S. Marzullo, and F. E. Sennett

A study has been made of solid-state reactions in the quaternary system MgO-CaO-SnO_2-TiO_2 and in its subordinate binary and ternary systems. Compatibility relations have been determined for each. Extensive solid-solution formation has been noted in the SnO_2-TiO_2, MgO-SnO_2-TiO_2, CaO-SnO_2-TiO_2, and MgO-CaO-SnO_2-TiO_2 systems. Little or no solid solution was observed in the other systems involved. One ternary compound, having the probable formula $2MgO \cdot SnO_2 \cdot TiO_2$, has been observed. No quaternary compounds were detected.

A survey has been conducted of the effect of composition and temperature variations on the dielectric properties of specimens in some of these systems.

Data are given for the values of K and Q at 50 kilocycles per second, and at 1 and 20 megacycles per second. The changes in these values with changes in temperature have been studied at 1 megacycle per second.

Indexed X-ray powder patterns are listed for the compounds $CaO{\cdot}TiO_2$, $CaO{\cdot}SnO_2$, and $2MgO{\cdot}SnO_2{\cdot}TiO_2$. An unindexed pattern is given for the compound $2CaO{\cdot}SnO_2$. 14 p.

RP2577. Chromatographic method for the fractionation of asphalt into distinctive groups of components..................Lawrence R. Kleinschmidt

A chromatographic method for the separation of asphalt into four distinct groups of components is described. The method utilizes fuller's earth as the adsorbent, and *n*-pentane, methylene chloride, and methyl ethyl ketone as selective solvents. The fractionation of asphalts into components in this manner facilitates the study of the degradation of asphalts in service. Although the method, in general, is not limited by the size of the specimen, it is particularly suited to samples of 3 to 6 grams, in which case it requires from 6 to 8 hours, depending upon the nature of the asphalt, for a complete fractionation. The time required to fractionate the *n*-pentane soluble components is about 3 hours. 4 p.

RP2578. Nature of stark rubber.......Donald E. Roberts and Leo Mandelkern

The melting behavior and X-ray diffraction patterns of four different samples of "stark rubber" have been investigated. The melting temperatures, 39° to 45.5° C, are substantially higher than that observed for natural rubber crystallized by cooling. The X-ray diffraction patterns indicate that the crystallites in stark rubber are oriented. This observation can explain the higher melting temperatures. Thus, the previous assignment of an equilibrium melting temperature, 28° ±1° C, to unoriented crystalline natural rubber is shown to be appropriate. Several different methods that have been used successfully in preparing stark rubber under controlled conditions in the laboratory are outlined. 10 p.

RP2579. Partially balanced incomplete block designs with two associate classes and two treatments per block...............Willard H. Clatworthy

In physical science experimentation the experimental material may divide naturally into groups of two objects (treatments) each. Thus, the experimental arrangement will involve what is known in the design of experiments as an incomplete block design. In this paper an investigation is made of a special kind of incomplete block design known as the partially balanced incomplete block design with two associate classes. In these designs the various comparisons of pairs of objects involve two kinds of precision.

An enumeration is made of all partially balanced incomplete block designs with two associate classes and two treatments per block where r, the number of times each treatment appears in the arrangement, is less than or equal to 10. Simple instructions are given for writing the experimental arrangements. These designs have a definite known method for analysis of the data. No attempt has been made to state which of the various designs are best, since it is felt that the best design must be determined for the particular investigation. 14 p.

RP2580. Solid-state reactions and dielectric properties in the systems magnesia-zirconia-titania and lime-zirconia-titania........L. W. Coughanour, R. S. Roth, S. Marzullo, and F. E. Sennett

A study of solid-state reactions and dielectric properties was made for the ternary systems $MgO\text{-}ZrO_2\text{-}TiO_2$ and $CaO\text{-}ZrO_2\text{-}TiO_2$. The compatibility relations were determined for each, and an estimate of the extent of the solid-solution areas was obtained. One ternary compound having the formula $CaO{\cdot}ZrO_2{\cdot}2TiO_2$ was discovered. An X-ray diffraction powder pattern of this compound is included.

Ceramic dielectric-test pieces were prepared from compositions within these systems. Data are given for the values of K and Q at 50 kilocycles per second, and at 1 and 20 megacycles per second. The variations of these values with changes in temperature were observed at a frequency of 1 megacycle per second. 9 p.

RP2581. Synthesis of α-D-glucose-2-C^{14}, α-D-mannose-2-C^{14}, and α-D-galactose-2-C^{14}........Horace S. Isbell, Harriet L. Frush, and Robert Schaffer

α-D-Glucose-2-C^{14}, α-D-mannose-2-C^{14}, and α-D-galactose-2-C^{14} have been synthesized from the corresponding 1-C^{14}-labeled pentoses in yields of 50, 18, and 36 percent, respectively. The methods are adaptations of those previously employed in the syntheses of the 1-labeled sugars, but include certain improvements, among them, the use of sodium acid oxalate as a buffer in the reduction of D-mannono-γ-lactone, and the elimination of the crystallization of D-lyxose-1-C^{14}. 3 p.

RP2582. The system of lime, silica, and water at 180° C. . . . Richard B. Peppler

Solid-liquid equilibria in the system CaO-SiO_2-H_2O were investigated at 180° C. Only four compounds were found to be stable in equilibrium with the liquid: Xonotlite ($5CaO \cdot 5SiO_2 \cdot H_2O$), hillebrandite ($2CaO \cdot SiO_2 \cdot H_2O$), α-quartz, and $Ca(OH)_2$. The metastable equilibrium curves of gyrolite ($2CaO \cdot 3SiO_2 \cdot 2H_2O$) and a particular silica gel were determined. The results also suggested several other metastable compounds. Supplementary experiments of six months' duration with oxide mixtures confirmed the stability at 180° C of only two ternary compounds, xonotlite and hillebrandite. 7 p.

RP2583. An algorithm for solving the transportation problem. . . . . . A. Gleyzal

This article describes a new computational scheme for solving the transportation problem in which combinatorial ideas, rather than the theory of linear inequalities, play the major role. Whether the algorithm is superior to other methods previously employed or proposed must await computational experience, but preliminary inspection is encouraging. 4 p.

RP2584. An X-ray study of the system uranium monocarbide-uranium dicarbide-beryllium carbide. . . . . M. D. Burdick, H. S. Parker, R. S. Roth, and E. L. McGandy

Mixed carbide preparations within the system uranium monocarbide-uranium dicarbide-beryllium carbide were investigated after heating and quenching. X-ray diffraction methods were used to identify the phases found and to determine the degree of interaction. Carbide alloys were studied after treatments at 1,700° and 1,900° C, and a constitutional diagram for the 1,700° C level is presented. No ternary compounds were identified within the system. The limit of solubility of beryllium carbide in uranium monocarbide at 1,700° and 1,900° C was found to be 20 mole percent and 40 mole percent, respectively. Lattice parameters based on X-ray patterns in the back-reflection region failed to indicate any other interactions, but evidence is presented to indicate some solid solution among the uranium carbides without lattice parameter change. The room-temperature stability of uranium sesquicarbide (U_2C_3), which has been reported by other investigators, was verified. X-ray diffraction data were obtained for this cubic compound, using CuK_α radiation. 13 p.

RP2585. An analysis of within-the-hour fading in 100- to 1,000-Mc transmissions
H. B. Janes

An analysis is made of the fading range of 100- to 1,000-Mc transmissions received both within and beyond the radio horizon. The measurements were made during August 1952 over the various Cheyenne Mountain Field Station paths and over the Cedar Rapids, Iowa-Quincy, Ill. path. Fading range is defined as the ratio in decibels of the signal levels exceeded 10 and 90 percent of an hour. For each of the four frequencies studied, the extent to which median fading range and median signal level depend on the angular distance and time of day is shown in the form of graphs and sample recordings. The data show that beyond the region where diffraction is considered to be the dominant mechanism, the signal level distributions closely resemble the Rayleigh distribution in both fading range and general shape. Deviations from the 13.4-db fading range of a Rayleigh distribution are thought to be due to changes in the average signal power during the hour. The method developed by Norton for estimating from the fading range the ratio of the Rayleigh-distributed component of signal to the constant diffracted component is applied to a sample of the data, and the techniques for applying the method to these particular data are discussed. 20 p.

RP2586. Astigmatism of skew pencils in optical systems containing toric surfaces
Walter Weinstein

A method is described for tracing skew rays through toric refracting surfaces and for determining the astigmatism of pencils around these rays. 12 p.

RP2587. Osculatory interpolation in the complex plane.....Herbert E. Salzer

Tables of coefficients to facilitate osculatory n-point interpolation ($n=2(1)7$) in the complex plane are given. 4 p.

RP2588. Macromethods for reducing aldonic lactones to sugars: The preparation of L-glucose..................Harriet L. Frush and Horace S. Isbell

Two macroprocedures are described for the efficient reduction of lactones of aldonic acids by sodium amalgam in the presence of an oxalate buffer. One employs a stainless-steel flask equipped with a stirrer that sweeps the bottom of the flask; the other, a high-speed "blender." Either method is suitable for the preparation of rare sugars in relatively large quantities. By the procedures described, L-glucose has been prepared from L-glucono-δ-lactone in 88-percent yield, for use as carrier in the preparation of L-glucose-1-C^{14}. 2 p.

RP2589. Stress-strain relationships in yarns subjected to rapid impact loading: 1. Equipment, testing procedure, and typical results
Walter K. Stone, Herbert F. Schiefer, and George Fox

Equipment is described for elongating yarns by longitudinal impact at velocities ranging from 10 to 100 meters per second. The rate of straining at impact varies from about 100,000 to 500,000 percent per minute.

A procedure is discussed for obtaining load-elongation curves for loading and for unloading of the specimen and for loading to rupture in a time interval of only a few milliseconds. The results of a typical loading and unloading test are presented. 8 p.

RP2590. Stress-strain relationships in yarns subjected to rapid impact loading: 2. Breaking velocities, strain energies, and theory neglecting wave propagation............Frank L. McCrackin, Herbert F. Schiefer, Jack C. Smith, and Walter K. Stone

The behavior of a yarn specimen fastened at one end to a head mass and at the other end to a small tail mass is analyzed for longitudinal impact of the specimen at the head. The analysis leads to a basic formula for "limiting breaking velocity," which is a characteristic property of the material and independent of the dimensions of the specimen. A simple procedure is described for obtaining its value. The values for cotton, nylon, and undrawn nylon yarns tested at room temperature are found to be 130, 228, and 550 meters per second, respectively. The practical application of the limiting breaking velocity to safety engineering is shown by an example on safety lines. Formulas are derived for computing energy to any strain under impact loading, and the computed values are found to agree with those obtained from the area under the impact load-extension curves. 4 p.

RP2591. Waterdrop collisions with solid surfaces..............Olive G. Engel

An approach is described to the difficult problem of the dynamics of an impinging water sphere. The flow in the impact plane is traced chemically. The stages in the collapse of the water mass and of its radial flow are shown in photographs that were taken with a high-speed motion-picture camera. Empirical determinations of the time dependence of the impact force and of the radial flow velocity are reported. The possible occurrence of cavitation in the radial flow is considered. A semiempirical analysis based upon various simplifying assumptions leads to equations for the maximum impact pressure and for the rate of spread of the water after the collision. 18 p.

RP2592. Effect of Darling-Dennison and Fermi resonance on thermodynamic functions.......................................Harold W. Woolley

The effect on thermodynamic functions due to resonance of the Darling-Dennison type for water and of the Fermi type for carbon dioxide is calculated working directly with the elements of the secular determinants that define the energy levels. 10 p.

RP2593. Titrations of bases with diphenyl phosphate in some aqueous and nonaqueous solvents..................Marion Maclean Davis and Hannah B. Hetzer

Successful titrations of various bases with diphenyl phosphate in benzene, methanol, water, and mixtures of these solvents have been performed, in some cases potentiometrically (using the glass, saturated calomel electrode-system) and in other cases using indicator dyes. Several of the dyes (bromophthalein magenta E, 5-phenyl-9-diethyl Nile blue, and the anhydro-base of tamarack green and Victoria blue B) have not been used elsewhere as acid-base indicators. Diphenyl phosphate is shown to be a strong acid which is easily obtained and maintained as anhydrous crystals. It is not strong enough, however, to serve as a replacement for perchloric acid in titrations in acetic acid. Attention is called to the differing behavior of benzoic acid and diphenyl phosphate when the solvent is changed from water to methanol. Using a "nonleveling" solvent in place of water makes it possible to obtain separate, sharp end-points in titrating a mixture of two such acids. Other pertinent information about diphenyl phosphate is summarized. 12 p.

RP2594. An improved method of measuring efficiencies of ultra-high-frequency and microwave bolometer mounts . . . R. W. Beatty and Frank Reggia

A method is presented for measuring efficiencies of bolometer mounts used for ultra-high-frequency and microwave power measurement. It is based upon the impedance method of Kerns, but avoids the direct measurement of impedance. Pertinent theory is developed, and the errors in measuring efficiency by this method are analyzed and discussed. Experimental results are given. 7 p.

RP2595. A study of some strontium aluminates and calcium-strontium aluminate solid solutions . . . . Elmer T. Carlson

Tristrontium aluminate hexahydrate, $3SrO \cdot Al_2O_3 \cdot 6H_2O$, was prepared hydrothermally as well as by various methods employing ordinary temperatures and atmospheric pressure. It crystallizes in the isometric system, with a unit cell edge of 13.04 A, and has a refractive index of 1.588. It is isomorphous with $3CaO \cdot Al_2O_3 \cdot 6H_2O$, and a complete series of solid solutions exists between the two. No evidence was found of hexagonal hydrated strontium aluminates analogous to those of calcium. Tristrontium aluminate hexahydrate is stable up to about 454° C at 420 atmospheres water vapor pressure. One of the products of hydrothermal decomposition appears to have the composition $5SrO \cdot 4Al_2O_3$. This compound breaks down on being heated, forming $SrO \cdot Al_2O_3$ and $3SrO \cdot Al_2O_3$. Attempts to prepare a strontia-alumina-silica hydrogarnet were unsuccessful. 6 p.

RP2596. A measurement of the velocity of propagation of very-high-frequency radio waves at the surface of the earth . . . . Edwin F. Florman

The velocity of propagation of electromagnetic waves was measured at the surface of the earth, using a radio-wave interferometer operating at a frequency of 172.8 Mc. The measured phase velocity, converted to velocity in vacuum, or the "free-space" value, was found to be 299795.1 ± 3.1 km/sec. The uncertainty of ± 3.1 km/sec includes a 95-percent confidence interval for the mean, plus an estimated limit to the systematic error of ± 0.7 km/sec. Based on a 50-percent confidence interval (probable error of the mean), the uncertainty, including the estimated limit to the systematic error of ± 0.7 km/sec, becomes ± 1.4 km/sec.

The accuracy with which the free-space phase velocity of radio waves could be measured was limited primarily by the accuracy to which the refractive index of air could be obtained from measured values of pressure, temperature, and relative humidity. 11 p.

RP2597. A study of the system magnesium oxide-magnesium chloride-water and the heat of formation of magnesium oxychloride
Edwin S. Newman

The precipitation of magnesium oxychlorides is discussed, and the results of solubility measurements are given. The heats of solution in HCl, $26 \cdot 61H_2O$ (2.00 N HCl at 25° C) of four compounds in the system MgO-$MgCl_2$-H_2O were determined. From those data and other data taken from the literature, the heats of formation of the compounds at 25° C were calculated. The results are applied to the calculation of the heat of reaction of hardening of magnesium oxychloride cement. 9 p.

RP2598. Dielectric relaxation for spherical molecules in a crystalline field: Theory for two simple models . . . . John D. Hoffman and Benjamin M. Axilrod

A theory of dielectric relaxation is given for two simple models where the dipoles may occupy orientational sites arranged in three dimensions. In the first model, the dipole may point toward the corners of a regular tetrahedron, and in the second, toward the faces of a cube. Both models are simplified to the extent that only one of the sites can differ in energy from all the others.

The calculations show that these models lead to a discrete set of dielectric relaxation times when the sites are not equivalent. The effect of the set of relaxation times on the characteristics of the dielectric relaxation spectrum is examined. The relaxation times are always sufficiently close together so that the dielectric loss is confined to a single region. However, the separation of the relaxation times is sufficient to cause the dielectric loss peak to be considerably broader than that predicted by the Debye equations. In addition, it is found that the loss maximum will frequently be asymmetrical. The variation of the dielectric constant with temperature, and the breadth and asymmetry of the loss peaks are discussed. 7 p.

TITLE PAGE AND CONTENTS TO VOLUME 54, 4 P.

RESEARCH PAPERS FROM THE JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 55, JULY—DECEMBER 1955

RP2599. Some properties of a glass used in paper manufacture
Martin J. O'Leary and Donald Hubbard

The chemical durability, heterogeneous equilibria, hygroscopicity, pH response, dispersal, and thermal expansion characteristics of a fiber glass used in paper manufacture were investigated. The chemical durability of this glass was found to be very poor between pH 2 and pH-2, apparently due to the high alumina and low silica composition. Above and below this range the chemical durability greatly improved, showing with the interferometer no detectable attack for exposures of 6 hours at 80° C either in high concentrations of H_2SO_4, or between pH 4 and pH 8. At alkalinities above pH 8 the durability again decreased as is characteristic of many silicate glasses. In addition, the heterogeneous equilibria at the solution-glass interface, using $Ag(NH_3)_2+$ ions as indicator, showed the fiber glass when leached at pH 4.1 to have an uneven distribution of migratable ions between the negatively charged glass surface and ambient aqueous solutions, to a greater extent than most commercial glasses. In accord with the very low hygroscopicity and poor chemical durability, electrodes prepared from this glass gave no definite response to hydrogen ion activity of the ambient solutions. The dispersal characteristics of the fibers in aqueous solutions follow the "critical" points indicated by the chemical durability curve covering the range from pH$-$8.1 to pH 11.8. The annealing and softening temperatures as obtained from the respective expansion curves were found to be higher for the fiber glass than for either Pyrex 7740 or Kimble N 51–A.

The chemical durability data, the acid titration of sodium silicate, and the dispersal-pH series are consistent with the findings of O'Leary et al., in emphasizing pH 2.9 as a critical condition for the most successful production of paper from fibers of this glass. 9 p.

RP2600. Adsorption of nitrogen on carbon adsorbents at low pressures between 69° and 90° K. . Juan de Dios Lopez-Gonzalez, Frank G. Carpenter, and Victor R. Deitz

Nitrogen adsorption isotherms were determined on three carbon adsorbents (two bone chars and an activated coconut shell charcoal) at three temperatures between 69° and 90° K and at relative pressures from 10^{-7} to 0.9. A cryostat was used to obtain temperatures below the normal boiling point of liquid nitrogen. The attainment of steady pressure readings at very low pressures required considerably more time than at higher pressures. Corrections for thermomolecular diffusion were found to be appreciable at pressures below one millimeter of mercury.

At relative pressures below 10^{-4}, the amount of nitrogen adsorbed depended upon the condition of the surface in regard to previous adsorption of nitrogen. A technique involving a series of consecutive adsorptions at low temperatures and outgassings at room temperature led to a reproducible isotherm at low pressures. These data could be represented by a Freundlich equation. The Brunauer, Emmett, Teller surface areas of the carbon adsorbents were also determined. 8 p.

RP2601. Stress-strain relationships in yarns subjected to rapid impact loading, 3. Effect of wave propagation. . Jack C. Smith, Frank L. McCrackin, and Herbert F. Schiefer

The tensile behavior of a Hookean material, elongated by rapid impact at one end has been calculated, using a theory in which wave propagation is considered. As a result of these calculations, limits have been established on the applicability of a simpler theory, discussed in a preceding publication, in which wave propagation was neglected. 10 p.

RP2602. Thermal expansion and phase transformations of low-expanding cobalt-iron-chromium alloys. . . . Peter Hidnert and Richard K. Kirby

Coefficients of linear thermal expansion of some cobalt-iron-chromium alloys are reported for various temperature ranges between −65° and +800° C, and the effects due to temperature, chemical composition, heat treatment, etc., were determined. Some of the alloys investigated have coefficients of expansion less than those for fused quartz and ordinary invar between −65° and +60° C. Some of the low-expanding cobalt-iron-chromium alloys have $\gamma \rightarrow \alpha$ transformations on cooling to low temperatures, and the resulting α-phase reverted to γ on heating to high temperatures. Ar_3 temperatures were observed as high as −10° C and Ac_1 temperatures at about 600° C. The effects of various heat treatments from −196° to +1,000° C on the transformations were investigated, and the resulting changes of thermal expansion were correlated with the structure of these alloys. 9 p.

RP2603. Vapor pressures of the methanes. . . . . George T. Armstrong, F. G. Brickwedde, and R. B. Scott

Experimental measurements, not previously reported in detail, of the vapor pressure of CH_4 and the differences in vapor pressures of CH_4 and the deuteromethanes below the normal boiling point are presented. A critical review of the literature relating to the vapor pressures of methane and the deuteromethanes is given. On the basis of the experimental measurements and the previous literature the following best values are assigned to fixed points on the vapor pressure curves. The triple points are: CH_4, 87.50 mm, 90.66°; CH_3D, 84.5 mm, 90.41°; CH_2D_2, 82.0 mm, 90.17°; CHD_3, 80.2 mm, 89.96°; CD_4, 79.1 mm, 89.79° K. The boiling point of CH_4 is 111.67° K; the critical point 45.6 atmospheres and 190.6° K. Equations and a table are given for the vapor pressure of CH_4 in the solid region, the liquid region below the normal boiling point and the liquid region above the normal boiling point.

The ratios of the vapor pressures of the methanes are expressed by equations of the form $T \log_{10} P_D/P_H = A - B/T$. The constants A and B have the following values, respectively: in the solid range CH_3D, 1.260, 110.2; CH_2D_2, 2.694, 222.2; CHD_3, 4.452, 351.7; CD_4, 5.529, 410.5; in the liquid range, CH_3D, 1.328, 129.5; CH_2D_2, 2.671, 245.4; CHD_3, 3.969, 343.8; CD_4, 5.159, 421.1. The vapor-pressure ratios of the isotopic methanes form a nearly geometric progression with increasing deuterium substitution. Deviations of their mixtures from ideal solutions are very small. 14 p.

RP2604. Data on the atomic form factor: Computation and survey Ann T. Nelms and Irwin Oppenheim

This paper presents the results of calculations of atomic form factors, based on tables of electron charge distributions computed from Hartree wave functions, for a wide range of atomic numbers. Computations of the form factors for five elements—carbon, oxygen, iron, arsenic, and mercury—are presented and a method of interpolation for other atoms is indicated. A survey of previous results is given and the relativistic theory of Rayleigh scattering is reviewed. Comparisons of the present results with previous computations and with some sparse experimental data are made. 10 p.

RP2605. Absolute calibration of the National Bureau of Standards photoneutron standard: I. . . . . . . J. A. De Juren D. W. Padgett, and L. F. Curtiss

The absolute emission rate of neutrons from the National Bureau of Standards radium-beryllium photoneutron standard source has been determined from the volume integral of the neutron absorption rate in water. Thin indium and manganese foils were employed to measure the thermal-neutron density as a function of distance from the source. The foil activities were converted to neutron densities by calibration of the foils in a reference thermal-neutron flux previously calibrated with boron films. A motor driven mechanical integrator, which moves foils radially from the source at a rate that takes into account the increase in area with distance from the source and the decay of the foils, provided over 80 percent of the volume integral. A value of $1.26_5 \times 10^6$ neutrons per second was determined for the emission rate of the photoneutron standard, with an estimated standard error of 3 percent. 7 p.

RP2606. A fast responding electric hygrometer................Arnold Wexler,
Samuel B. Garfinkel, Frank E. Jones, Saburo Hasegawa, and
Albert Krinsky

The performance characteristics of a fast responding electric hygrometer of high sensitivity are presented in some detail. The hygrometer is made by evaporating, under vacuum, potassium metaphosphate to obtain a thin film of material (3 microinches thick) on a specially treated glass blank. The logarithm of the resistance is approximately linear with relative humidity at constant temperature. The resistances vary from 4×10^4 to 10^{13} ohms. For the temperature range of $-40°$ to $+40°$ C, a group of nearly parallel calibration curves is obtained. The manufacturing process is sufficiently well controlled so that hygrometer elements, made in different batches, closely conform to a mean calibration curve. The average hysteresis for the hygrometer element over the temperature range 0° to 40° C is 2.7 percent relative humidity. The polarization effect for reversed direct current loading (1 minute cycles) is of the order of 0.3 percent relative humidity at the end of two hours; it is 1.4 to 2.2 percent for intermittent direct current loading (15 seconds on, 45 seconds off); and it is 3.7 to 6.8 percent for continuous direct current loading. Elements aged by humidity cycling appear to be less subject to polarization. Following a discrete change in relative humidity, the average response time of the element for a 63 percent change in indication at $-20°$ C, with an air velocity of 800 feet per minute parallel to the long edge of the element, is 1.9 seconds for a relative humidity change from 41.1 to 82.3 percent (with respect to water); it is 3.4 seconds for the same relative humidity change in the reverse direction. Times for 90 percent change in indication are 5.0 and 16.4 seconds, respectively. At room temperature, the average response time, for a 63 percent change in indication, with a velocity of 768 feet per minute, is 0.10 second for a discrete change in relative humidity from 33 to 80 percent, and 0.42 second for the same change in the reverse direction. Corresponding times for 90 percent change are 0.74 and 11.2 seconds. In comparison with lithium chloride elements currently produced for radiosonde use, the response time of the element was found to be less by at least an order of magnitude. 8 p.

RP2607. A simplified method of measuring the marginal powers of spectacle
lenses.......................................Francis E. Washer

A device is described that permits the measurement of marginal meridional power of spectacle lenses on a standard commercially available vertex power measuring instrument. The device consists of a hemispherical mounting surface and a variable prism which when mounted on a standard instrument permits the measurement of meridional power with respect to the vertex sphere in the extra-axial regions. It is used primarily to measure the meridional powers in the region of the lens normally used at a viewing angle of 30° from the axis. Some measurements on typical lenses are reported. 4 p.

RP2608. Thermodynamic properties of the alkali metals......William H. Evans,
Rosemary Jacobson, Thomas R. Munson, and
Donald D. Wagman

The available data on the thermodynamic properties of the elements lithium, sodium, potassium, rubidium, and cesium have been analyzed, and selected values of these properties are presented in tabular form. The tables include values of the free-energy function, $(F° - H_0^°)/T$; heat-content function, $(H° - \mathrm{H}_0^°)/T$; entropy, $S°$; heat content, $(H° - H_0^°)$; heat capacity, $\mathrm{C}_p^°$; heat of formation, $\Delta Hf°$; free energy of formation, $\Delta Ff°$; and logarithm of the equilibrium constant of formation, log Kf, for the solid, the liquid, and the monatomic and diatomic gases as a function of temperature from 0° K to high temperatures. 14 p.

RP2609. Arc and spark spectra of ruthenium.............Karl G. Kessler and
William F. Meggers

The direct-current arc and high-voltage spark spectra of ruthenium have been investigated for the purpose of compiling a comprehensive line-list for forthcoming term analyses of these spectra. These spectra were observed photographically with 30,000, 15,000, and 7,500 lines-per-inch concave gratings in a Wadsworth mounting. Wavelengths and estimated relative intensities are presented for 6,000 lines in the spectra, Ru I, Ru II, and Ru III, in the wavelength range 2005.69 to 11483.91 A. This list is compared with line lists reported by other investigators. 30 p.

RP2610. Heat capacity of some butadiene-styrene copolymers from 0° to 330° K
George T. Furukawa, Robert E. McCoskey, and
Martin L. Reilly

The heat capacity of butadiene-styrene copolymer polymerized at 41° F (5° C) containing 22.61 weight percent of bound-styrene and of butadiene-styrene copolymer polymerized at 122° F (50° C) containing 42.98 weight percent of bound-styrene was determined in the range 15° to 330° K, and the data have been used to construct tables of smoothed values of heat capacity, enthalpy, and entropy. The glass-transformation temperature of the 41° F copolymer was estimated to be 213° K and that of the 122° F copolymer 237° K. 6 p.

RP2611. Setting reaction of zinc oxide and eugenol.....Henry I. Copeland, Jr.,
Gerhard M. Brauer, W. T. Sweeney, and A. F. Forziati

Zinc oxide-eugenol mixtures have been used in dentistry for a number of years. The setting mechanism of these mixtures was investigated. X-ray diffraction data and electron photomicrographs give evidence that a crystalline compound is formed. Analysis and molecular-weight determinations show that this compound corresponds to the empirical formula $(C_{10}H_{11}O_2)_2$ Zn, zinc eugenolate. Infrared data, as well as the nonreactivity of meta and para substituted phenols as compared to the ortho isomers, suggest that the zinc eugenolate is a chelate. The hardened mass consists of zinc oxide embedded in a matrix of long sheath-like crystals of zinc eugenolate. The excess eugenol is sorbed by both the zinc eugenolate and the zinc oxide. 6 p.

RP2612. Development of a photoresist for etching designs in glass
Chester I. Pope and Raymond Davis

The preparation of a light-sensitive coating from phenol-formaldehyde resin is described. The light-sensitive coating may be used as a resist or mask in etching scales or reticule patterns in glass. A new etching solution was developed for use with this resist, and it is also recommended for fine line etching with wax resists. 4 p.

RP2613. Preferred orientation in stark rubber....C. J. Newton, L. Mandelkern,
and D. E. Roberts

The method of pole-figure analysis of preferred orientation is outlined and is applied to the problem of X-ray diffraction from stark rubber. A single nonrotating texture is deduced. The texture indicates that the chain-molecule axis is tilted about 22° from the plane of the rubber sheet and that a (101) plane normal lies approximately parallel to the sheet. 4 p.

RP2614. Thermodynamic properties of some gaseous halogen compounds
William H. Evans, Thomas R. Munson, and Donald D. Wagman

Tables of values of the heat of formation, ΔHf°; free energy of formation, ΔFf°; logarithm of the equilibrium constant of formation, $\log_{10}Kf$; free-energy function, $(F^\circ-H^\circ_0)/T$; heat-content function, $(H^\circ-H^\circ_0)/T$; entropy, S°; heat content, $(H^\circ-H^\circ_0)$, and heat capacity, C°_p, are given from 0° K to high temperatures for the following gaseous substances: F, F_2, F_2O, Cl, Cl_2, ClO_2, Cl_2O, ClF, ClF_3, Br, Br_2, BrF, BrF_5, BrCl, I, I_2, IF, IF_5, IF_7, ICl and IBr. The data used in preparing the tables are discussed in detail. 18 p.

RP2615. Atomic negative-ion-photodetachment cross-section and affinity measurements..............Stephen J. Smith and Lewis M. Branscomb

The spectral distributions of the H^- and 0^- cross sections for photodetachment have been measured. The H^- measurements are consistent with the theory of Chandrasekhar. A curve has been fitted to the results for O^-. The threshold of this cross section, the affinity of O^-, is found to be 1.48 ± 0.10 electron volts. No evidence is found for resonance at the threshold or for the existence of excited O^- ions. The apparatus is described in detail. 12 p.

RP2616. A study of the final stages of the austenite to martensite transformation in SAE 1050 steel. . . . Melvin R. Meyerson and Samuel J. Rosenberg

The austenite-martensite transformation curves in the temperature range from M_s to −320° F have been established for two SAE 1050 steels. No significant effect of austenitizing temperature or austenite grain size on the amount of martensite formed per degree drop in transformation temperature was observed at temperatures lower than about 100° F below the M_s. Within the limits tested, cooling rate from the austenitizing temperature had no effect on the austenite-martensite transformation. The amount of martensite formed per degree drop in temperature decreased at transformation temperatures of about 350° F and below, and the transformation did not go to completion even at the lowest temperature utilized (−320° F). At this temperature the amount of retained austenite was about 1 percent. 5 p.

RP2617. Infrared absorption and emission spectra of carbon monoxide in the region from 4 to 6 microns. . Earle K. Plyler, Lamdin R. Blaine, and Eugene D. Tidwell

The infrared absorption and emission spectra of carbon monoxide and carbon dioxide have been measured with high resolution in the region from 4 to 6 microns. The measurements of the $C^{12}O^{16}$ fundamental band were carried out to a high precision, and a set of molecular constants were calculated from the experimental data. In emission the 1—0 and 2—1 bands of CO were measured in the P branch. Twenty lines of $C^{13}O^{16}$ were measured in absorption, and the molecular constants were calculated for this molecule. The fundamental band of CO_2 was found to have its center at 2,349.16, $B_0=0.39026 \pm 0.00005$, and $D_0=12.6 \pm 0.8\times10^{-8}$ cm^{-1}.
The complete emission spectra of CO and CO_2 from 4 to 6 microns are shown in two figures. 7 p.

RP2618. Specific heats of collagen and leather. . . . . Joseph R. Kanagy

Determinations of the specific heats of collagen, vegetable-tanned leather, chrome-retanned leather, chrome leather, and these materials containing varying percentages of moisture were made at 25° C. The same determinations were also made on dry chestnut and quebracho tanning extracts and on a stuffing grease and an animal oil. The results obtained with the collagen and leather containing various percentages of moisture show abrupt breaks in the curves, which indicate phase changes. These changes are explained on the basis of changes in the vibrational activity of the polar groups in the collagen molecule.
Lubricating materials, added to leather, increase the specific heat. This affects the comfort of the leather adversely during cold weather. 5 p.

RP2619. *p*H values of the Clark and Lubs buffer solutions at 25° C
Vincent E. Bower and Roger G. Bates

The *p*H values of the well-known Clark and Lubs buffer solutions have been determined at 25° C on the conventional activity *p*H scale defined by the NBS standards. These solutions, which are useful for *p*H control in the range 1 to 10, are readily prepared by combining portions of four stock solutions with standard solutions of hydrochloric acid or sodium hydroxide. The four stock solutions contain potassium chloride, potassium hydrogen phthalate, potassium dihydrogen phosphate, or boric acid and potassium chloride. The compositions and buffer values of the solutions are listed at intervals of 0.1 *p*H. The estimated accuracy is ±0.02 *p*H unit. 4 p.

RP2620. Heat capacity; heats of fusion, vaporization, and transition; and vapor pressure of *N*-dimethylaminodiborane, $(CH_3)_2NB_2H_5$
George T. Furukawa, Robert E. McCoskey, Martin L. Reilly, and Ann W. Harman

The heat capacity of *N*-dimethylaminodiborane was determined in the temperature range from 17° to 285° K by means of an adiabatic calorimeter. A first-order solid-solid transition was found at 199.9 ± 0.1° K, with a latent heat of 7794 abs j mole^{-1}. The triple-point temperature was found to be $218.4 \pm 0.2°$ K, and the heat of fusion to be $1{,}408 \pm 30$ abs j mole^{-1}. The measurements of the heat of vaporization at 271.60° K (94.3 mm Hg) yielded $30{,}119 \pm 30$ abs j mole^{-1}. The results of the vapor-pressure measurements from 220° to 290° K can be represented by the equation

$$\log_{10} p_{\mathrm{mmHg}} = 406.5734/T + 5.2095614 \times 10^{-2} T + 1.01048 \times 10^{-5} T^2 - 1.390588 \times 10^{-7} T^3 - 11.63086.$$

The data were used to construct a table of smoothed values of heat capacity, enthalpy, entropy, and Gibbs free energy from 0° to 285° K. The entropy of *N*-dimethylaminodiborane in the ideal gas state at 1 atm and 271.60° K was computed from the data to be 302.3 ± 0.6 abs j deg^{-1} mole^{-1} (72.25 ± 0.14 cal deg^{-1} mole^{-1}). 7 p.

RP2621. Phase equilibrium relations in the systems titania-niobia and zirconia-niobia........................R. S. Roth and L. W. Coughanour

The systems TiO_2-Nb_2O_5 and ZrO_2-Nb_2O_5 were studied by means of solid-state reactions and by observation of fusion characteristics. Two binary compounds, $TiO_2 \cdot Nb_2O_5$ and $TiO_2 \cdot 3Nb_2O_5$, were found to exist in the TiO_2-Nb_2O_5 system. One compound, $6ZrO_2 \cdot Nb_2O_5$, was found to exist in the ZrO_2-Nb_2O_5 system. This compound has been found to be essentially isostructural with $ZrO_2 \cdot TiO_2$ and has orthorhombic symmetry with the following unit cell parameters when quenched from 1,550° C: $a = 4.964$ A, $b = 5.120$ A, $c = 5.289$ A. Solid-solution formation was observed in both systems. A probable equilibrium diagram is presented for each system. 5 p.

RP2622. Synthesis of a fluoro talc and attempted synthesis of fluoro chrysotile and fluoro anthophyllite................Alvin Van Valkenburg, Jr.

As part of a general study of the substitution of fluorine for hydroxyl in silicate structures, it was found that fluorine would partially substitute for hydroxyl in the talc structure. As a result of this substitution it was observed that the γ index of refraction was lowered by 0.01 and the temperature of thermal decomposition was raised about 180° C. Attempts to convert a fluoro talc to a fluoro anthophyllite hydrothermally were not successful. Also fluorine substitution for hydroxyl in chrysotile was not achieved hydothermally. 3 p.

RP2623. Determination of natural rubber in GR–S—natural rubber vulcanizates by infrared spectroscopy......Max Tryon, Emanuel Horowitz, and John Mandel

A rapid method for the estimation of natural rubber in vulcanizates of GR–S and natural rubber by means of infrared spectroscopy is reported. Samples were carefully prepared to contain known amounts of natural and GR–S rubber; the samples were vulcanized, extracted with acetone, and dried in a vacuum oven. Specimens from each sample were pyrolyzed in a combustion furnace at 550° C and the liquid pyrolyzates were analyzed by infrared absorption spectroscopy. An empirical relationship was developed in which the band intensities at 11.02 and 11.25 microns were related to natural rubber content. The experimental error of the method is characterized by a standard deviation of a single determination of 0.023, which represents approximately 3-percent natural rubber. 4 p.

RP2624. Thermal degradation of polychlorotrifluoroethylene, poly-α,β,β-trifluorostyrene, and poly-*p*-xylylene in a vacuum..........S. L. Madorsky and S. Straus

Polychlorotrifluoroethylene (Kel-F) (I), poly-α,β,β-trifluorostyrene (II), and poly-*p*-xylylene (III) were pyrolyzed under conditions of molecular distillation, and some of the light volatile fractions analyzed in the mass spectrometer. The volatiles from (I) consisted of 27.9 weight percent monomeric fragments, mostly monomer, and 72.1 percent large fragments of average molecular weight 904. In the case of (II), the volatiles consisted of 73.6 percent monomeric fragments, almost all monomer, and 26.4 percent large fragments of average molecular weight 458. The volatiles from (III) consisted of 3.6 percent monomeric fragments, not containing any monomer, and 96.4 percent large fragments of average molecular weight 661. Rates of thermal degradation, in terms of rates of volatilization, were also investigated. The activation energies calculated from these rates are 66, 67, and 76 kilocalories per mole for (I), (II), and (III), respectively. The following order of thermal stability was found: (III) > (I) > (II). 8 p.

RP2625. Infrared transmittance of some calcium aluminate and germanate glasses....Jack M. Florence, Francis W. Glaze, and Mason H. Black

The infrared transmittance of some calcium aluminate and germanate glasses has been measured out to 6 microns. The range of compositions of the calcium aluminate glasses was CaO, 26.7 to 52.0 percent, and Al_2O_3, 28.2 to 49.6 percent. Barium oxide, BeO, Bi_2O_3. La_2O_3, MgO and PbO were added in varying amounts up to a maximum of 36.0 percent for any one constituent. These calcium aluminate glasses are good infrared transmitters, but show a prominent water absorption band at 2.9 to 3.0 microns. This absorption can be decreased somewhat by means of a dry air treatment of the melt. These glasses have a strong tendency toward devitrification.

Germanium oxide is a good glass-former. Its glasses have about the same infrared transmittance as the calcium aluminate glasses in the absence of oxides such as SiO_2 and BeO, which absorb in the 4.5- to 5.5-micron region. 7 p.

RP2626. Properties of piezoelectric ceramics in the solid-solution series lead titanate-lead zirconate-lead oxide: Tin oxide and lead titanate-lead hafnate......................B. Jaffe, R. S. Roth, and S. Marzullo

Compositional proximity to a morphotropic transformation between two ferroelectric solid-solution phases seems to yield ceramic transducers having desirable properties over a wide range of temperature. Examples of the phenomenon were observed in the systems $PbTiO_3$-$PbZrO_3$, $PbTiO_3$-PbO:SnO_2, $PbTiO_3$-$PbZrO_3$-PbO:SnO_2, and $PbTiO_3$-$PbHfO_3$. The dielectric and piezoelectric properties of ceramics having compositions in these systems and in the system $PbZrO_3$-PbO:SnO_2 are described.

The composition $Pb(Ti_{.45}Zr_{.55})O_3$ exhibits a high radial coupling coefficient, greater than 0.3, for temperatures as high as 275° C and has the highest g_{31} constant, 11.7×10^{-3} volt-meters per newton. For the series of compositions containing 30 percent PbO:SnO_2 in the ternary system $PbTiO_3$-$PbZrO_3$-PbO:SnO_2, the tetragonal composition nearest the morphotropic boundary has the highest d_{31} value, 74×10^{-12} coulombs per newton. The rhombohedral composition nearest the morphotropic boundary shows the least change of frequency constant with temperature, a 2 percent variation over the range of 25° to 225° C. 16 p.

RP2627. Heat capacity, heats of fusion and vaporization, and vapor pressure of decaborane ($B_{10}H_{14}$).........George T. Furukawa and Rita P. Park

Measurements of the heat capacity of decaborane ($B_{10}H_{14}$) were made from 55° to 380° K by means of an adiabatic calorimeter. The data were used to obtain a table of smoothed values of heat capacity, enthalpy, entropy, and Gibbs free energy from 60° to 380° K. The heat of fusion, the triple-point temperature, the heat of vaporization at 378° K (23.96 mm Hg), and their corresponding estimated uncertainties were determined to be, respectively, 21,965 ±40 abs j $mole^{-1}$, 371.93 ±0.02° K, and 50,759 ±100 abs j $mole^{-1}$. The vapor pressure was measured from 345° to 395° K by means of an isoteniscope and the results above the triple-point temepraturе were found to be representable by the equation:

$$\log_{10}p_{\mathrm{mmHg}}=-4225.345/T-0.0107975T+16.63911.$$

The entropy of decaborane in the ideal gas state at 378° K and 1-atmosphere pressure was computed from the data to be 402.18 abs j deg^{-1} $mole^{-1}$ (96.12 cal deg^{-11} $mole^{-1}$) with an estimated uncertainty of ±0.87 abs j deg^{-1} $mole^{-1}$. 6 p.

RP2628. Preparation of titanium tetrachloride of high purity
W. Stanley Clabaugh, Robert T. Leslie, and Raleigh Gilchrist

A procedure is described for the preparation of titanium tetrachloride of high purity. Procedures are also given for determining the purity of titanium tetrachloride by cryoscopic, spectrochemical, and infrared absorption measurements.

The triple-point temperature of pure titanium tetrachloride was found to be 249.045° K, with an estimated uncertainty of ±0.010° K. 4 p.

RP2629. Liquid-vapor phase equilibrium in solutions of oxygen and nitrogen at pressures below one atmosphere.............George T. Armstrong, Jack M. Goldstein, and D. Ellis Roberts

A cryostat and equilibrium vessel, together with auxiliary apparatus for establishing equilibrium between liquid and vapor phases of solutions of low boiling materials by a circulation method, is described. The equilibrium vessel incorporates a novel liquid sampling device. Vapor and liquid compositions and total vapor pressures of solutions of oxygen and nitrogen were measured along isotherms at 77.5°, 70° and 65° K. The activity coefficients of nitrogen and oxygen may be represented by equations of the form

$$\frac{RT}{V_{N_2}} \log_e \gamma_{N_2} = A_{12}\phi^2_{O_2} \text{ and } \frac{RT}{V_{O_2}} \log_e \gamma_{O_2} = A_{12}\phi^2_{N_2},$$

in which A_{12} in cal/cm^3 mole has the values 1.22 at 77.5°, 1.38 at 70°, and 1.47 at 65° K. The deviations of the solutions from ideality are much less than is to be expected of regular solutions, in which the interaction energy between unlike molecules follows a geometric mean law. The data are not entirely consistent with the assumption that molar volumes are additive in the solutions. 13 p.

RP2630. Precise measurement of wavelengths in infrared spectra
Earle K. Plyler, Lamdin R. Blaine, and Eugene D. Tidwell

The precise measurement of infrared absorption spectra has been accomplished by using the white-light fringes of a Fabry-Perot interferometer in conjunction with atomic spectral lines. Wavelengths from the first spectra of neon, argon, krypton, and zenon were used for calibrating the fringes. The absorption spectra and the fringe system are recorded simultaneously by a two-pen recorder. One pen records the higher orders of the fringe system of visible light as detected by a 1P28 photomultiplier. The other pen records the infrared absorption spectrum, which is detected by a PbTe cell. A measurement of the distance from the center of the absorption line to the neighboring maxima of the fringe system determines the line position to a high precision. Wavelengths of infrared lines can be measured with an error of one part in 500,000. Eight infrared lines of mercury, seventeen lines of krypton, and five lines of xenon have been measured by this method. Tables are given of visible and infrared lines of the noble gases, which are useful for calibration. 6 p.

RP2631. Ideal gas thermodynamic functions of the isotopic hydrogen sulfides
Lester Haar, Joe C. Bradley, and Abraham S. Friedman

The ideal gas thermodynamic functions for H_2S, D_2S, T_2S, HDS, and HTS and DTS were calculated from molecular data. The recent spectroscopic data for H_2S and D_2S by Allen were employed. The zero-order frequencies for the other isotopes were obtained by a normal coordinate treatment. The partition functions are obtained in closed form. The calculations include high-temperature corrections for vibrational anharmonicity, rotation-vibration coupling, centrifugal stretching, and a low-temperature correction for nonclassical rotation. The statistical calculations were performed on the Bureau's digital computer. Tables of C°_p/R, $(H^\circ-E^\circ_0)/RT$, $-(F^\circ-E^\circ_0)RT$, and S°/R have been calculated at close temperature intervals from 50° to 5,000° K. 6 p.

RP2632. Measurement of field distortion in free-air ionization chambers by analog method.............William Miller and Robert J. Kennedy

A two dimensional analog of a free-air ionization chamber for the measurement of field distortion was obtained by painting conducting lines on resistance paper to represent cross sections of the electrodes. Guard wires were simulated by driving record player needles into the paper. The volume of the chamber from which charge was collected was related to the resistance between two of the lines on the paper, and small changes in this volume could be determined accurately by observing resistance changes. Grounded plates external to the chamber were simulated by additional lines painted on the paper, and the effect of these plates on the collecting volume was determined by measuring a change in resistance as the potential of these (simulated) external plates was changed. Measurements were also made for guards in the form of double wires and strips. There is some evidence from measurements on three dimensional ionization chambers that the top and bottom of the surrounding grounded X-ray shield tends to decrease the effects of distortion caused by the ends of the X-ray shield, so that the data obtained here would represent an upper limit to the error for the indicated chamber cross section. 7 p.

RP2633. The first spectrum of barium, Ba I.........Henry Norris Russell and Charlotte E. Moore

The analysis of the Ba I spectrum is presented. Although a monograph based on homogeneous observations is needed, this paper has been prepared from existing references, to present unpublished analysis by the senior author and, also, because Ba I is important in the history of atomic spectra. The first regularities attributed to two excited electrons were found in Ba I as well as in Ca I and Sr I.

Three tables are included: A complete term list; a complete line list containing all observed and all classified lines; a table giving the estimated intensities of the observed combinations. There are approximately 390 classified lines.

The limit, derived from well-established series, is 42032.4 K, giving an ionization potential of 5.210 volts. 8 p.

RP2634. Compressibilities of long-chain normal hydrocarbons...C. E. Weir and J. D. Hoffman

Measurements were made of the compressions of n-$C_{18}H_{38}$, n-$C_{20}H_{42}$, n-$C_{24}H_{50}$, n-$C_{26}H_{54}$, n-$C_{28}H_{58}$, and n-$C_{30}H_{62}$ in the crystalline state at 21° C. The pressure range used was from 1,000 to 10,000 atmospheres. Within the experimental error, which was fairly large because of the small size of sample, no significant variation of the compression with chain length was observed. The average compression of all the hydrocarbons studied may be represented by the equation

$$-\Delta V/V_0=0.1717 \log_{10} (2{,}500+P)-0.6272.$$

The average compressibility of the hydrocarbons extrapolated to 1 atmosphere was calculated to be 29.8×10^{-6} atm^{-1} at 21° C. 4 p.

RP2635. Absolute calibration of the National Bureau of Standards photoneutron standard: II. Absorption in manganese sulfate......James DeJuren and Jack Chin

An absolute method of calibrating a neutron source by determining the neutron absorption rate in a manganese sulfate bath is described. In this method slightly more than one liter of solution from the bath is irradiated in a strong neutron flux. The absolute activity of manganese in an aliquot of this activated solution is determined with a 4π flow proportional counter. Concurrently, one liter of this solution is added to the inactive bath and after stirring, the counting rate is measured with a dip counter. As the number of radioactive manganese nuclei contained in the liter is obtained from the aliquot activity, the dip counter is calibrated for a known manganese activity. Then the bath is irradiated by the source and the dip counting rate at saturation yields the neutron capture rate by the manganese. From a knowledge of the neutron capture cross sections and the manganese sulfate concentration, the fraction of neutrons captured by manganese is determined. As a result, the total neutron capture rate in the bath at saturation is obtained. A value of $Q=1.25_0\times10^6$ neutrons per second was obtained for the National Bureau of Standards source (1954). The standard error is ±2 percent. 6 p.

RP2636. A new Bunsen-type calorimeter......................Ralph S. Jessup

A new Bunsen-type calorimeter, using diphenyl ether as the calorimetric substance, is described. Tests of this calorimeter show that it can be used to measure quantities of heat of the order of 38 calories with a precision of about 0.05 percent. 6 p.

RP2637. Mass spectra of thermal degradation products of polymers....Paul Bradt and Fred L. Mohler

Polymers are degraded or evaporated from a tube furnace directly into the mass spectrometer, and mass spectra recorded as the temperature of the sample is increased. Polyethylene degrades into paraffins, olefins, and diolefins and at 386° C the mass spectrum extends to mass 684, $C_{49}H_{96}$. Polyvinyl chloride degrades in two stages. From 127° to 300° C it loses HCl and some benzene, and above 300° C it evolves a great variety of hydrocarbons.

The heavy fraction from rubber degradation evaporates over a wide temperature range, and molecules containing from 3 to 16 units of the monomer, C_5H_8, are recorded. The heaviest ion is $C_{80}H_{127}$ of mass 1,087. Degradation of polyxylylene gives molecules containing from 1 to 9 units of the monomer, C_8H_8, the heaviest ion being $C_{72}H_{71}$ of mass 935. A low polymer of polyphenyl was evaporated and molecules containing 2 to 11 monomer units were recorded. The heaviest ion was $C_{66}H_{46}$ of mass 838. 5 p.

RP2638. Heats of combustion of liquid *n*-hexadecane, 1-hexadecene, *n*-decylbenzene, *n*-decylcyclohexane, *n*-decylcyclopentane, and the variation of heat of combustion with chain length....Frances Maron Fraser and Edward J. Prosen

The heats of combustion of five highly purified long-chain liquid hydrocarbons were measured with a bomb calorimeter. The calorimetric data yield the following values for the heats of combustion, $-\Delta Hc^\circ(25^\circ\ \mathrm{C})$, of the liquid hydrocarbon with gaseous oxygen to form gaseous carbon dioxide and liquid water; 1 kilocalorie=4.1840 kilojoule.

n-Decylbenzene=2340.58±0.42 kcal/mole
1-Hexadecene=2519.17±0.44
n-Hexadecane=2557.15±0.42
n-Decylcyclohexane=2497.90±0.43
n-Decylcyclopentane=2347.54±0.46

It is shown that, in the liquid as well as in the gaseous state, the increment in the heat of combustion (and hence in the heat of formation) per CH_2 group added in the *n*-alkyl side chain is a constant except for the first two members of the series, and that this increment has the same value for each of these series of compounds. 5 p.

RP2639. Computation of atomic energy levels: Spectrum of singly-ionized tantalum (Ta II)....Richard E. Trees, W. F. Cahill, and P. Rabinowitz

Energies and wave functions of atomic systems can be calculated as the characteristic values and vectors of matrices in accordance with long-established procedures. Coding for carrying out these computations on the Standards Eastern Automatic Computer is described. Some preliminary values are given for the energy levels of the spectrum of singly-ionized tantalum (Ta II). 7 p.

RP2640. Reflection and transmission of gamma radiation by barriers: Monte Carlo calculation by a collision-density method....Martin J. Berger

The collision density of photons in an infinite Compton-scattering medium was calculated by random sampling. The intensity, spectral composition, and angular distribution were then determined for radiation reflected and transmitted by plane-parallel barriers by carrying out appropriate integrations over the collision density, taking into account the absorbing properties of the medium and the effect of boundaries. All numerical work was done on the National Bureau of Standards automatic computer (SEAC). Sample results are presented for 0.66-Mev radiation incident on water barriers of various thicknesses. 8 p.

TITLE PAGE AND CONTENTS TO VOLUME 55, 4 p.

RESEARCH PAPERS FROM JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 56, JANUARY—JUNE 1956

RP2641. Dielectric constant of water from 0° to 100° C...C. G. Malmberg and A. A. Maryott

An equal ratio arm, capacitance-conductance bridge, operated at frequencies below 100 kilocycles per second, was used to measure the dielectric constant of water with an accuracy of better than 0.1 percent at 5-degree intervals over the range 0° to 100° C. At 25° C the dielectric constant was found to have the value 78.30, which is about 0.3 percent lower than that usually accepted. The data fit the equation

$$\epsilon=87.740-0.40008t+9.398(10^{-4})t^2-1.410(10^{-6})t^3,$$

with a maximum deviation of 0.01 unit in dielectric constant. The experimental method and sources of error are considered in some detail. 8 p.

RP2642. A calorimeter for measuring the power in a high-energy X-ray beam
John McElhinney, Bernard Zendle, and Steve Domen

The design and calibration of a calorimeter to measure the power in X-ray beams having peak energies between 1 and 180 million electron volts are described. The calorimeter included two thermally balanced lead cylinders, 4 centimeters in diameter by 7.5 centimeters long, one irradiated by an X-ray beam. The lead cylinder was large enough to absorb almost completely the X-ray beam. The absorbed energy resulted in an unbalance of temperature of the two cylinders, which was measured by the change in resistance of embedded thermistors.

Calibration of the calorimeter consisted in observing the temperature rise due to a measured quantity of electric energy dissipated in the same cylinder. The results are given for five calibration runs, each using about 70 microwatts of power for approximately 20 minutes. The probable error of the mean was about ±1 percent. Separate reports of measurements of X-ray-beam powers at 1.4 and 36 million electron volts are in preparation. 8 p.

RP2643. Pyrochlore-type compounds containing double oxides of trivalent and tetravalent ions.................................Robert S. Roth

A study has been made by X-ray diffraction analyses of the A_2O_3:$2BO_2$-type double oxides. It was found that many of these mixed oxides, after appropriate heat treatment, formed compounds of the formula type $A_2B_2O_7$. Most of these compounds crystallized in the cubic system with a face-centered cell similar to that found for the mineral pyrochlore, although some were distorted from the ideal cubic structure.

Indexed X-ray diffraction powder patterns are given for the cubic compounds $Sm_2O_3 \cdot 2TiO_2$, $Gd_2O_3 \cdot 2TiO_2$, $Dy_2O_3 \cdot 2TiO_2$, $Y_2O_3 \cdot 2TiO_2$, $Yb_2O_3 \cdot 2TiO_2$, $La_2O_3 \cdot 2SnO_2$, $Nd_2O_3 \cdot 2SnO_2$, $La_2O_3 \cdot 2ZrO_2$, $Nd_2O_3 \cdot 2ZrO_2$, and for the possible compounds $Y_2O_3 \cdot 2ZrO_2$ and $Nd_2O_3 \cdot 2UO_2$. Unindexed patterns are given for $La_2O_3 \cdot 2TiO_2$, $Nd_2O_3 \cdot 2TiO_2$ and $Bi_2O_3 \cdot 2SnO_2$.

On the basis of the existence of the two compounds $La_2O_3 \cdot 2ZrO_2$ and $Nd_2O_3 \cdot 2ZrO_2$, the phase diagrams for the systems La_2O_3-ZrO_2 and Nd_2O_3-ZrO_2 have been revised. 9 p.

RP2644. Thermal decomposition of polytetrafluoroethylene in various gaseous atmospheres......................L. A. Wall and J. D. Michaelsen

The effects of various gaseous atmospheres on the thermal decomposition of polytetrafluoroethylene have been investigated in the range 450° to 500° C. Both catalysis and inhibition were observed. The inhibitory substances, chlorine, hydrogen, carbon tetrachloride, and toluene, all produced marked changes in the mechanism of polytetrafluoroethylene decomposition. Whereas the normal degradation reaction in a vacuum produces mainly monomer, the inhibited reactions give large fragments plus side reactions, such as the defluorination of the skeletal carbon structure. The results can be interpreted in terms of previous theoretical treatments of chain mechanisms for polymer decomposition and lead to the conclusion that, although the inhibited reactions produce little monomer and are highly random, the relatively high rates observed indicate induced decomposition by the inhibitory substances. Energetic considerations are discussed and appear consistent with the postulated mechanisms. 8 p.

RP2645. Abscissas and weights for gaussian quadratures of high order
P. Davis and P. Rabinowitz

Weights and abscissas are presented for the Gaussian quadrature rules of order $n=16, 20, 24, 32, 40, 48$. These constants were computed on Standards Automatic Computer by the method described and have passed a number of checks with about 20 places of decimals. Values of the weights and abscissas are also available for $n=64$, 80, and 96. 3 p.

RP2646. Behavior of cements and related materials under hydrostatic pressures up to 10,000 atmospheres.............C. E. Weir, C. M. Hunt, and R. L. Blaine

Compression studies were made on hardened cement pastes at 21° C and at pressures as high as 10,000 atmospheres. The effects of composition, age, moisture content, and water-cement ratio were studied. Compressibility of dried portland cement pastes appeared to proceed through a maximum with increased cure, the existence or location of the maximum being dependent on the water-cement ratio. Compression of both portland and aluminous cements increased with increasing evaporable water content. Portland cements with evaporable water contents in the range 17.5 to 32.4 percent exhibited a transition between 2,000 and 3,000 atmospheres. No similar effect occurred in aluminous cement. Experiments indicated that the transition was attributable to hydrated lime formed in the portland cement. Average compressibilities of dried paste were 3.1×10^{-6} and 2.2×10^{-6} atm^{-1} between 1 and 5,000 atmospheres and between 5,000 and 10,000 atmospheres, respectively. Compression studies were also made with wet silica gel, hydrated tricalcium silicate, and dry and wet calcium hydroxide. 12 p.

RP2647. Formulas for inverse osculatory interpolation.......Herbert E. Salzer

Formulas for inverse osculatory interpolation are obtained by inversion of Hermite's formula. They cover the cases for $n=2(1)7$, where n is the number of points required in direct osculatory interpolation. The formulas provide an improved means for inverse interpolation in the case where the first derivative is either tabulated alongside the function or is easily obtained. 4 p.

RP2648. Residual entropy of linear polymers.............H. N. V. Temperley

The question whether it is possible to assign a finite entropy to a polymer, bearing in mind the fact that it may not be a well-defined substance in thermodynamic equilibrium, is considered. It is shown that the entropy of chain configurations is the only contribution that will be important at low temperatures. Existing knowledge of the thermodynamics of hydrocarbons enables one to arrive at a generalization of the well-known "flexible chain" model of a polymer molecule. The new model is in good accord with experimental facts on the specific heat of polymers, and enables a finite entropy to be defined and to be reasonably accurately calculated. These findings are then compared with certain experimental results throwing light on the length of the "effective segment" of polymer chains of various types, this quantity being defined in the text. The experimental facts come from studies of polymer solutions, solid polymers, solid and liquid paraffins, and related compounds, and are remarkably consistent with the theoretical expectations. A few apparent inconsistencies and a few instances of alternative possible interpretations for the same facts are noted. 12 p.

RP2649. Molecular weights of thermally degraded polymethyl methacrylate
Victor E. Hart

Molecular weights of polymer residues from the thermal degradation in vacuum of two polymethyl methacrylate samples, one polymerized with benzoyl peroxide and the other without any initiator, have been obtained over wide extents of degradation at various constant temperatures. A linear relation, dependent upon the temperature but independent of rate of volatilization and rate of change of $1/M_w$, is found when log R is plotted against $1/M_w$. (R=ratio of residue weight to original specimen weight, and M_w=weight-average molecular weight.) The results are explained on the basis of a free-radical chain-reaction mechanism in which intermolecular chain transfer (activation energy=29 kilocalories) is the primary, or perhaps the sole, cause of the molecular-weight decrease. 5 p.

RP2650. Thermal expansion of binary alkaline-earth borate glasses
Herman F. Shermer

The thermal expansivity of a number of calcium, strontium, and barium borate glasses are reported. The expansivity of the calcium and strontium borates increases with increasing alkaline-earth oxide concentration. The expansivity of the barium borate glasses is a minimum at about 20 mole percent of barium oxide. The expansivity measurements on the glasses were correlated with the density measurements in the liquid range. The expansivity of any composition is the lowest in the glassy (solid) region and is greater in the liquid region. The expansivity in a third region which was described as "very viscous" was not measured but was indicated to be greater than in either of the measurable regions. The density curves for each alkaline-earth borate series converges with increasing temperature. 7 p.

RP2651. Dielectric relaxation for a three-dimensional rotator in a crystalline field: Theory for a general six-site model..........Benjamin M. Axilrod

A theory of dielectric relaxation is presented for a generalized six-site model where the transition probabilities for the turning of dipoles from one orientational site to another are arbitrary. The sites are arranged in three dimensions. The nature of the set of discrete relaxation times generated by this model is examined in a general manner. It is found that the relaxation times are all real and positive and the range of the relaxation times is established. 6 p.

RP2652. A matrix with real characteristic roots................Karl Goldberg

It is proved that a certain matrix, which is the coefficient matrix of a differential equation found in the theory of dielectric relaxation, has only real characteristic roots. This is done by finding a real symmetric matrix with the same principal minors and thus the same characteristic roots. 1 p.

RP2653. Reflection and transmission of gamma radiation by barriers: Semianalytic Monte Carlo calculation...Martin J. Berger and John Doggett

The transport equation for photons which have been Compton-scattered repeatedly with a specified sequence of energy losses and deflections was solved analytically, by an "orders of scattering" approach, to obtain conditional reflection and transmission probabilities. These probabilities were then averaged over all possible intermediate angular and energy configurations in a Monte Carlo calculation carried out on the NBS automatic computer (SEAC). The efficiency of the Monte Carlo calculation was increased by taking advantage of the close correlation between the transmission of radiation through thick barriers and the corresponding penetration problem in an infinite homogeneous medium for which an exact solution was available. The reflected and transmitted energy flux (integrated over all spectral energies and directions) has been calculated for 0.66-, 1- and 4-Mev radiation incident on water barriers, and 1-, 4-, and 10-Mev radiation incident on iron, tin, and lead barriers. Angular and energy spectra were obtained for water at 0.66 Mev. The ratio of the scattered energy flux, transmitted through a barrier to the scattered flux at equal depth in an infinite medium, was found to be constant for distances from the source greater than four mean free paths of the source radiation. 10 p.

RP2654. An examination of the helium vapor-pressure scale of temperature using a magnetic thermometer............E. Ambler and R. P. Hudson

The variation of the mutual inductance of two coils surrounding a paramagnetic crystal has been measured as a function of the saturation vapor pressure of helium in the range 1.3° to 4.2° K. The fact that this quantity should vary inversely as the absolute temperature has been made use of to investigate the consistency of two recently proposed vapor-pressure temperature scales. The results suggest errors above 2° K in the empirical equation proposed by Clement, Logan, and Gaffney (in contrast to the experiences of Erickson and Roberts with a magnetic thermometer) and are in closer accord with the thermodynamic calculation of Van Dijk and Durieux. 6 p.

RP2655. Calculation of thermodynamic functions for polyatomic molecules
Harold W. Woolley

Formulas are given from which the thermodynamic functions may be obtained for polyatomic molecules not exhibiting special phenomena, such as internal rotation. The effects of first and second order anharmonicities and rotational-vibrational interaction are treated in detail, as also are the angular momentum effects of doubly degenerate vibrations in linear molecules. This paper presents formulas for the corrections carried to higher order than has hitherto been available. 6 p.

RP2656. Penetration of gamma radiation from a plane monodirectional oblique source..Martin J. Berger

The penetration of gamma radiation from a plane monodirectional oblique source is solved by the moment method of Spencer and Fano. The novel feature of the treatment is the systematic investigation and exploitation of a function-fitting technique, which consists of approximating the desired radiation-flux function, $f(x)$, by an expression of the form $\sum_n A_n \phi(B_n x)$, the parameters A_n and B_n being determined from the knowledge of the flux moments.

A discussion is given of the criteria for the proper choice of the "weight function," $\phi(x)$, and of the accuracy of the fitting procedure. The results of a sample calculation are presented for an 0.66-Mev source in water. 18 p.

RP2657. A re-entrant cavity for measurement of complex permeability in the very-high-frequency region.....R. D. Harrington, R. C. Powell, and P. H. Haas

A re-entrant cavity, constructed for measuring the initial complex permeability of magnetic toroids in the very-high-frequency region, is described. Many of the electrical and mechanical problems associated with the development of an instrument of this type are considered. The general theory of permeability measurements, using a re-entrant cavity, is discussed, and the associated working equations are derived. Calibration techniques and results of measurements on several samples are also given. 6 p.

RP2658. Fundamental factors controlling electrical resistivity in vitreous ternary lead silicates.................Simon W. Strauss, Dwight G. Moore, William N. Harrison, and Lloyd E. Richards

The resistivities of selected vitreous ternary lead silicates containing ions of groups I, II, III, IV, and also the ions chromium, manganese, iron, cobalt, and nickel were measured in the range 200° to 500° C and at an applied direct-current field of 525 volts per centimeter. In addition, the resistivities of vitreous silica and of quartz, with optic axis parallel and perpendicular to the applied field, were measured over the same temperature range. The resulting data are given as log resistivity-composition isotherms for the alkalies and alkaline earths and as log resistivity-temperature curves for the other ions. Correlations between resistivity and bonding energy and between frequency factor and heat of activation are presented. The resistivities of the alkali lead silicates were interpreted from the standpoint of the activation energy principle. 8 p.

RP2659. Some factors affecting the precision of polarographic half-wave potential measurements..............John K. Taylor and Stanley W. Smith

The experimental conditions required for the precise determination of polarographic half-wave potentials have been investigated and are discussed. The values of half-wave potentials vary with the characteristics of the dropping-mercury electrode in the case of reduction of metal ions to metal soluble in mercury. Consequently, it is necessary to specify the experimental condition whenever values for half-wave potentials are reported. With proper precautions it is possible to attain reproducibility within ±0.2 millivolt in the measurements. 6 p.

RP2660. Infrared measurements from 50 to 125 microns...Earle K. Plyler and Nicolo Acquista

A prism spectrometer has been changed to a long wavelength grating spectrometer by removing the prism and by replacing the Littrow mirror with a grating. Gratings of 320 and 180 lines per inch were used for the region 50 to 125 microns. A thermocouple with a crystal quartz window served as the detector. Stray radiation was greatly reduced by the use of reflection filters. Three types of reflection filters were found to be efficient. They were gratings with 2,000 lines per inch, roughened silver mirrors, and reststrahlen plates of NaCl, KBr, and CsBr. The absorption lines of water vapor were used to calibrate the spectrometer. The spectra of several substituted ethylenes and ethanes have been measured, and absorption bands have been found between 50 and 100 microns. 5 p.

RP2661. Surface tension of molten glasses in the system barium oxide-boric oxide-silica....................................Herman F. Shermer

The surface tension of 154 compositions in the system $BaO-B_2O_3-SiO_2$ were measured by a maximum pull-on-cylinder method, over the approximate range 900° to 1,300° C. The region of glass formation was investigated along with the adjacent regions. Several compositions were studied in the two-immiscible-liquid region. In this two-liquid region the lines of constant surface tension followed the tie lines in the phase diagram. Outside the two-liquid region the surface tension was increased by the addition of BaO and to a lesser degree by SiO_2. At 900° C the surface tension was relatively high near the composition corresponding to the $3BaO \cdot 3B_2O_3 \cdot 2SiO_2$ compound, which has a melting point of 1,009° C. 4 p.

RP2662. Relationship between crystal orientation and stress-corrosion cracking in alpha and beta brasses........................Hugh L. Logan

The crystallographic planes bounding intercrystalline stress corrosion cracks in two large-grained Alpha brasses and those followed by transcrystalline stress-corrosion cracks in large-grained beta brass were determined by X-ray diffraction methods. Intercrystalline stress-corrosion cracking in the alpha brasses originated between grains that, because of their relative orientation, had high interfacial energy contents. It is the relative orientation, not the crystallographic type, that determines the susceptibility to stress-corrosion cracking of alpha brass in grain boundaries approximately normal to the applied stress. Transcrystalline stress-corrosion cracking of beta brass occurred in grains that were oriented most favorably for slip, and in planes that were approximately normal to the applied stress. No plane or family of planes in beta brass was found to be particularly susceptible to stress-corrosion cracking. It is postulated that in each case cracking progressed by a film rupture mechanism. 8 p.

RP2663. New descriptions and analyses of the third and fourth spectra of zirconium, Zr III and Zr IV..........................C. C. Kiess

Recent observations of the spectra emitted by ionized zirconium atoms have added many new lines to the descriptions of these spectra and have led to revisions and extensions of their term structures. The low, even terms of Zr III arise in the electron configurations $4d^2$, $4d\ 5s$, and $5s^2$. Excitation of these states leads to higher terms of the $4d\ 5p$, $5s\ 5p$, $4d\ 5d$, $4d\ 6s$, $4d\ 4f$, $5s\ 5d$, $4d\ 6p$, $5s\ 6s$, $5s\ 4f$, and $5s\ 5g$ configurations. Most of the singlet and triplet terms from these configurations have now been established. Zeeman patterns from Massachusetts Institute of Technology plates have confirmed and corrected some of the classifications of earlier work. From the series-forming terms of Zr III the separation of the ground states of Zr III and Zr IV is calculated as 198590 cm^{-1}, corresponding to an ionization potential of 24.6 electron volts for the ion Zr^{2+}. In the doublet spectrum of Zr IV, which arises from the migration of the single electron outside the krypton shell, the terms from the $7s$, $6p$, $6d$, $5f$, $6f$, $5g$, and $6g$ electrons have been added to those already known. A mean value of 276970 cm^{-1} for the separation of the ground states of Zr IV and Zr V has been derived from three accordant values calculated from series of ^2S, $^2F^\circ$, and ^2G terms. This corresponds to an ionization potential of 34.33 electron volts for Zr^{3+}. 11 p.

RP2664. Frequency conversion with positive nonlinear resistors..Chester H. Page

A nonlinear resistor subject to an almost periodic voltage will absorb power at some frequencies, and supply power at other frequencies. Necessary and sufficient relations among these powers are found. Among the practical consequences are the results: (1) modulation efficiency cannot exceed unity, (2) subharmonics are not produced, and (3) the efficiency of generating an nth harmonic cannot exceed $1/n^2$. 4 p.

RP2665. Electrical resistivity of vitreous ternary lithium-sodium silicates
Simon W. Strauss

Resistivities of vitreous lithium disilicate, sodium disilicate, and selected ternary lithium-sodium silicates were measured in the range 150° to 230° C. The resulting data are given as log resistivity-composition isotherms. A correlation between heats of activation and composition is also presented. The composition containing approximately equimolar quantities of lithium oxide and sodium oxide showed a maximum value on the resistivity-composition isotherms as well as on the heat of activation-composition curve. The resistivities of the glasses were interpreted in terms of the structure of glass. 3 p.

RP2666. Isothermal compressibilities of alkaline earth oxides at 21° C
C. E. Weir

Compression measurements were made by the piston-displacement method on powdered alkaline earth oxides at 21° C at 1,000-atmosphere intervals for pressures between 2,000 and 10,000 atmospheres. Pressure volume data are linear within experimental error. Compressibilities, β, and standard deviations of compressibilities, σ, in units of 10^{-6} per atmosphere are as follows: BeO, $\beta = 0.27$,

$\sigma=0.04$; MgO, $\beta=0.60$, $\sigma=0.12$; CaO, $\beta=0.89$, $\sigma=0.04$; SrO, $\beta=0.84$, $\sigma=0.10$; BaO, $\beta=1.76$, $\sigma=0.05$. Some abnormality in compressibility behavior for CaO and SrO is noted. This is probably related to a similar abnormality in densities. 3 p.

RP2667. Improved synthesis of sodium D-glucuronate-6-C^{14} and of D-glucose-6-C^{14}
R. Schaffer and H. S. Isbell

A process is reported for the synthesis of barium 1,2-*O*-isopropylidene-D-glucofururonate-6-C^{14} in 55 percent yield from 1,2-*O*-isopropylidene-D-*xylo*-dialdopentofuranose and sodium cyanide-C^{14}. The salt was converted to sodium D-glucuronate-6-C^{14} in 92 percent radiochemical yield and to D-glucose-6-C^{14} in 84 percent yield. The over-all radiochemical yield of D-glucose-6-C^{14} based on the sodium cyanide-C^{14} used was 45 percent in comparison with prior yields of approximately 15 percent. 5 p.

RP2668. Ideal gas thermodynamic functions of the isotopic hydrogen cyanides
Joe C. Bradley, Lester Haar, and Abraham S. Friedman

The ideal gas thermodynamic functions for HCN, DCN, and TCN were calculated from molecular data. The recent spectroscopic data for HCN and DCN by Allen and Douglas and Sharma were employed. The zero frequencies of TCN were obtained by a normal coordinate treatment. The partition functions are obtained in closed form. The calculations include high-temperature corrections for vibrational anharmonicity, rotation-vibration coupling, centrifugal stretching, and azimuthal quantum effects, and low-temperature corrections for nonclassical rotation. The statistical calculations were performed on the Standards Electronic Automatic Computer (SEAC). Tables of C_p°/R, $(H^\circ-E_0^\circ)/RT$, $-(F^\circ-E_0^\circ)/RT$, and S°/R have been calculated at small temperature intervals from 50° to 5,000° K. 4 p.

RP2669. Surge voltage breakdown of air in a nonuniform field. . .J. H. Park and
H. N. Cones

The discharge and breakdown phenomena in air when a surge voltage is applied to sphere-plane electrodes were investigated. A steeply rising surge of 145 kilovolts peak value was applied to the plane placed 86 centimeters above the laboratory floor. A 1.6-centimeter diameter sphere, mounted an adjustable distance below the plane, was connected to ground through the surge impedance of a coaxial cable. Experimental data consisted of oscillograms of the current to the sphere and pictures of the discharge between the electrodes. A method for chopping the applied voltage surge at an accurately controllable time was used to study the discharge at gap spacings for which a full-wave applied surge would cause breakdown.

Complete breakdown did not occur for gap spacings greater than 28 centimeters, sphere positive, or 20 centimeters, sphere negative. But at gap spacings up to 56 centimeters, sphere positive, and 46 centimeters, sphere negative, discharge streamers (corona) did develop from the sphere and they were accompanied by short pulses of current to the sphere. At gap spacings near those giving breakdown, these initial streamers span the gap without yielding breakdown. Measured speeds of formation of these initial streamers were found to be 500 centimeters per microsecond for the sphere negative and 800 centimeters per microsecond for the sphere positive.

For shorter gap spacings the discharge leading to breakdown is illustrated by the data obtained with the applied voltage chopped. Bright conducting channels develop between the sphere and plane. At the same time the current to the sphere starts to rise again fairly slowly at first and then at an increasing rate up to breakdown. The mechanism leading to breakdown is not the same for the sphere negative as for the sphere positive, and it is different for very short gaps which correspond to high overvoltage. An attempt is made to explain how the initial streamers form and how the channels leading to breakdown develop. 24 p.

RP2670. Index of refraction and particle size as factors in the infrared spectrophotometry of polyvinyl chloride. . . . . .Mary Reiney Harvey,
James E. Stewart, and Bernard G. Achhammer

The scope of solid-phase infrared spectroscopy is broadened by the elimination of particle size restrictions heretofore placed on the sample. This applies only, however, to samples whose indices of refraction change only slightly with change in wavelength and can be matched to the indices of refraction of the suspending medium.

The potassium bromide pellet technique has been applied to the infrared spectral measurement of relatively large, solid particles (up to 44 microns diameter) of polyvinyl chloride, thus providing a technique for obtaining the infrared spectrum of polyvinyl chloride without subjecting the polymer to degrading forces. A near-match in the indices of refraction of potassium bromide and polyvinyl chloride is apparently responsible for the well-resolved, scatter-free spectrum obtained. Other imbedding salts having different indices of refraction were used to demonstrate the necessity of matching the indices of refraction of medium and sample when the sample particles are relatively large. The measurement of potassium bromide pellets containing polyvinyl chloride of various particle sizes showed that even very large particles (up to 110 microns) will yield characteristic spectra when the indices of refraction of sample and medium are matched. Infrared spectra of nylon and paper fibers imbedded in potassium bromide were obtained; these spectra demonstrate the feasibility of this method for use with other materials. Equipment developed to make suitable pellets is described. 11 p.

RP2671. Radiation from a vertical antenna over a curved stratified ground
James R. Wait

The problem of a radial electric dipole outside a concentrically stratified spherical conductor, such as the earth, is formulated. The solution is facilitated by considering the analogous nonuniform transmission line for the radial modes. The general result is then transformed to a Watson-type residue or azimuthal mode series, which reduces to the well-known result for the homogeneous earth as a special case. Following a method introduced recently by Bremmer, the residue series is converted to an alternative expansion, which is more suitable at short distances. The leading term of this new expansion corresponds to the case of the transmitter and receiver over a plane stratified conducting earth. 8 p.

RP2672. Characteristics of an image-forming system.......Roland V. Shack

Two general approaches to the analysis of an image-forming system are considered. One depends on the image of a point object and the other on the Fourier transform of this image. The two are developed independently and then coordinated, a practical characteristic function being determined for each approach. The relative merits of the two approaches are considered. 16 p.

RP2673. Advances in the design and application of the radiofrequency permeameter....Alvin L. Rasmussen, Albert W. Enfield, and Alfred Hess

Improvements are described for increasing the frequency coverage, accuracy, and ease of application of the radiofrequency permeameter developed at the National Bureau of Standards to measure initial complex permeability of toroidally shaped ferromagnetic materials of low conductivity. A brief review of the development of the permeameter is also presented. These improvements include (1) calibration of a permeameter, using a transfer permeability standard, (2) design of permeameter primaries for the frequency range of 0.05 to 50 megacycles, (3) modifications of the short of the permeameter secondary, (4) analysis and modifications of loss equations, (5) graphical methods of obtaining dissipation factor and permeability from measurement data, and (6) capacity calibration of a *Q* meter. 8 p.

RP2674. A new computer for calculating the water content of gases
A. W. Diniak and E. R. Weaver

A new computer designed to reduce the labor in computing the water content of gases is described, and details of construction and use are given. The computer is of the circular slide-rule type with an accuracy of about that of a 10-inch slide rule. The computer consists of three disks with appropriate circular scales, which automatically correct for all deviations from ideality. It is a completely new design of an earlier model, and it is based on newly determined values for the corrections. The primary function of the computer is to calculate the water content and dewpoint of gases at pressures up to 6,000 pounds per square inch quickly, accurately, and with a minimum of effort, but it may be used for many other computations. Attention should be called to the fact that deviations from ideality are not dependent on methods of measurement and that they affect. many measurements and computations in which they are usually ignored. 10 p.

RP2675. Vibrational constants of acetylene-d_2. . . . . Harry C. Allen, Jr., L. R. Blaine, and Earle K. Plyler

The infrared spectrum of acetylene-d_2 has been investigated in the region from 1 to 5 microns. The new data have enabled a consistent interpretation of the 16 bands in which only the stretching modes are excited. It is shown that there is a resonance interaction present between the vibrational levels (v_1,v_2,v_3) and (v_1-2,v_2,v_3+2) analogous to that present in C_2H_2. The new vibrational constants enable the calculation of band centers that are in excellent agreement with the observed band centers. By combining the photographic infrared results with those obtained in this work it is found that $B_0=0.84770\pm0.00007$ cm^{-1} and $D=(7.04\ \pm0.63)\times10^{-7}$ cm^{-1}. 5 p.

RP2676. Heat capacity of polyisobutylene from 0° to 380° K George T. Furukawa and Martin L. Reilly

Measurements of the heat capacity of polyisobutylene of the viscosity average molecular weight of 1.35×10^6 were made from about 14° to 380° K by means of an adiabatic calorimeter. The glass-transformation temperature was estimated to be 199° K. The values of the heat capacity above the glass-transformation temperature can be represented within ±0.2 percent by

$$C(\text{abs j deg}^{-1}\text{ g}^{-1})=0.844+3.03\times10^{-3}T+2.24\times10^{-6}\text{ T}^2.$$

The data were used to obtain smoothed values of heat capacity, enthalpy, entropy, and Gibbs free energy from 0° to 380° K. 4 p.

RP2677. Preparation of barium titanyl oxalate tetrahydrate for conversion to barium titanate of high purity. . . . . W. Stanley Clabaugh, Edward M. Swiggard, and Raleigh Gilchrist

A procedure is described for preparing barium titanyl oxalate tetrahydrate, $BaTiO(C_2O_4)_2\cdot4H_2O$, in which the mole ratio of TiO_2 to BaO is unity. To achieve this ratio the salt must be precipitated from solutions that do not contain sodium, potassium, or ammonium ions.

Ignition of barium titanyl oxalate tetrahydrate produces barium titanate, $BaTiO_3$. To prepare barium titanate free of strontium, the barium chloride used must be specially purified. 3 p.

RP2678. A five-band recording spectroradiometer. . . . . C. S. McCamy

In a project undertaken to determine the properties of flames that might be utilized in the detection of accidental fires in aircraft engine compartments, an instrument was constructed to measure and record the radiant energy emitted by flames in five separate wavelength regions from 0.23 to 2.5 microns. The radiant intensity of several types of hydrocarbon flames was determined in each spectral region. The frequency distribution of the fluctuations in the radiant intensity (flicker) was also determined. 7 p.

RP2679. Polarographic determination of lead and cadmium in zinc-base alloys, using electrolytic separations at controlled potential John K. Taylor and Stanley W. Smith

A method is described for the polarographic determination of lead and cadmium in zinc-base alloys. It involves the separation of the metals from the zinc by electrolysis at controlled potential, using a mercury cathode. Fresh electrolyte is substituted for the residual solution and the metals are anodically redissolved from the mercury by controlled-potential electrolysis and determined by polarographic measurement. For lead and cadmium contents of a few ten-thousandths of a percent and greater, the determinations can be made with the usual precision of polarographic measurements. 3 p.

RP2680. Calcium hydroxide as a highly alkaline *p*H standard. . Roger G. Bates, Vincent E. Bower, and Edgar R. Smith

The National Bureau of Standards conventional activity scale of *p*H is defined by a series of standard buffer solutions prepared from certified materials issued as NBS Standard Samples. The five standards thus far established cover the pH range 1.68 to 9.18 at 25° C. In order to increase the accuracy of measurements at high pH, a highly alkaline standard is needed.

A solution of calcium hydroxide saturated at 25° C is recommended as the sixth pH standard. No weighing is necessary, for the solution is easily prepared by shaking finely granular calcium hydroxide with water. The material must not be contaminated with soluble alkalies, but the presence of insoluble carbonate is of no concern. The filtered solution supersaturates readily and can usually be used from 0° to 60° C without the separation of solid phase.

Electromotive-force measurements of 29 cells containing mixtures of calcium hydroxide and potassium chloride were made in the range 0° to 60° C, and standard pH values were assigned to 0.0203-, 0.02-, 0.019-, 0.0175-, and 0.015-*M* solutions of calcium hydroxide without added chloride. The saturated solution is about 0.0203 *M* and has a pH of 12.45 at 25° C. The buffer capacity is high (0.09 mole/pH). Like most other alkaline solutions, however, this standard has a rather large dilution value (−0.28 pH unit) and a large temperature coefficient of pH (—0.033 pH unit/deg C). 8 P.

RP2681. Heats of formation of hexacalcium dialumino ferrite and dicalcium ferrite........................E. S. Newman and Roald Hoffman

Measurements were made of the heat of solution of $6CaO{\cdot}2Al_2O_3{\cdot}Fe_2O_3$ and $2CaO{\cdot}Fe_2O_3$ in HCl, $26.61H_2O$ (2.000 normal at 25° C). From these data, together with appropriate heat-of-dilution measurements and data taken from the literature, the heats of formation of the two compounds were calculated. 6 p.

RP2682. Response of a sodium-iodide scintillation spectrometer to 10- to 20-million-electron-volt electrons and X-rays.........H. W. Koch and J. M. Wyckoff

The response of a large-crystal sodium-iodide spectrometer was studied for individual monoenergetic electrons extracted from a 50-million-electron-volt betatron operated between 1 and 20 Mev. The energy resolution with crystals 5 inches in diameter by 4 inches in length and 5 inches in diameter by 9 inches in length reaches its optimum value for electrons of 6 Mev, where the total width of the pulse-height distribution at half maximum is 4 percent. Syntheses of pulse-height distributions for 11- and 19-Mev monoenergetic X-ray photons are made by using the experimental electron pulse-height distributions. The computed results compare favorably with the measured pulse-height distributions for 11.6- and 17.6-Mev gamma rays. Syntheses provide one of the few procedures for predicting spectrometer response functions in this X-ray energy range. 8 p.

RP2683. Hydrogarnet formation in the system lime-alumina-silica-water
Elmer T. Carlson

Glasses of the composition of grossularite and similar glasses poorer in silica were treated hydrothermally, and the composition of the resulting hydrogarnets was estimated from the unit cell size as calculated from X-ray powder patterns. The silica content of the hydrogarnets increased continuously with the temperature of formation, approximating that of grossularite at 800° C. When mixtures of lime, alumina, and silica, either as such or in various states of combination, were treated in the same manner as the glasses, equilibrium was not attained even after several weeks. At times as many as three distinct hydrogarnet compositions were found to coexist. The equilibrium temperature for the hydrothermal decomposition of $3CaO{\cdot}Al_2O_3{\cdot}6H_2O$ to $4CaO{\cdot}3Al_2O_3{\cdot}3H_2O$ plus $Ca(OH)_2$ was found to be between 220° and 226° C. Hydrogarnets containing increasing amounts of silica underwent the same type of decomposition at progressively higher temperatures. 9 p.

RP2684. Infrared absorption spectrum of trimethylborane....James E. Stewart

The infrared absorption spectrum of gaseous trimethylborane, $B(CH_3)_3$, has been observed in the 2- to 40-micron spectral region. Vibrational assignments have been made for infrared bands, as well as for the Raman lines reported by other investigators. The perfect gas entropy was calculated for a temperature of 199.92° K and compared with the experimental value. Barriers to internal rotation of methyl groups of about 750 or 1,640 calories per mole are calculated for structures with or without a threefold axis of symmetry. 5 p.

RP2685. Pyrolysis of cellulose in a vacuum. . . . S. L. Madorsky, V. E. Hart, and S. Straus

Samples of cotton, cotton hydrocellulose, and viscose rayon, both by themselves and impregnated with sodium carbonate or sodium chloride, were pyrolyzed at 250° to 397° C in a high vacuum. The volatile products were fractionated and the fractions analyzed in the mass spectrometer and by infrared absorption. The volatile fractions consisted mainly of CO, CO_2, water, and levoglucosan (tar). The residue consisted mainly of carbon (char). Impregnation of the cellulosic materials with salts caused a decrease in the yield of tar and an increase in the yields of CO, CO_2, H_2O, and char. Rates of thermal degradation of the same materials were investigated in the range 245° to 305° C by a loss-of-weight method, using a very sensitive tungsten spring balance enclosed in a vacuum. Plots of rates of loss of weight versus percentage of loss of weight, in the case of pure cellulosic materials, pass through maxima at about 13 to 23 percent loss of weight, then drop gradually to the carbonization end point. In the case of samples impregnated with sodium carbonate or sodium chloride, the initial rates of loss of weight are very high, but drop rapidly to the carbonization end point. The activation energies of thermal degradation of the pure cellulosic materials are much greater than those of the same materials impregnated with sodium carbonate or sodium chloride. 12 p.

RP2686. Response function of thallium-activated sodium-iodide scintillation counters. . . . . Martin J. Berger and J. Doggett

Measurements of gamma rays with NaI(Tl) crystals yield pulse height distributions related to the true energy spectrum by an integral equation whose kernel (response function) is the probability that an incident photon of energy E will give rise to a pulse of size E'. The response function has been calculated by the Monte Carlo method for photons with energies from 0.279 to 4.45 Mev. Results are presented for cylindrical crystals ranging in size from 0.25 (radius) by 0.5 inch (length) to 2.5 by 9 inches. They are based on the analysis of 50,000 photon histories sampled with the use of the Standards Electronic Automatic Computer (SEAC). Analytical corrections were made for the escape of annihilation radiation and bremsstrahlung from the crystal. 12 p.

TITLE PAGE AND CONTENTS TO VOLUME 56, 4 P.

RESEARCH PAPERS FROM THE JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 57, JULY-DECEMBER 1956

RP2687. Mixed path ground wave propagation: 1. Short distances
James R. Wait

An expression is derived for the mutual impedance between two short vertical antennas on a flat earth with a straight boundary separating two media of differing electrical constants. After making some approximations that are valid at low and medium frequencies and where the antennas are not near the boundary, the integral formula for the field is evaluated for a wide range of the parameters. The numerical results computed in this paper are shown to be in reasonably good agreement with experiment. Finally, the effect of the obliqueness of the boundary is considered by a refinement of the stationary phase evaluation of the integrals. 15 p.

RP2688. Effect of object frequency on focal position of four photographic objectives. . . . . Fred W. Rosberry

Three wide-angle aerial-camera lenses of 6-inch nominal focal length and one smaller lens of 32-millimeter focal length were given photographic resolving-power tests. Targets were of the parallel line type with several groups of three lines representing a wide range of lines-per-millimeter values. The image plane of best focus was visually located, and exposures were made at four different positions inside of this focus and the same number outside. Measurement of the resultant negatives by a recording microdensitometer revealed the image contrast of the various line-space frequency groups at the nine focal positions. Curves are presented showing the focal positions of maximum image contrast for four values of line-space frequency. 6 p.

RP2689. An examination of the 1955 helium vapor-pressure scales of temperature
E. Ambler and R. P. Hudson

In a previous communication, magnetic thermometer calibrations in the region 1.3° to 4.2° K were used to examine the internal consistency of two provisional helium vapor-pressure scales of temperature. Since that article went to press, these scales have been made available in their final form, and further measurements have also been made. The results of all the measurements, seven runs in all and with two different apparatuses, are used here to examine the latter scales. The results of six runs were self-consistent and could be reconciled with the empirical scale of Clement et al. (T_{55E}) to within 2 millidegrees, and with the calculated scale of Van Dijk and Durieux (T_{55}) to within 5 millidegrees. The remaining run showed better agreement with T_{55}. It appears, therefore, that the previous assessment of the T_{55} scale may have been a little too favorable. The most critical interpretation of the findings is that the present technique of vapor-pressure measurement is not sufficiently precise to discriminate between the two scales. 3 p.

RP2690. Heats of formation of xonotlite, hillebrandite, and foshagite
Edwin S. Newman

The heats of solution of synthetic xonotlite, $5CaO.5SiO_2.H_2O$, hillebrandite, $2CaO.SiO_2.H_2O$, and a sample of naturally occurring foshagite, $5CaO.3SiO_2.3H_2O$, were determined in a mixture of nitric and hydrofluoric acids, and their heats of formation from the oxides were calculated to be −92.6, −34.7, and −94.6 kilocalories per mole, respectively. 4 p.

RP2691. Effect of camera tipping on the location of the principal point
Francis E. Washer

Asymmetric distortion is introduced in a lens-camera combination when the camera is incorrectly alined for calibration. A method is described whereby the magnitude and direction of the angle of camera tipping can be determined from analysis of the asymmetric values of distortion for the case of the object lying at equal but opposite angles from the central line of sight. The displacement of the central image from the principal point of autocollimation is then readily determined. Theoretical analysis of the problem is given and the results confirmed by experiment. The point of symmetry and the principal point of autocollimation coincide for the case of no prism effect present on the lens. 9 p.

RP2692. Mass spectra of some lead alkyls. . Edith I. Quinn, Vernon H. Diebeler and Fred L. Mohler

Monoisotopic mass spectra are given for the compounds: tetramethyllead, trimethylethyllead, dimethyldiethyllead, methyltriethyllead, tetraethyllead, tetrapropyllead, trimethyl-*n*-butyllead, trimethyl-*sec*-butyllead, trimethyl-*tert*-butyllead, and tetra-*iso*-butyllead. Relations between relative probabilities of ion formation and molecular structure are observed for several ion configurations and are discussed briefly. 3 p.

RP2693. Frequency response of second-order systems with combined coulomb and viscous damping . . . . Thomas A. Perls and Emile S. Sherrard

Curves obtained with an analog computer are presented for the magnification factor versus frequency ratio of second-order systems with combined coulomb and viscous damping. The ranges of the parameters are as follows: Viscous damping ratio from 0.05 to 5.0, in 15 steps; coulomb damping ratio from 0 to 0.9, in 11 steps; and frequency ratio from 0 to 2.0. Boundaries between regions with 0, 1, and 2 stops per half-cycle are also shown. 21 p.

RP2694. Thermal properties of aluminum oxide from 0° to 1,200° K
George T. Furukawa, Thomas B. Douglas, Robert E. McCoskey, and Defoe C. Ginnings

Accurate measurements of the heat capacity of α-aluminum oxide (corundum) from 13° to 1,170° K are described. An adiabatic calorimeter was used from 13° to 380° K and a drop method was used with a Bunsen ice calorimeter from 273° to 1,170° K. The results are compared in the range 273° to 380° K, where the two methods overlap. From the data, smoothed values of the heat capacity, enthalpy, entropy, and Gibbs free energy from 0° to 1,200° K are derived and tabulated. 16 p.

RP2695. Stress-strain relationships in yarns subjected to rapid impact loading: 4. Transverse impact tests.....Jack C. Smith, Frank L. McCrackin, Herbert F. Schiefer, Walter K. Stone, and Kathryn M. Towne

If a textile yarn segment clamped at each end, is impacted transversely at the midpoint, the stress-strain curve for this yarn can be obtained from measurements on a high speed photographic record of the motion of the yarn. This paper describes the apparatus and procedure used. Stress-strain curves for high rates of straining, of the order of 5,000 percent per second, obtained by this method are given for high-tenacity nylon, Fortisan, and Fiberglas. Comparision with stress-strain data obtained at conventional rates shows that these materials have higher initial moduli, and that their stress-strain curves remain linear up to higher stress values when the testing rate is high. The breaking tenacities are slightly greater and breaking elongation slightly smaller at these high test rates. 7 p.

RP2696. Thermal expansion of polytetrafluoroethylene (Teflon) from −190° to +300° C..................................Richard K. Kirby

The linear thermal expansion of four samples of Teflon was determined. The results for annealed Teflon are indicated in a plot of the expansion versus temperature and in a table listing the average coefficients of linear expansion from −190° to +300° C. The effect of internal residual stresses on the expansion of Teflon was studied and found to be considerable. The first-order transitions at 20° and 30° C are clearly shown in a plot of the coefficients of expansion versus temperature. 4 p.

RP2697. Preparation of D–arabinose–5-C^{14} from D–glucose–6–C^{14}
Horace S. Isbell, Nancy B. Holt, and Harriet L. Frush

D-Arabinose-5-C^{14} has been prepared from D-glucose-6-C^{14} by bromine oxidation to D-gluconic-6-C^{14} acid, followed by a Ruff degradation of the calcium salt. The over-all yield, 58 percent, was obtained without the separation of any intermediate products. 1 p.

RP2698. Thermal expansion of binary alkali silicate glasses...Herman F. Shermer

The thermal expansions of a number of binary lithium, sodium, and potassium silicate glasses are reported over the temperature range from room temperature to their deformation points. The expansivities of the glasses increased with increasing alkali oxide concentration. These expansivities were used to calculate density values, which were correlated with density measurements in the liquid range. At room temperature the density of each series increased with increasing alkali oxide concentration. With increasing temperature, the density-temperature curves for each binary series crossed each other and the density-concentration order was reversed. This reversal occurred in the lowest temperature range for the lithium silicates, in an intermediate temperature range for the potassium silicates, and in the highest temperature range for the sodium silicates. 5 p.

RP2699. Investigation of an alternating-current bridge for the measurement of core losses in ferromagnetic materials at high flux densities
Irvin L. Cooter and William P. Harris

The use of bridge methods for measuring core losses in ferromagnetic materials has generally been restricted to measurements at low flux density. However, accurate values can be obtained at higher flux densities if they are corrected by the application of a term derived from the harmonic components of the exciting current. This correction term is obtained by considering the ferromagnetic material to absorb energy from current and voltage at the fundamental frequency and to return energy to the circuit at harmonic frequencies. 10 p.

RP2700. Ionization and dissociation of the trifluoromethyl halides by electron impact...Vernon H. Dibeler, Robert M. Reese, and Fred L. Mohler

Relative abundances and appearance potentials are reported for positive and negative ions observed in CF_4, CF_3Cl, CF_3Br, and CF_3I. The kinetic-energy distribution of positive ions is obtained by means of a "beam-deflection" technique. These data combined with that of recent thermochemical and spectroscopic studies permit a new calculation of the ionization potential of the CF_3 radical of 9.3 ±0.2 electron volts, as well as estimates of fluorocarbon bond-dissociation energies. The energetics of probable dissociation processes are discussed. 6 p.

RP2701. Techniques in high-resolution coincidence counting. . George H. Minton

Circuitry, systems, and techniques used in radiation coincidence measurements with millimicrosecond resolution are discussed. An analysis of the time fluctuations in a scintillation counting system is presented and comparisons with experimental results are made. 11 p.

RP2702. Chemical activity of gamma-irradiated polymethyl methacrylate
Leo A. Wall and Daniel W. Brown

In studies of polymerization and depolymerization with γ-irradiated polymethyl methacrylate, effects were observed indicative of long-lived free radicals in the solid polymer. With a dose of 10^7 roentgens, the free-radical concentration, as measured by both types of experiments, is estimated to be at least 10^{-5} mole per liter. When irradiated in air the polymer contains peroxide structures of at least 10^{-3} mole per liter concentration. The decomposition of these peroxidic groups is accelerated by *tert*-butyl catechol and is associated with the production of scissions in the polymer chain. 6 p.

RP2703. Purification of substances by a process of freezing and fractional melting under equilibrium conditions. . . . . Augustus R. Glasgow, Jr., and Gaylon Ross

A purification technique has been developed whereby a mass of well-defined crystals, formed by slow crystallization of a liquid, is melted under equilibrium conditions into a series of fractions. In this process the entire mass of the substance is fractionated into its gross impurities and high-purity material. This offers distinct advantages over conventional fractional crystallization techniques. The apparatus provides for conducting the fractionating process in a closed inert system and is well adapted for purifying compounds that are corrosive, toxic, or reactive with air. Details of construction and operation of the apparatus, including experimental results on 2,5-dichlorostyrene, are included in the report. 6 p.

RP2704. A high-voltage pulse generator and tests on an improved deflecting system of a cold-cathode oscillograph. . . . . Harold N. Cones

An improved deflecting system for a cold-cathode oscillograph is described. This deflecting system reduces transit-time errors and eliminates errors due to impedance mismatch between the signal coaxial cable and the deflector.

A high-voltage pulse generator for producing single pulses in the millimicrosecond range was devised, and its use in testing the improved deflecting system is explained. 10 p.

RP2705. Dissociation constant of piperidinium ion from 0° to 50° C and related thermodynamic quantities. . . . Roger G. Bates and Vincent E. Bower

The acidic dissociation constant, K_a, of piperidinium ion has been determined at 5-degree intervals from 0° to 50° C from measurements of the electromotive force of hydrogen-silver chloride cells without liquid junction. The results are given by the equation

$$-\log K_a=\frac{2105.6}{T}-6.3535-0.0076865T,$$

where T is the temperature on the Kelvin scale. Appreciable ion-pair formation between piperidinium ion and chloride ion was postulated in order to explain the mode of variation of the apparent dissociation constant with ionic strength.

The changes of heat content, entropy, and heat capacity for the dissociation reaction have been calculated from the temperature coefficient of the dissociation constant. For the acidic dissociation of piperidinium ion at 25°, the following values were obtained: $\Delta H^\circ=53{,}390$ j mole^{-1}, $\Delta S^\circ=-33.9$ j deg^{-1} mole^{-1}, and $\Delta C_p^\circ=88$ j deg^{-1} mole^{-1}. The corresponding values for the basic dissociation of piperidine at 25° are $\Delta H^\circ=3{,}170$ j mole^{-1}, $\Delta S^\circ=-44.3$ j deg^{-1} mole^{-1} and $\Delta C^{p\circ}=-283$ j deg^{-1} mole^{-1}. 5 p.

RP2706. Color evaluation in the cane sugar industry. . . . . Victor R. Deitz

A fundamental unit of sugar color based on the National Bureau of Standards color scale is described and used to evaluate a variety of commercial sugar products. The results are in good agreement with actual visual experience. The proposed scale is based on color differences, whereby the color of the sugar solution is evaluated by the amount of departure from a colorless sucrose solution. Some information on spectral distribution is lost, but this is balanced by the great gain in simplicity. A special color chart is presented, whereby the value of the color can be read directly from a knowledge of the attenuation at wavelengths 420 and 560 millimicrons. 12 p.

RP2707. System for classification of structurally related carbohydrates
Horace S. Isbell

A system is presented for the classification of structurally and configurationally related carbohydrates. Each substance is assigned a code number that defines the structure and configuration. By inspection of the code numbers, or by a punched-card technique, groups of structurally related carbohydrate derivatives can be selected readily from a heterogeneous collection. The structures, configurations, and conformations of pyranose and furanose derivatives are discussed, and classifications are made on the basis of a few fundamental structures.

Certain ambiguous and objectionable features in the classification of pyranose ring conformations in the C1 and 1C categories of Reeves are pointed out. In this paper, C1 denotes the chair conformation *in both the* D *and the* L *aldohexose series* in which the reference group attached to carbon 5 of the ring is in the equatorial position. Similarly, C2 denotes the chair conformation in both series in which the reference group attached to carbon 5 of the ring is in the axial position. Xylose and sorbose are classified like glucose; lyxose and tagatose like mannose; arabinose and fructose like galactose; and ribose and psicose like talose. Because the designations are independent of the D or L series, they avoid the erroneous classification of enantiomorphs in different conformations. 8 p.

RP2708. Infrared spectra of D-talose monobenzoate and related substances
H. S. Isbell, J. E. Stewart, H. L. Frush, J. D. Moyer, and F. A. Smith

Infrared absorption spectra for D-talose monobenzoate, α-D-talose, β-D-talose, pentaacetyl-α-D-talose, tetraacetyl-α-D-talose, and β-L-rhamnose 1,2-(methyl orthoacetate) show that the previously held, orthoacid structure for D-talose monobenzoate is not correct. The spectrum and the method of synthesis of D-talose monobenzoate indicate that the compound is a 1-benzoyl-D-talopyranose. The infrared absorption of the alpha and beta pyranose modifications of D-talose was found to be anomalous in that each form shows absorption heretofore considered characteristic of the alpha modification as well as that considered characteristic of the beta. 5 p.

RP2709. Small oil-free bearings............................Hobart S. White

An investigation was made of materials that may be suitable for use as oil-free bearings in aircraft clocks and similar instruments between −55° and +70° C, to replace lubricated jewels that do not give satisfactory operation at subzero temperatures because of congealing of the oil. Another advantage of an oil-free instrument is the freedom from cleaning and oiling periodically during shelf storage. Materials included in the investigation were plastics, plastics with fillers, impregnated metals, and impregnated carbon. Friction tests were made with an inclined-plane type of static-friction apparatus, and with shafts rotating in loaded journal bearings, at temperatures from −55° to +70° C. With bearings of typical materials stored on steel shafts, the effect of shelf storage on static friction was investigated. Wear tests were made with loaded bearings on ¼-inch-diameter rotating shafts made of different types of steel. With oscillating ⅛-inch-diameter shafts and 1,000-gram loads, wear data were obtained on bearings of the more promising materials. Using an endstone wear testing machine, wear data were obtained for end-thrust bearings made of typical bearing materials. The performance of oil-free bearings in 18 timepieces was investigated. 20 p.

RP2710. Preliminary spectroradiometric measurements of the solar constant
Ralph Stair and Russell G. Johnston

Spectroradiometric measurements of the distribution of direct solar radiation at Sunspot, New Mexico (altitude 9,200 feet), in June 1955 are described. Detailed spectral data were obtained within the spectral range of 299 to 535 millimicrons for different air masses. At longer wavelengths radiant-energy evaluations were made only for selected points between the water-absorption bands.

From these data, supplemented by other measurements and estimates for radiant-energy intensities for very short and very long wavelengths, a preliminary spectral integration of the total solar intensity yields a solar constant in general agreement with the best published values. 7 p.

RP2711. Infrared spectrum of acetylene..................Harry C. Allen, Jr., Eugene D. Tidwell, and Earle K. Plyler

The spectrum of acetylene has been observed and measured under high resolution from 1,900 to 8,500 cm^{-1}. Many of the bands observed have been analyzed and precise values obtained for ν_0 and $B'-B''$. A good value of B_0 (1.17684 ± 0.00016) has been obtained by combining the results of the present work with previous data in the photographic infrared. The vibrational-energy problem is discussed. 3 p.

RP2712. Variation of peak temperature with heating rate in differential thermal analysis......................................Homer E. Kissinger

In differential thermal analysis, the temperature at which the maximum deflection is observed varies with heating rate for certain types of reactions. An expression can be derived relating this variation with the kinetics of the reaction. By making a number of differential thermal patterns at different heating rates, the kinetic constants can be obtained directly from the differential thermal data.

Measurements of the variation of peak temperature with heating rate have been made for several minerals of the kaolin group, the values of the kinetic constants determined, and these values compared with corresponding values obtained for both the same samples and similar material by conventional isothermal techniques. Some factors affecting the results are discussed. 5 p.

RP2713. Mass spectrum of sulfur vapor......Paul Bradt, Fred L. Mohler, and Vernon H. Dibeler

The mass spectrum of sulfur vapor has been measured by evaporating sulfur from a heated tube directly into the ionization chamber of a mass spectrometer. Ions S_x^+ with x ranging from 1 to 8 are observed with S_2^+ most abundant. Isotope abundances were computed from the S_2^+ ions. The appearance potentials of S_8^+ and S_2^+ are respectively 8.9 ± 0.2 and 8.3 ± 0.2 electron volts. This suggests that the vapor in the ionization chamber is a mixture of molecules containing S_2 and S_8 and possibly other molecules. 3 p.

RP2714. Calibration of vibration pickups by the reciprocity method
Samuel Levy and Raymond R. Bouche

The reciprocity theory for the relationship between mechanical force and velocity and electric current and voltage is presented for a linear electrodynamic vibration-pickup calibrator having a driving coil, a velocity-sensing coil, and a mounting table. The theory takes account of flexibility in the calibrator structure and in the coils, electric coupling between different parts of the same coil and between parts of one coil and parts of the other and flexibility in the magnet structure. The theory shows what measurements are required in using a linear electrodynamic calibrator for the absolute calibration of vibration pickups.

A description is given of the mechanical arrangement and electric circuitry used at the National Bureau of Standards in calibrating calibrators by the reciprocity method. A typical velocity-sensing-coil calibration curve is presented showing the effect of pickup mass on the calibration factor. Typical examples of measurement of calibration factor and mechanical impedance of pickups are also presented.

Practical limitations of the reciprocity method due to nonlinearity resulting from lack of tightness of mechanical joints, resonance effects, amplitude effects, etc., are discussed. 17 p.

RP2715. Method for the controlled burning of combustible materials and analyses of the combustion gases........................Alan Schriesheim

A method is described to burn a given quantity of a combustible material in a fixed amount of air at a selected initial temperature. Analyses of most of the gaseous combustion products were made quickly and comprehensively by means of a mass spectrometer. Hydrogen chloride was not detected with the mass spectrometer because of its adsorption upon the walls of the glass combustion chamber. The concentration of this gas was determined by titrating a water wash of the combustion chamber with a standard silver nitrate solution. Carbon monoxide when present in concentrations below 1,000 parts per million was determined by an indicator method, and when present in concentrations above 1,000 parts per million was determined by the mass spectrometer. Several organic coatings of different chemical composition were burned in a combustion space initially maintained at three temperatures. The lowest temperature (250° C) produced the smallest variety of combustion gases, whereas the highest temperature (550° C) produced the largest variety. 5 p.

RP2716. Efficiency of 4π-crystal-scintillation counting: 1. Experimental technique and results .... C. C. Smith, H. H. Seliger, and J. Steyn

The technique of 4π-crystal-scintillation counting has been applied to the standardization of beta-emitting nuclides. Phototubes viewing an anthracene sandwiched source at 180° have been used with high-gain nonoverloading amplifiers in addition and in coincidence circuits to obtain high detection efficiencies. A precise shorted delay-line coincidence analyzer is described. The results of measurements made with P^{32}, Co^{60}, Sr^{90}-Y^{90}, I^{131}, and Tl^{204} are compared with those obtained by $4\pi\beta$-gas-proportional counting. 5 p.

RP2717. Efficiency of 4π-crystal-scintillation counting: 2. Dead-time and coincidence corrections .... W. B. Mann and H. H. Seliger

The dead-time and coincidence corrections to be applied in 4π-crystal-scintillation counting have been both approximately and rigorously derived. It has been shown that under special conditions the non-randomness due to "true" counts appearing in both channels requires additional correction terms. 8 p.

RP2718. Entropy changes in rarefaction waves .... Robert F. Dressler

Frictional flow of a polytropic gas is investigated for centered rarefaction waves. Energy balance is maintained by assuming that mechanical energy loss due to frictional force reappears as heat. Entropy behavior at the wave front is discussed. The nonhomogeneous linear system of partial differential equations with variable coefficients for first-order frictional effects is derived. Utilizing the geometrical similarity of the Mach lines, the functional form of these quantities is ascertained, which permits explicit solutions of the boundary value problem. The expansion procedure is singular at the wave front, and results are not applicable there. First-order effects are expressed as polynomials plus terms singular at the wave front. Results are compared with expressions obtained when heat generation due to frictional force is neglected. 7 p.

RP2719. Statistical investigation of the fatigue life of deep-groove ball bearings
J. Lieblein and M. Zelen

Fatigue is an important factor in determining the service life of ball bearings. Bearing manufacturers are therefore constantly engaged in fatigue-testing operations in order to obtain information relating fatigue life to load and other factors. Several of the larger manufacturers have recently pooled their test data in a cooperative effort to set up uniform and standardized ball-bearing application formulas, which would benefit the many users of antifriction bearings. These data were compiled by the American Standards Association, which subsequently requested that the National Bureau of Standards perform the necessary analyses. This paper summarizes the principal results of the analyses undertaken by the Bureau, and describes the statistical procedures used in the investigation. 44 p.

RP2720. Properties of barium titanium silicate glasses ..Given W. Cleek and Edgar H. Hamilton

The glass-forming region of the BaO-TiO_2-SiO_2 system has been determined. The refractive index, n_D, nu value, liquidus temperature, and transmittances in the near infrared have been measured. Also measured for representative glasses were linear coefficient of thermal expansion, deformation temperature, chemical durability, and hygroscopicity. A number of stable glasses were found, which have high refractive indices, good infrared transmittances, and high deformation temperatures, and which are unique in their resistance to attack by both acids and alkalis. 7 p.

RP2721. Scavenging characteristics of a two-stroke-cycle engine as determined by skip-cycle operation. . . . . P. M. Ku and T. F. Trimble

A method for determining the mass fraction of fresh charge in the cylinder of the two-stroke-cycle engine, from measurements of engine power under normal operation and with engine fired only once in several cycles of operation is described. The results obtained from a crankcase-scavenged engine are presented. 7 p.

RP2722. Synthesis of β-gentiobiose-1-C^{14}. . Robert Schaffer and Horace S. Isbell

Gentiobiose-1-C^{14} was synthesized in 24.3 percent radiochemical yield. Its preparation involved the degradation of nonradioactive gentiobiose by the Ruff method to 5-*O*-β-D-glucosyl-D-arabinose, the use of the latter material with sodium cyanide-C^{14} in the Fischer-Kiliani cyanohydrin synthesis, and the crystallization of β-gentiobiose-1-C^{14}. The procedure is relatively simple and is satisfactory for the production of gentiobiose-1-C^{14} in any desired amount. 2 p.

RP2723. Hydration of aluminous cements and its relation to the phase equilibria in the system lime-alumina-water. . . . . Lansing S. Wells and Elmer T. Carlson

A study was made of the reaction of water at room temperature on eight aluminous cements covering a wide range of composition. The results are compared with data previously obtained from similar tests on the calcium aluminates, and are discussed in the light of more recent studies of the system $CaO\text{-}Al_2O_3\text{-}H_2O$. Like the less basic calcium aluminates, the aluminous cements give rise to metastable monocalcium aluminate solutions from which $2CaO \cdot Al_2O_3 \cdot 8H_2O$ and $Al_2O_3 \cdot aq$ are gradually precipitated until the concentration has fallen to about 0.19 gram of Al_2O_3 and 0.46 gram of CaO per liter. From this point, true equilibrium is approached very slowly, the stable solid phases being $3CaO \cdot Al_2O_3 \cdot 6H_2O$ and macrocrystalline gibbsite ($Al_2O_3 \cdot 3H_2O$). The precipitated $Al_2O_3 \cdot aq$ is shown to be a microcrystalline form of gibbsite. It is suggested that this phase is the principal "inorganic glue" of aluminous cements. The process of aging to macrocrystalline gibbsite is accelerated by increased temperature, and probably is the chief cause of the decreased strength of aluminous cements at higher temperatures. 19 p.

RP2724. Axial performance of spectacle lenses. . . . . Francis E. Washer

The measured values of the axial meridional powers for 311 spectacle lenses are reported. The spherical refractive powers range from +7.00 to −20.00 diopters with cylindrical powers of 0.00, 1.00, and 2.00 diopters. The departures of the measured from the nominal values are shown. The probable errors of measurement are discussed. A set of tolerance values is suggested and the degree of compliance with these suggested tolerances is shown. Theoretical and experimental justifications for the proposed tolerance range are given. 12 p.

RP2725. A survey of negative ions in mass spectra of polyatomic molecules Robert M. Reese, Vernon H. Dibeler, and Fred L. Mohler

A survey was made of negative-ion production in 27 different molecules covering a wide variety of chemical compounds. In nine compounds no ions were found. For the other compounds rough measurements of the appearance potentials and relative abundance of the ions are reported. About 60 different ionization processes are observed in 18 compounds. Formation of ions by dissociative resonance attachment is the most common process, but there are several cases of ion pair formation and of attachment without dissociation. Perchlorylfluoride gives by far the greatest abundance and variety of ions. 3 p.

RP2726. Heat conduction through insulating supports in very low temperature equipment. . . . . R. P. Mikesell and R. B. Scott

An apparatus is described that is used to measure the heat conduction through insulating supports of storage vessels for cryogenic liquids and presents the data obtained from the conduction measurements. Two types of supports were tested: (1) multiple-contact supports in the form of stacks of thin metallic plates or spirally wound strips, and (2) nonmetallic spheres. The high thermal resistance of the multiple-contact supports arises from the numerous relatively poor contacts between the individual plates. Some special treatments of the plates were tried, and two of these, perforating and dusting, were found to be effective. Pyrex-glass spheres were also found to be excellent insulators, but, of course, are not as rugged as a stack of metal plates. Of the untreated plates tested, those of stainless steel (0.0008 inch thick) were found to be the best insulators per unit length of stack. The heat conduction through these plates, at a load pressure of 1,000 pounds per square inch, was found to be 2 percent of the conduction by a solid sample of the same metal having the same dimensions. 8 p.

TITLE PAGE AND CONTENTS TO VOLUME 57, 4 p.

RESEARCH PAPERS FROM THE JOURNAL OF RESEARCH OF THE NATIONAL BUREAU OF STANDARDS, VOLUME 58, JANUARY—JUNE 1957

RP2727. Influence of a ridge on the low-frequency ground wave
James R. Wait and Anabeth Murphy

The problem of a plane wave incident on a semielliptical boss on an otherwise perfectly conducting flat ground plane is considered. A solution in terms of elliptic wave functions is obtained. Numerical values of the field on the near and far side of this idealized ridge are given for a base width of about two-thirds of a wavelength and various ellipticity ratios. 5 p.

RP2728. Phase-diagram study of alloys in the iron-chromium-molybdenum-nickel system....................C. J. Bechtoldt and H. C. Vacher

Alloys in the iron-chromium-molybdenum-nickel system were examined after quenching from 2,200°, 2,000°, 1,800°, 1,650°, and 1,500° F. Compositional limits of stability of seven phases were summarized in diagrams. Fe_2Mo was found to be a stable phase; and a ternary phase, not previously reported, was identified to have the approximate composition of 4 percent of chromium, 53 percent of iron, and 43 percent of molybdenum. 13 p.

RP2729. Construction of a Kösters double-image prism.........J. B. Saunders

An interferometric method is described for use in constructing and adjusting double-image prisms of the Kösters type. The faces of the prisms form the elements of several interferometers that are used for testing and for making adjustments during construction. The prisms are cemented together and are quite stable. The precision attainable in the adjustments approaches interferometric perfection. 6 p.

RP2730. The Kösters interferometer..........................J. B. Saunders

Results are given on an investigation of the Kösters double-image prism. Some of these results are not in harmony with those given by other investigators. A modification of the Kösters prism is described that forms a simple interferometer that is easy to apply to the testing of lenses, mirrors, and combinations of these elements. A practical test is given for determining the maximum size of the source that is usable in any interferometer. 5 p.

RP2731. Spectral absorbance of some aqueous solutions in the range 10° to 40° C
Elizabeth E. Sager and Fleur C. Byers

The effect of temperature upon the absorption spectra in the ultraviolet and part of the visible ranges was determined for several compounds in aqueous solution. Temperatures used were 10°, 25°, and 40° C. The materials used as solutes included both inorganic and organic compounds, namely, potassium nitrate, potassium dichromate, diphenylsulfone, diphenyl phosphate, 4,4′-diaminobenzophenone, and *m*-cresolsulfonphthalein. As the temperature was decreased there was an increase in maximum absorbance of all compounds except in the case of diphenyl phosphate, the behavior of which was anomalous. A slight shift of the absorbance curves also occurred. The relationship between absorbance and temperature was not linear in the temperature range investigated. The results showed that temperature should be controlled within ±2 deg C if molar absorbance values are to be obtained within 0.5 percent. Temperature coefficients for an individual compound require extensive absorption measurements of that compound in known media, and such coefficients will hold for the specified wavelengths only under specified conditions. As a general guide the temperature should be controlled to ±0.5 deg C. 4 p.

RP2732. Radiant-heat transfer between nongray parallel plates
Stanley Goodman

Radiant-heat transfer rates between infinite parallel plates were computed for Inconel and aluminum over a wide range of plate temperatures. Results indicate that assuming the plates to be graybodies introduces an error of 2 to 29 percent in the computed heat-transfer rate.

In cross-sectional heat flow through box beams typical of aircraft structures, it was found that radiant-heat transfer predominates in Inconel beams and is significant in aluminum beams. 4 p.

RP2733. Wavelengths from iron-halide lamps..........Robert W. Stanley and William F. Meggers

The history of secondary standards of wavelength for spectroscopic measurements is briefly reviewed. The present system of international secondary standards is based on interferometer determinations of wavelengths emitted by an electric arc between iron electrodes at atmospheric pressure; their uncertainty is of the order of 1 part in 3 million. It is shown that iron lines obtained from an electrodeless lamp, containing a minute amount of iron bromide, permit higher accuracy of wavelength measurement. The wavelengths of 103 radiations from such a lamp have been measured with Fabry-Perot interferometers. They range from 2954.8031 to 4064.7414 A, and calculated probable errors, as well as atomic-energy intervals, indicate that the relative values are uncertain by only 1 part in 7 or 8 million. 9 p.

RP2734. Resistance of flow in Teflon and brass tubes.....Marion R. Brockman

The results of a study of water flow through Teflon tubing to determine the existence of slip flow are reported. The coefficient of resistance was measured over the range of Reynolds number 2,000 to 120,000. This investigation is composed of two series of tests. In the first series, resistance was measured in both laminar and turbulent flow. The second series dealt entirely with turbulent flow.

The resistance measurements determined for extruded Teflon tubing were compared with those of smooth-drawn brass tubing. The coefficients were so similar that it can be said that no slip flow exists for water flowing through Teflon tubing. 10 p.

RP2735. Theory of dielectric relaxation for the three-dimensional polar rotator: Lattice models leading to bimodal loss curves
John D. Hoffman and Benjamin M. Axilrod

The characteristics of the dielectric relaxation spectrum associated with some simple three-dimensional lattices consisting of polar molecules of specified shape have been investigated with the object of determining whether dielectric loss curves with two distinct maxima (bimodal loss curves) could be predicted on a theoretical basis for such systems. For the types of lattice and molecular shape considered, each dipole has one stable and four metastable orientations.

The calculations show that under certain circumstances bimodal loss curves may arise for pear-shaped molecules in both the body-centered orthorhombic and tetragonal systems. All of the models lead to a single loss peak if the barrier system is sufficiently isotropic as in the body-centered cubic lattice. The changes with temperature of the shape of the loss curves, the static dielectric constant, and configurational entropy are discussed. The abrupt changes in these properties that will occur at phase transitions due to cooperative interaction are also considered. Qualitative predictions concerning the expected behavior of bimodal loss curves for three-dimensional lattices, in which each dipole has only a single stable orientation, are compared with experiment.

Using an argument based on the fact that broadened loss curves in monophase molecular crystals become narrower with increasing temperature, it is concluded that fluctuations of structure are not the principal cause of the broadening of loss curves. The present theory leads to the correct type of temperature dependence, and this strengthens the view that the origin of multiple relaxation times in molecular crystals is the anisotropy of the crystalline field. 13 p.

RP2736. Classification of perovskite and other ABO_3-type compounds
Robert S. Roth

A classification of $A^{+2}B^{+4}O_3$ compounds has been made on the basis of ionic radii of the constituent ions. A graph of this type for the perovskite compounds can be divided into orthorhombic, pseudocubic, and cubic fields, with an area of ferroelectric and antiferroelectric compounds superimposed on the cubic field. The structures of solid solutions between various perovskite compounds cannot be completely correlated on the basis of this simple two-dimensional chart. Therefore, a new type of classification of the perovskite-type compounds has been attempted, using a three-dimensional graph with polarizability of ions plotted as the third dimension. This three-dimensional graph has been applied successfully to compounds of the type $A^{+2}B^{+4}O_3$, which crystallize with perovskite-type structures. In addition, a classification of double oxides of trivalent ions has shown that all compounds of this type having the perovskite structure can be divided into two groups, with rhombohedral and orthorhombic symmetry. No ideal cubic perovskites of the $A^{+3}B^{+3}O_3$ compounds have been found. 14 p.

RP2737. Thermal expansion of some nickel alloys..............Peter Hidnert

Data on the linear thermal expansion of some nickel alloys (manganese nickel, Hoskins Alloy 667, Inconel, Evanohm, Monel metal, M-M-M alloy, Illium alloy, and Waspalloy) for various temperature ranges between 20° and 1,000° C are given. During the first heating of Inconel alloys (probably with a supersaturated content of carbon), irregularities were noted in the expansion at about 700° C and were ascribed to precipitation of carbide. The coefficients of expansion of the alloys are tabulated. For the range 20° to 300° C, these coefficients varied from 13.1 to 15.5×10^{-6} per deg C. The effects of additions of copper cobalt, and iron to nickel-chromium alloys (0 to 24 percent of chromium) are indicated. 4 p.

RP2738. Intermolecular forces in air....................Abraham S. Friedman

The intermolecular force constants for a 6–12 Lennard-Jones potential model have been computed for air from second virial coefficients derived from experimental pressure-volume-temperature measurements. Nitrogen: oxygen interaction second virial coefficients and interaction force constants have also been derived. 2 p.

RP2739. Matrices of spin-orbit interaction of the electron configuration d^4s
W. R. Bozman and R. E. Trees

The matrices of spin-orbit interaction of the d^4s configuration have been calculated. These matrices are for use in calculations to aid in locating levels and making electron configuration assignments in Tc I and Ta I. The calculations were made by using methods and tables given by G. Racah and by the use of tables of the W-coefficients prepared by L. C. Biedenharn, and by Obi and coworkers. The matrices have been checked by calculating their eigenvalues with the National Bureau of Standards Electronic Computer (SEAC). 6 p.

RP2740. A high-speed computer for predicting radioactive fallout
J. H. Wright, L. Taback, and H. K. Skramstad

A very high-speed analog computer has been developed for predicting the geographic pattern of radioactive fallout that will occur following a nuclear-weapon explosion. Input data consist of wind magnitudes and directions as functions of initial height in the cloud, and the distribution of radioactivity in the cloud as a function of the particle size (in terms of settling rate) and initial height in the cloud. Output data are presented on a cathode-ray tube, so that the luminance at any point on the screen represents the intensity of fallout accumulated at that point. 9 p.

RP2741. Standard ionization-chamber requirements for 250- to 500-kilovolt X-rays............................H. O. Wyckoff and F. S. Kirn

Information is provided on the correction factor required for the determination of the dose in roentgens of 250- to 500-kilovolt X-rays from measurement with a free-air ionization chamber. Special emphasis is placed on the determination of each of the factors so that an over-all accuracy of 0.5 percent can be obtained. 7 p.

RP2742. Relative dimensional stabilities of a selected series of stainless-steel decimeter bars.................................Benjamin L. Page

The results of intercomparisons of the lengths of a series of stainless-steel decimeter bars for the past twenty-five years are reported. Data on the degree of dimensional stability of these bars were obtained and the results were analyzed. Some of the bars were found suitable for use as line standards of length. 6 p.

RP2743. Thermal quenching in alpha- and gamma-excited fluorescent solutions
H. H. Seliger and C. A. Ziegler

The effects of reduction of temperature on the relative light outputs of the gas-free liquid scintillators, DPO, αNPO, and PBD+POPOP, dissolved in xylene, have been investigated. From room temperature down to —35° C the relative light outputs increase markedly under both alpha and gamma excitation. Under the conditions of the present experiments it has been possible to make a gas-free solution of PBD+POPOP in xylene more efficient than crystal anthracene. 2 p.

RP2744. Two-parameter gloss methods............................I. Nimeroff

The concept of a parameter of glossiness, that is, measurement under one set of illuminating and viewing conditions, is developed. To describe completely the glossiness of a specimen requires multiparametric measurements on the geometric distribution of reflected light-flux. As one-parameter methods have been found to yield inadequate descriptions of specimen glossiness, two-parameter methods were investigated. For specimens with differing incidence-angle dependency, a two-parameter method using specular gloss measurements at two incidence angles is suggested. For specimens with differing flux-scattering characteristics, a two-parameter method using specular gloss measurements for two receptor apertures is suggested. Several existing standard two-parameter methods are reviewed. Results of a seven-laboratory round-robin test of the two-parameter (receptor aperture) method are reported and analyzed. To establish correlation between measurements obtained with the suggested two-parameter (receptor aperture) method and subjective evaluation of image brightness and image distinctness, a subjective test was formulated. The results of this test, here analyzed and discussed, indicate the usefulness of the two-parameter method. 9 p.

RP2745. Glassy state transitions of poly-(chlorotrifluoroethylene), poly-(vinylidene fluoride), and their copolymers...L. Mandelkern, G. M. Martin, and F. A. Quinn, Jr.

The glass transition temperatures, T_g, of poly-(chlorotrifluoroethylene), poly-(vinylidene fluoride), and copolymers prepared from these two comonomers were determined using dilatometric and interferometric methods. The glass temperature of poly-(chlorotrifluoroethylene) was found to be at 45° C, an upper limit for the glass temperature of poly-(vinylidene fluoride) was set at —35° C, and the glass temperatures for the copolymers were between the values for the two homopolymers.

These results are found to substantiate the recent theoretical deductions of Fox and Loshaek relating the glass temperature of a copolymer to its composition, and indicate that the glass temperature of a copolymer is a monotonic function of its composition. The effect of crystallization of a copolymer on the location of its glass temperature is illustrated and the various contradictory results of this effect that have been reported are discussed. 7 p.

RP2746. Measurement of the corrosion rate of iron by polarization techniques
W. J. Schwerdtfeger

Corrosion-rate-measuring techniques previously shown to be applicable to low-carbon steel exposed to corrosive soils are also shown to apply to low- and medium-carbon steels in a sodium chloride solution having a concentration of 2,000 parts per million. Unlike the work previously reported, *IR* drops, attributable to polarizing currents, are included in the potential measurements.

It is shown how corrosion-rate measurements can be made automatically by using a synchronously driven voltage divider and a two-pen electronic recorder.

The polarizing characteristics of high-silicon cast iron when exposed to a 2,000-parts-per-million sodium chloride solution were also studied. It is shown that the corrosion rate becomes relatively low as the corrosion reaction changes from cathodic to anodic control. 9 p.

RP2747. Numerical computation of the transfinite diameter of two collinear line segments..Philip Davis

Orthonormal polynomials are employed to compute the transfinite diameter of a set consisting of two collinear line segments. With polynomials of degree 10, two-place accuracy has been achieved. 2 p.

RP2748. Influence of crystallographic orientation on the corrosion rate of aluminum in acids in alkalies........................Theodore H. Orem

The corrosion of single crystals of high-purity aluminum in strong acid and alkali media is disclosed as an orderly process, the rate of attack being dependent on the orientation of the corroding surface. For a 15-percent NaOH solution, corrosion apparently progressed by revealing facet surfaces of the [335] type, resulting in gross corrosion of spheres into cubes; in contrast, substantiating other investigations, corrosion in aqua regia-hydrofluoric acid mixture revealed etch pits with surfaces of the [100] type, resulting in gross corrosion of spheres into equilateral octahedra. Observations of the corrosion by acid and alkali solutions of disks with central holes, and rectangular prisms, both of monocrystalline aluminum, result in interesting conclusions and comparisons with respect to the corrosion process. 11 p.

RP2749. Comparisons of national radium standards..T. P. Loftus, W. B. Mann, L. F. Paolella, L. L. Stockmann, and W. J. Youden

The national primary radium standards of the Federal Republic of Germany and the Dominion of Canada have recently been compared with the two United States national primary radium standards at the National Bureau of Standards. The comparisons were made using the standard electroscope and radiation balance, and the results obtained for these four Hönigschmid standards have been compared with those obtained in an earlier comparison of the United States primary radium standards with that of the United Kingdom, which is also a Hönigschmid standard. In every case, agreement with Hönigschmid's values to within 0.2 percent has been obtained. 6 p.

RP2750. Temper brittleness of boron-treated steels........Samuel J. Rosenberg

Two series of steels, melted to the base composition of 8140, were studied to ascertain whether titanium and zirconium (present in many commercial boron addition agents) had any adverse effect upon the impact properties of the base steels, particularly with reference to temper brittleness.

The results obtained indicate that with fully hardened steels tempered at 1,200° F, the presence of relatively small amounts of titanium as introduced into the test steels by the boron addition agents is sufficient to cause an impairment in the Charpy V-notch impact properties of the steels or an increased susceptibility to temper brittleness, or both. This was confirmed by the addition of titanium without boron. Similar effects, previously thought possibly due to the presence of zirconium, were not observed. 13 p.

RP2751. Optical and volumetric relaxation effects in glass following removal of high hydrostatic pressures........C. Weir, S. Spinner, I. Malitson, and W. Rodney

Optical and volumetric relaxations in glass were studied after compressing specimens 4 hours at 9,000 atmospheres and 21° C. Following release of pressure the refractive index was higher than the original value and decreased with time, recovering its initial value within 12 hours. Optical-relaxation curves for lead and borosilicate glasses were complex, the detailed behavior depending on composition and thermal history. No corresponding effects were observed in fused silica after exposure to even higher pressures. Volumetric changes associated with index changes were determined interferometrically and found to be less than corresponding changes known to accompany annealing. Possible implications of the results are discussed. 6 p.

RP2752. Reference wavelengths for calibrating prism spectrometers....Earle K. Plyler, L. R. Blaine, and Matthew Nowak

Standard wavelengths for calibrating infrared-prism instruments have been measured from the absorption bands of polystyrene, 1,2,4-trichlorobenzene, and toluene. Several bands of didymium glass have been calibrated for the near-infrared region, and 27 rotational lines of the 3.3-micron band of methane have been measured.

The wavelengths fall in the region from 0.6 to 24 microns, but the greatest number are in the 3- to 6-micron region. A few bands of several other materials are also given in the wavelength tables, and 11 figures of the spectra marked with the calibrating values are included for identification. 6 p.

RP2753. Tensile properties of copper, nickel, and 70-percent-copper–30-percent-nickel and 30-percent-copper–70-percent-nickel alloys at high temperatures..................William D. Jenkins, Thomas G. Digges, and Carl R. Johnson

Short-time tensile tests were made at temperatures ranging from 75° to 1,700° F on high-purity nickel, copper, a 70-percent-nickel–30-percent-copper alloy, and a 70-percent-copper–30-percent-nickel alloy. The high-purity component metals and the two alloys were investigated in the initial conditions, as annealed for a uniform grain size, and as cold-drawn 40-percent reduction in area. The results were affected markedly by variations in the nickel content, temperature, and degree of cold-working. However, the effects of cold-drawing at room temperature were obliterated at temperatures above that of recrystallization.

The effects of cold-drawing the 30%-Ni–70%-Cu alloy different amounts and of variations in grain size of the copper on the tensile properties are evaluated. Results on the tensile properties of the same annealed materials at low temperatures are included for completeness. 11 p.

RP2754. Accuracy of the Cutler-Hammer recording gas calorimeter when used with gases of high heating value.................John H. Eiseman and Elwin A. Potter

The accuracy of the Cutler-Hammer recording gas calorimeter, when used with gases of high heating value, is discussed. The study includes the preparation of a standard gas of high heating value, a comparison of hydrogen and methane as calibrating gases, the effect upon the instrument of changes in room and tank-water temperature, the instrument's accuracy when burning propane, the effects of bleeder burner height, and the effects of differences in inlet gas pressure. It is concluded that an accuracy of 0.25 percent, or even better, can be obtained with the Cutler-Hammer calorimeter if certain precautions are carefully followed. 14 p

RP2755. Frequency conversion with nonlinear reactance.......Chester H. Page

A lossless nonlinear impedance subject to an almost periodic voltage (sum of sinusoids) will absorb power at some frequencies and supply power at other frequencies. Necessary and sufficient relations among these powers are found. It is shown that simple cubic capacitors ($Q \propto V^3$) are sufficient for producing any possible conservative modulation or distortion process. 10 p.

RP2756. Amplitude and phase of the low-frequency ground wave near a coastline James R. Wait

A theoretical analysis is given for the amplitude and the phase change of the ground wave, originating from a distant transmitter on land, as it crosses a coastline. The land and sea are assumed to be smooth, and homogeneous with a sharp boundary of separation. Attention is focused on the effects that take place near the coastline when it is not permissible to employ arguments based on the principle of stationary phase. A limited comparison is made with the recent experimental work of Pressey, Ashwell, and Fowler. 6 p.

RP2757. Vessels for the storage and transport of liquid hydrogen
B. W. Birmingham, E. H. Brown, C. R. Class, and A. F. Schmidt

The design and construction of a large-scale hydrogen liquefier by the National Bureau of Standards required a concurrent development of large, transportable liquid-hydrogen containers. These containers, known as Dewar vessels after the inventor, James Dewar, had to be capable of road and air transport, which implied ruggedness and light weight. This article reports on large-scale liquid-hydrogen Dewar development conducted by the NBS Cryogenic Engineering Laboratory. A 440-liter and an 840-liter Dewar are discussed. Every effort has been made to design Dewars with very low hydrogen-loss rates within the limitations of the transport requirement. 11 p.

RP2758. Infrared spectra of polychlorobenzenes...............Earle K. Plyler, Harry C. Allen, Jr., and E. D. Tidwell

The infrared spectra of 12 chlorinated benzenes have been measured from 2 to 38 microns. In addition, the spectra of benzene, monofluorobenzene, monobromobenzene, and monoiodobenzene have been included. An assignment of the fundamental bands of the monosubstituted benzenes has been made. Some of the frequencies of the other compounds have also been assigned.

The spectrum of each compound is shown in the figures, and a table containing all the observed bands is included. 9 p.

RP2759. Infrared spectra of chromatographically fractionated asphalts
James E. Stewart

Undegraded and weathered specimens of three roofing asphalts were chromatographically separated into three components after removal of the asphaltenes. The infrared absorption spectra of the fractions, recorded in the 2- to 15-μ spectral region, provide information about the chemical constitution of the material, the differences among asphalts from different sources, and the changes in constitution produced by weathering. 5 p.

RP2760. Thermal conductivity of nitrogen from 50° to 500° C and 1 to 100 atmospheres....................R. L. Nuttall and D. C. Ginnings

A new apparatus has been constructed for measurements of the thermal conductivity of gases up to 500° C and 100-atmosphere pressure. The parallel-plate method was used with a spacing of about 0.5 millimeter between the hotplate and coldplate. A capacitance method was used to measure the effective spacing and area of the plates under the conditions of the experiment. No solid material was used between the plates. The effect of radiation was minimized by use of polished silver parts and was accounted for by experiments with the conductivity cell evacuated. Measurements on nitrogen were made at 1, 50, and 100 atmospheres, and from 50° to 500° C. It is believed that the accuracy of the results is about 0.5 percent, except at the highest gas densities. 8 p.

RP2761. Apatites deficient in divalent cations............Aaron S. Posner and Alvin Perloff

The preparation and results of a study of stoichiometric and divalent cation-deficient (defect) lead and calcium hydroxyapatites are reported. X-ray diffraction and index-of-refraction data show that it is possible to have divalent cations missing from "columnar" positions in the hydroxyapatite structure, with possible hydrogen bonding in proper proportion for electrical neutrality. A general formula for apatites is suggested to be $D_{10-x}M_{2x}(PO_4)_6(OH)_2$, where D represents the divalent cation (Pb^{+2}, Ca^{+2}, Mg^{+2}, etc.) and M the monovalent cation, such as Na^+ and H^+, and the upper limit of x is probably 2. It is suggested that the apatite portion of bone and tooth mineral may be some form of defect apatite. 8 p.

RP2762. Slotted-cylinder antenna with a dielectric coating..James R. Wait and Walter Mientka

Analysis is presented for the fields produced by an arbitrary slot on a circular cylinder which has a concentric dielectric coating. Expressions for the far-zone fields are developed by evaluating the appropriate integrals using a saddle-point method. Numerical results are presented for the case of a narrow axial slot for a range of values of cylinder diameters and electrical constants of the dielectric coating. There is some evidence that the coating provides a trap or a duct for surface waves, resulting in an increase of over-all amplitude of the field in the backward direction. 10 p.

RP2763. Emission spectra of actinium....William F. Meggers, Mark Fred, and Frank S. Tomkins

Small samples of actinium, produced by transmuting radium, have been investigated spectroscopically by photographing the spectra of light emitted by the samples when excited in a hollow cathode or in arcs and sparks between copper or silver electrodes. The wavelengths were measured, and intensities estimated, for some 500 lines characteristic of actinium in the spectral range 2062.00 to 7886.82 A. A comparison of line characteristics in different sources permitted sorting into five categories; about 140 lines belong to Ac I, more than 300 were ascribed to Ac II, 8 were definitely assigned to Ac III, 5 may belong to Ac IV, and about 80 represent band heads characteristic of AcO, the actinium-monoxide molecule.

Analyses of the first three spectra of actinium have revealed their most important features, including atomic-energy levels, spectral terms, and electron configurations. The ground state of Ac III is found to be $(7s)^2S_{0\frac{1}{2}}$, that of Ac II is $(7s^2)^1S_0$, and that of Ac I is $(6d7s^2)^2D_{1\frac{1}{2}}$. Comparisons of the analogous spectra of the chemical homologs (scandium, yttrium, lanthanum, and actinium) show that actinium closely resumbles yttrium, except that additional terms of odd parity, first found in lanthanum spectra and attributed to the $4f$ electron, are also found in actinium spectra, where they provide evidence of the presence of the $5f$ electron. The blinding force on the $4f$ electron in La II is much stronger than on $5f$ in Ac II. The principal ionization potential of Ac^+ ions is about 12.0 electron volts. 19 p.

RP2764. Thermal design of large storage vessels for liquid hydrogen and helium
Russell B. Scott

Principles of insulating vessels for the storage and transportation of liquefied gases are discussed. The use of shields cooled by the vapor leaving the liquid being stored is analyzed, and formulas, graphs, and tables are presented for the convenience of the designer of large vessels for storing and transporting liquid hydrogen and liquid helium. An analysis is given of the use of escaping vapor to intercept heat entering by conduction through solid supporting members. The evidence presented indicates that substantial improvements are possible in the design of such vessels. 9 p.

RP2765. Further studies on the pyrolysis of polytetrafluoroethylene in the presence of various gases..........J. D. Michaelsen and L. A. Wall

The thermal decomposition of polytetrafluoroethylene in the presence of gases or vapors has been explored in the range 450° to 500° C. Gases that have been used can be divided into three groups, depending on whether they inhibit, catalyze, or exert no effect on the thermal-decomposition process. Fluorine-containing gases, i. e., ClF_3 and IF_5, which are capable of dissociating at the pyrolysis temperatures to give fluorine atoms, showed the most marked inhibition yet observed. From the brevity of the duration of inhibition, it is concluded that the fluorine atoms directly attack the polymer to produce scissions through a metathetical reaction. 5 p.

RP2766. A nonlinear instrument diaphragm. Fidel Cordero, Harry Matheson, and
Daniel P. Johnson

Details of fabrication for the production of sensitive diaphragms having a controlled nonlinear pressure-deflection characteristic are presented. The desired characteristic was such that when the diaphragm formed one plate of a condenser in the frequency-controlling network of a Wien-bridge oscillator, the resulting pressure-frequency transfer characteristic would be linear between −30 and +30 dynes per square centimeter. Typical transfer curves are shown. 5 p.

RP2767. Optical studies of crazed plastic surfaces.....Sanford B. Newman and
Irvin Wolock

Optical studies were made of crazed surfaces, principally those of cast polymethyl methacrylate. The techniques used for these studies were multiple-beam interferometry and light and electron microscopy.

The dimensions of the craze cracks produced by short-time stress crazing and by stress-solvent crazing were determined by the above techniques. Stress-crazed specimens contained the smallest cracks observed during this investigation. The dimensions determined in some of these specimens were: Length, 2 to 10 microns; width, 0.1 to 0.25 micron; depth, 0.05 to 0.15 micron. In other specimens and in solvent-crazed surfaces the dimensions were larger. The craze cracks did not appear to approach dimensions unresolvable by the electron microscope, but instead appeared to have a minimum crack length.

An elevation of the surface in the vicinity of craze cracks was observed, of the order of 0.02 micron for cracks produced by stress-crazing and 0.3 micron for those produced by stress-solvent crazing. This rise was observed in crazed specimens while still under load. The typical surface displacement was observed in specimens crazed in tension produced by flexure as well as in pure tension, and was observed in polystyrene and in polymethyl alpha-chloroacrylate as well as in polymethyl methacrylate.

Some crazed specimens in which the crazing had apparently "recovered" when viewed with the unaided eye still exhibited the surface displacement typical of crazed specimens. Experiments conducted by heating stress-crazed specimens and stress-solvent-crazed specimens to accelerate the recovery of crazing indicated that surface recovery is essentially complete in the former case but not in the latter. This difference in recovery behavior is probably due to the nature of the deformation associated with the two types of crazing.

Tensile specimens to which loads had been applied that were slightly too low to produce immediate crazing did not exhibit surface displacements typical of crazed specimens. 12 p.

TITLE PAGE AND CONTENTS TO VOLUME 58, 4 p.

CIRCULARS

Circulars are compilations of information on various subjects related to the Bureau's scientific, technical, and engineering activities. They include not only the results of Bureau studies, but give data of general interest from other sources.

C464. Gas calorimeter tables . . . . Ralph S. Jessup and Elmer R. Weaver

This Circular contains condensed directions for operating a gas calorimeter of the water-flow type, with forms and directions for recording and computing results; tables of "reduction factors" for gas volumes between 32° and 110° F and from 24 to 30.9 in. of mercury pressure; and tables of correction factors needed in fuel-gas calorimetry. Blank forms are included to be filled in with data pertaining to local situations and individual laboratory instruments, so that the user may have all the data needed in gas calorimetry conveniently arranged under one cover. March 25, 1948. 42 p. (Supersedes C417.)

C465. Instructions for the use of Basic Radio Propagation Predictions

This Circular explains how calculations to maximum usable frequencies and optimum working frequencies may be made for sky-wave transmission over any path for any time of day during the month in question by use of the contour charts of frequency issued monthly in the Basic Radio Propagation Predictions (CRPL Series D). August 27, 1947. 41 p.

C466. American standard specification for dry cells and batteries (Leclanché type).

This specification, also known as ASA C18–1947, is the fifth edition of the American Standard Specification for Dry Cells and Batteries of the Leclanché type, and was approved as an American Standard by the American Standards Association on August 6, 1947. It is a revision of the previous specification, designated as ASA C18–1941. The new specification differs from the specification of 1941 in giving a list of standard voltages of dry cells, in introducing specifications for A-B battery packs, and giving more emphasis to smaller sizes of dry cells, including flat cells. This specification also includes a complete revision of specifications for hearing-aid batteries and battery terminals and changes in specifications for cell jackets and top closures. Revisions are made periodically of this specification and the Federal Specification W–B–101. These two specifications differ in form but are identical in technical requirements. December 1, 1947. 18 p. (Supersedes C435 and Superseded by C559.)

C467, Vols. I and II. Atomic energy levels . . . . Charlotte E. Moore

The compilation of Atomic Energy Levels as derived from the analyses of optical spectra, exclusive of hyperfine structure, has been completed for 206 spectra of the first 23 elements in the periodic table, hydrogen through vanadium. These data comprise Volume I of Circular 467, which was issued in June 1949. The energy levels are listed by terms starting with the ground state zero. A uniform style of notation is used, and for complex spectra arrays of observed terms are included for comparison with similarly arranged arrays of predicted terms, which are given in the Introduction for each isoelectronic sequence. For each spectrum a brief discussion of the analysis is given, together with a detailed bibliography. Limits and ionization potentials are given when known. Similarly, the configurations of the individual terms are included together with *g*-values derived from the observed Zeeman patterns. June 15, 1949. 309 p.

Volume II contains similar data for 152 spectra of the elements chromium through niobium, atomic numbers 24 through 41. August 15, 1952. 227 p.

C468. Printed circuit techniques..........Cledo Brunetti and Roger W. Curtis

A comprehensive treatment of the complete field of printed circuits is presented. Circuits are defined as being "printed" when they are produced on an insulated surface by any process. The methods of printing circuits fall in six main classifications: *Painting*—Conductor and resistor paints are applied separately by means of a brush or a stencil bearing the electronic pattern. After drying, tiny capacitors and subminiature tubes are added to complete the unit. *Spraying*—Molten metal of paint is sprayed on to form the circuit conductors. Resistance paints may also be sprayed. Included in this classification are an abrasive spraying process and a die-casting method. *Chemical deposition*—Chemical solutions are poured onto a surface originally covered with a stencil. A thin metallic film is precipitated on the surface in the form of the desired electronic circuit. For conductors the film is electroplated to increase its conductance. *Vacuum processes*—Metallic conductors and resistors are distilled onto the surface through a suitable stencil. *Die-stamping*—Conductors are punched out of metal foil by either hot or cold dies and attached to an insulated panel. Resistors may also be stamped out of a specially coated plastic film. *Dusting*—Conducting powders are dusted onto a surface through a stencil and fired. Powders are held on either with a binder or by an electrostatic method.

Methods employed up to the present have been painting, spraying, and die-stamping. Principal advantages of printed circuits are uniformity of production and the reduction of size, assembly and inspection time and cost, line rejects, and purchasing and stocking problems. Production details as well as precautions and limitations are discussed. Many applications and examples are presented including printed amplifiers, transmitters, receivers, hearing aid subassemblies, plug-in units, and electronic accessories. November 15, 1947. 43 p.

C469. Optical glass at the National Bureau of Standards.....Francis W. Glaze and Clarence H. Hahner

A description is given of the procedures used at the National Bureau of Standards for the production of optical glass. This includes compositions, melting schedules, molding procedures, and annealing schedules for many types of optical glass. During World War II, the types of optical glass regularly produced increased from 5 to 28. Also, in this period, the quality of the glass and the appearance of the molded blanks were improved. November 1, 1948. 14 p.

C470. Precision resistors and their measurement............James L. Thomas

This Circular contains information on the construction and characteristics of wire-wound resistors of the precision type. There are also included descriptions of the methods used at this Bureau for the test of precision resistors and the calibration of precision resistance measuring apparatus. Although the presentation is nontechnical, there is a considerable amount of information on the characteristics and limitations of apparatus of this type that should be of interest to any one making accurate measurements of electrical resistance. October 8, 1948. 32 p.

C471. Spectral-transmissive properties and use of eye-protective glasses
Ralph Stair

This paper contains spectral-transmissive data on most of the widely distributed brands and types of glasses employed in protecting the eyes from harmful ultraviolet, visible, or infrared radiant energy, which may be encountered in industry, in driving, or while at home or at play. The standardization of shade numbers for protective glasses used in industry, glasses for special welding operations, the use of colored glasses for night driving, and the elimination of glare in sunlight are given considerable attention. October 8, 1948. 34 p. (Supersedes C421).

C472. Table and Mollier chart for ammonia below −60° F....Cyril H. Meyers

This paper contains a table of thermodynamic properties of saturated ammonia vapor and liquid below −60° F, and a Mollier chart for saturated and for super heated ammonia vapor covering the pressure range 0.8 to 5 $\mathrm{lb/in.^2}$ These data are based on the same equations and are expressed in the same units as those used in National Bureau of Standards Circular C142. The table and Mollier chart are extensions of those given in C142 to lower temperatures and pressures, terminating at the triple point of ammonia (−107.86° F, 0.878 lb/in.^{2}). November 1, 1948. 3 p.

C473. Measurement of radioactive isotopes.................. Leon F. Curtiss

This manual is intended to accompany radioactive standards and calibrated samples of radioisotopes. It contains a discussion of the principles of measurement of radioisotopes in absolute terms with explanation of units and illustrative examples of precautions that must be taken in measurements to determine disintegration rates. A simple chart for computation of radioactive decay is included. 1948. 12 p.

C474. Automotive antifreezes......... Donald B. Brooks and Ronald E. Streets

When antifreeze should be installed, what strength should be used, and what kind of antifreeze is best suited to the service involved are discussed. Pertinent physical properties and service performance of the major categories of antifreezes are given. A section treats of how the automobile should be prepared for antifreeze. Simple means for distinguishing the different types of antifreezes and for determining the protection are described. The replacement of antifreeze solution loss and the question of whether antifreeze solutions can be used safely for more than one season is discussed. November 10, 1948. 16 p. (Superseded by C506).

C475. Establishment and maintenance of the electrical units...... F. B. Silsbee

A history is given of the establishment of the "international" system of electrical units, its operation during the interval 1911 to 1947, inclusive, and of the developments that caused it to be superseded. It includes a record of the international comparisons, which indicated that the units of some countries have at times drifted nearly 0.01 percent from the mean, an account of the maintenance procedures used at the National Bureau of Standards, and brief descriptions of the methods currently available for the absolute measurement of resistance and of current, which will be used in the future as a check on the maintenance of the units. June 30, 1949. 38 p.

C476. Measurements of radioactivity........................ Leon F. Curtiss

This publication is a compilation of information intended to be useful to those starting out in research on problems in radioactivity and nuclear physics. An effort has been made to provide, in brief form, most of the essential background for all phases of experimental investigations in this general field. The number of topics involved limits the space that could be given to each, and the author is aware that for many items this has resulted in the elimination of important information. This defect may be corrected in future revisions, when criticisms and suggestions have indicated the direction of most useful expansion. This Circular is issued in its present form to provide a convenient source of the information contained and to provide an opportunity for those interested in this field to offer critical comments that can serve as the basis of an improved compilation. October 15, 1949. 84 p.

C477. Testing of hydrometers............. Elmer L. Peffer and Mary G. Blair

This Circular discusses the design and construction of hydrometers, with particular reference to hydrometers that are to be submitted to this Bureau for test. The various scales that are commonly used for hydrometers are defined and recommendations given for subdividing and marking them. These scales include density, specific gravity, degrees Baumé, degrees API, percentage by weight, percentage by volume, percentage proof spirit, Brix, Balling, and some others. The relations between some of the arbitrary scales (for example, API) and specific gravity are stated.

The Circular outlines the procedure of testing hydrometers that are submitted to the Bureau and discusses the forms of certificates and reports issued as a result of these tests. Instructions and other helpful information about submitting hydrometers for test are given. September 1, 1949. 9 p. (Supersedes C16 and Superseded by C555).

C478. Colorimetry... Deane B. Judd

The definition of color as a characteristic of light is given, and the basic principles of its measurement are outlined. Reduction of spectrophotometric data is outlined, and three methods are illustrated by examples. The various methods of direct colorimetry are treated briefly, and a more detailed treatment is given of visual and photoelectric methods of colorimetry by difference from a material color standard. The most useful collections of material color standards (Lovibond, Arny, Maerz & Paul, TCCA, Ostwald, Munsell) are described, and the most widely used one-dimension color scales (color temperature, Union, Saybolt) are explained. Five widely used specifications of color having general applicability are summarized. March 1, 1950. 56 p.

C479. Unified screw thread standards.

An accord for unification of American, British, and Canadian standard systems of screw thread was signed at the National Bureau of Standards on November 18, 1948. The proceedings of this meeting, together with detailed illustrations, tables, and numerical data setting forth standards of thread form, are presented in this illustrated Circular.

In the past, international trade in mechanical equipment of all kinds has been seriously handicapped by the lack of interchangeability of screw thread parts. Manufacturers have been forced to supply and distribute these parts along with equipment marketed in a foreign area, a factor which has acted as a deterrent to those purchasing products from other nations. The adoption of these unified screw thread standards removes an important barrier to the exchange of manufactured goods throughout the world. 27 p.

C480. Fundamental techniques in the frequency adjustment of quartz crystals
Leland T. Sogn and Catherine Barclay

Techniques that are required in the art of adjusting frequencies of quartz oscillator plates are dealt with in some detail. A number of the problems associated with crystal finishing are reviewed. Ways to prevent the introduction of erratic behavior, such as sudden changes in frequency and amplitude, are discussed, and methods of eliminating these undesirable characteristics, should they appear, are described. A schematic diagram of a high-frequency oscillator which will give a fairly accurate indication of the quartz-crystal unit performance is included. A simplified concept of the modes of vibration found in quartz oscillators is presented in order that the reasons behind the techniques employed may be better understood. September 1, 1949. 9 p.

C481. High-frequency voltage measurements.................Myron C. Selby

The paper presents an up-to-date account of fundamental principles and techniques used for voltage measurements primarily for frequencies in the upper audio- and radio-frequency ranges and including part of the ultrahigh frequency range. Subject matter is limited to principles and methods that have met with some degree of success for both high and moderate precision, emphasizing those developed and applied for primary standard work in this frequency range at the National Bureau of Standards. This paper is intended to give professional workers and graduate students a more comprehensive picture of the method employed with regard to this subject than is presently available in textbooks and handbooks. September 1, 1949. 14 p.

C482. Bibliography of books and published reports on gas turbines, jet propulsion, and rocket power plants.............................Ernest F. Fiock

The purpose of this Circular is to present references to published sources of information on gas turbines and jet propulsion, classified so that the reader may select with ease articles of specific interest. For convenience, the references are grouped according to subject matter. To aid in the use of the bibliography, there is included a brief introduction on the classification and rating of jet engines. The introduction also discusses the scope and arrangement of the bibliography. September 1, 1949. 49 p. (Superseded by C509).

C483. Testing by the National Bureau of Standards—policy, general information, fee schedule.

This Circular contains a statement of the testing policy of the Bureau. Fee schedules showing the types of tests undertaken are included, and detailed information covering the procedures and requirements to be met in arranging for Bureau tests is outlined. December 30, 1949. 93 p.

C484. Spectrophotometry (200 to 1,000 milliimcrons).........Kasson S. Gibson

This paper describes various spectrophotometric instruments and methods for use in the ultraviolet, visible, and near infrared spectral regions. These include photographic, visual, and photoelectric methods, but not the radiometric methods so widely used throughout the infrared. Errors and their elimination are discussed, and various types of spectrophotometric standards are described. September 15, 1949. 48 p.

C485. Nickel and its alloys.

This Circular reviews available information about nickel and its alloys, with particular attention to the physical properties and applications of the metal, and its ferrous and nonferrous applications. It is a revision of National Bureau of Standards Circular 100, issued in 1924. March 15, 1950. 72 p.

C486. Thermal expansion of solids...........Peter Hidnert and Wilmer Souder

This Circular describes 10 methods for determinations of thermal expansion of solids. The procedures used in determining expansion equations and coefficients of expansion of materials are given. Relations between thermal expansion, temperature, chemical composition, density, compressibility, specific heat, melting point, atomic weight, and other properties of materials are indicated. The problems in which the thermal expansion of materials must be recognized are as varied as our industries. One of the important applications of thermal expansion is in thermostats that are described in the publication. March 15, 1950. 29 p.

C487. Density of solids and liquids..........Peter Hidnert and Elmer L. Peffer

Density data may be used for obtaining relationships between density, chemical composition, thermal and mechanical treatments of materials, etc. This Circular defines density and specific gravity, describes 11 methods (hydrostatic weighing, picnometer, flotation, hydrometer, falling drop, balanced column, Boyle's law, electromagnetic, elastic helix, ice calorimeter, and volumetric) for determinations of the densities of solids and liquids, and indicates the accuracy of various methods. March 15, 1950. 29 p.

C488. Section 1. An ultraviolet multiplet table............Charlotte E. Moore

This table lists by multiplets, in order of increasing excitation potential, the leading lines in the spectra of the more abundant elements. In addition to the multiplets of a given spectrum, ionization potentials, excitation potentials, and literature references are included. The wavelength region extends from 3000 A to shorter waves, since the author's "Multiplet Table of Astrophysical Interest" published in 1945 (Princeton University Observatory Contr. No. 20) covers the range from 3000 A to longer waves. Section 1 of the Ultraviolet Multiplet Table, issued in April 1950, includes selected multiplets of 79 spectra of the first 23 elements in the periodic table hydrogen through vanadium. April 28, 1950. 78 p. 45c.

C488. Section 2 contains the leading multiplets of 46 spectra of the elements, chromium through niobium (atomic numbers 24 through 41). The arrangement is identical with that in Section 1. Upon completion of the tabulation of the multiplets, a Finding List will be prepared containing all lines in order of wavelength. This work is being done in conjunction with the program on "Atomic Energy Levels", Circular 467; each section of the Multiplet Table will include the same elements as each volume of "Atomic Energy Levels." August 15, 1952. 115 p.

C489. Care and repair of the house.......................Vincent B. Phelan

This is a revision of the Bureau's publication "Care and Repair of the House", which was written to assist those who are faced with problems incident to the proper maintenance of the house. It points out the usual conditions of disrepair that arise in the structure and equipment from time to time, describes their causes briefly, and indicates in the text, and by means of illustrations what tools, materials, and methods can be employed for correcting the difficulties. It also deals to some extent with minor improvements which may be effected by the home owner who wishes to enhance the value of his house to make it a more attractive and comfortable place in which to live. 209 p. (Supersedes BH15).

C490. The Geiger-Müller counter............................Leon F. Curtiss

This Circular includes a discussion of the Geiger-Muller counter prepared to supply information regarding this device. A brief explanation of the development and mode of action of the Geiger-Müller counter is given with descriptions of various modifications for special uses. Some typical circuits used with these counters are shown, and an outline of a procedure for filling vapor-type counting tubes is also given. 25 p.

C491. Control of odors..................................Elmer R. Weaver

This Circular is intended to present, in a general and interesting way, information that will be of practical use in the control of industrial and household odors. The discussion of industrial odors is limited to means for preventing a nuisance to the neighborhood. Nothing is said about the professional perfumer's job of making articles of commerce smell good. Attention is called to the fact that some of the information given may be useful in hospitals and places of business. April 17, 1950. 12 p.

C492. Solders and soldering..................R. W. Mebs and Wm. F. Roeser

This Circular discusses compositions used and procedures followed in soldering. All classes of solders are treated, namely, soft and precious metal solders and common brazing alloys. The procedures include preparation of the parts to be soldered, application of fluxes and solders, and subsequent cleaning. The uses of various solders, and some precautions necessary in applying certain fluxes and solders, are discussed. Also presented are illustrations of several types of soldering equipment and a survey of characteristics of soldered joints. A comprehensive list of references to additional information on solders and soldering is included in the Circular. April 28, 1950. 12 p.

C493. Development of the National Bureau of Standards casting resin
Philip J. Franklin, David M. French, and Wilbur C. Nyberg

The NBS casting resin fills the need for a plastic suitable for the potting of certain types of electronic circuits. This Circular has been prepared to present a definitive summary of the development, uses, and properties of the resin as well as new data obtained in the past 2 years. Choices of ingredients, methods of preparation, and characteristics of the finished resin are discussed. May 22, 1950. 10 p.

C494. Plastics research and technology at the National Bureau of Standards—A review and bibliography........................Gordon M. Kline

This paper consists of a summary of the activities of the National Bureau of Standards relating to plastics. It gives a brief outline of the work carried on in each of eight different fields of investigation and concludes with 160 references to publications by members of the staff of this Bureau. June 15, 1950. 14 p.

C495. Heat treatment and properties of iron and steel. .Samuel J. Rosenberg and Thomas G. Digges

This Circular has been prepared to give an understanding of heat treatment principally to those unacquainted with this subject. To this end, the basic theoretical and practical principles involved in the heat treatment of iron and steel are presented in simplified form. August 10, 1950. 33 p. (Supersedes C409.)

C496. Standard time throughout the world......................R. E. Gould

This Circular contains a historical sketch on the development of the standard time system, a time zone map of the United States, a list of stations transmitting time signals, a list of the times used in several large cities, a complete table of the legal time used in the various countries of the world, notes on summer time, and other useful information regarding standard time. August 1, 1950 30 p. (Supersedes C406.)

C497. Research on dental materials at the National Bureau of Standards
I. C. Schoonover and Wilmer Soudes

A general account is given of the research and development work in the field of dental materials that is now being conducted at the National Bureau of

Standards. Included are noteworthy accomplishments on design and construction of special equipment, the development of specific techniques for evaluating these materials, fundamental research on the chemical and physical nature and behavior of dental products, development of better techniques for use in dental practice, clinical research, and the development of new products for dental use. The relationship of the work to the dental health of the nation, dental industries, dental schools, and the Federal dental services is discussed. A list of 156 Bureau publications on dental materials is included. The publications constitute the most extensive set of reference material ever produced in any dental research laboratory. August 15, 1950. 14 p.

C498. Bibliography of recent research in the field of high polymers
Robert Simha, Irma G. Callomon, Mary Budge Gaughan, and Helen H. Jeppson

This bibliography contains references to papers that appeared in American and foreign scientific periodicals. The former covers the period January 1946 to December 1949, inclusive. The foreign journals include those available up to January 1, 1950, in the Library of the Bureau. English periodicals are incorporated from 1945, Russian periodicals from 1943, Japanese periodicals from 1941, and the remainder from 1944. In some cases older issues are included.

The literature included deals with fundamental investigations of the chemistry and physics of certain classes of natural and synthetic organic high polymers. September 18, 1950. 56 p.

C499, Supplements 1, 2, and 3. Nuclear data....... Katharine Way, Lilla Fano, Millicent R. Scott, and Karin Thew

Nuclear Data is a collection of experimental values of nuclear constants such as relative abundances, half-lives, radiation energies, moments, and cross sections in tabular form. Decay schemes or level diagrams giving graphical representation of a number of results have been drawn wherever possible. Several values for each quantity are given when available so that the extent of agreement is at once apparent. Discrepancies which seem to call for further experiment are emphasized.

The data collection is the most comprehensive yet attempted and is up-to-date as of June 1952. Supplementary lists of new results and future revisions are planned. The tables are intended to be not only a tool for the active experimental and theoretical workers in the field of nuclear physics but also a source book for nuclear engineers and biophysicists. September 1, 1950 to June 9, 1952. 494 p.

C500. Selected values of chemical thermodynamic properties
Frederick D. Rossini, Donald D. Wagman, William H. Evans, Samuel Levine, and Irving Jaffe

This Circular contains tables giving the selected "best" values of certain thermodynamic properties of all inorganic compounds and organic compounds containing up to two carbon atoms. The properties covered are the following: Heat of formation, free energy of formation, entropy, logarithm of the equilibrium constant of formation, heat capacity, heat and temperature of melting, vaporization and sublimation.

Extensive references to the literature are given. February 1, 1952. 1268 p.

C501. Federal and State Weights and Measures Laws.. Kathryn M. Schwartz and Ralph W. Smith

This is a compilation of the weights and measures laws and regulations of the United States, and laws of the forty-eight States, the District of Columbia, Alaska, Hawaii, Puerto Rico, and the Virgin Islands, through 1949 enactments. December 17, 1951. 1182 p. (Supersedes M20.)

C502. Bibliography of electron microscopy...... Claire Marton, Samuel Sass, Max Swerdlow, Alan VanBronkhorst, and Harold Meryman

This bibliography was prepared to meet the indicated need for an up-to-date compilation of the literature dealing with electron microscopy. The titles are grouped into broad categories, such as books, survey articles, instrumentation, electron optics, related instruments, and applications. The references are intended to contain only those papers published in scientific periodicals prior to

January 1, 1950. The references are consecutively numbered and an authors index refers to these numbers. August 1, 1950. 87 p.

C503. Statutory net-content marking requirements for packages (undefined) and packages of foods, drugs, and cosmetics....Kathryn M. Schwartz and Ralph W. Smith

This is a summary and a detailed tabulation of statutory requirements for net-content declarations on packaged commodities, and includes suggested statutory language to require that packages of all commodities be marked with statements of their net content. November 16, 1950. 4 p.

C504. (Cancelled).

C505. Preservation of the Declaration of Independence and the Constitution of the United States.

At the request of the Librarian of Congress, an investigation was undertaken by the National Bureau of Standards to determine the best means of preserving the original copies of the Declaration of Independence and the Constitution of the United States. This Circular reports the recommendations made by the Bureau to the Library of Congress on a method for the preservation of the documents. July 2, 1952. 16 p.

C506. Automotive antifreezes.

When antifreeze should be installed, what strength should be used, and what kind of antifreeze is best suited to the service involved are discussed. Pertinent physical properties and service performance of the major categories of antifreezes are given. A section treats of how the automobile should be prepared for antifreeze. Simple means for distinguishing the different types of antifreezes and for determining the protection are described. The replacement of antifreeze solution loss and the question of whether antifreeze solutions can be used safely for more than one season is discussed. November 4, 1952. 31 p. (Supersedes C474 and Superseded by C576.)

C507. X-ray calibration of radiation survey meters, pocket chambers, and dosimeters..Frank H. Day

The responses of instruments of ionization-chamber and Geiger-Müller counter types to measured exposures or intensities have been studied for radiations generated by applied X-ray tube potentials ranging from 30 to 1,200 kilovolts. The results of these studies indicate that instruments of a given type constructed by different manufacturers behave similarly in the 250 to 1,200-kilovolt range. However, marked discrepancies occur among instruments of the same type constructed by different manufacturers for radiations generated by potentials lower than 250 kilovolts. These discrepancies are related to the atomic numbers of the wall materials that envelop the sensitive volumes of the instruments. July 25, 1951. 11 p.

C508. Reference tables for thermocouples..Henry Shenker, John I. Lauritzen, Jr., and Robert J. Corruccini

Expanded reference tables for common commercial thermocouples are given. The tables incorporate recent changes in electrical units and temperature scale. May 7, 1951. 71 p. (Superseded by C561.)

C509. Bibliography of books and published reports on gas turbines, jet propulsion, and rocket power plants..........E. F. Fiock and Carl Halpern

The purpose of this Circular is to present references to published sources of information on gas turbines and jet propulsion, classified so that the reader may select with ease articles of specific interest. For convenience, the references are grouped according to subject matter. To aid in the use of the bibliography, there is included a brief introduction on the classification and rating of jet engines. The introduction also discusses the scope and arrangement of the bibliography. June 1, 1951. 64 p. (Supersedes C482.)

C509. Supplement 1. Bibliography of books and published reports on gas turbines, jet propulsion, and rocket power plants, January 1950 through December 1953........................E. F. Fiock and Carl Halpern

The purpose of this Circular is to bring up-to-date references to published sources of information on gas turbines, jet propulsion, and rocket power plants. Each subdivision is arranged chronologically, and within the chronological sections the arrangement is alphabetical by author, followed by anonymous articles. For greater convenience in use, the number of topical subdivisions has been increased somewhat over the number used in the parent Circular. June 2, 1954. 110 p.

C510. Tables of chemical kinetics—homogeneous reactions.

These tables represent a critically evaluated compilation of all the available factual numerical data on rates and rate constants of homogeneous chemical reactions. Stress is laid on experimentally ascertained facts. Data largely contingent on interpretations have generally not been included. In order to put the tabulations in uniform units, original data have been systematically recalculated wherever necessary. Reactions are arranged and numbered in the order of increasing complexity of the key reactant, thus, in the case of organic compounds, in the order of increasing numbers of carbon atoms with branched isomers placed after the normal-chain isomers. Literature references and comments are appended to each table. September 28, 1951. 731 p.

C510. Supplement 1. Tables of chemical kinetics, homogeneous reactions.

This volume is the first supplement to Tables of Chemical Kinetics, Homogeneous Reactions, issued as NBS Circular 510 in 1951. Circular 510 and Supplement contain a critically evaluated compilation of the available numerical data on rates and rate constants of homogeneous chemical reactions. The emphasis is placed on experimentally ascertained facts, and data depending on interpretations are not generally included. The program is jointly sponsored by the Bureau, the National Research Council, and the Army Office of Ordnance Research.

Supplement 1 includes new tables, additions to the published tables, and revised sheets canceling and replacing parts of the present tables. The tables are issued in the form of punched loose sheets for use in a suitable loose-leaf binder. November 14, 1956. 472 p.

C511. Hydrogen embrittlement of steel—review of the literature. R. W. Buzzard and H. E. Cleaves

A review of the literature establishes the fact that steel absorbs hydrogen on exposure to the gas at an elevated temperature or in the environment of a chemical reaction. Initial concern of hydrogen so absorbed centered in the tendency to cause porosity and blowholes in the cast metal. Subsequently the list of defects attributed to hydrogen was greatly enlarged to include flaking, pickling embrittlement, shatter cracks, hairline cracks, weldment failures, and numerous other service failures. The data presented in the literature fail to establish quantitative proof that hydrogen is the sole cause of these defects, but it is well established that when procedures for maintaining the hydrogen content at a minimum are utilized, certain defects generally ascribed to hydrogen can be eliminated. September 24, 1951. 29 p.

C512. Methods of measuring humidity and testing hygrometers—a review and bibliography.................Arnold Wexler and W. G. Brombacher

This paper is a review of methods for the measurement of the water-vapor content of air and other gases and for the production and control of atmospheres of known humidity for hygrometer testing and calibration and for general research. Among the hygrometric techniques discussed are psychrometry, mechanical hygrometry, dewpoint measurement, electric hygrometry, gravimetric hygrometry, thermal conductivity, index of refraction, pressure and volume measurements, and dielectric constant. Descriptions are given of suitable equipment for establishing desired humidities over a wide range of temperature. A list of 157 selected references pertaining to hygrometry is included. September 28, 1951. 17 p.

C513. Bibliography on the measurement of gas temperature.....Paul D. Freeze

The various temperatures which are of interest in hot gases moving at high velocities, such as those constituting the working media of gas turbines and jet engines, are reviewed in an introduction to a bibliography of approximately 400 references on the measurement of gas temperatures in general. These references, grouped for convenience in accordance with instrument types, cover approximately the last 20 years. August 20, 1951. 14 p.

C514. Table of dielectric constants of pure liquids.....Arthur A. Maryott and Edgar R. Smith

The "static" dielectric constants of more than 800 substances in the liquid state were critically examined and tabulated in concise form. The table consists of three sections: A, Standard Liquids; B, Inorganic Liquids; and C, Organic Liquids. An indication of the probable accuracy of the data is given. Wherever feasible, a simple analytical function is employed to express the variation of dielectric constant with temperature. August 10, 1951. 44 p.

C515. Energy and angle distribution of the photoprotons from deuterium
Martin Wiener

Formulas and graphs are given that describe the relationships between the energy of the photon which disintegrates a deuteron and the energy and direction of the resulting photoprotons. Data are also given for the conversion of angles from the laboratory to the center-of-mass system of reference. The formulas are valid for all photon energies, whereas the graphs extend to 200 Mev. December 3, 1951. 13 p.

C516. Selection of hearing aids..........................Edith L. R. Corliss

For several years the National Bureau of Standards has given attention to the properties of hearing aids, and there has been increasing demand for information on this subject. The Circular gives information useful in the selection of a hearing aid, and to those wishing to explore this field. Some properties of sound and hearing, the general properties of hearing aids, and the care of such devices are subjects discussed, and, in addition, a scale of degrees of hearing loss and a list of hearing-aid clinics are included. September 10, 1951. 17 p. (Superseded by C534).

C517. Calibration of commercial radio field-strength meters at the National Bureau of Standards.............................Frank M. Greene

A brief description is given of the standards and methods used in the calibration of commercial radio field-strength meters at the National Bureau of Standards in the frequency range 10 kc to 300 Mc. A calibration consists in part of measuring the over-all linearity of the field-strength meter at one or more frequencies and radio-frequency input voltage levels, and in measuring the internal attenuator ratios at one or more frequencies in terms of precision dissipative-type step attenuators, as well as precision mutual-inductance attenuators, depending upon the frequency being used. The remainder of the calibration consists in determining the so-called antenna coefficient or correlation factor of the set relating field strength to the output meter reading. Below about 30 Mc this is done only for sets using loop antennas in terms of a quasi-static magnetic field produced by a single-turn balanced transmitting loop. Above this frequency for sets using only dipole antennas a locally generated radiation field is used and is evaluated in terms of the electromotive force induced in a horizontal receiving dipole. The accuracies of the various parts of the calibration are discussed for different portions of the above frequency range. December 1951. 5 p.

C518. Molecular microwave spectra tables...Paul Kisliuk and Charles H. Townes

This group of tables gives the frequencies, assignment of quantum numbers, and intensities of about 1,800 microwave absorption lines. The best available values of other pertinent molecular data, such as rotational constants, dipole moments, quadrupole coupling constants, and rotation-vibration interaction constants are also included. The frequencies are listed once for each molecule, and again in consecutive ascending order of frequency. References are given for all data included. For easy calculation of quadrupole hyperfine structure, Casimir's function is tabulated up to J=10, and I=9/2. Explanations of the tables and a short discussion of microwave spectra and important formulas are given in the introduction. June 23, 1952. 127 p.

C519. Low-temperature physics.

The papers presented at the Low Temperature Symposium held at the National Bureau of Standards on March 27, 28, and 29, 1951, are given. The subjects include superconductivity, liquid helium, liquid mixtures of the isotopes He^3 and He^4, and magnetic, calorimetric, and elastic properties of various materials at very low temperatures. A few of the papers appear in abstract form, but the majority of them appear complete articles.

The papers were presented by representatives from many foreign and domestic research laboratories, educational institutions, and government agencies. October 6, 1952. 291 p.

C520. Mechanical properties of metals at low temperatures.

A knowledge of the behavior of metals at low temperatures is of importance in understanding their fundamental rheological properties. Many mechanical devices and equipment are required to operate at low temperatures. Embrittlement of materials and accompanying brittle failures at low temperatures is of concern to designers, manufacturers, and users. Moreover, the importance of the subject has grown as the applications of metals at low temperatures have increased with the steady growth of the refrigeration industry and the expanding demand for the liquefaction, transportation, and storage of many gases.

The nine papers in this volume present some of the latest results of studies conducted both in industry and government. The Circular reports the Proceedings of the NBS Semicentennial Symposium on Mechanical Properties at Low Temperatures held at the National Bureau of Standards on May 14 and 15, 1951. May 7, 1952. 206 p.

C521. Gravity waves.

Thirty-three papers on the subject of gravity waves were presented at the June 1951 symposium held at the National Bureau of Standards. The papers extend over a wide range of subjects, covering theoretical and experimental work, as well as observations in nature. They report the results of investigations of many leading institutions, both in the United States and abroad. November 28, 1952. 287 p.

C522. Mass spectroscopy in physics research.

This is the proceedings of the National Bureau of Standards Semicentennial Symposium on Mass Spectroscopy in Physics Research held September 6, 7, and 8, 1951. Thirty-six papers by leading authorities in this field were presented. Eight papers cover the field of precision mass measurements, nine papers deal with instrumental improvements and new types of mass spectrometers and four papers are on isotope abundances. Other subjects include appearance potentials, applications to nuclear physics, mass spectra of heavy hydrocarbons and interaction of ions with molecules. The book includes the informal discussions that followed the presentation of the papers and an informal session on experimental methods. January 23, 1953. 273 p.

C523. Energy transfer in hot gases.

The 16 papers presented at the Symposium on Energy Transfer in Hot Gases held at the National Bureau of Standards are included in the volume. The papers were presented by outstanding scientists of the United States and from foreign laboratories. The titles of papers presented are: Processes of electronic excitation in relation to flame spectra; Studies of some polyatomic flame bands; Emission spectra of polyatomic free radicals; Distributions of OH rotational intensities in flames; Spectroscopic studies of low-pressure combustion flames; Studies of emission and absorption in flames; Energy distribution of CO molecules in $CO\text{-}O_2$ flames; High-resolution spectra of hydrocarbon flames in the infrared; Infrared emissivity of diatomic gases; Infrared spectra of thermally excited gases; Present position of the theory of flames; Detailed mechanism of elementary reactions: Production of $OH(^2\Sigma^+)$ in the H_2—O_2 flames (abstract); Some reactions of atomic hydrogen in flames; Temperature of the hydrogen-fluorine flames; Effect of flame-generated turbulence on heat transfer from combustion gases; and Astrophysicist's concept of temperature.

The Symposium was the sixth of a series of such conferences held at the National Bureau of Standards during 1951, the year which marked the fiftieth anniversary of the establishment of the Bureau. March 10, 1954. 126 p.

C524. Electrochemical constants.

A knowledge of standards of electromotive force, resistance, and current is of importance in all fields of electrochemistry, as well as of other electrochemical constants, including equivalent conductances, transference numbers, ionization constants, activity coefficients, electrode potentials, and the parameters of electrode kinetics, polarography and electrophoresis, is of importance in studies of electrochemical equilibria and mechanisms.

Research in electrochemistry was one of the first functions of the National Bureau of Standards. Maintenance of standards of electromotive force and determinations of standards of resistance and current were authorized as legal functions of the National Bureau of Standards by an Act of Congress in 1901. At that time, the values of the ampere and faraday were determined with silver coulometers. The standard of electromotive force, the unit of which is the volt, is maintained by a group of standard cells in the Bureau's Electrochemistry Section. This standard is compared periodically with the international standard maintained at the Bureau International des Poids et Mesures, Sèvres, France.

The papers in this volume present some of the latest results, both experimental and theoretical, in the field of fundamental electrochemistry from many leading establishments in the United States and abroad. They were initially presented at the Symposium on Electrochemical Constants, the seventh of a series of twelve symposia held by the National Bureau of Standards during its Semicentennial in 1951. August 14, 1953. 310 p.

C525. Polymer degradation mechanisms.

Research on the durability of polymeric materials is of increasing significance in view of the growing importance of these synthetic products in our national economy and defense. A knowledge of the mechanisms by which polymers degrade is needed in order to predict more accurately their expected service life, to inhibit degradation more effectively, and to devise better methods of accelerated testing.

The papers in this volume record progress that has been made in elucidating the structure of the polymers and the mechanisms of their break-down. They were initially presented at the Symposium on Polymer Degradation Mechanisms, the eighth of a series of twelve symposia held by the National Bureau of Standards during its Semicentennial in 1951. November 16, 1953. 280 p.

C526. Optical image evaluation.

The Symposium on the Evaluation of Optical Imagery was one of the twelve symposia conducted as part of the scientific program of the National Bureau of Standards in the year 1951, which marked the fiftieth anniversary of its establishment. The subject for this symposium was chosen because of its current interest and because it is one in which the Bureau has been active for many years.

In the field of applied optics it is the generally accepted practice to evaluate optical designs on the basis of geometrical optics, and the performance of optical systems has often been based upon measurements of the geometric aberrations. This practice is justified when the aberrations are so large that diffraction plays but a small part in determining the quality of imagery. Now, however, better optical systems are being produced, automatic computing machines make it feasible to completely test an optical design by computation, the interferometer enables the wave front emergent from an optical system to be completely mapped, and integrating devices enable the diffraction effects to be readily and completely determined. With these contemporary developments it seemed timely to reexamine and compare the different methods of image evaluation with the purpose of placing them on a sound engineering basis and utilizing the principles of physical optics when justified.

The scientific excellence of the symposium resulted from the quality of the papers and discussions presented by the participants. April 29, 1954. 289 p.

C527. Electron physics.

This circular is the proceedings of an International Symposium on Electron Physics held at the National Bureau of Standards in 1951. The Symposium was arranged around two specialized topics in this field, Electron Scattering and Electron Optics. The volume contains 47 original or review papers. These papers represent a summary of the state of knowledge here and abroad concerning these topics at the time of the Conference. March 17, 1954. 416 p.

C528. Characteristics and applications of resistance strain gages.

The Symposium on Resistance Strain Gages is one of the twelve Symposia held as part of the scientific program of the National Bureau of Standards in the year 1951, which marks the fiftieth anniversary of its establishment. The subjects of the Symposia represent phases of science and technology in which there is considerable current interest.

The papers presented at this Symposium represent some of the latest results, both experimental and theoretical, in the study of resistance strain gages by many leading institutions in the United States and abroad. February 15, 1954. 140 p.

C529. Electrodeposition research.

Electrodeposition processes have become an integral and important part of many industries—for example, the printing, metal-refining, extractive metallurgy, hardware, automobile, and electronic industries. This has come about largely as a result of extensive research in the field of electrodeposition, especially during the past 25 years.

To encourage further research in this field, to present current research results and problems, and to facilitate the exchange of information, the National Bureau of Standards held the Symposium on Electrodeposition Research as the last of a series of twelve symposia conducted during the Bureau's Semicentennial in 1951. The papers presented at the Symposium are published in this volume. These papers represent a cross section of research currently being conducted in electrodeposition by industrial, university, and government laboratories in Europe and the United States. May 22, 1953. 129 p.

C530. Printed circuit techniques: An adhesive tape resistor system. . B. L. Davis

A carbon-resin film-type resistor in tape form which is self-adhesive and suitable for use in printed circuitry has been developed. The range covered is 10 ohms to 10 megohms. The use of asbestos paper tape and silicone resin binder results in a resistor capable of operation up to 200° C. The size of the resistor is fixed, 0.130 by 0.300 inch. Resistance values are varied by changing the resin-to-carbon ratio and by changing carbons. The curing temperature is high, 300° C for several hours. Consequently the tape is applicable at present only to be less than +6-percent change during 500 hours under ¼-watt load at the stated ambient temperatures. Other electrical characteristics are similar to those of commercial carbon-resin film-type resistors. February 29, 1952. 83 p.

C531. Extension and dissemination of the electrical and magnetic units by the National Bureau of Standards. Francis B. Silsbee

Starting with the ohm and the volt as maintained by groups of standard resistors and cells, this paper describes the experimental processes by which the other electric and magnetic units, e. g., farad, henry, ampere, watt, joule, gauss, and oersted are derived. It also describes the series of steps by which the scales of measurement of resistance, direct and alternating current, and voltage are derived experimentally. Brief mention is made of the procedures for the dissemination of these standards of measurement throughout the world by the calibration of standard electrical measuring apparatus. An extensive bibliography lists papers describing the measurement procedures in greater detail and serves as a historical report of the work of the National Bureau of Standards in the field of electrical measurements during its first 50 years. July 14, 1952. 33 p.

C532. Measurement of the thickness of capacitor paper. . . . Wilmer Souder and Sanford B. Newman

Accurate determinations of the thickness of thin papers present a number of problems that must be considered if adequate data are to be obtained with the equipment and methods available in the average physical laboratory. The definition of thickness is one factor that must be carefully analyzed before choosing an instrument for such measurements. Three methods are available for the measurement of the thickness of capacitor paper: (1) by direct observation across an edge section by means of a micrometer microscope, (2) by measuring the separation of two geometric surfaces between which one or more specimens are placed, and (3) by determining the mass of a definite area of sample and computing the thickness, using the density parameter. Each of these methods has some difficulties or limitations, but each supplies useful information.

Measurements have been made on some commercial thin capacitor papers, using the interferometer, micrometer microscope, mechanical micrometers, and the surface analyzer. These data have been analyzed. It has been found that the precision dial micrometer or the precision screw micrometer may be used for such measurements. The size and type of contact and the load to be applied will depend on the needs of the manufacturer and user of the paper. July 15, 1952. 10 p.

C533. Method for determining the resolving power of photographic lenses
Francis E. Washer and Irvine C. Gardner

This Circular provides the photographer with two sets of charts by which the resolving power of a photographic lens may be numerically measured with respect to a definite scale of values. A detailed description is given of the procedure and technique to be followed in order that comparable values may be obtained by different observers. The test provides an objective method of testing a photographic lens. The six charts of one set are printed in black ink on a white background to form a high-contrast chart. The six charts of the other set are printed with gray ink on a gray background to form a low-contrast chart. Additional uses of these charts are also described. These uses include the testing of goggle lenses for definition and prismatic power and the testing of telescopes and binoculars for definition. May 20, 1953. 27 p. (Supersedes C428.)

Supplement to NBS Circular 533, National Bureau of Standards Charts for Testing Lens Resolution.

This consists of only 1 set of charts, with a cover sheet. May 20, 1953.

C534. Hearing aids.......................................Edith L. R. Corliss

Information is given on several topics relating to hearing and hearing aids. For several years the National Bureau of Standards has been active in studying the properties of hearing aids, largely for such Government agencies as the U. S. Veteran's Administration. The present Circular is a revision of Circular 516, and contains information previously made available in mimeograph form. Several Government agencies, manufacturers, individuals, and National bodies concerned with the problem provided important assistance and suggestions in the work and during the preparation of the Circular. March 2, 1953. 18 p. (Supersedes C516.)

C535. An annotated bibliography of selected references on the solid-state reactions of the uranium oxides.......................................S. M. Lang

An annotated bibliography of 257 references, and about 60 not abstracted, on the solid-state reactions of the uranium oxides with 36 other oxides and on the properties, crystal structure, and solid-state reactions (including oxidation and reduction) of UO_2, U_2O_5, U_3O_8, and UO_3 as reported in the literature. Subject and author indexes are included. January 9, 1953. 95 p.

C536. Radio-frequency power measurements................Roald A. Schrack

A comprehensive survey is presented of methods used to measure radio-frequency power. The methods covered are classified according to their theoretical origin. The theoretical background, practical limitations, and advantages are discussed briefly for each method. A comparative table and list of references are included. March 16, 1953. 16 p.

C537. Table of dielectric constants and electric dipole moments of substances in the gaseous state..............Arthur A. Maryott and Floyd Buckley

Values of the dipole moments and other pertinent information are tabulated for approximately 350 substances in the vapor state. All values derived from measurements of dielectric constants have been recalculated by one of two systematic procedures in order to place the work of various investigators on a more comparable basis than exists in the literature. Values obtained independently from microwave spectroscopy and other methods are also included.

Values of the dielectric constants recommended for reference purposes are listed for helium, hydrogen, oxygen, argon, air, nitrogen and carbon dioxide. These selected values were derived from a consideration of radio-frequency, microwave, and optical data. June 25, 1953. 29 p.

C538. Protective display lighting of historical documents.

The display and preservation of historical documents is a continuing problem for libraries and museums. The Library of Congress, custodian of the original documents of the Declaration of Independence and Constitution of the United States, requested the National Bureau of Standards to recommend the best means available to modern science for preserving these documents.

Two important qualifications had to be considered in the development of methods for preserving these documents. First, preservation must be effective for an indefinite time into the future. Second, it is desirable that the method of preservation should not detract from the exhibition of the documents.

Two phases of the problem have previously been described in National Bureau of Standards Circular 505, Preservation of the Declaration of Independence and the Constitution of the United States. These are the sealing of the documents in an inert atmosphere of pure helium and the use of filters to protect the manuscripts against harmful radiation.

The present report discusses the problem of lighting the Shrine at the Library of Congress where the documents are displayed, to secure maximum protection while assuring the best conditions for viewing the documents. Many of the considerations entering into the solution of this problem are applicable to the display of documents and art treasures in general. April 1, 1953. 8 p.

C539, Vol. I. Standard X-ray diffraction powder patterns. Data for 54 inorganic substances............Howard E. Swanson and Eleanor Tatge

In continuation of the National Bureau of Standards project for improving the file of X-ray diffraction patterns published by the American Society for Testing Materials, sets of patterns in the file, each representing a different chemical, have been reviewed with the object of supplanting them with single standard patterns. Reports are made on substances for each of which a pattern prepared at the Bureau is offered to replace a set now in the file. Four additional reports are included, one for high cristobalite, for which no pattern was prepared at the NBS, and three, which are not represented in the ASTM file, on selenium dioxide, zinc borate, and magnesium tungstate.

The substances reported upon are Mg, Al, Ni, Cu, Zn, Ge, Mo, Pd, Ag, Sn, Te, W, Ta, Pt, Au, Pb, BeO, MgO, SiO_2 (low cristobalite), SiO_2 (high cristobalite), CaO, TiO_2 (rutile), TiO_2 (anatase), NiO, CuO, GeO_2, As_2O_3, SeO_2, SnO_2, CeO_2, ThO_2, $Ca(OH)_2$, NH_4Cl, LiF, LiCl, NaF, KF, KCl, KBr, KI, CaF_2, BaF_2, Hg_2Cl_2, $HgCl_2$, HgI_2, PbFCl, KCN, NaCN (cubic), NaCN (orthorhombic), $Sr(NO_3)_2$, $Ba(NO_3)_2$, ZnB_2O_4, Mg_2SiO_4, and $MgWO_4$.

The ASTM patterns are tabulated for comparison with additional patterns from the literature and one prepared at the NBS. Miller indices are derived from the calculation of spacings by desk calculator or the electronic computer SEAC. Interplanar spacings in angstroms (except where otherwise noted) and relative intensities from 1 to 100 are tabulated. For the NBS pattern the three strongest lines are given, as well as the lattice constants and the computed density. The index of refraction of the sample is noted if it could be determined. Crystal-structure data from the literature are noted. June 15, 1953. 95 p.

C539, Vol. II. Standard X-ray diffraction powder patterns. Data for 30 inorganic substances....Howard E. Swanson and Ruth K. Fuyat

Twenty-eight standard X-ray diffraction powder patterns are presented in revision of one hundred corresponding patterns in the ASTM card file, a system for the identification of unknown crystalline materials, based on the three strongest reflections of each distinct phase. Two patterns not represented in the file are also included. A comparison is made between all powder data available for each of the substances reported. The patterns were made with a high-angle geiger-counter spectrometer, using samples of exceptionally high purity. The *d*-spacings were assigned Miller indices determined in part from calculated patterns of theoretical spacings and from space group considerations. The lattice constants and density were calculated and, whenever possible, the refractive indices were measured.

This report includes X-ray data for the following thirty substances: C (diamond), Si, Ga, Zr, α-Sn, Re, ZnS (wurtzite), ZnS (sphalerite), PbS (galena), α-Al_2O_3 (corundum), Cu_2O (cuprite), ZnO (zincite), CdO, Tl_2O_3, PbO (litharge), PbO (massicot), UO_2, $MgAl_2O_4$ (spinel), $ZnAl_2O_4$, NaCl (halite), CsCl, $PbCl_2$ (cotunnite), $PbBr_2$, NH_4Br, $CaCO_3$ (calcite), $BaCO_3$ (witherite), $PbCO_3$ (cerussite), Na_2SO_4 (thenardite), $SrSO_4$ (celestite), and $Zn_4(OH)_2Si_2O_7 \cdot H_2O$ (hemimorphite). June 15, 1953. 65 p.

C539, Vol. III. Standard X-ray diffraction powder patterns. Data for 34 Inorganic substances....................Howard E. Swanson, Ruth K. Fuyat, and George M. Ugrinic

Data for thirty-two standard X-ray diffraction powder patterns are presented in revision of the eighty-one corresponding patterns in the ASTM card file, a system for the identification of unknown crystalline materials based on the three strongest reflections of each structurally distinct phase. Patterns for two compounds not represented in the file are also included. A comparison is made between all powder data available for each of the substances reported. The patterns were made with a geiger counter X-ray spectrometer, using samples of exceptionally high purity. The *d*-spacings were assigned Miller indices determined from calculated patterns of theoretical spacings and from space group considerations. The lattice constants and densities were calculated, and the refractive indices were measured whenever possible.

Included in this report is X-ray data for the following thirty-four substances: Ti, As, Rh, Cd, In, Sb, I_2, Hf, Bi, ZnSe, SiO_2 (α-quartz), Sc_2O_3, Y_2O_3, MoO_3 (molybdite), Sb_2O_3 (senarmontite), La_2O_3, HgO (montroydite), α-$Al_2O_3 \cdot H_2O$ (bohmite), β-$Al_2O_3 \cdot H_2O$ (diaspore), $SrTiO_3$, $BaTiO_3$, NaBr, CsBr, $CsICl_2$, $NaClO_3$, $CaCo_3$ (aragonite), $SrCO_3$ (strontianite), KNO_3 (niter), Na_2SO_3, K_2SO_4 (arcanite), $BaSO_4$ (barite), $PbSO_4$ (anglesite), KH_2PO_4, and $(NH_4)_2OsBr_6$. June 10, 1954. 73 p.

C539, Vol. IV. Standard X-ray diffraction powder patterns. Data for 42 inorganic substances..Howard E. Swanson, Ruth K. Fuyat, and George M. Ugrinic

Forty-two standard X-ray diffraction powder patterns are presented in revision of the ninety-five corresponding patterns in the ASTM card file, a system for the identification of unknown crystalline materials based on the three strongest reflections of each material or structurally distinct phase. Patterns for seven compounds not represented in the file are also included. A comparison is made between all powder diffraction data available for each of the substances reported. The patterns were made with a Geiger counter X-ray diffractometer, using samples of exceptionally high purity. The *d*-spacings were assigned Miller indices determined by comparison with calculated interplanar spacings and from space group considerations. The densities and lattice constants were calculated, and the refractive indices were measured whenever possible.

Included are X-ray data for the following forty-two substances: α-Fe, Ru, Ba, Os, Ir, α-MnS (alabandite), CuS (covellite), CdS (greenockite), HgS (cinnabar), HgS (metacinnabar), Bi_2S_3, α-Ga_2O_3, Nd_2O_3, PdO, SnO, LiBr, NaI, MgF_2, CuCl, CuBr, CuI, $SrCl_2$, RbCl, RbI, AgCl (cerargyrite), AgBr, CsI, HgI, TlCl, orthorhombic TlI, BiOCl (bismoclite), NH_4I, $SrCl_2 \cdot 6H_2O$, $SrBr_2 \cdot 6H_2O$, $Ag_7O_8NO_3$, $NaNO_2$, $NH_4H_2PO_4$, $CaSO_4$ (anhydrite), $ZrSiO_4$ (zircon), AlSb, and InSb. March 1, 1955. 75 p.

C539, Vol. V. Standard X-ray diffraction powder patterns. Data for 45 inorganic substances . . Howard E. Swanson, Nancy T. Gilfrich, and George M. Ugrinic

Forty-five standard X-ray diffraction powder patterns are presented in revision of seventy-four corresponding patterns in the ASTM file. This is a system for the identification of unknown crystalline materials based on the three strongest reflections of each material or structurally distinct phase. Patterns for five compounds not represented in the file are also included. A comparison is made of all powder diffraction data available for each of the substances reported. The patterns were made with a Geiger counter X-ray diffractometer, using samples of exceptionally high purity. The *d*-spacings were assigned Miller indices determined by comparison with calculated interplanar spacings and from space group considerations. The densities and lattice constants were calculated, and the refractive indices were measured whenever possible.

Included are X-ray data for the following forty-five substances: $(NH_4)_2PtCl_6$, $(NH_4)_2SnCl_6$, $(NH_4)_2SiF_6$ (cryptohalite), Sb_2S_3 (stibnite), $BaZrO_3$, $3CaO \cdot Al_2O_3$, Cs_2PtCl_6, Cs_2SnCl_6, Cs_2GeF_6, Cs_2SiF_6, Cr, Cr_2O_3, CuF_2, GeI_4, In_2O_3, HIO_3, FeS_2 (pyrite), α-PbF_2, β-PbF_2, PbI_2, $Pb(NO_3)_2$, PbSe (clausthalite), $PbTiO_3$, Mg_2Sn, $MgTiO_3$ (geikielite), MnO, MoS_2 (molybdenite), K_2PtCl_6, K_2SiF_6 (hieratite), $KZnF_3$, PrF_3, Rb_2PtCl_6, Se, Ag_3AsO_4, $AgBrO_3$, $AgNO_3$, $AgNO_2$, Ag_3PO_4, $NaHF_2$, $NaBrO_3$, SrF_2, SrO, Tl_2PtCl_6, SnI_4, and $Zn(CN)_2$. October 21, 1955. 75 p.

C539, Vol. 6. Standard X-ray diffraction powder patterns. Data for 44 inorganic substances........Howard E. Swanson, Nancy T. Gilfrich, and Marlene I. Cook

Forty-four standard X-ray diffraction powder patterns are presented. Twenty-three are to replace thirty-three patterns already represented in the ASTM card file, and twenty-one are for substances not previously represented. The ASTM card file is a compilation of diffraction patterns from all sources and is used for the identification of unknown crystalline materials by matching spacing and intensity measurements. In this Circular, comparison is made of all powder diffraction data available for each of the substances reported. The patterns were made with a Geiger counter X-ray diffractometer, using samples of high purity. The *d*-values were assigned Miller indices determined by comparison with calculated interplanar spacings and from space group considerations. The densities and lattice constants were calculated, and the refractive indices were measured whenever possible.

Included are X-ray data for the following forty-four substances: $NH_4Al(SO_4)_2 \cdot 12H_2O$, $(NH_4)_2PdCl_4$, $NH_4Cr(SO_4)_2 \cdot 12H_2O$, $(NH_4)_2GeF_6$, $NH_4Ga(SO_4)_2 \cdot 12H_2O$, $NH_4Fe(SO_4)_2 \cdot 12H_2O$, $(NH_4)_2SO_4$ (mascagnite), $(NH_4)_3ZrF_7$, SbI_3, AsI_3, BaO_2, BiI_3, $CdMoO_4$, $CaWO_4$ (scheelite), $CsAl(SO_4)_2 \cdot 12H_2O$, Cs_2PtF_6, $CsFe(SO_4)_2 \cdot 12H_2O$, Cr_3Si, GaSb, $Mg(OH)_2$ (brucite), $MgSiO_3$ (enstatite), $Hg(CN)_2$, $KAl(SO_4)_2 \cdot 12H_2O$, K_2SnCl_6, $KCr(SO_4)_2 \cdot 12H_2O$, K_2PtF_6, $KClO_4$, $RbAl(SO_4)_2 \cdot 12H_2O$, Rb_2SnCl_6, $RbCr(SO_4)_2 \cdot 12H_2O$, Rb_2PtF_6, Rb_2SiF_6, $NaNO_3$ (soda-niter), SrO_2, $TlAl(SO_4)_2 \cdot 12H_2O$, Tl_2SnCl_6, $TlCr(SO_4)_2 \cdot 12H_2O$, Tl_2SiF_6, $TlGa(SO_4)_2 \cdot 12H_2O$, $TlNO_3$, Tl_2SO_4, and ZnF_2. September 26, 1956. 62 p.

C540. Weights and measures case reference book.....Kathryn M. Schwarz and Malcolm W. Jensen

An index to and digest of Federal and State weights and measures decisions of record, through July 1952. The decisions have been digested and considerably condensed. The material presented is designed as a guide to the lay reader; it gives in lay language condensed legal principles as expounded by the courts. April 13, 1953. 97 p.

C541. A spectrophotometric atlas of the $^2\Sigma^+ - ^2\Pi$ transition of OH
Arnold M. Bass and Herbert P. Broida

The near ultraviolet spectrum of OH (2600 to 3500 A) is a characteristic feature of the radiation emitted by hydrocarbon flames. In order to facilitate the detailed use of this spectrum in problems of temperature measurement and chemical kinetics, a spectrophotometric atlas has been prepared for this region, using a grating spectrometer equipped with a photoelectric detector.

The spectrum is presented in a series of charts covering intervals of about 50 A, and most of the lines in the spectrum are identified. June 26, 1953. 22 p.

C542. Graphs of the Compton energy-angle relationship and the Klein-Nishina formula from 10 kev to 500 Mev......................Ann T. Nelms

The Compton energy versus angle relationship and the differential and integral Klein-Nishina cross sections are presented graphically as functions of the energy and direction of the scattered photon and of the recoil electron. These graphs are intended to serve the purpose of tables. Unpolarized primary gamma rays in an energy range from 10 kev to 500 Mev are considered. The accuracy of all curves is estimated at 1 percent. The advantage of this form of presentation is the convenience and accuracy of two-way interpolation. In general, interpolated values may be obtained with an accuracy of 2 percent. August 28, 1953. 89 p.

C543. Reference data for orienting quartz plates by X-ray diffraction
Catherine Barclay and Leland T. Sogn

The relative intensities of X-rays reflected from a large number of planes in quartz were measured. The results of these experiments are given with suggestions for their most effective use in the determination of orientation of crystal blanks. Graphs are presented which indicate the effect of inclined planes on the intensities of the reflected beam as well as the zero position of the Bragg angle reading. Tables and charts to facilitate the use of the most essential X-ray data are included. Other information of use to the technician in checking the orientation of crystal cuts is presented. July 24, 1953. 7 p.

C544. Formulas for computing capacitance and inductance....Chester Snow

Explicit formulas are given for the computation of (1) the capacitance between conductors having a great variety of geometrical configurations, (2) the inductance, both self- and mutual, of circuits of various shapes, and (3) the electrodynamic forces acting between coils when carrying current. Formulas for skin effect and proximity effect in concentric cables and parallel wires are included. The formulas for the simpler configurations are given in terms of the elementary functions, whereas more complex shapes involve the use of Legendre polynominals, Legendre functions, and elliptic functions. One section is devoted to a discussion of the relation between the Legendre and the elliptic functions. September 10, 1954. 69 p.

C545. Subminiaturization techniques for low-frequency receivers
Gustave Shapiro

A subminiature radio receiver, tuning from 190 to 550 kc, has been developed. Total volume of this 12-tube unit is 55 in^3. This compactness is made possible by 14 new components, including r-f inductors and i-f transformers, using high-temperature litzendraht wire, glass dielectric capacitors, tantalum electrolytic capacitors, and audio inductors wound with ceramic insulated wire. Design and fabrication techniques, which make this receiver adaptable to quantity production, are applicable to other miniature electronic devices. April 7, 1954. 64 p.

C546. Effective radio ground-conductivity measurements in the United States
R. S. Kirby, J. C. Harman, F. M. Capps, and R. N. Jones

Maps are presented showing the results of effective ground-conductivity measurements made by various broadcasters and consulting engineers throughout the United States. The need for such detailed maps has been indicated by the lack of reliability inherent in the use of general-area conductivity maps and by studies of the correlation of effective ground-conductivity measurements with surface soil conditions. Over 7,000 radials are shown on the maps, and provisions have been made for entering new measurements, as the results become available, for possible future publication. Due to the complexity of ground-wave propagation over an inhomogeneous earth, the determination of effective ground conductivity over a given radial strictly applies only at the frequency at which the measurements were made. February 26, 1954. 87 p.

C547, Section 1. Precision laboratory standards of mass and laboratory weights
T. W. Lashof and L. B. Macurdy

This is the first part of the revision of National Bureau of Standards Circular 3, Design and Test of Standards of Mass, last revised in 1918. Laboratory standards of mass in order of decreasing precision are classes J, M, S, and S–1. The newly introduced class J weights, with a tolerance of 0.003 milligram for each weight, may be used for the calibration of equipment for ultramicroanalysis. Class M weights are reference standards for high-precision work and work demanding high constancy. Class S weights are laboratory working standards. Maintenance tolerances start at 0.0054 milligram for class M fractional weights and 0.014 milligram for the smallest class S weights, and decrease to 5 parts per million for the larger weights of both classes. Class S–1 are for use in routine analytical work with quick-weighing balances and are the most precise weights available in nonmetric units. Tolerances vary from 0.025 milligram for the smallest weights to 10 parts per million for the larger weights.

Classified for the first time are class P laboratory weights for routine analytical work, class Q for technical and student use, and class T for rough weighing operations. Maintenance tolerances for these weights start at 0.1 milligram for classes

P and Q and 0.8 milligram for class T and decrease to 40, 100, and 300 parts per million, respectively, for the larger weights of these classes.

In addition to the tolerances, the denominations, composition, construction, marking, packing, and performance of weights of each class are fully described. Also described are the nature and precision of the tests available and other features of the Bureau's weight-calibration service. In general, the calibration service is intended primarily to provide standard weights for the calibration of other weights, for legal use, and for use in scientific work where the highest precision is required. August 20, 1954. 24 p. (Supersedes C3, in part.)

C548. Miniature intermediate-frequency amplifiers............Robert K-F Scal

Three miniature high-gain, high-frequency, intermediate-frequency amplifiers (20 to 100 Mc) were developed with particular emphasis on the use of circuit elements suitable for maximum design simplicity, circuit flexibility, and ease of manufacture. The units are about one-eighth the size and one-half the weight of the equipments they supersede. The circuitry was designed with emphasis on the use of subminiature tubes and their application in low-noise input circuits. Some units are hermetically sealed for protection against contamination and moisture, and to provide for operation under the extreme temperature range (−65° to +200° C) required for such equipment. July 16, 1954. 46 p.

C549. Computation of achromatic objectives..............Robert E. Stephens

Procedures for the computation of the curves for achromatic doublet objectives by the algebraic method are presented in considerable detail, using the design of two such objectives as examples. The reasons for choosing particular pairs of glass types and the changes in procedure necessary to accomplish different degrees of correction are discussed.

The information contained in this Circular is sufficient to guide the reader in computing algebraically achromatic objectives for his own specific applications. It also serves as an introduction to the algebraic method for those who may wish to delve further into the design of lens systems. September 20, 1954. 7 p.

C550. Mechanical failures of metals in service............John A. Bennett and G. Willard Quick

For many years the National Bureau of Standards has made examinations of metal parts that have failed in service for evidence bearing on the causes of failure. Thirty-five such cases, representing the most frequently observed types of failures are described, and the factors of design, fabrication, or use contributing to these failures are presented. The characteristics by which the various types of fractures can be recognized are discussed, and recommended precautions that should be observed to reduce mechanical failures of metals in service are included. September 27, 1954. 36 p.

C551. Computer development (SEAC and DYSEAC) at the National Bureau of Standards, Washington, D. C.

Since 1946 the National Bureau of Standards has been active in the general field of electronic digital computers, largely for other agencies of the Government. The Bureau's computer program has been conducted jointly by the Electronics Division and the Applied Mathematics Division. The work of the Electronics Division in Washington has included the development and construction of two computers (SEAC and DYSEAC), components research and development, and various technical and advisory services. The work of the Applied Mathematics Division has included research in numerical analysis of importance in the solution of problems by computers and the design and construction of a computer (SWAC) at the Bureau's Institute for Numerical Analysis in Los Angeles.

This volume presents reports on various aspects of the computer program through 1953, based largely on the work and experience relating to SEAC and DYSEAC. Such topics as systems development, engineering development, design, construction, and maintenance of computer equipment are covered. The introduction summarizes the history of this program in the Electronic Computers Laboratory of the Electronics Division. January 25, 1955. 146 p.

C552. Standard samples and reference standards issued by the National Bureau of Standards.

This Circular contains a descriptive listing of the various Standard Samples issued by the National Bureau of Standards. A schedule of weights and fees, as well as directions for ordering, is included. Summarized tables of analyses are presented, to indicate the type of standards of composition presently available. Announcements of new standards will be made in scientific and trade journals, and the current status of the various standards will be indicated by a mimeographed insert. August 31, 1954. 23 p. (Supersedes C398 and its Supplements. Superseded by C552, 2d ed.)

C552, 2d ed. Standard samples. A catalog of reference materials issued by the National Bureau of Standards.

A descriptive listing of the various Standard Samples issued by the National Bureau of Standards is given. A schedule of weights and fees, as well as directions for ordering, is included. Summarized tables of analyses are presented, to indicate the type of standards of composition presently available. Announcements of new standards will be made in scientific and trade journals, and the current status of the various standards will be indicated by an insert sheet issued with the Circular. April 15, 1957. 24 p. (Supersedes C552, dated Aug. 31, 1954.)

C553. The ISCC–NBS method of designating colors and a dictionary of color names........................Kenneth L. Kelly and Deane B. Judd

In 1939 there was published a Method of Designating Colors as a solution of the problem proposed by the first chairman of the Interm-Society Color Council, E. N. Gathercoal, who said: "A means of designating colors in the United States Pharmacopoeia, in the National Formulary, and in general pharmaceutical literature is desired; such designation to be sufficiently standardized as to be acceptable and usable by science, sufficiently broad to be appreciated and used by science, art and industry, and sufficiently commonplace to be understood, at least in a general way, by the whole public." This method was developed with the assistance of the American Pharmaceutical Association following plans outlined in 1933 by the Inter-Society Color Council. As a result of suggestions of the member bodies and individual members of the ISCC, a revision of the proposed system was made and approved by the Council in June 1949, and recommended for use in general color description. The revised ISCC–NBS color designations are defined in Munsell terms by 31 name charts, one for each of 31 ranges of Munsell hue. The ISCC–NBS equivalents of 7,500 color names previously defined by reference to 11 different sets of material standards have been determined and listed both alphabetically and by ISCC–NBS color designation to form a dictionary of color names. November 1, 1955. 158 p.

C554. Cheyenne Mountain tropospheric propagation experiments..A. P. Barsis, J. W. Herbstreit, and K. O. Hornberg

The National Bureau of Standards has established extensive facilities for studies of tropospheric radio-wave propagation in the very-high frequency and ultra-high frequency portion of the frequency spectrum at Cheyenne Mountain, Colorado. These facilities include high-power continuous-wave transmitters on five frequencies, from 92 to 1,046 Mc. Continuously recording field-strength receivers are located at four fixed receiving locations ranging to 226 miles from Cheyenne Mountain, with provisions for semifixed recordings at Anthony, Kans., and Fayetteville, Ark., which are 393 and 617 miles, respectively, from the transmitter site. An extensive radio meteorological installation is located at Haswell, Colo., where accurate measurements of temperature, pressure, and humidity are made with electronic measuring devices, and refractive-index turbulence is measured with the microwave refractometer developed at the Bureau. These facilities are described and sample results are reported. The new theory of tropospheric propagation embodying the Booker-Gordon scattering principles as extended by Staras is related to the measurements. January 3, 1955. 39 p.

C555. Testing of hydrometers..................................J. C. Hughes

The design and construction of hydrometers, with particular reference to hydrometers that are to be submitted to the National Bureau of Standards for test are discussed. The various scales that are commonly used for hydrometers are defined and recommendations given for subdividing and marking them. These scales include density, specific gravity degrees Baumé, degrees API, percentage by weight, percentage by volume, percentage proof, spirit, Brix, Balling, and some others. The relations between some of the arbitrary scales (for example, API) and specific gravity are stated.

The Circular outlines the procedure of testing hydrometers that are submitted to the Bureau and discusses the forms of certificates and reports issued as a result of these tests. Instructions and other helpful information about submitting hydrometers for test are given. October 22, 1954. 10 p. (Supersedes C477).

C556. Thermal conductivity of metals and alloys at low temperatures: A review of the literature..........Robert L. Powell and William A. Blanpied

An extensive compilation is given of the measured values of thermal conductivity for metals and alloys from room temperature down to approximately 0° K. The more extensive and important data are plotted in 48 graphs. The tables and graphs for the metallic elements and alloys are essentially complete for literature reference from 1900 to early 1954. For comparison, several graphs and tables are given for some representative dielectrics. September 1, 1954. 68 p.

C557. Worldwide radio noise levels expected in the frequency band 10 kilocycles to 100 megacycles......W. Q. Crichlow, D. F. Smith, R. N. Morton, and W. R. Corliss

External radio noise levels are presented in the form of an effective antenna noise figure F_a, which is defined as the noise power available from an equivalent lossless antenna relative to kt_0b (the thermal noise power available from the passive resistance of a circuit with bandwidth, b, and at the standard absolute temperature, t_0). This form of expressing the noise has been chosen for convenience in combining for practical applications the noise received external to the antenna with the noise already present in the receiver. This form of presentation includes the frequency squared factor arising from the absorbing area of the receiving antenna and provides a measure of noise directly applicable to the "transmission-loss" method of measuring radio propagation.

Curves are given that show the expected median levels of radio noise during 4-hour time blocks for each season. The curves also show the effects of frequency and geographical location (using noise grade maps) and include atmospheric, galactic, and manmade noise sources.

The expected median values of atmospheric noise levels were largely based on the information given in the National Bureau of Standards Circular 462.

Also, the expected variability of noise levels within the 4-hour time blocks is given in terms of the ratios of the upper decile to median level and median to lower decile level. These ratios are shown to be a function of frequency, time of day, and median noise-level amplitude.

The results of measurements at Boulder, Colo., Front Royal, Va., and Tatsfield England, are shown in comparison with the expected levels. August 25, 1955. 36 p.

C558. Bibliography and index on dynamic pressure measurement W. G. Brombacher and T. W. Lashof

This Circular contains a bibliography of 850 items on dynamic pressure measurement and, in less detail, on related subjects such as static pressure measurement and general information on the components of instruments. An index of the bibliography by both subject and author is included. February 14, 1955. 124 p.

C559. Specification for dry cells and batteries.

This sixth edition of Specification for Dry Cells and Batteries, includes new tests, up-to-date data, and covers new types of dry cells. Mercury cells, flat cells and air-depolarized cells are included in this specification for the first time. A photoflash test with results on photoflash batteries is a new feature of this 6th edition of the specification. Performance data on flashlight batteries, radio batteries, hearing-aid batteries, etc., have been brought up to date. The project was carried out by the American Standards Association Sectional Committee on Dry Cells and Batteries—C18, under the Sponsorship of the National Bureau of Standards, and approved as an American Standard on August 19, 1954. April 20, 1955. 17 p. (Supersedes C466.)

C560. Leather research and technology at the National Bureau of Standards: A review and bibliography........................Everett L. Wallace

A summary of the activities of the Leather Section, Organic and Fibrous Materials Division, of the National Bureau of Standards is given. Some of the more noteworthy accomplishments mentioned are: Establishment of the optimum pH of 3.0, below which leather is not stable during storage; method for the quantitative determination of amino acids in collagen; measurement of the size and distribution of pores in leather; methods of impregnating leather with polymers; measurement of the physical constants of leather and other polymers; investigation of the tanning properties of synthetic organic compounds; and the construction and design of special equipment for laboratory evaluation of performance.

A list of publications by members of the National Bureau of Standards Leather Section staff pertaining to collagen, leather, and other polymers is included. June 1, 1955. 13 p.

C561. Reference tables for thermocouples. . Henry Shenker, John I. Lauritzen, Jr., Robert J. Corruccini, and S. T. Lonberger

Expanded reference tables for platinum versus platinum–10-percent rhodium, platinum versus platinum–13-percent-rhodium, chromel-alumel, iron-constantan (modified 1913), copper-constantan, and chromel-constantan thermocouples are given with temperature in degrees Celsius (centigrade) and Fahrenheit and electromotive force in millivolts as the arguments. The tables are based upon the absolute electrical units and the International Temperature Scale of 1948. April 27, 1955. 84 p. (Supersedes C508.)

C562. Bibliography of research on deuterium and tritium compounds
Lawrence M. Brown, Abraham S. Friedman, and Charles M. Beckett

A bibliography of 2,482 references to published research on the properties of deuterium and tritium compounds is given. The subject matter of each entry in the bibliography is indicated by letter codes related to a list of broad subject headings shown in the Introduction. An index of deuterium and tritium compounds and a subject index are included. January 27, 1955. 85 p.

C562 Supplement 1. Bibliography of research on deuterium and tritium compounds . . . . Virginia R. Johnson, Lawrence M. Brown, and Abraham S. Friedman

A bibliography of 720 references to published research on the properties of deuterium and tritium compounds is given. The subject matter of each entry in the bibliography is indicated by letter codes related to a list of broad subject headings as shown in the Introduction. An index of deuterium and tritium compounds and a subject index are included. July 15, 1957. 31 p.

C563. Periodicals and serials received in the Library of the National Bureau of Standards April 1955 . . . Natalie J. Hopper and Dorothy H. Pepperman

An alphabetically arranged list of the periodicals and serials received in the National Bureau of Standards Library is given, including American and foreign journals. Some 1,600 such documents are cited, together with the call number indicating the location of each item on the Bureau Library shelf. Although the material is organized primarily for use by the Bureau's scientific and technical staff, the information is of value to libraries, scientific and technical organizations, research workers, and others concerned with the problem of effective library planning, organization, facilities, and service in meeting the need of the scientific worker for the current literature in his field of research activity. August 15, 1955. 40 p.

C564. Tables of thermal properties of gases . . . . Joseph Hilsenrath, Charles W. Beckett, William S. Benedict, Lilla Fano, Harold J. Hoge, Joseph F. Masi, Ralph L. Nuttall, Yerman S. Touloukian, and Harold W. Woolley.

Tables are given at close temperature intervals for the thermodynamic and transport properties of air, argon, CO_2, Co, H_2, N_2, O_2, and steam. The thermodynamic properties—compressibility factor, density, entropy, enthalpy, specific heat, specific-heat ratio and sound velocity are tabulated for the real gas at pressures up to 100 atmospheres and to temperatures of 600° K for hydrogen, 1,500° K for carbon dioxide, 850° K for steam, and 3,000° K for the remainder. The ideal-gas thermodynamic functions are tabulated uniformly to 5,000° K. Also tabulated are the vapor pressures and transport properties-thermal conductivity, viscosity, and Prandtl number. These were fitted either semi-theoretically or empirically to the experimental values and are tabulated over the range of the available experimental data. Comparisons of the tabulated values with the existing experimental data are shown in deviation plots which exhibit the range and distribution of the experimental data as well as their agreement with the tabulated values. November 1, 1955. 488 p.

C565. Techniques for ruling and etching precise scales in glass and their reproduction by photoetching with a new light-sensitive resist
Raymond Davis and Chester I. Pope

Two methods are described for the making of very precisely graduated circles for theodolites. In one method the graduations and numbers are ruled in a wax resist coated on the glass circle by means of a ruling engine followed by etching. In the other method the circle is coated with a light-sensitive resist and exposed in contact with a glass master negative followed by etching. The requirements of precise circles and the mechanics of engraving the resist on both circles and reticules are discussed. The development of resist coatings and their application on the glass and the methods of glass etching are reviewed. A new mild etching solution containing phosphoric acid and hydrofluoric acid was developed. The synthesis of phenol-formaldehyde resin for use as a light-sensitive resist coating and the procedure for its use are given in detail. August 26, 1955. 36 p.

C566. Bibliography of solid adsorbents, 1943 to 1953 .... Victor R. Deitz

An annotated bibliographical survey of the scientific literature was made for the period from 1942 to 1953. The coverage is restricted to heterogenous phenomena at solid-liquid and solid-gas interfaces. The number of commercial solid adsorbents has increased markedly in the last decade. The applications are to gases, liquids or solutions and are of particular importance to the petroleum, sugar, biochemical, agricultural, mining, and metallurgical industries as well as in water purification. Since catalytic processes involve adsorption as an essential step, this bibliography is of especial value to those interested in catalysis. A complete author index and a very complete subject index are features of this Circular. The utility of the subject indexing is contained in the main heading which is based on the type of adsorbent and the subheadings which cover some general aspects of the gas or solution phase. March 1, 1956. 1528 p.

C567. Guide to instrumentation literature .... W. G. Brombacher, Julian F. Smith, and Lyman Van der Pyl

This compilation consists of (1) an introduction, (2) a source list of instrumentation literature, (3) an author index, and (4) a subject index. Over 1,200 references are listed, including abstract journals, bibliographies, 660 books on technology, directories of manufacturers, guides to and indexes of technical literature, periodicals of interest, and guides to dissertations, patents and specifications. Articles published in periodicals are not referenced, but indexes and abstracts of such articles on a given subject are indicated in the subject index. December 14, 1955. 156 p.

C568. High-temperature reactions of uranium dioxide with various metal oxides
S. M. Lang, F. P. Knudsen, C. L. Fillmore, and R. S. Roth

The high-temperature reactions of UO_2 with 15 metal oxides are described, usually in the form of phase-equilibrium diagrams, from data determined at the National Bureau of Standards and from a survey of the available literature. The systems are discussed in groups according to the cation valence of the second oxide; the divalent oxides BeO, MgO, CaO, SrO, BaO, and CuO; the trivalent oxides Al_2O_3, Y_2O_3, and Nd_2O_3; the tetravalent oxides SiO_2, ZrO_2, SnO_2, CeO_2, and ThO_2; and the pentavalent oxide V_2O_5. A brief review is presented for the relations in the U–O system, particularly in the region of UO_2. Detailed descriptions of the equipment and the procedures used for the National Bureau of Standards investigation are included in an appendix. February 20, 1956. 32 p.

C569. Fused-quartz fibers. A survey of properties, applications, and production methods .... Nancy J. Tighe

Fused-silica fibers have an important function in many measuring instruments used in scientific research. Much of the information on the production and fabrication methods and on the properties of the fibers is widely scattered throughout the technical literature. This Circular is a survey of this literature and a summary of the findings. A bibliography of pertinent references on the subject is included to provide the sources of more complete and detailed information necessary for specific applications. January 25, 1956. 26 p.

C570. Units and systems of weights and measures. Their origin, development, and present status.................................Lewis V. Judson

The Circular brings together in a convenient form information about weights and measures that experience has shown is of interest to the general public. Much of it has been issued previously by the National Bureau of Standards in temporary and scattered form. The Circular discusses the origin and early history of units and standards, gives general information about the metric system, and states and explains the present status of standards of length, mass, time, and capacity in the United States and in Great Britain. It discusses for the benefit of the general reader such matters as the distinction between units and standards, and that between mass and weight. Two items of everyday life relating to weights and measures are considered in some detail: The weight of coal, and the definitions and usages of the terms "ton" and "tonnage." The Circular concludes with tables of weights and measures, prepared for the benefit of those requiring such tables for occasional ready reference. School teachers will find in this Circular considerable material to supplement their textbooks. May 21, 1956. 29 p.

C571. Electron physics tables..........L. Marton, C. Marton, and W. G. Hall

The tables presented here are intended as replacement of "Miscellaneous Physics Tables—Part II. Electronic Functions" (Mathematical Tables 17 of of the National Bureau of Standards, 1941). Eight parameters have been calculated on the Standards Electronic Automatic Computor (SEAC) and are tabulated with an eight digit accuracy. March 30, 1956. 83 p. (Supersedes Part II of Mathematical Table 17).

C572. Calibration of line standards of length and measuring tapes at the National Bureau of Standards.................................Lewis V. Judson

The methods used at the National Bureau of Standards in calibrating line standards of length and measuring tapes submitted for standardization are outlined. The equipment used is described briefly. There is a discussion of some considerations that should be given as to whether or not a standard should be submitted to the Bureau. Instructions are given for submitting items to the Bureau for calibration. The appendix contains useful information on the use of steel tapes. June 4, 1956. 11 p. (Supersedes Circulars 328 and 332).

C573. Phase of the low radiofrequency ground wave..............J. R. Johler, W. J. Kellar, and L. C. Walters

The special theoretical considerations pertinent to the computation of the phase of the ground wave at low radiofrequencies are discussed. The formulas necessary for the numerical evaluation of the amplitude and phase, and the results of the numerical computation are presented. The effects of frequency, conductivity of the earth, altitude above the surface of the earth, and vertical lapse of the permittivity of the atmosphere are evaluated. June 26, 1956. 38 p.

C574. Amplitude and phase curves for ground-wave propagation in the band 200 cycles per second to 500 kilocycles..James R. Wait and H. Herbert Howe

After making several extensions to the formulas of Van der Pol and Bremmer, field strength and phase values of the very low frequency ground wave from a short vertical antenna are computed. The ground conductivity values chosen are 4, 0.01, and 0.001 mho per meter. The distances considered range from 1 to 1,500 miles. May 21, 1956. 17 p.

C575. Bibliography on nitrogen 15..........M. W. Chapman and H. P. Broida

References to the literature on nitrogen 15 that has appeared from 1919 to 1952, inclusive, with a few later references, are given. The citations relate to the abundance of N^{15} naturally occuring, its physical properties, methods of concentrating it, methods of N^{15}/N^{14} measurement, and the synthesis and uses of N^{15} compounds. October 1, 1956. 12 p.

C576. Automotive antifreezes........Frank L. Howard, Donald B. Brooks, and Ronald E. Streets

This Circular gives information on the pertinent physical properties of various materials used as engine antifreezes and on their water solutions. Factors regarding choice of antifreeze, cooling-system corrosion, and testing of antifreeze solutions are discussed. July 26, 1956. 23 p. (Supersedes C506).

C577. Energy loss and range of electrons and positrons........Ann T. Nelms

Tabulations of the mean energy loss due to ionization and excitation and the range derived from this quantity are given for electrons and positrons in several materials. July 26, 1956. 30 p.

C578. Suggested practices for electrical standardizing laboratories
Francis B. Silsbee

A number of basic principles are given that experience has shown to be important in the operation of private standardization laboratories. Types of standard apparatus are classified and schedules appropriate for their intercomparison and for their checking at the National Bureau of Standards are suggested. August 30, 1956. 9 p.

C579. Underground corrosion..............................Melvin Romanoff

The Circular is a final report on the studies of underground corrosion conducted by the National Bureau of Standards from 1910 to 1955.

Up to 1922, the studies were confined to corrosion due to stray-current electrolysis and its mitigation. After it became apparent that serious corrosion occurred in soils under conditions that precluded stray-currents as an explanation, a field burial program was initiated in order to obtain information pertaining to the effect of soil properties on the corrosion of metals. More than 36,500 specimens, representing 333 varieties of ferrous, nonferrous, and protective coating materials, were exposed in 128 test locations throughout the United States. During this time the electrical and electrochemical aspects of underground corrosion have been continuously studied in the laboratory. Results from both field and laboratory investigations are presented. April 1957. 227 p. (Supersedes C450.)

C580. Bibliography on ignition and spark-ignition systems..George F. Blackburn

Approximately 425 references to books, papers, and reports are listed, on ignition of combustible gaseous mixtures and ignition apparatus. The ignition of gases includes ignition by electric sparks and arcs and by hot surfaces. The references on ignition apparatus are for the most part on ignition systems and components for internal-combustion engines, with spark plugs listed separately from other components. November 1, 1956. 15 p.

C581. Metrology of gage blocks.

The papers presented at the Symposium on Gage Blocks held at the National Bureau of Standards on August 11 and 12, 1955, are given.

Three papers dealt with the metallurgical and physical properties of gage-block materials, with particular reference to dimensional stability. Another paper considered the characteristics of gage-block measuring surfaces, such as average roughness, depth of individual scratches, and condition of edges.

The present state of the art of applying light waves as standards of length is such that optical interference methods have attained supremacy in the accurate determination of length of contact length standards such as gage blocks. Accordingly, six papers dealt with the application of interferometric measurements and the precision and accuracy attained in recent comparative length measurements by different laboratories. Two other papers were on recent improved interferometer designs.

The four concluding papers and two formal discussions and an informal discussion period were concerned with the development of commercial and government standards and specifications for gage blocks. Consideration was given to procedures for the surveillance of gage blocks after they have been in use. April 1, 1957. 119 p.

C582. Worldwide occurrence of sporadic *E*.................E. K. Smith, Jr.

This study attempts to describe sporadic *E* on a worldwide basis utilizing observations at high frequencies (HF) with vertical-incidence ionosphere-sounding equipments (ionosondes) and at very high frequencies (VHF) of transmissions over oblique-incidence paths. An attempt is made to evaluate some of the consequences of this description in terms of possible energy sources of sporadic *E*.

Ionosonde data on sporadic *E* must be used with extreme care due to the fact that ionosondes are not calibrated for system gain and the sporadic-*E* critical frequency (*fE*s) is power sensitive. Particular attention is therefore paid to the errors that may be introduced.

Ionosonde results are analyzed for the occurrence of *fE*s greater than 5 Mc. The reasons for the choice of this limiting frequency are given in some detail. Three major zones are delineated on the basis of the temporal characteristics of the sporadic *E* in each. The Auroral Zone is separated from the Temperate Zone, for the purposes of this study, by the 15 percent auroral isochasm. A distinct Equatorial Zone is not observed on the nighttime side of the globe, but is recognized on the daytime side within the bounds of plus and minus 10° of magnetic dip angle. Within this Equatorial Zone the customary phenomena of the Temperate Zone are found plus an additional type of sporadic *E* unique to the Equatorial Zone. The *E*s characteristics of these zones are then examined geographically for six time blocks and also temporally at a series of individual locations through "time maps".

Treatment of the vertical-incidence data differs from that of previous studies chiefly in that the sunspot-cycle variation is here found to be a second-order effect compared to the other variations in the data and is consequently averaged out. An effective increase by a factor of five in the data sample is thereby obtained. A further difference in the treatment is that full geographical variation rather than variation of sporadic *E* with some latitude parameter is investigated. The VHF oblique-incidence data are treated in terms of transmission loss where possible. However, a study of some three thousand reports of television reception for which transmission loss could not be computed is also included.

New effects uncovered by this study are an outcome, first, of the parallel treatment of the vertical-incidence and the VHF oblique-incidence data and, second, of taking long-term averages of the vertical-incidence data. For example, the Temperate-Zone longitude effect was first suspected through intercomparison of VHF transmission-loss probabilities for United States and Japanese paths. Inspection of the vertical-incidence data covering seven years from the worldwide network of ionosondes confirms this effect in that a well-defined maximum in sporadic *E* is found to exist to the south of Japan. Similarly, in the investigation of correlation between magnetic activity and sporadic *E* a negative correlation is found in the Temperate Zone in vertical-incidence data. However, the effects of absorption could account for the observed correlation. In the VHF band the effects of absorption become unimportant and as the negative correlation is still observed it appears that this result is real.

The Phillips frequency-dependence rule is found to work quite well for occurrence of sporadic *E* on vertical-incidence sounders. An example is also given where this rule is found to apply, in a reinterpreted form, to oblique-incidence data.

The results of this study point towards a terrestrial energy source for Temperate-Zone sporadic *E* and an extraterrestrial one for sporadic *E* in the Auroral Zone. In the latter area it would appear that solar corpuscles are either directly responsible for much of the sporadic *E* or indirectly responsible through *E*-region currents. The Huancayo type of daytime sporadic *E* appears connected to the "equatorial electrojet". March 15, 1957. 278 p.

C583. X-ray attenuation coefficients from 10 kev to 100 Mev.
Gladys White Grodstein

A tabulation of attenuation coefficients of X-rays and gamma rays from 0.01 to 100 Mev for 29 materials is presented. A summary of information on the probability of the basic interaction processes of photons with matter and a detailed analysis of experimental and theoretical evidence are included. Present information on the basic processes is adequate for many applications; however, improved theory and additional experimental data are needed in certain areas. A comparison of calculated and experimental coefficients points up this need. April 30, 1957. 54 p.

HANDBOOKS

These are recommended codes of engineering and industrial practice, including safety codes, developed in cooperation with the national organizations and others concerned. In many cases the recommended requirements are given official status through their incorporation in local ordinances by State and municipal regulatory bodies.

H28. Supplement. 1950 Supplement to screw-thread standards for Federal services 1944.

The Supplement contains the Unified screw thread standards as agreed upon by standards organizations of Canada, The United Kingdom, and The United States. It also contains a revision of Section II of the 1944 Handbook covering nomenclature, definitions, and letter symbols; also a new section showing standards for cross recessed machine screws. Corrections and revisions of the several sections of H28 (1944) are also indicated. March 20, 1951. 113 p. (Supersedes the Supplement issued June 15, 1949.)

H28 (1957)—Part I. Screw-thread standards for Federal services, 1957. Amends in part H28 (1944) (and in part its 1950 Supplement)

Screw thread standards for the Federal services are formulated by the Interdepartmental Screw Thread Committee, comprising representatives of the Department of Defense, Army, Navy, Air Force, Department of Commerce, and industry liaison members. This volume constitutes Part I of a new revision of the Handbook issued in 1944 and the 1950 Supplement thereto. It includes standards for threads applicable to bolts, nuts, screws, and other mechanical components used for fastening purposes. (Supersedes sections I, II, III, IV, V, XV, and XVI and appendixes 1, 2, 6, and 8 of Handbook 28 (1944). Sections XI, XII, XIII, XIV, and XVII and appendix 7 of Handbook 28 (1944) are superseded by Federal Specifications listed in appendix 6.) September 10, 1957. 208 p.

H41. Medical X-ray protection up to two million volts.

The Handbook contains detailed recommendations for providing protection against X-rays produced up to 2 million volts. While directed primarily at medical installations, the same recommendations hold for most industrial installations. The handbook includes specific rules relating to fluoroscopic, radiographic, and dental X-ray installations. It also covers the use of mobile diagnostic equipment, photofluorographic equipment, and high-voltage therapeutic installations up to 2 million volts.

A section on electrical protection includes recommendations for the installation of high-voltage circuits, warnings, and procedures on expansion and maintenance.

Given in the appendix are the latest radiation attenuation curves for lead and concrete for radiations of all voltages up to 2 Mv for both. March 30, 1949. 43 p. (Supersedes H20 and superseded by H60.)

H42. Safe handling of radioactive isotopes.

The Handbook includes recommendations for the handling of radioactive isotopes in medical and industrial installations, but is not geared to the large-scale problems such as encountered in some AEC installations. The section on personnel covers the selection of workers and details on their training, operating instructions, and supervision. Details of laboratory design and equipment are discussed, including such things as the construction and ventilation of rooms and equipment so as to minimize the effects of accidental spills. There is also a discussion of the disposal of contaminated wastes.

Instrumentation problems in the radioactivity laboratory are also discussed.

Details are given for the monitoring of personnel, work areas, and laboratory equipment, with the idea of controlling radiation exposure either by external or internal means.

A section on the transportation of radioactive materials covers problems both in the laboratory and in shipment by public conveyance. Data on shielding by various protective agents are given, in addition with the Interstate Commerce Commission and Post Office Department regulations. September 1949. 30 p.

H43. Installation and maintenance of electric supply and communication lines (safety rules and discussion).

The Handbook contains definitions, grounding rules and Part 2 of the fifth edition of the National Electrical Safety Code dealing with the construction and maintenance of overhead and underground lines, originally published as Handbook H32, together with a discussion of the grounding rules and of Part 2 of the Code published as Handbook H39. The printing of this Handbook serves to combine in one binding the Code rules on lines with related engineering data and useful information. An index has been added to assist in locating rules and discussion thereof. August 15, 1949. 386 p.

H44. Specifications, tolerances, and regulations for commercial weighing and measuring devices.

The specifications, tolerances, and regulations published herein comprise all of the current codes as adopted by the National Conference on Weights and Measures, the latest action reported having been taken by the 1949 Conference. The material relates to: linear measures, fabric-measuring devices, cordage-measuring devices, taximeters, odometers, liquid measures, graduates, measure-containers, milk bottles, lubricating-oil bottles, liquid-measuring devices, grease-measuring devices, vehicle tanks, dry measure, berry baskets and boxes, scales, and weights. Correction sheets, relating deletions, amendments, and additions, are available from the National Bureau of Standards upon request and without charge soon after each National Conference. September 1, 1949. 144 p.

H44, 2d Ed., 1955. Specifications, tolerances, and regulations for commercial weighing and measuring devices.

The publication, except for the introduction and the appendix, reports the actions of the National Conference on Weights and Measures. It provides the States with a model regulation on the supervision and control of the devices involved in commercial weights and measures administration. The specifications, tolerances and regulations are developed by the Conference Committee on Specifications and Tolerances with technical advice and counsel from the National Bureau of Standards. July 15, 1955. 196 p. (A complete revision of H44, issued in 1949.)

H45. Testing of measuring equipment........................Ralph W. Smith

A manual for State and local weights and measures officials, and for industry, sales, and service personnel, describes various types of commercial measuring equipment, the principles of their operation, and methods for their inspection and text. May 15, 1951. 205 p.

H46. Code for protection against lightning.

Recommended practices for the lightning protection of persons, structures, and of buildings containing flammable liquids are given. The Code recognized aluminum as a suitable material for lightning protective systems. The extensive use of sheet aluminum for the exterior finish of buildings and the growing use of stranded aluminum cable for the transmission of electric power make the use of this material desirable for this purpose, both from the standpoint of availability and because when used with aluminum roofing and siding, it eliminates the junction of dissimilar metals in locations not normally accessible. Aluminum grounds are not permitted.

New rules on grain elevators and on vents and stacks emitting explosive dusts, vapors or gases are included. These rules are intended to eliminate or reduce the possibility of ignition of such dusts, gases or vapors by lightning.

As a result of experience obtained in the field, additional bonding requirements have been added for steel tanks containing flammable liquids and gases.

The Handbook is a revision of the 1950 edition. The project was carried out by the Committee on Protection Against Lightning, under the joint sponsorship of the American Institute of Electrical Engineers, National Fire Protection Association, and the National Bureau of Standards, and approved by the American Standards Association. December 10, 1952. 88 p. (Supersedes H40.)

H47. Recommendations of the International Commission on Radiological Protection of the International Commission on Radiological Units—1950.

The Handbook gives the detailed recommendations of the International Commission on Radiological Protection and of the International Commission on

Radiological Units, as agreed upon at the Sixth International Congress of Radiology held in 1950.

It is of particular note that the permissible radiation exposure level has been reduced by a factor of about 2 from the value used prior to 1950. At the same time, an increase in the permissible exposure to the hands is now allowed. Detailed recommendations regarding radium and X-ray protection were carried over from the 1937 report with little change, although it is recognized that some of these are now obsolescent in view of recent progress. A supplement gives the maximum permissible amounts of radioactive isotopes that may be fixed in the body or contained in air or water taken into the body. These permissible amounts were agreed upon on a tentative basis and are subject to future revision.

The recommendations of the International Commission on Radiological Units give the newly adapted energy unit for expressing radiation dosage above 3 Mev. The roentgen will continue to be used for radiations below 3 Mev. June 29, 1951. 29 p. (Superseded by H62.)

H48. Control and removal of radioactive contamination in laboratories.

The Handbook gives detailed information on laboratory procedures designed to minimize the possibility of any accident involving radioactivity and to minimize the effects if such accidents do occur.

In addition to including a number of general safety precautions, the handbook contains specific recommendations and discussions intended primarily for the guidance of such users of radiactive isotopes as universities, hospitals, and industrial concerns. Wherever practical, recommendations are presented separately for different groups of isotopes. December 15, 1951. 24 p.

H49. Recommendations for waste disposal of phosphorus-32 and iodine-131 for medical users.

The Handbook deals primarily with the problem of the disposal of wastes of radioactive phosphorus and radioactive iodine from hospitals located in metropolitan areas. In the expectation that disposal of the greater part of these wastes will be by sewer, the Handbook considers permissible concentrations from the point of view of safety to the general community and more especially to sanitation workers and sewage plant personnel. Detailed recommendations are given regarding disposal of various amounts. One of the principal conclusions is that there is virtually no likelihood of any serious radiation-exposure problems developing in connection with the disposal of radioactive iodine and phosphorus from metropolitan hospitals under any foreseeable conditions. November 2, 1951. 11 p.

H50. X-ray protection design....Harold O. Wyckoff and Lauriston S. Taylor

The Handbook contains primarily factual data and basic principles necessary for designing shielded X-ray installations. It is based on the recommendations of the National Committee on Radiation Protection. Architects and designers of buildings and rooms in which X-rays will be used for fluoroscopy, radiography, or therapy can derive much helpful information from the discussion in the Handbook of these recommendations and from its sample design problems and methods of computing barriers for real installations.

In discussing typical cases, the Handbook gives a variety of examples to illustrate the application of the fundamental principles and recommendations. It carries out detailed calculations showing how to arrive at the optimum conditions providing sufficient protection for safe operation with the most economical form of radiation shielding. May 9, 1952. 36 p.

H51. Radiological monitoring methods and instruments.

Representing the best current knowledge of the subject, this report establishes some basic guides for methods of determining radiation hazards and of selecting suitable instruments for measuring them.

The Handbook explains different types of radiation detectors, measuring instruments, and personnel monitoring instruments; and it discusses instrument construction standards and characteristics required for the diverse purposes.

General information is also given on hazard determination and control, airborne hazards, surface contamination, personnel monitoring radiation-survey methods for radioactive-isotope monitoring and in medical and industrial installations, air and water sampling equipment and methods, and counting of alpha and beta particles. April 7, 1952. 33 p.

H52. Maximum permissible amounts of radioisotopes in the human body and maximum permissible concentrations in air and water.

This first official published report of the Subcommittee on Permissible Internal Dose of the National Committee on Radiation Protection gives the most acceptable values of maximum permissible amounts of the various radioisotopes in the human body and of the maximum permissible concentrations of these radioisotopes in air and water. The report considers about 70 radioisotopes that are of present-day interest. The report discusses in detail the methods of estimating maximum permissible amounts and concentrations, factors that determine the hazards of radioisotopes, and recommendations for avoiding or minimizing the hazards. March 20, 1953. 45 p.

H53. Recommendations for the disposal of carbon-14 wastes.

With the increasing use of radioactive isotopes in industry, the medical profession, and research laboratories, it is essential that certain minimal precautions be taken to protect the users and the public. This report presents technical practical information for this purpose. Recommendations for the disposal of carbon-14 wastes is one of a series of reports of the National Committee on Radiation Protection. The Handbook was prepared by the Subcommittee on Waste Disposal and Decontamination. October 26, 1953. 14 p.

H54. Protection against radiations from radium, cobalt-60, and cesium-137.

Advances in the field of radioactivity have made necessary a revision of Handbook 23. The enlarged scope of this new Handbook deals with protection against radium, cobalt-60, and cesium-137. However, the general principles outlined for these sources will also be applicable to other gamma emitters as they become available and attenuation data are obtained for them. No specific references are made to industrial applications, as these are to be treated in a separate code. However, the basic principles and the attenuation data of the Handbook are applicable to both medical and industrial uses. The Handbook was prepared by the National Committee on Radiation Protection. September 1, 1954. 60 p. (Supersedes H23.)

H55. Protection against betatron-synchrotron radiations up to 100 million electron volts.

National-Committee-on-Radiation-Protection recommendations, published as NBS Handbooks, serve as guides for protection against the general hazards of radiation sources. The Handbook attempts to supply these recommendations as they apply to high-energy electron accelerators of the betatron and synchrotron types. The protection requirements for operating personnel, hospital patients, and the public against the potential hazards of the accelerators are outlined. The hazards resulting from the various radiations produced by the sources are included, as well as those due to certain associated effects, such as noise, electricity, and ozone production. Recommendations are also given on a consistent system of units and of measurement procedures that can be applied to radiations with energies above 5 Mev. February 26, 1954. 52 p.

H56. Safe handling of cadavers containing radioactive isotopes.

Pertinent information is provided for the guidance of mortuary and medical personnel involved in the handling and autopsy of cadavers containing radioactive materials. The Handbook discusses general considerations in dealing with cadavers containing radioactive isotopes, an analysis of extreme cases, accident or injury during autopsy, contaminated clothing or instruments, and cremation, and provides an acceptable form for a radioactivity report accompanying the body. The Handbook was prepared by an ad hoc subcommittee of the National Committee on Radiation Protection. October 26, 1953. 15 p.

H57. Photographic dosimetry of X- and gamma rays........Margarete Ehrlich

The Handbook contains primary factual data and basic principles necessary for photographic dosimetry of X- and gamma rays. It was prepared in response to an urgent need for more complete information on this topic. The data presented are the results of an extensive program in this field conducted over a number of years by the NBS Radiation Physics Laboratory.

Most of the information presented is concerned with the use of commercial photographic film for X- and gamma-ray dosimetry. Emphasis is placed on those properties of photographic emulsions that are basic to radiation dosimetry. Likewise, attention is called to limitations inherent in the methods and materials and to precautions that should be observed. Because considerable flexibility in techniques and procedures of film dosimetry is possible without appreciable effect on the end result, no attempt is made to specify all of the details uniquely. August 20, 1954. 20 p.

H58. Radioactive-waste disposal in the ocean.

The ever-increasing production and use of radioactive isotopes has raised numerous questions concerning their handling, transportation, and ultimate disposal. It appears that the sea may be an appropriate place for the disposal of intermediate and large amounts of isotopes having long half-lives (more than 1 year) or high radiotoxicity. It is the purpose of the Handbook to bring to the attention of those concerned, the many different factors that should be taken into account when radioactive wastes are to be dumped into the ocean, and to make recommendations for the proper use of this disposal method. The Handbook was prepared by the Subcommittee on Waste Disposal and Decontamination of the National Committee on Radiation Protection. August 25, 1954. 31 p.

H59. Permissible dose from external sources of ionizing radiation.

The recommendations and discussions of permissible dose contained in the Handbook form the basis of all other recommendations of the National Committee on Radiation Protection; including permissible doses for radioactive material within the body, safe handling of radioactive materials, waste disposal, etc. Although the formal preparation of this report has been delayed, the substance of the recommendations of the Subcommittee on Permissible Dose from External Sources has been well known and in use for a number of years.

The Handbook presents discussions of the basic concepts of permissible dose and discussions of each of the many factors considered in the formulation of the recommendations. For easy reference the exposure limits of parts of the body to various types of ionizing radiation are briefly stated in the section "Protection Rules."

This report was used as a basis for the discussion at the meeting of the International Commission on Radiological Protection in Copenhagen in 1953. The general principles developed by the subcommittee were included in the most recent international recommendations. September 24, 1954. 79 p.

H60. X-ray protection.

The increasing use of high-energy X-rays in medical diagnosis and treatment and in industry has presented problems in all phases of radiation protection and shielding. The Handbook recommends standards of safety set forth by the National Committee on Radiation Protection and is intended primarily for the protection of the radiation worker and the public.

Included in the Handbook are specific rules for medical fluoroscopic, medical radiographic, dental radiographic and therapeutic X-ray installations, and for the use of fluorographic and mobile medical diagnostic equipment.

Tables are included for each application giving protection requirements for lead and concrete.

Given in the appendix are computations for the determination of protective barriers, and the latest radiation attenuation curves for lead and concrete. December 1, 1955. 41 p. (Supersedes H41.)

H61. The regulation of radiation exposure by legislative means.

The Handbook presents the problem of radiation in relation to its possible control by State or municipal authorities. The problem is a very new one to all except a few States; however, with the accelerating growth of radiation uses, State control may become a necessity.

The National Committee on Radiation Protection has studied the problem, and consulted with a great many authorities, both technical and legal. This report contains its recommendations, offered as a guide for States planning to develop radiation-control legislation.

The report discusses the general problem of developing legislation for the control of radiation exposure, and the various problems that must be considered by a State in the development of such legislation. Because of the procedural difficulties involved in changing statutes, it is recommended that they be made as simple as possible; and that regulations be developed, which can be amended administratively, to implement the statutes. The Handbook contains a suggested State radiation-protection act and suggested regulations. December 9, 1955. 60 p.

H62. Report of the International Commission on Radiological Units and Measurements (ICRU), 1956.

This report of the ICRU supersedes the material previously published in National Bureau of Standards Handbook 47, and was prepared as a result of the Commission's meetings in Geneva in April 1956. In addition to new recommendations regarding radiological units, the report includes an extensive description of the physical background and factors that enter into the problems of the measurement of absorbed dose of all kinds of radiation. It also includes reports of two Subcommittees of the ICRU; namely, Subcommittee on X-ray Standards and Subcommittee on Standards of Radioactivity. Five members of NBS are presently members of the ICRU or its Committees, and this report was prepared in the main through the efforts of four of the Bureau's staff members. April 10, 1957. 48 p. (Supersedes H47.)

MISCELLANEOUS PUBLICATIONS

As the name implies, this series includes material, which, because of its character or because of its size, does not fit into any of the other regular publication series. Some of these are charts, administrative pamphlets, Annual Reports, Weights and Measures Conference Reports, and other subjects appropriate to the Miscellaneous series.

M188. Microbiological deterioration of organic materials: Its prevention and methods of test....................................Edward Abrams

A detailed review is presented of the literature on the microbiological deterioration of organic and fibrous materials. Also, representative problems incidental to the development of test methods for the evaluation of mildew resistance and the development of mildew resistant materials are given. The most widely recognized test methods for the evaluation of mildew-resistance and rot-resistance are listed. A wide variety of fungicides for different uses is classified according to effectiveness. Plastics and plasticizers and related materials are rated according to their susceptibility to support mold growth. November 1, 1948. 41 p.

M189. Report of the thirty-third National Conference on Weights and Measures.

A report of the proceedings of the thirty-third National Conference on Weights and Measures, held in Washington, D. C., September 22, 23, 24, and 25, 1947, and attended by State, county, and city weights and measures officials. 184 p.

M190. Standard time zones of the United States.

The time-zone boundaries in the United States and the adjacent parts of Canada and Mexico are shown. It is a revision of M155 and shows the latest changes in the boundaries. January 1, 1948. 1 p. (Supersedes M155.)

M191. Charts of compressibility factors and charts showing quantities delivered by commercial cylinders, for hydrogen, nitrogen, and oxygen. .Harold J. Hoge, Cyril H. Meyers, Robert E. McCoskey

For each of the gases hydrogen, nitrogen, and oxygen, two charts are given. The first gives directly the number of standard cubic feet of the gas which a cylinder will deliver. The second chart gives values of the compressibility factor $Z=PV/nRT$ and of the density ρ. Examples of the use of the charts are given, also numerical values of constants used in the preparation of the charts or needed in the solution of problems. November 17, 1948. 4 p. 3 charts.

M192. New advances in printed circuits.

A report of the proceedings of the First Technical Symposium on Printed Circuits. The symposium was sponsored by the Electronic Components Subcommittee of the Aircraft Radio and Electronics Committee of the Aeronautical Board with the cooperation and under the technical direction of the National Bureau of Standards. The meeting was held in the Department of Interior Auditorium, Washington, D. C., on October 15, 1947. Twenty speakers and an audience of over 700 persons reviewed the many methods of printing circuits. New techniques were described in detail, many examples of new approaches to the method of printing circuits were demonstrated, and a number of samples were exhibited by manufacturers. November 22, 1948. 73 p.

M193. Laboratory and service tests of hand luggage......Edward T. Steiner, Robert B. Hobbs, and Elizabeth R. Hosterman

Test methods for hand luggage are suggested as suitable for inclusion in a commercial standard for this commodity. The methods are based on laboratory and service tests of hand luggage, which are reported in detail. The materials and types of bags studied were chosen in accordance with the results of surveys in rail and bus baggage rooms. The results of the surveys, showing the types and materials of construction occurring most frequently, the general condition of luggage, and the loaded weights of bags in service, are presented. The relationship of properties of luggage to the kind and extent of damage occurring in service is discussed.

The three test methods recommended are: A static load test, a handle fatigue test, and a repeated drop test. Minimum performance requirements for these tests are suggested. The results obtained from these methods correlated well with the behavior of replicate pieces of luggage in service. Two other methods, a puncture test and the hexagonal revolving drum test, showed promise, but are not recommended at this time, because the results are insufficient to justify the high cost of the apparatus. July 1, 1949. 20 p.

M194. Research and development in applied optics and optical glass at the National Bureau of Standards. A review and bibliography
Irvine C. Gardner and C. H. Hahner

A general account of the research and development work in technological optics that has been completed at the National Bureau of Standards. Noteworthy accomplishments that are mentioned include the production of a 70-inch optical disk (at the time of manufacture the largest produced in this country) for Ohio Wesleyan University; a comprehensive study of the relation between chemical composition and index of refraction of optical glass; a study of the relation between annealing temperature and index; the design and construction of an *f*/6.3 airplane camera lens of 50-inch focal length which resolves railroad ties and shows individuals from a height of nearly two miles; the design and construction of large interferometers; the construction of a special laboratory for testing range finders and similar tasks. A list of 195 Bureau publications pertaining to optical glass and optical instruments is included. July 15, 1949. 20 p.

M195. Report of the thirty-fourth National Conference on Weights and Measures.

A report of the proceedings of the thirty-fourth National Conference on Weights and Measures, held in Washington, D. C., May 24, 25, 26, and 27, 1949, and attended by State, county, and city weights and measures officials. 169 p.

M196. Nomograms for obtaining the compound composition of hydrated limes from the oxide analysis.

Two nomograms are presented for rapidly obtaining the compound composition of hydrated limes from the oxide analysis. The general nomogram can be applied to any commercial hydrated lime, and gives values accurate to within 0.3 percent. The special nomogram is applicable only to regularly hydrated and highly hydrated dolomitic limes and is accurate to within 0.1 percent. The equations for calculating the compound composition are derived, and the significance of the unhydrated oxide content is stressed. December 30, 1949. 5 p. 1 sheet of two charts.

M197. Fire tests of bulb-type carbon-tetrachloride fire extinguishers..O. J. Hodge

Results are given of fire tests on samples of seven different bulb-type carbon-tetrachloride fire extinguishers ranging in capacity from 0.44 to 1.75 quarts. Six of the extinguishers were tested both for manual and automatic operation. The seventh device was tested for automatic operation only, since it was not designed for manual use.

The tests of the devices as automatic extinguishers were conducted in a room with ventilation just sufficient to permit the test fires to burn freely until the fuel was consumed, with no extinguishers present.

The test results showed that the bulb-type carbon-tetrachloride fire extinguishers, as represented by the samples tried, when operated by hand were distinctly less effective than the ordinary one-quart carbon-tetrachloride pump-gun extinguisher, and when employed as automatic devices were not effective for the protection of the enclosed space. The seven devices were tested in the number recommended by the manufacturer and six of them were also tried in double that number. May 8, 1951. 8 p.

M198. Annual report 1949 National Bureau of Standards.

This is a summarized illustrated report of the research and development activities of the Bureau in the fields of physics, chemistry, engineering, and mathematics, during the fiscal year ending June 30, 1949. Brief accounts are included relating to projects completed by or in progress in the Bureau's scientific and technical divisions, including electricity and optics, metrology, heat, atomic and radiation physics, chemistry, mechanics, organic and fibrous materials, metallurgy, mineral products, building technology, applied mathematics, commodity standards, electronics and ordnance, and radio propagation.

A statment of the Bureau's testing, calibration, and Standard Samples activities by divisions is also included, as well as a review of its technical services and cooperation, both national and international. 98 p.

M199. Report of the thirty-fifth National Conference on Weights and Measures.

A report of the proceedings of the thirty-fifth National Conference on Weights and Measures, held in Washington, D. C., May 23, 24, 25, and 26, 1950, and attended by state, county, and city weights and measures officials. 170 p.

M200. Annual report 1950 National Bureau of Standards.

This is a summarized illustrated report of the research and development activities of the Bureau in the fields of physics, chemistry, engineering, and mathematics, during the fiscal year ending June 30, 1950. Brief accounts are included relating to projects completed by or in progress in the Bureau's scientific and technical divisions, including electricity, optics and metrology, heat and power, atomic and radiation physics, chemistry, mechanics, organic and fibrous materials, metallurgy, mineral products, building technology, applied mathematics, electronics, ordnance development, and radio propagation.

A statement of the Bureau's testing, calibration, and Standard Samples activities by Divisions is also included, as well as a review of its technical services and cooperation, both national and international. 110 p.

M201. Hydraulic research in the United States.......... Helen K. Middleton and Sonya W. Matchett

Research and development projects being conducted in 1951 in hydraulic and hydrologic laboratories of universities and federal agencies throughout the United States and Canada are briefly described. For each project is given the name and address of the person to whom inquiries for further information should be addressed. Recent publications relating to projects are included. Translation of foreign articles and foreign publications available on loan are given in a separate section. Important committees relating to hydraulics are also listed. There is a list of contributing laboratories with addresses, and a subject index. August 20, 1951. 190 p.

M202. Report of the thirty-sixth National Conference on Weights and Measures.

A report of the proceedings of the thirty-sixth National Conference on Weights and Measures, held in Washington, D. C., May 22, 23, 24, and 25, 1951, and attended by state, county, and city weights and measures officials. 115 p.

M203. Index to the reports of the National Conference on Weights and Measures. From the first to the thirty-sixth—1905 to 1951... William S. Bussey and Malcom W. Jensen

This publication comprises a detailed index to the Reports of the National Conference on Weights and Measures, from the first through the thirty-sixth (1905 to 1951). The document actually embodies two indexes, one for locating readily all material on any specific subject and the other for locating all material presented by any particular speaker. The subject index is carefully cross-indexed, to enable those using it to locate the desired information under principal or associated words. The indexed Reports are the main and most complete sources of information on the broad subject of commercial weights and measures.. April 21, 1952. (Supersedes M172.) 45 p.

M204. Annual report 1951 National Bureau of Standards.

This is a summarized illustrated report of the research and development activities of the Bureau in the fields of physics, chemistry, engineering, and mathematics, during the fiscal year ending June 30, 1951. Brief accounts are included relating to projects completed by or in progress in the Bureau's scientific and technical divisions, including electricity, optics and metrology, heat and power, atomic and radiation physics, chemistry, mechanics, organic and fibrous materials, metallurgy, mineral products, building technology, applied mathematics, electronics, ordnance development, and radio propagation.

A statement of the Bureau's testing, calibration, and Standard Samples activities by Divisions is also included, as well as a review of its technical services and cooperation, both national and international. 105 p.

M205. Hydraulic research in the United States, 1952---Helen K. Middleton and Sonya W. Matchett

Research and development projects being conducted in 1952 in hydraulic and hydrologic laboratories of universities and Federal agencies throughout the United States and Canada are briefly described. A list of the contributing laboratories is given. The status of continuing projects covered by previous issues of the publication is reported upon, as well as on new projects in progress, the results of completed work are given. References to publications relating to the projects and an extensive subject index are included. September 4, 1952. 200 p.

M206. Report of the thirty-seventh National Conference on Weights and Measures.

A report of the proceedings of the thirty-seventh National Conference on Weights and Measures, held in Washington, D. C., May 20, 21, 22, and 23, 1952, and attended by state, county, and city weights and measures officials. 105 p.

M207. Annual report 1952 National Bureau of Standards.

A summarized illustrated report of the research and development activities of the Bureau in the fields of physics, chemistry, engineering, and mathematics, during the fiscal year ending June 30, 1952. Brief accounts are included relating to projects completed by or in progress in the Bureau's scientific and technical divisions, including electricity, optics and metrology, heat and power, atomic and radiation physics, chemistry, mechanics, organic and fibrous materials, metallurgy, mineral products, building technology, applied mathematics, electronics, ordnance development, and radio propagation.

A statement of the Bureau's testing, calibration, and Standard Samples activities by Divisions is also included, as well as a review of its technical services and cooperation, both national and international. 89 p.

M208. Hydraulic research in the United States, 1953..Helen K. Middleton and Sonya W. Matchett

Research and development projects being conducted in 1953 in hydraulic and hydrologic laboratories of universities and Federal agencies throughout the United States and Canada are briefly described. A list of the contributing laboratories is given. The status of continuing projects covered by previous issues of the publication is reported upon, as well as on new projects in progress, the results of completed work are given. References to publications relating to the projects and an extensive subject index are included. July 31, 1953. 203 p.

M209. Report of the thirty-eighth National Conference on Weights and Measures.

A report of the proceedings of the thirty-eighth National Conference on Weights and Measures, held in Washington, D. C., May 19, 20, 21, and 22, 1953, and attended by state, county, and city weights and measures officials. 116 p.

M210. Hydraulic research in the United States, 1954....... Helen K. Middleton

Research and development projects being conducted in 1954 in hydraulic and hydrologic laboratories of universities and Federal agencies throughout the United States and Canada are briefly described. A list of the contributing laboratories is given. The status of continuing projects covered by previous issues of the publication is reported upon, as well as on new projects in progress, the results of completed work are given. References to publications relating to the projects and an extensive subject index are included. June 2, 1954. 193 p.

M211. American standard building code requirements for masonry.

This standard is a revision of an earlier edition (1944), and has been approved by the American Standards Association as American Standard Building Code Requirements for Masonry, A41.1–1953. It is a complete code of minimum requirements for masonry construction including definitions, requirements for materials, allowable stresses, and general requirements for all types of masonry except reinforced masonry and thin veneers. This document, prepared by American Standards Association Sectional Committee A41 under the sponsorship of the National Bureau of Standards, is one of a series of building code standards prepared by various committees under the jurisdiction of the Construction Standards Board of the American Standards Association. The basis of the requirements of this standard, together with examples of good practice, is discussed in an appendix. July 15, 1954. 39 p. (Supersedes M174.)

M212. Report of the 39th National Conference on Weights and Measures, 1954.

A report of the proceedings of the thirty-ninth National Conference on Weights and Measures, held in Washington, D. C., May 17, 18, 19, 20, 21, 1954, and attended by state, county, and city weights and measures officials. October 21, 1954. 108 p.

M213. Biennial report 1953 and 1954 National Bureau of Standards.

Reviews the research and development activities of the Bureau during the 2 years July 1, 1952, to June 30, 1954. The Report consists of five sections: (1) A general review, (2) a resume of the Bureau's research and development achievements, (3) a review of the testing and calibration program, (4) a discussion of the Bureau's various cooperative activities, (5) appendix material consisting primarily of statistical and organizational material. The recommendations of the ad hoc committee appointed by the Secretary of Commerce to evaluate the functions and operation of the Bureau in relation to national needs are given. Additional tabular material relating to NBS organization, advisory committees, awards and honors to NBS staff, and a list of Bureau publications issued during the 2-year period are included. The agreement between the Bureau and the General Services Administration relating to specifications and testing is printed in full. 162 p.

M214. Units of weight and measure (United States Customary and Metric) Definitions and tables of equivalents.................... L. V. Judson

The units of length, area, volume, capacity, and mass in use in the United States are defined. Tables of interrelation and tables of equivalents for these units in the metric system and in the U. S. customary system are given. Such tables are needed in scientific, industrial, commercial, and other fields, and have been published by the United States Government for many years.

There is a section in which the fundamental equivalents are stated, one containing the approved spelling and abbreviation of each of the most common units of weight and measure, and one showing the status of the metric system in the United States. All of the tables and other material have been revised to conform to the definitions, equivalents, and usages current at the date of issue. The conversion tables are confined to simple units, excluding all compound units such as foot-pounds, pounds per cubic foot, and feet per second. July 1, 1955. 64 p.

M215. Hydraulic research in the United States, 1955....... Helen K. Middleton

Research and development projects being conducted during 1955 in 185 hydraulic and hydrologic laboratories of universities, Federal and State agencies, and private organizations throughout the United States and Canada are described. A list of the contributing laboratories is given. The status of continuing projects covered by previous issues of the publication is reported upon, as well as on new projects in progress, the results of completed work are given. References to publications relating to the projects and an extensive subject index are included. July 1, 1955. 198 p.

M216. Report of the 40th National Conference on Weights and Measures 1955.

A report of the proceedings of the fortieth National Conference on Weights and Measures, held in Washington, D. C., May 16, 17, 18, 19, and 20, 1955, and attended by state, county, and city weights and measures officials. 143 p.

M217. Annual report 1955 National Bureau of Standards.

This is a summarized illustrated report of the research and development activities of the Bureau in the fields of physics, chemistry, engineering, and mathematics, during the fiscal year ending June 30, 1955. Brief accounts are included relating to projects completed by or in progress in the Bureau's scientific and technical divisions, including electricity and electronics, optics and metrology, heat and power, atomic and radiation physics, chemistry, mechanics, organic and fibrous materials, metallurgy, mineral products, building technology, applied mathematics, data processing systems, cryogenic engineering, radio propagation physics, radio propagation engineering, radio standards, and basic instrumentation.

A statement of the Bureau's testing, calibration, and Standard Samples activities by Divisions is also included, as well as a review of its technical services and cooperation, both national and international. 175 p.

M218. Hydraulic research in the United States, 1956......Helen K. Middleton

Research and development projects being conducted in 1956 in hydraulic and hydrologic laboratories of universities and Federal agencies throughout the United States and Canada are briefly described. A list of the contributing laboratories is given. The status of continuing projects covered by previous issues of the publication is reported upon, as well as on new projects in progress, the results of completed work are given. References to publications relating to the projects and an extensive subject index are included. June 7, 1956. 216 p.

M219. Report of the 41st National Conference on Weights and Measures 1956.

A report of the proceedings of the forty-first National Conference on Weights and Measures, held in Washington, D. C., May 21, 22, 23, 24, and 25, 1956, and attended by state, county, and city weights and measures officials. 190 p.

M220. Annual report 1956 National Bureau of Standards.

This is a summarized illustrated report of the research and development activities of the Bureau in the fields of physics, chemistry, engineering, and mathematics, during the fiscal year ending June 30, 1956. Brief accounts are included relating to projects completed by or in progress in the Bureau's scientific and technical divisions, including electricity and electronics, optics and metrology, heat and power, atomic and radiation physics, chemistry, mechanics, organic and fibrous materials, metallurgy, mineral products, building technology, applied mathematics, data processing systems, cryogenic engineering, radio propagation physics, radio propagation engineering, radio standards, and basic instrumentation.

A statement of the Bureau's testing, calibration, and Standard Samples activities by Divisions is also included, as well as a review of its technical services and cooperation, both national and international. 158 p.

BUILDING MATERIALS AND STRUCTURES REPORTS

This series reports the results of work at the National Bureau of Standards in the field of building research. The objective is to provide the government, the interested professions, and the building industry with technical data useful in the preparation of building codes, standards, and engineering design criteria. The subjects of primary interest are the properties of building materials, structures, equipment, and facilities.

BMS111. Performance of a coal-fired boiler converted to oil....Richard S. Dill and Paul R. Achenbach

As part of the research program on heating plants for small homes being conducted at the National Bureau of Standards in collaboration with the National Housing Agency and its technical staff, the performance characteristics of cast-iron boilers, both coal- and oil-fired, have been investigated. This report discusses the performance of a cast-iron boiler designed for coal firing after it had been converted to the use of oil by means of a gun-type burner. It is shown that a refractory firebox of low heat capacity and low thermal conductivity increased the efficiency of the converted boiler several percent, and that baffles which effectively direct the hot combustion gases over the heat-transfer surface increased the capacity of the boiler up to 27 percent. May 20, 1948. 11 p.

BMS112. Properties of some lightweight-aggregate concretes with and without an air-entraining admixture....................Perry H. Petersen

The physical properties of several lightweight-aggregate portland cement concretes made with burned shale or expanded slag were investigated at the National Bureau of Standards. Three grades of concrete using each aggregate were made. Air-entrainment of greater than 20 percent is reported for the mixtures leanest in cement, an air-entraining admixture being used to increase the workability of all but the richest concretes. Compressive, transverse, and bond strengths are given as well as resistance to heat transfer, rain penetration, and water penetration by capillarity. Also included are the coefficients of thermal expansion, shrinkage, and values for change in length due to wetting and drying. August 16, 1948. 7 p.

BMS113. Fire resistance of structural clay tile partitions......Harry D. Foster, Earl R. Pinkston, and S. H. Ingberg

The results of fire-endurance or hose-stream tests of 20 structural clay tile partitions tested at the National Bureau of Standards are given. The partitions were 3, 4, and 6 in. thick, exclusive of the plaster. Some of the partitions were built of tile laid on end; some, with the tile laid on side; and some, with the tile laid alternately on side and on end.

The fire-endurance and the hose-stream tests in this series were made on the same partitions. The hose-stream tests indicated that tile partitions can be considered as meeting the hose-stream requirements applicable to their respective fire-resistance ratings. October 29, 1948. 19 p.

BMS114. Temperatures in a test bungalow with some radiant and jacketed space heaters....................................Paul R. Achenbach

The temperature distribution produced in a four-room test bungalow on the grounds of the National Bureau of Standards was observed for three space heaters with and without jackets. Tests were made to show the effect of heater location, of size and type of jacket, of open transoms over interior doorways, of an unattached fan for air circulation, and of an underfloor plenum on the temperatures in the four-room house. The temperature patterns obtained were used as a basis for conclusions concerning the severity of the climate and the size of houses of similar materials and insulation for which space heaters could provide minimum acceptable comfort. The temperature distributions for two commercial models of space heaters burning gas and oil were also included for comparison. January 28, 1949. 44 p.

BMS115. A study of a baseboard convector heating system in a test bungalow Paul R. Achenbach and Edward M. Tierney

The temperature distribution produced by a baseboard convector heating system was observed in a 4-room Tets Bungalow on the gounds of the National Bureau of Standards. The distribution system consisted of finned sections of iron pipe placed beneath the windows, standard iron pipe connecting the finned elements in a continuous loop around the house at the baseboard level, and a hot-water boiler located on the first floor. The vertical temperature differences, room-to-room temperature differences, heat loss of the house, and the heat emission per unit length of finned pipe were observed for a range of outside air temperatures. In addition, the control of room temperature provided by an electric room thermostat and by an outdoor-thermostat control and modulating water-flow valve were compared for steady outside air temperatures. The characteristics of the outdoor-thermostat control and modulating water-flow valve were also studied for transient outside air temperatures and under pick-up conditions indoors. August 1, 1949. 20 p.

BMS116. Preparation and revision of building codes......George N. Thompson

Building construction has been subjected for many years to legal control in the interest of safety and health. While there is general agreement on the need for this, specific applications in the form of building codes have been frequently criticized on the grounds of imposing excessive expense and of failing to make adjustments to changing conditions.

The responsibility for preparing or revising building codes usually falls upon local committees. These are called upon to do a great deal of tedious and exacting work. One of their first problems is to determine what source material is available and how they should proceed.

In this discussion, a description is given of how such work is done and useful sources of technical information are indicated. Some of the problems that are encountered by local committees are mentioned, including what basic principles are involved; methods of presentation, arrangement, and numbering; advantages of using national standards and ways of referring to them; methods of recognizing new materials and new methods of construction; extent of delegation of authority to the building official and safeguards against arbitrary action; and other questions of major importance.

An attempt has been made to place committees in possession of sufficient information to proceed in their work with a minimum of lost motion. Not all questions can be answered with finality, since the situation is complicated by the existence of proposals of nearly equal merit and by differing judicial decisions. Such differences will no doubt continue to exist for some time; but they are not of sufficient importance to be allowed to obscure the main objective of providing adequate protection without creating too much of a drag on the building industry. Constructive work in the field of building-code requirements has been going on continuously for some time and will exert an ever-increasing influence. This discussion is offered to supplement such work and as a contribution to the orderly development of good requirements. September 1, 1949. 17 p. (Supersedes BMS19.)

BMS117. Fire resistance of walls of lightweight-aggregate concrete masonry units........Harry D. Foster, Earl R. Pinkston, and S. H. Ingberg

The results of fire-endurance and hose-stream tests of 16 walls of lightweight-aggregate concrete masonry units are given. The aggregates used in the manufacture of the units were cinders, expanded shale, pumice, or expanded slag. The constructions ranged from 3-in. nonload-bearing partitions to 10-in. load-bearing walls with no framed-in members and included brick-faced exterior bearing walls.

The fire-resistance values indicated by the tests varied with the thickness of the wall, the moisture content at the time of the test, and the kind of aggregate used in the units and ranged from 1 hr 9 min for a 4-in. unplastered partition to 7 hr 3 min for an 8-in. bearing wall faced with brick and backed with 4-in. lightweight-concrete units.

Hose-stream tests conducted at the end of the fire-endurance tests indicated that walls of lightweight-aggregate concrete masonry units met the requirements of this test for their respective fire-resistance values. May 1, 1950. 23 p.

BMS118. Stack venting of plumbing fixtures..................John L. French

This report describes the methods used and the results obtained in an investigation of the adequacy of stack venting a group of plumbing fixtures on the top floor of a building. Trap-seal losses of stack-vented fixtures in an experimental installation are reported, a test loading having a reasonable probability of occurrence is developed, and a criterion of satisfactory trap-seal loss is proposed. The experimental results are interpreted in the light of the adopted test loading and the adopted permissible trap-seal loss. And, finally, conclusions in a form suitable for the use of code-writing authorities are made. January 23, 1950. 21 p.

BMS119. Wet venting of plumbing fixtures..John L. French, Herbert N. Eaton, and Robert S. Wyly

This report gives the results of laboratory tests of various wet-vented single and two-story plumbing drainage systems. A suggested test or design loading for such systems is developed, and a permissible trap-seal loss for the fixture of wet-vented systems is proposed. Conclusions regarding the limits under which wet-vented fixtures located on the upper floor of a system will operate satisfactorily are given in a form sufficiently simple for inclusion in plumbing codes. December 1, 1950. 27 p.

BMS120. Fire resistance of walls of gravel-aggregate concrete masonry units
Harry D. Foster, Earl R. Pinkston, and S. H. Ingberg

Fire-endurance test results for 12 walls of gravel-aggregate concrete masonry units are given and hose-stream test results for three of the walls. The concrete units used in five of the walls were made with calcareous aggregates representing the group of natural aggregates less susceptible to damage by fire. The units used in the other seven walls were made with siliceous aggregates representing the group more susceptible to fire damage. The constructions included 4-in. nonload-bearing partitions and 8- to 12-in. load-bearing walls. The fire resistance of the 4-in. unplastered partition of units made with calcareous aggregates and of the 4- and 8-in. walls of units made with siliceous aggregates were limited to 1 hr or less either by collapse or load failure. The values for the 4-in. plastered partition and the 8-in. load-bearing walls made with calcareous aggregate ranged from 1 hr 51 min for the partition to 3 hr 57 min for one of the 8-in. load-bearing walls, and were determined by the temperature rise on the unexposed surface. The values for the 12-in. single-unit plastered wall and the 12-in. two unit-wall of siliceous aggregates were 5 hr or more and were limited by the temperature rise on the unexposed surface.

The hose-stream tests conducted at the end of the fire-endurance tests indicated that masonry walls built of units made with calcareous aggregates would meet the requirements of that test. Walls of units made with siliceous aggregates that were 8 in. or less in thickness in most cases had fire-endurance values of less than 1 hr and did not require the hose-stream test. Walls of units thicker than 8 in. made with siliceous aggregates that withstood long fire exposures may be expected to meet the hose-stream test requirements. March 30, 1951. 17 p.

BMS121. Investigation of failures of white-coat plaster....Lansing S. Wells,
Walter F. Clarke, Edwin S. Newman, and Dana L. Bishop

An investigation was made of a particular kind of plaster failure that is characterized by the formation of blisters or bulges in the finish coat of plaster. Extensive surveys revealed that the failures are widespread; that several years elapse before the bulges appear and thereafter the number and extent of failures increase as the age of the buildings increases; that the failures occur more extensively and rapidly during warm humid weather; and that there is a marked similarity in the failures regardless of the kind of plaster base coats, type of construction base, varying job conditions, and type of workmanship. The usual white coat is prepared from a lime putty gaged with plaster of paris (gypsum gaging plaster). Chemical analysis of 88 samples of white-coat plaster that had failed showed that in every instance a dolomitic lime had been used in preparing the white coat. Regularly hydrated dolomitic limes contain about 32 percent of total MgO (by weight), of which only about 5 percent is hydrated and the remaining 27 percent is still present as unhydrated MgO. This highly incomplete hydration is due to the fact that the magnesia has been badly overburned in the production of dolomitic quicklimes (which contain CaO and MgO in nearly equal molecular proportions) and thus is inactive toward hydration in the usual hydrators. Furthermore, only about 20 percent of the hydration of the magnesia is completed at the end of the customary 1-day soaking period. The amounts of $CaSO_4.2H_2O$, $CaCO_3$, $Ca(OH)_2$, $Mg(OH)_2$ and MgO in the hardened plasters were calculated from the chemical analysis and closely checked by the method of heat of solution. The presence of $CaSO_4.2H_2O$, $Mg(OH)_2$, $Ca(OH)_2$, and $CaCO_3$ was confirmed by thermal analysis. The average amount of hydration of the MgO for 88 samples of failed white coat was 59.0 percent—much in excess of the 20 percent attained after the customary 1 day of soaking the lime as a putty. Hydration of magnesia must, therefore, occur on the wall. The hydration of MgO is attended by marked expansion. Failures were also observed in base coats where dolomitic lime containing considerable unhydrated MgO was used in their preparation. It was shown that suggested causes other than hydration of MgO with its attendant expansion cannot account for the bulges that occur in plaster several years after a building has been erected. The precautions that should be exercised in specifying a proper lime in order to prevent future failures are discussed. February 1, 1951. 42 p.

BMS122. Physical properties of some samples of asbestos-cement siding
Cyrus C. Fishburn

Measurements were made of the water absorption, weight, porosity, dimensional stability, flexural strength, and flexibility of 23 samples of American asbestos-cement siding furnished by eight manufacturers. A report of an investigation on the weathering of British asbestos-cement roofing products was studied and is briefly reported in this paper.

The modulus of elasticity of the siding samples increased with decrease in absorption. The British investigation indicated that samples of roofing products having a high resistance to freezing and thawing also had low absorption and high modulus of elasticity. Slight decrease in length and in moisture movement were noted with repeated cycles of wetting and drying. July 6, 1951. 15 p.

BMS123. Fire tests of wood-framed walls and partitions with asbestos-cement facings..Nolan D. Mitchell

Three walls and four partitions with asbestos-cement facings on wood frames were subjected to fire-endurance tests and one wall and three partitions to fire and hose-stream tests. The partitions had asbestos-cement sheet facings on both sides over differing internal constructions. The edges of the studs of some of the partitions were lined with asbestos paper or gypsum-board strips. One partition had no insulation, four had mineral-wool batt fill between the studs; two had gypsum-board sheathing underlying the asbestos-cement sheet facings. The walls had matched diagonal sheathing, asphalt-saturated asbestos felt, and asbestos-cement shingles as the exterior facings. The interior facings were of asbestos-cement sheets or asbestos-cement insulated sheathing. Three walls had mineral-wool batt insulation between the studs. Fire-endurance limits for the partitions ranged from 9 to 90 minutes. Failure by a limiting rise of temperature was not a determinant in any of the tests of the walls. The fire exposures ranged from 38 to 85 minutes. Limits by failure under load for the walls ranged from 32 to 79 minutes. Failure from impact of the hose-stream occurred in one of three tests of the partitions and in the single hose-stream test of a wall. May 10, 1951. 14 p.

BMS124. Fire tests of steel columns protected with siliceous aggregate concrete
Nolan D. Mitchell

Results of fire-endurance tests of four 6-in. steel H-columns protected with concrete made with highly siliceous aggregates are presented. The concrete was of 2-in. thickness around the column shaft and filled the reentrant spaces. The aggregates investigated were river gravel and crushed quartz.

The columns were subjected to load throughout the tests. The loads on three columns of magnitude as computed by a standard formula for allowable load were constant. One column sustained a double load throughout the earlier part of the test.

The fire-endurance limits ranged from 2 hr 50 min for a column with crushed quartz aggregate concrete to 3 hr 34 min for one with gravel aggregate concrete.

The results were consistent for columns protected with gravel aggregate concrete, and within reasonable limits for columns covered with quartz aggregate concrete.

The results of the column tests with respect to lack of spalling of the concrete were confirmed by tests on concrete wall slabs made with the same or like aggregates. May 25, 1951. 12 p.

BMS125. Stone exposure test wall.....Daniel W. Kessler and R. E. Anderson

A test wall was built at the National Bureau of Standards during the months of September, October, and November 1948 in a plot set aside on the Bureau grounds for weathering tests of structural materials. The wall contains 2,059 samples of stone in the front, or south face, and 293 in the back and ends; of these, 2,032 were domestic stones supplied by 47 States, and 320 were foreign samples supplied by 16 countries.

Stones in the east half of the south face are set in lime mortar with the exception of those in the base. All other stones in the wall are set in a portland cement mortar with a small addition of whiting. The core of the wall is of concrete, reinforced with steel bars.

The wall contains 30 distinct types of stones, some of which are not commonly used for building purposes. There are many varieties of the usual types, such as marble, limestone, sandstone, and granite. The variations in composition or physical properties, such as strength, porosity, and density, will be of value in studying the relation between such properties and weather resistance.

The main problem is to determine the nature and relative severity of the various agents that cause deterioration and how they affect different stones. Certain structural features of the wall, such as length changes, warpage, back waterproofing, and grade waterproofing, are being studied in relation to weathering and discolorations on the stonework.

Each block is identified by a number determined by its position in the wall. This eliminates the necessity of frequent labeling. The various samples are described under the wall numbers in tables that give specific information on location of stone deposits, classification, color, texture, and geological age, when known. September 20, 1951. 41 p.

BMS126. Self-siphonage of fixture traps..................John L. French and Herbert N. Eaton

This paper describes the methods used and the results obtained in an experimental investigation of the self-siphonage of fixture traps in plumbing systems. Self-siphonage is the reduction in depth of the water seal in the trap by flow from the fixture that discharges through the trap. The different factors that affect self-siphonage are determined, and methods for reducing the ill effects of self-siphonage are suggested. Finally, recommendations and conclusions in a form suitable for use by code-writing authorities are presented. October 15, 1951. 32 p.

BMS127. Effect of aging on the soundness of regularly hydrated dolomitic lime putties..................Lansing S. Wells, Walter F. Clarke, and Ernest M. Levin

Regularly hydrated dolomitic limes are potentially unsound because they contain unhydrated magnesia that may hydrate subsequently in the set plaster, causing disruptive expansion. It is important to know the time required to soak these limes as putties so that sufficient magnesia will have been hydrated to give a sound putty. The customary soaking period of 1 day is inadequate, as evidenced by the prevalence of white-coat expansion failures. Consequently, the progressive hydration of magnesia in dolomitic lime putties upon aging and the attendant decrease in autoclave expansion of cement-lime putty bars were studied for 18 regularly hydrated dolomitic limes representative of commercial production. The limes differed markedly in regard both to the time required to reach a given percentage of expansion and to the extent of hydration at the given expansion. The shortest time of aging required to reduce the expansion to 1 percent (a suggested specification limit for soundness) was 3 weeks, whereas the longest time was in excess of 32 weeks. When the expansion had been reduced to 1 percent, the proportion of total magnesia hydrated ranged from 83 to more than 97 percent. Inasmuch as long and variable aging periods are impractical, suitable alternates, including the use of newly developed sound hydrated limes, are discussed. April 25, 1952. 14 p.

BMS128. Atmospheric exposure tests of nailed sheet metal building materials Theodore H. Orem

Tests of nailed metallic building sheets of aluminum, aluminum alloy, aluminum-coated steel, galvanized steel, and zinc alloy exposed for a period of 2 years to the atmospheres of Washington, D. C., and Hampton Roads, Va., are described. The tests indicate that improper installation practices can cause accelerated corrosion of such materials, but which when properly installed, may be expected to give long satisfactory service. Important conclusions and recommendations are given regarding the installation of sheet-metal building materials. March 28, 1952. 24 p.

BMS129. Fire resistance of shutters for moving-stairway openings Nolan D. Mitchell, Edward W. Bender, and James V. Ryan

The results of one exploratory and two full-scale fire-endurance tests on flexible rolling shutters for closing moving-stairway openings are given. The test specimens in the latter two tests included the balustrading of a normal installation. The shutters were made of galvanized steel slabs moving on rollers and were of the same design in all the tests. The shutters could be operated by hand or by power drive.

The results of the fire-endurance tests indicated that the first full-scale installation design was not satisfactory because of distortions due to differential expansion of the guide rails and other structural parts. The second design, with modifications to provide for the expansion of structural parts without undue distortion, proved adequate for a 3-hr fire resistance. March 1, 1952. 9 p.

BMS130. Methods and equipment for testing printed-enamel felt-base floor covering..........George G. Richey, Elizabeth H. McKenna, and Robert B. Hobbs

This paper describes methods and equipment for measuring the weight, over-all thickness, thickness of enamel and of seal coat, resistance to scrubbing with cleaning compound, resistance to kerosine, flexibility, and tearing strength of printed-enamel felt-base floor covering. Results of laboratory tests are correlated with results of service tests of 11 proprietary products. The correlation was significant for all properties studied except thickness of seal coat, but no single property was outstanding in its level of significance. May 1, 1952. 10 p.

BMS131. Fire tests of gunite slabs and partitions...........Nolan D. Mitchell

Eight slabs and four partitions made with gunite concrete on wire-fabric reinforcement were subjected to fire-endurance tests at the National Bureau of Standards. The slabs were made with aggregates composed of sand and wood sawdust, the sawdust ranging from 0 to 50 percent by volume of the aggregate. The aggregate for two partitions was sand, a third had a minor amount of asbestos added, and that of the fourth consisted of equal volumes of sand and sawdust. Fire-endurance limits for the slabs increased almost linearly with increased percentages of sawdust incorporated into the mix. Partitions made with sand aggregate only in the concrete or with the addition of a small amount of asbestos fiber to the concrete showed early failure by spalling and holing through. The explosive violence of the disruptions suggested the presence of entrapped water in the dense concrete. A partition made with a concrete having equal volumes of sawdust and sand as aggregates did not spall and failed by a limiting 325 deg F rise of temperature at a single point on the unexposed side after 70 min. of fire exposure, whereas the partitions having asbestos and sand or sand only as the aggregate reached fire-endurance limits through explosive spalling in 16 to 26 min. Subsequent to the fire-endurance test, the partition with sawdust successfully withstood the application of the hose-stream test. The effect of the sawdust is to lower the thermal conductivity of the concrete and increase its porosity, thus making easier the escape of moisture in the form of vapor. May 12, 1952. 11 p.

BMS132. Capacities of plumbing stacks in buildings........Robert S. Wyly and Herbert N. Eaton

This report gives the results of the first phase of a theoretical and experimental investigation of the capacities of plumbing drainage stacks in buildings. Because of the complexity of the problem and the wide variety of conditions that are encountered in providing sanitary drainage for buildings, no satisfactory means of determining the sizes of pipes required in the drainage system of a particular building has ever been developed. The present investigation was intended to solve one of the problems involved in determining the capacity of a vertical drainage stack, namely, the pressures that are produced in a horizontal drain by the interference of the flow down the stack from higher levels with the flow from a horizontal drain into the stack at some intermediate level. This was accomplished by developing an equation for the relation between rate of flow down the stack, rate of flow from the branch, pneumatic pressures in the stack and in the branch at the branch level under consideration, the diameters of the stack and the branch, and the backpressure produced in the branch. With the aid of experiment, the unknown quantities in the equation were determined, and the equation can be used to predict this backpressure for any given conditions when a sanitary tee stack fitting is used to connect the branch to the stack. May 28, 1952. 28 p.

BMS133. Live loads on floors in buildings.................John W. Dunham, Guttorm N. Brekke, and George N. Thompson

Information is presented on floor loads found in various occupancies such as office buildings, stores, factories, and warehouses. Most of this consists of the results of a recent survey in which the weight and distribution of goods, equipment, and occupants were obtained floor by floor and area by area. Such data are needed as a check on permissible minimum live loads in building codes and as a basis for design of buildings. Although there are indications in the survey that building codes may set higher figures than are warranted for certain occupancies, the amount of information available is still too small to justify firm conclusions. A method of reducing the assumed value for live load on structural members supporting large floor areas is described. Supplementary investigations of floor loading are recommended to clear up questions that have arisen in connection with the survey. December 19, 1952. 27 p.

BMS134. Fire resistance of concrete floors................Daniel S. Goalwin

The results of eleven exploratory and four full-scale fire-endurance tests on reinforced concrete floors are given. All the slabs were monolithic and were made with gravel aggregates; six consisted of slabs cast to engage the tops of precast lightweight concrete joists. The effects of moisture content, aggregate type, and soffit protection are discussed. A general equation for the relation between slab thickness and fire resistance for different aggregates is proposed. December 26, 1952. 11 p.

BMS135. Fire tests of steel columns encased with gypsum lath and plaster
Nolan D. Mitchell and James V. Ryan

The results presented are those derived from fire-endurance tests of 16 steel columns encased with gypsum lath and gypsum plasters. The laths were wired into place; those on eight columns were of the ⅜-in. thick perforated type in a single layer, those on seven of the other eight columns were of two layers of the ½-in. thick plain type, and on the other a single layer. Six of the latter eight also had a layer of wire fabric to reinforce the plaster. Expanded perlite was used as the plaster aggregate for 13 columns, sand for two, and vermiculite for one. The thickness of the plasters ranged from ½ in. to 2 in. and those of the encasements from ⅞ in. to 2½ in.

The fire-resistance values indicated by the tests varied with the composition, reinforcement, and thickness of the protective coverings, and to some degree with the size of the column. The fire-endurance limits, as determined from the tests, ranged from 1 hr 23 min for a 10-in. steel H-section column protected with ⅜-in. perforated lath and ½ in. of sanded gypsum plaster to 4 hr 42 min for one protected with two layers of ½-in. lath, and a 1½-in. thickness of perlite-gypsum plaster reinforced with wire fabric. April 3, 1953. 14 p.

BMS136. Properties of cavity walls........................Daniel S. Goalwin

A compilation is given of data on the performance characteristics of cavity walls, including previously published and some hitherto unpublished material. Structural tests were conducted on cavity walls of brick, concrete block, and structural clay tile. Other tests were made on the properties of wall ties, rain penetrability, thermal transmittance, and fire resistance.

Under certain conditions of loading, compressive strength, resistance to concentrated load, racking load, and impact strength were found to be roughly equivalent to those of conventional walls using the same quantity and quality of material. With respect to resistance to transverse load, the cavity walls were somewhat inferior. When properly flashed and with suitable weep holes, the cavity walls had satisfactory resistance to rain penetration. Their thermal transmittance was about 25 percent lower than for similar solid walls. Their resistance to the effect of fire was satisfactory provided certain limiting loading conditions were met. May 20, 1953. 15 p.

BMS137. Influence of the wash from bronze on the weathering of marble
Daniel W. Kessler and Ross E. Anderson

This investigation was made to determine whether rain water flowing over bronze work and then over marble in monuments or other structures causes deterioration of the marble. Experimental work included exposure tests, extending over a period of 13½ years, in which many specimens of a white calcite marble were exposed to the wash from three bronzes of typical compositions. Tests for flexural strength, abrasive resistance, absorption, and bulk density were made on some of the specimens after exposure periods of 5, 10, and 13½ years to determine the changes in test values. Several buildings and monuments were inspected where various marbles had been exposed to the wash from bronze for periods ranging from 20 to 98 years.

It was found that some marbles are not appreciably injured by such conditions, whereas others showed advanced stages of disintegration within a period of 30 years. Some marbles develop both green and brown discolorations, and disintegration usually occurs in the brown areas. The green staining matter does not appear to have any appreciable effect on the durability of marble. Treatment of the marble with molten paraffin to seal the pores does not prevent discoloration except for a period of 2 or 3 years. Tests indicated that this treatment materially reduces the flexural strength and abrasive resistance of marble. June 23, 1953. 11 p.

BMS138. Effect of edge insulation upon temperature and condensation on concrete-slab floors-----Harold R. Martin, Paul R. Achenbach, and Richard S. Dill

By means of a special structure, with necessary refrigerating apparatus and auxiliary equipment, nine concrete-slab floor specimens, each about 4½ by 6½ ft, were subjected to temperature conditions simulating those to which such floors in basementless houses are exposed during cold weather. As installed in the structure, the exposed edge of each specimen abutted or overlapped a foundation typical of that around the perimeter of a house; the other three edges were insulated to reduce the heat exchange to a negligible amount. The air in the structure above the specimen was maintained at about 70° F, and that above the earth beyond the exposed edge was maintained at 32° F and 0° F for the different tests simulating winter conditions. The exposed edges of the several specimens were insulated in different ways to determine the effect of edge insulation on floor-surface temperatures and the possibility of condensation. It was found that the temperature of the floors with edge insulation was from 9 to 13 deg F higher at a point 1 in. from the cold wall and the average temperature of the 30-in. border next to the cold wall from 3 to 5 deg F higher than that of the floor without edge insulation, the simulated outdoor temperature being about 0° F in both cases. Condensation, which probably would occur on uninsulated floors under certain conditions, can be prevented by the use of edge insulation. Some recommendations concerning types and arrangements of edge insulation are included for outdoor temperatures as low as 0° F. October 9, 1953. 21 p.

BMS139. Studies of stone-setting mortars---------------Daniel W. Kessler and Ross E. Anderson

Several mortars were studied for bonding strengths to four types of stone, dimensional changes under three conditions of storage, and frost resistance. Higher bonding strength was obtained for mortars to fine-grained stones than to coarse-grained stones. Indications were found that mortars shrink more in a vertical direction than horizontally. If shrinkage cracks form in the specimen, the measurements will be too low. Tests on mortars cast and cured in contact with porous materials gave higher strengths and lower absorptions than were obtained on specimens cured in nonabsorptive molds. Ground limestone was found to be a satisfactory plasticizing agent. Some studies were made of mortars in structures and certain recommendations are made for selecting mortars for use in stone masonry. November 23, 1953. 23 p.

BMS140. Selected bibliography on building construction and maintenance L. D. C. Nobel

Selected references on building materials, equipment, good construction practices for new construction, and the modernization and maintenance of buildings. May 28, 1954. 35 p.

BMS140, 2d ed. Selected bibliography on building construction and maintenance Edith R. Meggers

Selected references on building materials, equipment, good construction practices for new construction, and the modernization and maintenance of buildings. 1956. 40 p.

BMS141. Fire endurance of open-web steel-joist floors with concrete slabs and gypsum ceilings...........James V. Ryan and Edward W. Bender

The results presented were obtained in a program of 18 fire tests on open-web steel-joist floors, 16 of which were protected by ceilings of gypsum-perlite plaster on gypsum lath "furred" directly to the joists. Variables included plaster thickness, plaster mixes, spacing of furring channels, system of lath clips, reinforcing in the ceilings, and type of floor slab. An acoustical plaster finish was applied to one ceiling. The range of fire endurances obtained, from 1 hour to 4 hours 26 minutes, was sufficient to cover the requirements for floors in many building codes. The importance of the ceiling's protective function was demonstrated in two tests without ceilings, in each of which failure occurred at 7 minutes. August 23, 1954. 17 p.

BMS142. Frost closure of roof vents in plumbing systems.... Herbert N. Eaton and Robert S. Wyly

Results are reported of a laboratory investigation of the freezing up of roof vents in extremely cold weather and an analysis is given of the heat-transfer process that leads to the partial or complete closure of these vents by frost under sufficiently severe conditions. Information as to the occurrence of frost closure in Canada and methods used there to avoid or minimize the freezing up of roof vents is also included. October 25, 1954. 31 p.

BMS143. Fire tests of brick walls............................S. H. Ingberg

Fire-endurance tests were conducted of 54 solid and 19 hollow brick walls, supplemented by 10 fire and hose-stream tests.

The fire-resistance limit of 4-in. clay and shale brick walls was found to be about 1¼ hr, as based on stability under fire exposure, ability to carry load, and to protect combustible material on the side not exposed to fire. Plaster on both sides increased the limit to 2½ hr.

For clay and shale brick solid walls of 8-in. thickness, the fire-resistance limit from the above considerations was 5 hr, which was increased to 7 hr when the walls were plastered on both sides. For combustible members projecting into the walls 4 in. from the unexposed side, the protection period was 2 hr, and if plastered, 3 hr. With the 12-in. nominal thickness, the fire-resistance limits ranged from 8 to 10 hr, depending upon the fusion temperature of the bricks, and with 7 hr as the protection period for framed in members.

For solid 8- and 12-in. walls of concrete and sand-lime bricks, the fire-resistance limits were found 1 to 2 hr higher than for comparable walls of clay and shale bricks. This was apparently due to the retarding effect on temperature rise in the wall from evaporation of the combined water in the brick cementing material.

The fire-resistance limit of 8-in. clay and shale brick walls of the all-rolok design was 2½ hr, and with framed-in combustible members, 1 hr. With plaster, these were increased to 4 hr and 1½ hr, respectively. For 12-in. rolok walls, a fire-resistance limit of 5 hr was indicated, and 2½ hr as the protection period for members supported in the wall. For the plastered wall, these were 7 hr and 3½ hr, respectively.

For cavity walls of 10-in. nominal thickness, the fire-resistance period averaged about 5 hr, with 1½ or 2 hr as the protection period for supported combustible members, depending upon the degree of embedment assumed.

All wall constructions evidenced ability to meet the performance in the fire and hose-stream test required for their respective fire-resistance ratings. November 30, 1954. 52 p.

BMS144. Sound insulation of wall and floor structures
Prepared by the Staff of the Sound Section

The data obtained at the National Bureau of Standards on the sound transmission of door, wall, and floor constructions are summarized. The results in Report BMS17 (1939) and its two Supplements (1940 and 1947) are included, together with later results up to March 1954. The general principles of sound insulation are discussed, and the factors governing the transmission of airborne and impact sound in structures are examined. The importance of choosing suitably quiet locations for buildings is stressed, and the best use of the quieter rooms of a building is urged. The merits of suspended ceilings, floating floors, staggered studs, and other types of sound-insulating construction are discussed. A brief description of the measuring technique is given. February 25, 1955. 66 p. (Supersedes BMS 17 and its Supplements 1 and 2).

BMS144 Supplement. Sound insulation of wall, floor, and door constructions
Richard V. Waterhouse

The sound insulation figures are presented for 13 building structures that were measured at the National Bureau of Standards in the period March 1954 to June 1955. The details are also given of a change in the method of measuring impact sound insulation. February 27, 1956. 5 p.

BMS145. Fire effects and fire control in nitrocellulose photographic-film storage
J. V. Ryan, J. W. Cummings, and A. C. Hutton

The results are given of a comprehensive research investigation conducted to determine the effects of variables such as film load, size and orientation of vent opening, volume of chamber, containers for rolls of film, rack types, and automatic-sprinkler systems on fires in nitrocellulose-film storage vaults, as indicated by internal pressure, temperature, fumes and flames, and extent of film damage. The data are tabulated and those from an earlier independent study are included for comparison. The effects of the variables are discussed and conclusions with respect to the maximum preservation of film are given. April 2, 1956. 20 p.

BMS146. Plasticity and water retentivity of hydrated limes for structural purposes....Ernest M. Levin, Walter F. Clarke, and Lansing S. Wells

Workability characteristics imparted to plasters and mortars by hydrated lime are of importance to the plasterer and to the mason. Emley plasticity values were determined for putties prepared from 65 hydrated limes of the various types, after soaking them for 30 minutes and for 1 day. Water-retentivity values, defined as the ratio of the flow after suction to the flow before suction, were obtained for lime-sand mortars prepared in the proportions of 1:3 by weight, 1:3 by volume, and 1:3 by volume using lime putty aged overnight. It was found that acceptable plasticity was associated with acceptable water retentivity, but that acceptable water retentivity did not necessarily imply acceptable plasticity. Results are discussed with relation to the improvement of specifications. February 20, 1956. 10 p.

BMS147. Effects of mineral additives on the durability of coating-grade roofing asphalts....................................Sidney S. Greenfeld

The effects of 14 mineral additives on the durability of coatings made from three asphalts were evaluated in accelerated durability machines. It was found that while the durability of the coating is largely a function of the asphalt used, it increases, generally, with coating thickness and mineral additive concentration. Additives with flat, platelike particles finer than 75 microns in diameter (U. S. Standard Sieve No. 200) were most effective in producing coatings of increased durability. Complete dispersion of the additives in the base asphalts is necessary to produce consistent results. September 1956. 14 p.

BMS148. Fifteen-year exposure test of porcelain enamels....Dwight G. Moore and William N. Harrison

The weather resistance of 768 panels representing 14 types of enamel was evaluated after 15 years of exposure at Washington, D. C., St. Louis, Mo., Lakeland, Fla., and Atlantic City N. J. Changes in gloss and color were taken as criteria of weather resistance. A direct relation existed between acid resistance and weather resistance, except that a few of the red enamels of good acid resistance showed a pronounced fading after exposure. A modified acid-resistance test was devised that separated red enamels that showed pronounced fading from those that were highly resistant to color change.

The ease of cleaning was related to the weather resistance, the enamels that lost most of their initial gloss on weathering being more difficult to clean than those that showed high gloss retention. All of the enamels protected the steel from corrosion when initial coverage was complete.

Except for a relatively few enamels, variations in climate at the four exposure sites had only a minor effect on their weathering behavior. June 28, 1957. 13 p.

BMS149. Combustible contents in buildings....S. H. Ingberg, John W. Dunham, and James P. Thompson

Information is presented on the combustible contents, including the flooring and the interior finish and trim, found in buildings housing various classes of occupancy. The data given are based on surveys of specific buildings in which the weight and distribution of combustible contents were obtained area by area and floor by floor. The results indicate the range in the amounts of combustibles associated with different occupancies and show that, except for the areas used for filing and storage, the combustible load is uniformly light for residential buildings, schools, hospitals, and office buildings. The combustible load varies considerably in mercantile occupancies and even more so in industrial and storage buildings. In conjunction with fire severity tests, data from these surveys can be applied in developing requirements for minimum fire resistance of buildings. July 25, 1957. 18 p.

BMS150. Methods of testing small fire extinguishers.....H. Shoub, T. G. Lee, and J. M. Cameron

A study has been made of methods of testing small hand-portable fire extinguishers considered suitable for application to flammable liquids. The study was performed by evaluating the effectiveness of the extinguishers, in which 5 different extinguishing agents were used on 10 types of fires, selected either because they had been used in standard extinguisher tests or simulated other possible conditions of hazard. An analysis was made of the relative merit of the fires for extinguisher testing, the effect of ambient variables on the tests, and the value of the several extinguisher types for use on the fires. June 14, 1957. 9 p.

APPLIED MATHEMATICS SERIES

The Applied Mathematics Series contains mathematical tables, manuals and studies of special interest to physicists, engineers, chemists, biologists, mathematicians, computers and others engaged in scientific and technical work. Some of the volumes are reissues, to meet a continuing demand, of the Mathematical Tables prepared by the Project for the Computation of Mathematical Tables conducted by the Federal Works Agency, Work Projects Administration for the City of New York, under the scientific sponsorship of and made available through the National Bureau of Standards. The Mathematical Tables series (MT) as originally issued is out of print; the list, by title, is given in NBS Circular 460.

When the Applied Mathematics Division was established at the National Bureau of Standards in July 1947, the Mathematical Tables Project became identified with the unit of this Division known as the Computation Laboratory.

AMS1. Tables of the Bessel functions $Y_0(x)$, $Y_1(x)$, $K_0(x)$, $K_1(x)$, $0 \leqq x \leqq 1$. February 12, 1948. 60 p. (Superseded by AMS25.)

AMS2. Table of coefficients for obtaining the first derivative without differences.....................................Herbert E. Salzer

Exact values are given for coefficients in 4- to 7-point Lagrange-type formulas with interval of .01 for the 4-, 5-, and 6-point formulas, and interval .1 for the 7-point formula for the full range of arguments. April 22, 1948. 20 p.

AMS3. Tables of the confluent hypergeometric function $F(n/2,1/2;x)$ and related functions.

The function $F(n/2,1/2;x)$ is tabulated for x ranging from 0.10 to 100 and for odd values of n from 3 to 201. Tables of related functions are included. January 21, 1949. 73 p.

AMS4. Tables of scattering functions for spherical particles.

The tables give the angular distribution of intensity and the total light scattered by a small, spherical particle in terms of size of particle and wavelength of the incident light. They are based on Mie's theory on the scattering of light by particles with a radius comparable in magnitude with the wavelength of light. The tables permit both the concentration and diameter of spherical particles in suspension to be determined from measurements of the attenuation of an incident beam due to scattering, provided the particles are of uniform size.

The first of the four parts of the tables gives the angular distribution of the intensities of the two incoherent, plane polarized components scattered by a transparent particle illuminated with natural light. Part II gives the total scattering coefficient for a transparent material of refractive index 1.5. In part III the total scattering (and absorbing) coefficient may be obtained for absorbing materials of extinction coefficient varying from 0 to 0.1, and of real refractive index varying from 1.44 to 1.55. In part IV the tables have been extended to certain values of complex arguments for a problem in the application of microwave radar in the wavelength region in the order of 10 cm and shorter, where a dispersion by liquid water sets in, making the index of refraction complex and a function of wavelength. January 25, 1949. 119 p.

AMS5. Table of sines and cosines to fifteen decimal places at hundredths of a degree.

Tables of sine x and cosine x are given to 15 decimal places for x ranging from 0 to 90 degrees at intervals of 0.01 degree. Also included is a supplementary table of sine x and cosine x to 30 decimal places for x ranging from one degree to 89 degrees at intervals of one degree, as well as a table of Everett's interpolation coefficients. May 2, 1949. 95 p.

AMS6. Tables of the binomial probability distribution.

In table 1 the values of the individual terms $\binom{n}{r} p^r q^{n-r}$ of the binomial expression $(q+p)^n$ are tabulated to seven decimal places for $p=.01(.01).50$; $q=1-p$; $n=2(1)49$; $r=0(1)n-1$. These terms furnish values of the probability, Prob $\{s=r|n,p\}$, of exactly r successes in n independent trials for $2 \leq n \leq 49$ and $0 \leq r \leq n-1$, when the probability of occurrence in any single trial, p, is 0.50 or less. In table 2 the values of the sum of the last $n-r+1$ terms of the binomial expansion of $(q+p)^n$, that is, of the partial or cumulative sum $\sum_{s=r}^{n} \binom{n}{s} p^s q^{n-s}$, are tabulated to seven decimal places for $p=.01(.01).50$; $q=1-p$; $n=2(1)49$; $r=1(1)n$. These sums provide values of the probability, Prob $\{s \geq r|n,p\}$, of at least r successes in n independent trials, when the probability of success in any single trial, p, is 0.50 or less, for $2 \leq n \leq 49$ and $1 \leq r \leq n$. January 27, 1950. 387 p.

AMS7. Tables to facilitate sequential t-tests.

Tables are given for use in connection with the sequential test of the hypothesis that the mean of a normal (Gaussian) population with unknown mean and unknown variance is some given value. The entries $z \equiv z(L,n,\delta)$ in the table are solutions of the equation $L=\ln F(n/2, 1/2; \delta^2 z/2) - n\delta^2/2$, where $F(a,b;x)$ is the confluent hypergeometric function. All significant combinations of the arguments within the following limits are given: $\pm L=2(1)7$, ln 19, ln 99; $\delta=0.1(.1)1(.2)2,2.5$; $n=1(1)200$. Extensive introduction by K. J. Arnold. May 16, 1951. 82 p.

AMS8. Table of powers of complex numbers . . . . Herbert E. Salzer

Exact values of the powers of complex numbers, z^n, $(z=x+iy)$, are given for $x,y=1(1)10$, $n=1(1)25$. Also included is a table of the exact values of the powers of x, x^n, for $x=2(1)9$, $n=1(1)25$. February 28, 1950. 44 p.

AMS9. Tables of Chebyshev polynomials $S_n(x)$ and $C_n(x)$.

Tables of $S_n(x)$ and $C_n(x)$ are given for $n=2(1)12$, $x=0(.001)2$. An extensive introduction by C. Lanzcos gives the properties of Chebyshev polynomials, curve fitting, solution of linear differential equations with rational coefficients, use of the numerical tables, tables of the first 12 polynomials $C_n(x)$, $S_n(x)$, $T_n(x)$, and $U_n(x)$, the first 20 polynomials $T_n^*\binom{n}{x}$, and x^k $(k=1(1)12)$ expanded into $T_n(x)$ and $T_n^*(x)$. December 19, 1952. 161 p.

AMS10. Tables for conversion of X-ray diffraction angles to interplanar spacing.

The tables give spacing values d in angstrom units corresponding to the angles θ which are usually measured when diffraction patterns are used for chemical identification and crystal structure determination. The angles are related to interplanar spacings d by the formula $d=\lambda/2 \sin \theta$, where λ is the wavelength of incident X-radiation and θ is half the angle between the incident and diffracted rays. The first six tables give the spacing values for the angles θ from 0 to 90 degrees at intervals of .01 degree; they were calculated using the $K\alpha_1$ wavelengths for X-ray targets of molybdenum, copper, nickel, cobalt, iron and chromium, respectively. The wavelengths used are those adopted at the International

Conference sponsored by the British Institute of Physics in London, July 1946. The last two tables contain a rearrangement of the data for copper and iron, giving the spacing values for the argument 2θ from 0 to 180 degrees at intervals of .02 degree. Introduction by H. E. Swanson. September 20, 1950. 159 p.

AMS11. Table of Arctangents of rational numbers.................... J. Todd

The table gives Arctan m/n and Arccot m/n for $0<m<n\leq 100$, 12D. Also included are table of reductions of Arctan m/n for $0<m<n\leq 100$ and a table of reductions of Arctan n for reducible $n\leq 2089$. March 30, 1951. 105 p.

AMS12. Monte Carlo method.

Proceedings of a symposium held on June 29, 30, and July 1, 1949 at the NBS Institute for Numerical Analysis, Los Angeles, Calif. (Ten papers.) June 11, 1951. 42 p.

AMS13. Tables for the analysis of beta spectra.

Tables are given of the values of the Fermi function

$$F(Z,\eta)=\eta^{2+2S}e^{+\pi\delta}\cdot|\Gamma(i+S+i\delta)|^2,$$

where the upper and lower signs of exp $(\pm\pi\delta)$ apply to the spectra of negative and positive electrons, respectively; η=momentum of the electron after its ejection from the atom in units of mc; $S=\sqrt{1-Z^2/137^2}-1$; Z=atomic number; $\delta=Z\sqrt{1+\eta^2}/137\eta$. The tabulation covers all the values of Z that may be encountered in practice. The set of values of η should be sufficient to enable the reader to calculate the function at intermediate values by interpolation. The tabulation extends to $\eta=7$. The values of $F(Z,\eta)$ for $\eta>7$ are given to within approximately 1% by the empirical expression $\eta^{2+2S}(A+B/\eta+C/\eta^2)$. The values of η^{2+2S} can be read off a graph or calculated. The coefficients A, B, and C are given at the bottom of each main table. The Introduction includes a review by U. Fano of the principles of the analysis of β-spectra and instructions on the use of the table. Other auxiliary tables are available for use. June 2, 1952. 61 p.

AMS14. Tables of the exponential function e^x.

Tables of e^x are given for:
$x=-2.4999(.0001)0.9999$, 18D; $x=1(.0001)2.4999$, 15D;
$x=2.5(.001)4.999$, 15D; $x=5(.01)9.99$, 12D;
$x=-0.000099(.000001)0.000099$, 18D; $x=-100(1)100$, 19S;
$x=-9\text{x}10^{-n}(10^{-n})9\text{x}10^{-n}$, $n=10, 9, 8, 7$, 18D. Values of e and $1/e$ are given to 2556D. June 29, 1951. 537 p.
(Supersedes MT2, 2d ed. For an extension of this table, see AMS46.)

AMS15. Problems for the numerical analysis of the future.

Four papers are published that were presented at the Symposia on Modern Calculating Machinery and Numerical Methods, held in July 1948, at the NBS Institute for Numerical Analysis, Los Angeles, Calif. June 29, 1951. 21 p.

AMS16. Tables of $n!$ and $\Gamma(n+\frac{1}{2})$ for the first thousand values of n. . H. E. Salzer.

A table of n! is given to 16S, and a table of $\Gamma(\text{n}+\frac{1}{2})$ to 8S. June 15, 1951. 10 p.

AMS17. Vol. I. Tables of Coulomb wave functions.

The volume includes values of $\Phi_L(\eta,\rho)$ and its "reduced" derivatives with respect to η, for $\eta=-5(1)5$, $L=0(1)5, 10, 11, 20, 21$, $\rho=0(.2)5$; values of the real part of $[\Gamma'(1+i\eta)/\Gamma(1+i\eta)]$, $\eta=0(.005)2(.01)6(.02)10(.1)20(.2)60(.5)110$, 10D, modified second central differences; values of $\sigma_0=\arg\Gamma(1+i\eta)$, $\eta=0(.01)1(.02)3(.05)10(.2)20(.4)30(.5)85$, 8D, modified second central differences; values of $C_0(\eta)=(2\pi\eta)^{\frac{1}{2}}(e^{2\pi\eta}-1)^{-\frac{1}{2}}$, $\eta=0(.01)5(.05)10$, 8S. An extensive introduction by M. Abramowitz contains sections on the theory, method of computation, and contents of the table. April 25, 1952. 141 p.

AMS18. Construction and application of conformal maps.

Proceedings of a Symposium held on June 22–25, 1949, at the NBS Institute for Numerical Analysis, Los Angeles, Calif. (Thirty-two papers). December 26, 1952. 280 p.

AMS19. Hypergeometric and Legendre functions with applications to integral equations of potential theory............................C. Snow

This is an outline of the theory of, and a collection of formulas pertaining to the ordinary hypergeometric function with special reference to the associated Legendre functions. The linear (and some quadratic) transformations are considered, leading to the analytic continuation of the series to all parts of the z-plane, for unrestricted values of its three parameters. Application is made to a variety of potential problems that involve boundary value problems with reference to some surface of revolution. May 1, 1952. 427 p. (Supersedes MT15.)

AMS20. Tables for rocket and comet orbits.....................S. Herrick

Tables of $\sin E$ and $1-\cos E$ with argument $E-\sin E$, with parallel tables in the hyperbolic functions, are given for the determination of position and velocity from the time, for rectilinear orbits. Direct interpolation is possible, without the aid of series expansions or successive approximations. The tables may also be used in connection with nearly rectilinear motion, that is, motion in ellipses and hyperbolas whose excentricities are near unity. The application of the tables is set forth extensively in the Introduction. March 9, 1953. 100 p.

AMS21. A guide to tables of the normal probability integral.

The guide is a ready desk reference to the normal probability integral tabulated in standard statistical texts and other important sources. It provides not only a list of available tables but also the form of the function tabulated. July 11, 1952. 16 p.

AMS22. Probability tables for the analysis of extreme-value data.

An introduction by E. J. Gumbel gives an outline of the theory and application of extreme values and describes the nature, use, accuracy, and method of computation of the tables. The tabular part consists of six tables for the asymptotic (cumulative) distribution of the largest value, $\Phi=\exp(-e^{-y})$; its inverse; the corresponding density function; probability points for the asymptotic distribution of the mth largest values up to $m=50$; and the asymptotic cumulative and density functions of the range. Most of these functions are tabulated in sufficient detail so that linear interpolation will give sufficient accuracy for practical purposes over most of the ranges of the arguments. July 6, 1953. 32 p.

AMS23. Tables of normal probability functions.

The normal probability functions $(1/\sqrt{2\pi})\,e^{-x^2/2}$ and $(1/\sqrt{2\pi})\int_{-x}^{x} e^{-\alpha^2/2}\,d\alpha$, which are of fundamental importance in statistics, are tabulated to 15 decimal places, at intervals of 0.0001 in the range of x between 0 and 1, and at intervals of 0.0001 for x ranging between 1 and 7.8. For larger values of x, the functions values may be read by inspection to 15 decimals. A supplementary table gives values of $(1/\sqrt{2\pi})e^{-x^2/2}$ and of $(2/\sqrt{2\pi})\int_{x}^{\infty} e^{-\alpha^2/2}\,d\alpha$ to seven significant figures in the range of x between 6 and 10 at intervals of 0.01. In format and contents this is a companion volume to AMS41. Introduction by A. N. Lowan. June 5, 1953. 344 p. (A reissue of MT14.)

AMS24. Introduction to the theory of stochastic processes depending on a continuous parameter..........................Henry B. Mann

A development of the theory of stochastic processes is given with special reference to the needs of mathematical statisticians. February 11, 1953. 45 p.

AMS25. Tables of the Bessel functions $Y_0(x)$, $Y_1(x)$, $K_0(x)$, $K_1(x)$, $0 \leqq x \leqq 1$.

The tables give values of $Y_0(x)$ and $Y_1(x)$ with first and second differences for $x=0(.0001)0.05(.001)1$, mostly to 8 significant figures, and the values of $K_0(x)$ and $K_1(x)$ with first and second differences for $x=0(.0001)0.33(.001)1$ to 7 significant figures. Auxiliary functions are tabulated near the singularity. September 11, 1952. 60 p. (Supersedes AMS1.)

AMS26. Table of Arctan x.

The Arctan x is tabulated for $x=0(.001)7(.01)50(.1)300(1)2000(10)10000$, to 12 decimal places. Auxiliary tables of Gregory-Newton and Everett's interpolation coefficients and of conversion tables for radians⇄degrees are included. February 18, 1953. 170 p. (A reissue of MT16.)

AMS27. Tables of 10^x (Antilogarithms to the base 10).

Tables of 10^x are tabulated for x ranging from 0 to 1 in steps of .00001 to ten decimal places. A radix table of $10^{n \times 10^{-p}}$, $n=1(1)999$, $p=3(3)15$, makes it possible to obtain in a few steps the antilogarithm of any 15 decimal number to about 15 decimals or 15 significant figures. July 6, 1953. 543 p.

AMS28. Tables of Bessel-Clifford functions of orders zero and one.

Functions are tabulated as follows: $J_0(2\sqrt{x})$ and $J_1(2\sqrt{x})/\sqrt{x}$, $0 \leq x \leq 410$, 8D or 9D; $Y_0(2\sqrt{x})$ and $Y_1(2\sqrt{x})/\sqrt{x}$, $0 \leq x \leq 410$, 8D or 9D; $I_0(2\sqrt{x})$ and $I_1(2\sqrt{x})/\sqrt{x}$, $0 \leq x \leq 6.2$, 7D or 8D; $e^{-2\sqrt{x}} I_0(2\sqrt{x})$ and $e^{-2\sqrt{x}} I_1(2\sqrt{x})/\sqrt{x}$, $6.2 \leq x \leq 410$, 8D or 9D; $K_0(2\sqrt{x})$ and $K_1(2\sqrt{x})/\sqrt{x}$, $0 \leq x \leq 6.2$, 6D to 9D; $e^{2\sqrt{x}} K_0(2\sqrt{x})$ and $e^{2\sqrt{x}} K_1(2\sqrt{x})/\sqrt{x}$, $6.2 \leq x \leq 410$, 8D or 9D.

Auxiliary tables of Gregory-Newton and Everett's interpolation coefficients are included. February 2, 1953. 72 p.

AMS29. Simultaneous linear equations and the determination of eigenvalues.

Proceedings of a Symposium held on August 23–25, 1951, at Los Angeles, Calif., under the sponsorship of the National Bureau of Standards and the Office of Naval Research. (Nineteen papers.) August 31, 1953. 126 p.

AMS30. Tables of coefficients for the numerical calculation of Laplace transforms.......................................H. E. Salzer

The volume includes Lagrange interpolation coefficients, 2-point through 11-point; Laplace transforms of interpolation coefficients, 2-point through 11-point; Laplace transforms of Lagrange coefficients, 2-point through 11-point; and $n!/p^{n+1}$, $n=0(1)10$, $p=0.1(.1)10$. September 24, 1953. 36 p.

AMS31. Table of natural logarithms for arguments between zero and five to sixteen decimal places.

The table gives natural logarithms (to the base e) for numbers from zero to five at intervals of .0001, to 16 decimal places. October 1, 1953, 501 p. (A reissue of MT10.)

AMS32. Table of sine and cosine integrals for arguments from 10 to 100.

The sine and cosine integrals $Si(x)$ and $Ci(x)$ are tabulated for x ranging from 10 to 100 at intervals of .01, to 10 decimal places. Auxiliary tables give multiples of $\frac{1}{2}\pi$, also Gregory-Newton and Everett's interpolation coefficients. July 1, 1954. 187 p. (A reissue of MT13.)

AMS33. The statistical theory of extreme values and some practical applications.......................................E. J. Gumbel

This monograph is a revision of a series of four lectures given by the author in 1949 at the National Bureau of Standards. The extreme-value methods described involve the asymptotic theory of extremes. The theory is developed, and it is shown how many phenomena of great practical interest, such as floods, droughts, breaking strengths of materials, maximum gust loads, extremes of temperatures, pressure, etc., can be treated as extremes of large samples. The methods are illustrated by many examples of actual data together with the necessary tables and graphs. The monograph also includes a full set of instructions for applying the techniques in practice. February 12, 1954. 51 p.

AMS34. Table of the gamma function for complex arguments.

The real and imaginary parts of $\log_e \Gamma(x+iy)$ are tabulated to 12 decimal places for x and y ranging from 0 to 10 at intervals of .1. Auxiliary tables give $\sin \pi x$, $\cos \pi x$, $\sinh \pi x$ and $\cosh \pi x$ for x ranging from 0 to 10 at intervals of .1, to 15 decimal places or 15 significant figures. An extensive introduction by H. E. Salzer presents the theory, method of computation, and contents of the table. August 6, 1954. 106 p.

AMS35. Tables of Lagrangian coefficients for sexagesimal interpolation.

The tables give 3-, 4-, 5-, and 6-point Lagrangian interpolation coefficients $A_i(p)$ to 8 decimal places, where $0 \leq p \leq 1$, at intervals of 1/3600. The tables can be used for any $m/3600$ interval, since the coefficients A_i are functions of integral multiples of 1/3600. The introduction by H. E. Salzer provides illustrations of the use of the coefficients A_i. January 4, 1954. 157 p.

AMS36. Tables of circular and hyperbolic sines and cosines for radian arguments.

Tables of sine x, cosine x, hyperbolic sine x and hyperbolic cosine x are given to 9 decimal places for x ranging from 0 to 1.9999 at intervals of .0001 and from 0 to 10 at intervals of .1. Conversion tables express degrees, minutes, and seconds in terms of radians to 10D; also give radians from 10^{-10} to 10^2 in terms of degrees, minutes, and seconds, to an accuracy of 0.000005 sec. For an extension to the range $x=2(.001)10$, see AMS45. November 30, 1953. 407 p. (A reissue of MT3.)

AMS37. Tables of functions and of zeros of functions.

A collection of 18 short tables of the National Bureau of Standards Computation Laboratory brings together tabulations of special functions. All but three have been published separately previously. The three tables here published for the first time are: $\sin x$, $\cos x$, $x=100(1)1000$, 8D; radix tables for finding the logarithm of any number to 25D; and $x^n/n!$, for $x=.01(.01)1.99$, 13D, with n taken up to the point where the function vanishes in the last place, and for $x=1(1)10$, $n=1(1)40$, 8S. Tables included from the Mathematical Tables series* are MT18, 19, 20, 21, 23, 26, 28. In addition, the following tables previously published elsewhere are included: $E_n(x)=\int_1^\infty e^{-xu}u^{-n}du$; the Struve functions $L_\nu(x)$ and $H_\nu(x)$; zeros and weight factors of Laguerre polynomials; zeros of Bessel functions of fractional order and their derivatives; zeros of $\sin z=z$, $z=x+iy$; and complex zeros of $Y_1(z)$, $Y^1(z)$, $Y_1'(z)$. November 10, 1954. 211 p.

AMS38. Magnetic fields of cylindrical coils and annular coils...... Chester Snow

Mathematical formulas are developed in terms of complete elliptic integrals or of Legendre functions for the axial and radial components of the magnetic field produced by cylindrical coils carrying an electric current. Cases treated include cylindrical current sheet, circular current sheet (with circumferential flow of current), and multilayer solenoid. December 30, 1953. 29 p.

AMS39. Contributions to the solution of systems of linear equations and the determination of eigenvalues. (Seven papers.)
Edited by Olga Taussky

This is a sequel to AMS29. Some of the papers are theoretical and some are practical, being concerned with problems of computation, using both desk machines and high-speed automatic digital computing machines. September 30, 1954. 139 p.

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*See NBS Circular 460, page 219.

AMS40. Table of secants and cosecants to nine significant figures at hundredths of a degree.

Introduction by M. Abramowitz. March 26, 1954. 46 p.

AMS41. Tables of the error function and its derivative.

The error function, $H(x)=(2/\pi)\int_0^x e^{-t^2}dt$, and its derivative, $H'(x)=(2/\pi)e^{-x^2}$, are tabulated for $x=0(.0001)1(.001)5.6$ to 15 decimal places, followed by short critical tables to 15 decimal places for x greater than 5.6. Tables of $H'(x)$ and $1-H(x)$ are also included, for $x=4(.01)10$, to 8 significant figures. In format and contents this is a companion volume to AMS23. October 22, 1954. 302 p. (A reissue of MT8.)

AMS42. Experiments in the computation of conformal maps.

Edited by John Todd

Descriptions and evaluations are given for three computational experiments in the general field of conformal mapping: one carried out by desk calculation, one by punched-card equipment, and one on SEAC. (This volume is a sequel to AMS18.) January 20, 1955. 61 p.

AMS43. Tables of sines and cosines for radian arguments

Sin x, cos x are tabulated for $x=0(.001)25.2$, $0(1)100$, 8D. Shorter tables are given for $x=10^{-n}\,(10^{-n})9\times10^{-n}$, $n=5,4,3,2,1$, 15D; $x=0(.00001)0.01$, 12D. January 11, 1955. 278 p. (A reissue of MT4.)

AMS44. Table of salvo kill probabilities for square targets.

Let $\{x,y,\sigma\}$ denote the circular normal distribution centered at (x,y) with standard deviation σ in each direction. A salvo of N bombs is "centered" at (ξ,η), which has the distribution $\{0,y_0,\sigma_A\}$. The bombs of the salvo are independently distributed according to $\{\xi,\eta,\sigma_R\}$. If a bomb hits the square target $(x^2\leq1, y^2\leq1)$, there is chance P_K of a kill. Assuming the bombs act independently, the chance P_{SK} that the salvo kills the target is computed for $P_K=0.1,0.4,0.7,1$; $y_0=0,1,2,4,7,11,16,22$; $\sigma_A,\sigma_R=1,2,4,7,11,16,22$; $N=1,5,10,25,50,100,150,200$. The entries are 4D, with possible error of two in the last place. December 20. 1954. 33 p.

AMS45. Table of hyperbolic sines and cosines, $x=2$ to $x=10$.

The functions are tabulated for x ranging from 2 to 10 at intervals of 0.001, to 9 significant figures. This is an extension of AMS36. November 15, 1955. 81 p.

AMS46. Tables of the descending exponential, $x=2.5$ to $x=10$.

The descending exponential e^{-x} is tabulated for x ranging from 2.5 to 10 at intervals of 0.001, to 20 decimal places. This is an extension of AMS14. November 15, 1955. 76 p.

AMS47. Contributions on partially balanced incomplete block designs with two associate classes.......................... Willard H. Clatworthy

A group of closely related papers deals with the combinatorial properties and modes for the construction of incomplete block designs; tables of 75 experimental designs are included. December 12, 1956. 70 p.

AMS48. Fractional factorial experiment designs for factors at two levels.

118 fractional factorial plans of the $1/2^s\times2^n$ series are given for a range of $s=1(1)8$ and $n=5(1)16$. April 15, 1957. 85 p.

4. PRICE LIST OF AVAILABLE PUBLICATIONS

The following is a list of National Bureau of Standards publications issued from 1901 to date that may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at the prices given. See "HOW TO PURCHASE NBS PUBLICATIONS", page 1.

The tabulation brings up to date the information given in the basic Circular 460 and should be referred to instead of Circular 460 to determine if a given publication is still available.

National Bureau of Standards publications that are out of print are available for reference use in many of the leading scientific, technical, educational, and Government depository libraries.

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1516	5	1608	10	1689	10	1766	10
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1524	10	1612	5	1697	5	1769	15
1526	5	1614	10	1698	5	1770	10
1527	10	1616	5	1699	10	1773	10
1528	5	1617	5	1701	10	1776	10
1529	5	1618	10	1702	5	1778	*
1531	5	1619	5	1704	15	1779	15
1536	10	1620	*	1705	5	1781	10
1537	5	1622	5	1707	5	1783	10
1539	10	1623	5	1710	5	1784	10
1540	10	1626	10	1711	5	1785	10
1541	5	1628	5	1713	5	1791	10
1542	5	1630	15	1714	5	1795	25
1545	10	1631	10	1715	5	1799	5
1546	10	1635	5	1718	10	1800	10
1547	5	1638	5	1719	5	1801	10
1551	10	1640	5	1721	5	1802	10
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1554	10	1643	5	1727	5	1805	5
1555	5	1644	5	1730	10	1808	10
1556	5	1647	20	1732	15	1809	10
1558	5	1649	5	1733	10	1810	10
1559	10	1652	10	1734	10	1811	10
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1839	10	1960	10	2043	5	2121	15
1840	15	1961	15	2044	5	2122	15
1841	15	1964	10	2045	5	2123	10
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1851	10	1968	10	2050	10	2126	10
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1862	15	1976	10	2062	*	2134	10
1863	*	1977	10	2063	5	2137	10
1864	*	1979	10	2064	5	2139	10
1867	15	1980	10	2065	10	2140	10
1870	15	1981	10	2067	10	2141	10
1871	15	1982	10	2068	5	2142	10
1872	10	1983	10	2069	15	2143	15
1873	5	1984	10	2072	10	2144	10
1876	15	1987	10	2073	10	2145	10
1877	10	1989	10	2074	10	2146	10
1879	10	1991	10	2075	5	2147	10
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1885	10	1994	10	2078	10	2149	15
1886	10	1996	10	2079	10	2150	10
1888	10	1997	10	2080	10	2151	10
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1898	10	2000	20	2082	10	2153	10
1901	10	2001	10	2083	10	2154	10
1904	10	2002	10	2084	10	2155	10
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1910	10	2008	10	2089	15	2160	10
1912	10	2009	10	2090	10	2161	10
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1919	10	2013	10	2093	10	2170	10
1920	10	2016	10	2094	10	2171	10
1922	15	2017	5	2095	10	2172	10
1924	10	2018	10	2096	10	2173	10
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2192	10	2248	10	2304	10	2356	10
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2195	10	2250	5	2306	10	2358	10
2196	10	2251	10	2307	5	2360	5
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2203	10	2258	15	2314	10	2365	15
2204	10	2259	10	2315	10	2366	10
2205	10	2260	10	2316	10	2367	10
3306	10	2261	10	2317	10	2368	10
2207	15	2262	10	2318	5	2369	10
2208	10	2263	5	2319	10	2370	10
2209	10	2265	10	2320	10	2373	10
2210	20	2266	25	2322	10	2374	10
2211	10	2267	10	2323	10	2375	10
2212	10	2268	10	2324	10	2376	10
2213	10	2269	5	2325	5	2377	5
2214	10	2270	10	2326	10	2378	10
2215	*	2271	10	2327	5	2380	10
2216	10	2272	10	2328	*	2381	15
2217	10	2274	10	2329	10	2382	5
2218	10	2275	10	2330	10	2383	15
2219	10	2276	10	2331	10	2384	10
2220	10	2278	20	2333	10	2385	5
2221	10	2279	20	2334	5	2387	10
2222	15	2281	10	2335	10	2388	15
2223	10	2282	10	2336	10	2389	10
2224	10	2284	*	2337	10	2390	5
2225	10	2286	10	2338	5	2391	5
2228	15	2287	10	2339	5	2392	10
2229	10	2288	5	2340	10	2393	10
2230	10	2289	10	2342	10	2394	10
2232	15	2290	10	2343	5	2396	15
2233	15	2291	10	2344	10	2397	15
2235	10	2292	5	2345	10	2398	10
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[a] Supplement for 7-1-25 to 12-31-31.
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18	10
19 superseded by BMS116	----------
20	10
25	25
27	10
34	15
38	10
39	10
49	25
52	15
56	10
58	15
64	10
66	40
67	20
69	10
70	20
71	30
73	10
74	20
78	35
79	20
80	25
81	40
82	25
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95	30
102	15
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106	15
108	15
109	70
110	20
112	15
113	15
114	25
115	20
116	20
117	25
118	25
119	25
120	15
121	30
122	20
124	15
125	30
126	20
127	15
128	20
129	10
130	15
131	15
132	25
133	25
135	15
136	15
137	15
138	20
139	25
140 (2d ed.)	30
141	20
142	25
143	35
144	40
144 supplement----------	5
145	20
146	15
147	20
148	15
149	20
150	15

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43	$2. 25	60	20
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5. AUTHORS INDEX, JUNE 1, 1947, TO JUNE 30, 1957

A

Abramowitz, M., Tables of the functions $\int_0^\phi \sin^{1/3} x\,dx$ and $(4/3)\sin^{-4/3}\phi\int_0^\phi \sin^{1/3} x\,dx$. J **47**, 288 (1951) RP2255.

Abrams, E., Microbiological deterioration of organic materials: Its prevention and methods of test. (1948) M188.

Achenbach, P. R., Temperatures in a test bungalow with some radiant and jacketed space heaters. (1949) BMS114.

Achenbach, P. R., Dill, R. S., Performance of a coal-fired boiler converted to oil. (1948) BMS111.

Achenbach, P. R., Martin, H. R., Dill, R. S., Effect of edge insulation upon temperature and condensation on concrete-slab floors. (1953) BMS138.

Achenbach, P. R., Tierney, E. M., A study of a baseboard convector heating system in a test bungalow. (1949) BMS115.

Achhammer, B. G., Harvey, M. R., Stewart, J. E., Index of refraction and particle size as factors in the infrared spectrophotometry of polyvinyl chloride. J **56**, 225 (1956) RP2670.

Achhammer, B. G., Reiney, M. J., Reinhart, F. W., Study of degradation of polystyrene, using infrared spectrophotometry. J **47**, 116 (1951) RP2235.

Achhammer, B. G., Reiney, M. J., Tryon, M., Study of degradation of polystyrene, using ultraviolet spectrophotometry. J **51**, 155 (1953) RP2445.

Achhammer, B. G., Reinhart, F. W., Kline, G. M., Mechanism of the degradation of polyamides. J **46**, 391 (1951) RP2210.

Acquista, N., Mann, D. E., Plyler, E. K., Vibrational spectra of tetrafluoroethylene and tetrachloroethylene. J **52**, 67 (1954) RP2474.

Acquista, N., Plyler, E. K., Calibrating wavelengths in the region 0.6 to 2.6 microns. J **49**, 13 (1952) RP2338.

Infrared absorption spectra of cyclohydrocarbons. J **43**, 37 (1949) RP2002.

Infrared absorption spectra of five halomethanes. J **48**, 92 (1952) RP2290.

Infrared measurements from 50 to 125 microns. J **56**, 149 (1956) RP2660.

Infrared properties of cesium bromide prisms. J **49**, 61 (1952) RP2343.

Acquista, N., Plyler, E. K., Smith, W. H., Infrared spectra of bromochloromethane, dibromomethane, tribromochloromethane, and tetrabromomethane. J **44**, 503 (1950) RP2097.

Adams, G. H., Schubauer, G. B., Effect of support on the performance of vane anemometers. J **40**, 275 (1948) RP1872.

Albrecht, I., Lamb, J. J., Axilrod, B. M., Mechanical properties of laminated plastics at −70°, 77°, and 200° F. J **43**, 257 (1949) RP2028.

Allen, H. C., Jr., Blaine, L. R., Plyler, E. K., Vibrational constants of acetylene-d_2. J **56**, 279 (1956) RP2675.

Allen, H. C., Jr., Naylor, R. E., Plyler, E. K., The deuterium-sulfide band at 4,590 cm^{-1}. J **53**, 321 (1954) RP2549.

Allen, H. C., Jr., Plyler, E. K., Infrared spectrum of hydrogen sulfide in the 6,290-cm^{-1} region. J **52**, 205 (1954) RP2490.

Allen, H. C., Jr., Plyler, E. K., Tidwell, E. D., Infrared spectra of polychlorobenzenes. J **58**, 255 (1957) RP2758.

Allen, H. C., Jr., Tidwell, E. D., Plyler, E. K., Infrared spectrum of acetylene. J **57**, 213 (1956) RP2711.

Allred, C. M., Chart for the TE_{11} mode piston attenuator. J **48**, 109 (1952) RP2293.

Allshouse, C. C., Florence, J. M., Glaze, F. W., Hahner, C. H., Absorption of near-infrared energy by certain glasses. J **45**, 121 (1950) RP2118.

Ambler, E., Hudson, R. P., An examination of the helium vapor-pressure scale of temperature, using a magnetic thermometer. J **56**, 99 (1956) RP2654.

An examination of the 1955 helium vapor-pressure scales of temperature. J **57**, 23 (1956) RP2689.

Anderson, R. E., Kessler, D. W., Influence of the wash from bronze on the weathering of marble. (1953) BMS137.

Stone exposure test wall. (1951) BMS125.

Studies of stone-setting mortars. (1953) BMS139.

Appel, W. D., Forziati, F. H., Stone, W. K., Rowen, J. W., Cotton powder for infrared transmission measurements. J **45**, 109 (1950) RP2116.

Appel, W. D., Schaffer, R., Forziati, F. H., Reactions at wet-dry interfaces on fibrous materials. J **54**, 103 (1955) RP2570.

Armstrong, G. T., Vapor pressure of nitrogen. J **53**, 263 (1954) RP2543.

Armstrong, G. T., Brickwedde, F. G., Scott, R. B., Vapor pressures of the methanes. J **55**, 39 (1955) RP2603.

Armstrong, G. T., Goldstein, J. M., Roberts, D. E., Liquid-vapor phase equilibrium in solutions of oxygen and nitrogen at pressures below one atmosphere. J **55**, 265 (1955) RP2629.

Arnold, R. D., Hoge, H. J., Vapor pressures of hydrogen deuterium and hydrogen deuteride, and dew-point pressures of their mixtures. J **47**, 63 (1951) RP2228.

Attix, F. H., DeLaVergne, L., Plate-separation requirements for standard free-air ionization chambers. J **53**, 393 (1954) RP2558.

Axilrod, B. M., Dielectric relaxation for a three-dimensional rotator in a crystalline field: Theory for a general six-site model. J **56**, 81 (1956) RP2651.

Axilrod, B. M., Hoffman, J. D., Dielectric relaxation for spherical molecules in a crystalline field: Theory for two simple models. J **54**, 357 (1955) RP2598.

Theory of dielectric relaxation for the three-dimensional polar rotator: Lattice models leading to bimodal loss curves. J **58**, 61 (1957) RP2735.

Axilrod, B. M., Lamb, J. J., Albrecht, I., Mechanical properties of laminated plastics at −70°, 77°, and 200° F. J **43**, 257 (1949) RP2028.

Axilrod, B. M., Sherman, M. A., Strength of heat-resistant laminated plastics up to 300° C. J **45**, 65 (1950) RP2114.

Axilrod, B. M., Sherman, M. A., Cohen, V., Wolock, I., Effects of moderate biaxial stretch-forming on tensile and crazing properties of acrylic plastic glazing. J **49**, 331 (1952) RP2369.

B

Badger, F. T., Tilton, L. W., Rosberry, F. W., Refractive uniformity of a borosilicate glass after different annealing treatments. J **49**, 21 (1952) RP2340.

Bagg, T. C., Stair, R., Johnston, R. G., Continuous measurement of atmospheric ozone by an automatic photoelectric method. J **52**, 133 (1954) RP2481.

Spectral distribution of energy from the sun. J **53**, 113 (1954) RP2523.

Bailin, L. L., Analysis of the effect of the discontinuity in a bifurcated circular guide upon plane longitudinal waves. J **47**, 315 (1951) RP2258.

Baker, J. L., Bennett, J. A., Effects of prior static and dynamic stresses on the fatigue strength of aluminum alloys. J **45**, 449 (1950) RP2157.

Ball, A. F., Douglas, T. B., Furukawa, G. T., McCoskey, R. E., Calorimetric properties of normal heptane from 0° to 520°K. J **53**, 139 (1954) RP2526.

Ball, A. F., Douglas, T. B., Ginnings, D. C., Heat capacity of liquid mercury between 0° and 450° C; calculation of certain thermodynamic properties of the saturated liquid and vapor. J **46**, 334 (1951) RP2204.

Ball, A. F., Ginnings, D. C., Douglas, T. B., Heat capacity of sodium between 0° and 900° C, the triple point and heat of fusion. J **45**, 23 (1950) RP2110.

Ball, A. F., Ginnings, D. C., Vier, D. T., Calorimetric determination of the half-life of polonium. J **50**, 75 (1953) RP2392.

Ballinger, J. C., Scribner, B. F., Spectrochemical analysis of bronze by a porous electrode method. J **47**, 221 (1951) RP2246.

Barceló, J. R., Infrared absorption spectra of hexafluoroethane and of chloropentafluoroethane. J **44,** 521 (1950) RP2099.

Barclay, C., Sogn, L. T., Fundamental techniques in the frequency adjustment of quartz crystals. (1949) C480.
Reference data for orienting quartz plates by X-ray diffraction. (1953) C543.

Barrow, G. M., Epstein, M. B., Pitzer, K. S., Rossini, F. D., Heats, equilibrium constants, and free energies of formation of the dimethcyclopentanes. J **43,** 245 (1949) RP2026.

Barsis, A. P., Herbstreit, J. W., Hornberg, K. O., Cheyenne mountain tropospheric propagation experiments. (1955) C554.

Bass, A. M., Benedict, W. S., Plyler, E. K., Flame-emission spectrum of water vapor in the 1.9-micron region. J **52,** 161 (1954) RP2485.

Bass, A. M., Broida, H. P., A spectrophotometric atlas of the $^2\Sigma^+—^2\Pi$ transition of OH. (1953) C541.

Bates, R. G., Activity coefficients in aqueous mixtures of phosphates with sodium chloride, sodium bromide, and sodium iodide, and the pH of phosphate buffer solutions. J **39,** 411 (1947) RP1837.
First dissociation constant of phosphoric acid from 0° to 60° C; limitations of the electromotive force method for moderately strong acids. J **47,** 127 (1951) RP2236.

Bates, R. G., Bower, V. E., Dissociation constant of piperidinium ion from 0° to 50° C and related thermodynamic quantities. J **57,** 153 (1956) RP2705.
Standard potential of the silver-silver-chloride electrode from 0° to 95° C and the thermodynamic properties of dilute hydrochloric acid solutions. J **53,** 283 (1954) RP2546.
pH values of the Clark and Lubs buffer solutions at 25° C. J **55,** 197 (1955) RP2619.

Bates, R. G., Bower, V. E., Miller, R. G., Smith, E. R., pH of solutions of potassium hydrogen *d*-tartrate from 0° to 60° C. J **47,** 433 (1951) RP2268.

Bates, R. G., Bower, V. E., Smith, E. R., Calcium hydroxide as a highly alkaline pH standard. J **56,** 305 (1956) RP2680.
pH of solutions of potassium tetroxalate from 0° to 60° C. J **51,** 189 (1953) RP2450.

Bates, R. G., Canham, R. G., Resolution of the dissociation constants of *d*-tartaric acid from 0° to 50° C. J **47,** 343 (1951) RP2260.

Bates, R. G., Pinching, G. D., Acidic dissociation constant and related thermodynamic quantities for monoethanolammonium ion in water from 0° to 50° C. J **46,** 349 (1951) RP2205.
Acidic dissociation constant of ammonium ion at 0° to 50° C, and the base strength of ammonia. J **42,** 419 (1949) RP1982.
Dissociation constants of weak bases from electromotive-force measurements of solutions of partially hydrolyzed salts. J **43,** 519 (1949) RP2043.
First dissociation constant of succinic acid from 0° to 50° C and related thermodynamic quantities. J **45,** 444 (1950) RP2156.
Second dissociation constant of oxalic acid from 0° to 50° C and the pH of certain oxalate buffer solutions. J **40,** 405 (1948) RP1885.
Second dissociation constant of succinic acid from 0° to 50° C. J **45,** 322 (1950) RP2142.

Bates, R. G., Pinching, G. D., Smith, E. R., pH standards of high acidity and high alkalinity and the practical scale of pH. J **45,** 418 (1950) RP2153.

Beatty, R. W., Cascade-connected attenuators. J **45,** 231 (1950) RP2129.
Mismatch errors in the measurement of ultra-high-frequency and microwave variable attenuators. J **52,** 7 (1954) RP2465.

Beatty, R. W., Reggia, F., An improved method of measuring efficiencies of ultra-high-frequency and microwave bolometer mounts. J **54,** 321 (1955) RP2594.

Bechtoldt, C. J., Vacher, H. C., Delta ferrite-austenite reactions and the formation of carbide, sigma, and chi phases in 18 chromium-8 nickel-3.5 molybdenum steels. J **53,** 67 (1954) RP2517.
Phase-diagram study of alloys in the iron-chromium-molybdenum-nickel system. J **58,** 7 (1957) RP2728.

Beckett, C. W., Brown, L. M., Friedman, A. S., Bibliography of research on deuterium and tritium compounds 1945 to 1952. (1956) C562.

Beckett, C. W., Hilsenrath, J., Benedict, W. S., Fano, L., Hoge, H. J., Masi, J. F., Nuttall, R. L., Touloukian, Y. S., Woolley, H. W., Tables of thermal properties of gases. (1955) C564.

Beckett, C. W., Kilpatrick, J. E., Prosen, E. J., Pitzer, K. S., Rossini, F. D., Heats, equilibrium constants, and free energies of formation of the C_3 to C_5 diolefins, styrene, and the methylstyrenes. J **42,** 225 (1949) RP1964.

Beckett, C. W., Kilpatrick, J. E., Werner, H. G., Pitzer, K. S., Rossini, F. D., Heats, equilibrium constants, and free energies of formation of the alkylcyclopentanes and alkylcyclohexanes. J **39,** 523 (1947) RP1845.

Behrent, L. F., Fabrication of radio-frequency micropotentiometer resistance elements. J **51,** 1 (1953) RP2426.

Behrent, L. F., Selby, M. C., A bolometer bridge for standardizing radio-frequency voltmeters. J **44,** 15 (1950) RP2055.

Bekkedahl, N., Volume dilatometry. J **43,** 145 (1949) RP2016.

Bekkedahl, N., Quinn, F. A., Jr., Zimmerman, E. W., Vulcanization of synthetic rubbers by the Peachey process. J **40,** 1 (1948) RP1850.

Belknap, M. A., Gibson, K. S., Permanence of glass standards of spectral transmittance. J **44,** 463 (1950) RP2093.

Belknap, M. A., Judd, D. B., Plaza, L., A suggested relocation and respacing of the Union colorimeter scale for lubricating oil and petrolatum. J **44,** 559 (1950) RP2103.

Belknap, M. A., Keegan, H. J., Cordrey, D. J., Spectral transmissive properties of five selected optical glasses. J **52,** 305 (1954) RP2505.

Bell, R. K., Bendigo, B. B., Bright, H. A., Spectrophotometric determination of bismuth in lead-base and tin-base alloys. J **47,** 252 (1951) RP2250.

Bender, E. D., Mitchell, N. D., Ryan, J. V., Fire resistance of shutters for moving-stairway openings. (1952) BMS129.

Bender, E. W., Ryan, J. V., Fire endurance of open-web steel-joist floors with concrete slabs and gypsum ceilings. (1954) BMS141.

Bendigo, B. B., Bell, R. K., Bright, H. A., Spectrophotometric determination of bismuth in lead-base and tin-base alloys. J **47,** 252 (1951) RP2250.

Benedict, W. S., Bass, A. M., Plyler, E. K., Flame-emission spectrum of water vapor in the 1.9-micron region. J **52,** 161 (1954) RP2485.

Benedict, W. S., Claassen, H. H., Shaw, J. H., Absorption spectrum of water vapor between 4.5 and 13 microns. J **49,** 91 (1952) RP2347.

Benedict, W. S., Hilsenrath, J., Beckett, C. W., Fano, L., Hoge, H. J., Masi, J. F., Nuttall, R. L., Touloukian, Y. S., Woolley, H. W., Tables of thermal properties of gases. (1955) C564.

Benedict, W. S., Nelson, R. C., Plyler, E. K., Absorption spectra of methane in the near infrared. J **41,** 615 (1948) RP1944.

Benedict, W. S., Plyler, E. K., Absorption spectra of water vapor and carbon dioxide in the region of 2.7 microns. J **46,** 246 (1951) RP2194.
Fine structure in some infrared bands of methylene halides. J **49,** 1 (1952) RP2336.
Infrared emission spectra of cyanide and dicarbon radicals. J **53,** 161 (1954) RP2528.
Infrared spectra of eighteen halogen-substituted methanes. J **47,** 202 (1951) RP2245.

Bennett, J. A., A study of fatigue in metals by means of X-ray strain measurement. J **46,** 457 (1951) RP2214.

Bennett, J. A., Baker, J. L., Effects of prior static and dynamic stresses on the fatigue strength of aluminum alloys. J **45,** 449 (1950) RP2157.

Bennett, J. A., Quick, G. W., Mechanical failures of metals in service. (1954) C550.

Bennett, J. A., Vacher, H. C., Calibration of X-ray measurement of strain. J **40,** 285 (1948) RP1874.

Bennett, J. A., Weinberg, J. G., Fatigue notch sensitivity of some aluminum alloys. J **52,** 235 (1954) RP2495.

Berger, M. J., Penetration of gamma radiation from a plane monodirectional oblique source. J **56,** 111 (1956) RP2656.
Reflection and transmission of gamma radiation by barriers: Monte Carlo calculation by a

collision-density method. J **55**, 343 (1955) RP2640.

Berger, M. J., Doggett, J., Reflection and transmission of gamma radiation by barriers: Semianalytic Monte Carlo calculation. J **56**, 89 (1956) RP2653.

Response function of thallium-activated sodium-iodide scintillation counters. J **56**, 365 (1956) RP2686.

Bergholtz, W. A., Determination of metallic beryllium and beryllium carbide in beryllium metal. J **48**, 201 (1952) RP2306.

Bers, L., On mildly nonlinear partial difference equations of elliptic type. J **51**, 229 (1953) RP2455.

Bestul, A. B., Decker, G. E., White, H. S., Comparison of viscosities of rubbers from the McKee worker-consistometer and from the Mooney viscometer. J **46**, 283 (1951) RP2196.

Birmingham, B. W., Brown, E. H., Class, C. R., Schmidt, A. F., Vessels for the storage and transport of liquid hydrogen. J **58**, 243 (1957) RP2757.

Birnbaum, G., Bussey, H. E., Measurement of variations in atmospheric refractive index with an airborne microwave refractometer. J **51**, 171 (1953) RP2447.

Bishop, D. L., Wells, L. S., Clarke, W. F., Newman, E. S., Investigation of failures of white-coat plaster. (1951) BMS121.

Black, M. H., Florence, J. M., Glaze, F. W., Infrared transmittance of some calcium aluminate and germanate glasses. J **55**, 231 (1955) RP2625.

Transmission of near-infrared energy by some two- and three-component glasses. J **50**, 187 (1953) RP2408.

Black, M. H., Hubbard, D., Holley, S. F., Rynders, G. F., Electrode function (pH response), hygroscopicity, and chemical durability of soda-potash-silica glasses. J **46**, 168 (1951) RP2189.

Black, M. H., Hubbard, D., Rynders, G. F., Electrode function (pH response), hygroscopicity, and chemical durability of soda-lead oxide-silica glasses. J **45**, 430 (1950) RP2154.

Blackburn, G. F., Bibliography on ignition and spark-ignition systems. (1956) C580.

Blaine, L. R., Allen, H. C., Jr., Plyler, E. K., Vibrational constants of acetylene-d_2. J **56**, 279 (1956) RP2675.

Blaine, L. R., Plyler, E. K., Nowak, M., Reference wavelengths for calibrating prism spectrometers. J **58**, 195 (1957) RP2752.

Blaine, L. R., Plyler, E. K., Tidwell, E. D., Infrared absorption and emission spectra of carbon monoxide in the region from 4 to 6 microns. J **55**, 183 (1955) RP2617.

Precise measurement of wavelengths in infrared spectra. J **55**, 279 (1955) RP2630.

Blaine, R. L., Evans, D. N., Litvin, A., Figlia, A. C., Properties of some masonry cement. J **51**, 11 (1953) RP2427.

Blaine, R. L., Hunt, C. M., Rowen, J. W., Submicroscopic structure of cellulose from nitrogen sorption measurements. J **43**, 547 (1949) RP2048.

Blaine, R. L., Rowen, J. W., Sorption of nitrogen and water vapor on textile fibers. J **39**, 479 (1947) RP1842.

Blaine, R. L., Valis, H. J., Studies of the Mattson shot classifier. J **41**, 371 (1948) RP1931.

Surface available to nitrogen in hydrated portland cements. J **42**, 257 (1949) RP1967.

Blaine, R. L., Weir, C. E., Hunt, C. M., Behavior of cements and related materials under hydrostatic pressures up to 10,000 atmospheres. J **56**, 39 (1956) RP2646.

Blair, M. G., Peffer, E. L., Testing of hydrometers. (1949) C477.

Blanch, G., On the numerical solution of parabolic partial differential equations. J **50**, 343 (1953) RP2424.

Blanch, G., Siegel, R., Table of modified Bernoulli polynomials. J **44**, 103 (1950) RP2060.

Blanpied, W. A., Powell, R. L., Thermal conductivity of metals and alloys at low temperatures: A review of the literature. (1954) C556.

Bloom, E. G., Mohler, F. L., Lengel, J. H., Wise, C. E., Mass spectra of octanes. J **41**, 129 (1948) RP1912.

Metastable transitions in mass spectra of fifty-six hydrocarbons. J **40**, 437 (1948) RP1888.

Bloom, E. G., Mohler, F. L., Wells, E. J., Jr., Lengel, J. H., Wise, C. E., Doubly charged ion spectra in mass spectra of hydrocarbons. J **42**, 369 (1949) RP1975.

Bloom, E. G., Mohler, F. L., Williamson, L., Wise, C. E., Wells, E. J. Mass spectra of C_5H_8 isomers. J **43**, 533 (1949) RP2045.

Bloom, E. G., Mohler, F. L., Williamson, L., Wise, C. E., Wells, E. J., Dean, H. M., Mass spectra of nonanes. J **44**, 291 (1950) RP2078.

Bloom, E. G., Mohler, F. L., Wise, C. E., Wells, E. J., Metastable transitions in mass spectra of hydrocarbons. J **43**, 65 (1949) RP2005.

Blum, J., A problem in precision cam design. J **45**, 502 (1950) RP2164.

Bogue, R. H., Some recent advances in our understanding of the chemistry of portland cement. J **39**, 177 (1947) RP1822.

Bogue. R. H., Eubank, W. R., Preliminary study of portions of the systems Na_2O-CaO-Al_2O_3-Fe_2O_3 and Na_2O-CaO-Fe_2O_3-SiO_2. J **40**, 225 (1948) RP1867.

Studies on the flame photometer for the determination of Na_2O and K_2O in portland cement. J **43**, 173 (1949) RP2019.

Bogue, R. H., Taylor, W. C., A sulfate susceptibility test for portland cements. J **45**, 223 (1950) RP2128.

Boone, T. H., Sigler, P. A., Geib, M. N., Measurement of the slipperiness of walkway surfaces. J **40**, 339 (1948) RP1879.

Borysko, E., Newman, S. B., Swerdlow, M., Ultramicrotomy by a new method. J **43**, 183 (1949) RP2020.

Bouche, R. R., Levy, S., Calibration of vibration pickups by the reciprocity method. J **57**, 227 (1956) RP2714.

Bovey, H. L., Shafer, M. R., Applications of dimensional analysis to spray-nozzle performance data. J **52**, 141 (1954) RP2482.

Laboratory flow tests of fixed-spray nozzles with hydrocarbons and with air. J **43**, 449 (1949) RP2035.

Bovey, H. L., Shafer, M. R., Fiock, E. F., Van Lone, R. B., Correcting for density and viscosity of incompressible fluids in float-type flowmeters. J **47**, 227 (1951) RP2247.

Bower, V. E., Bates, R. G., Dissociation constant of piperidinium ion from 0° to 50° C and related thermodynamic quantities. J **57**, 153 (1956) RP2705.

pH values of the Clark and Lubs buffer solutions at 25° C. J **55**, 197 (1955) RP2619.

Standard potential of the silver-silver-chloride electrode from 0° to 95° C and the thermodynamic properties of dilute hydrochloric acid solutions. J **53**, 283 (1954) RP2546.

Bower, V. E., Bates, R. G., Miller, R. G., Smith, E. R., pH of solutions of potassium hydrogen *d*-tartrate from 0° to 60° C. J **47**, 433 (1951) RP2268.

Bower, V. E., Bates, R. G., Smith, E. R., Calcium hydroxide as a highly alkaline pH standard. J **56**, 305 (1956) RP2680.

pH of solutions of potassium tetroxalate from 0° to 60° C. J **51**, 189 (1953) RP2450.

Bower, V. E., Torgesen, J. L., Smith, E. R., Boiling points of aqueous solutions of dextrose within the pressure range of 200 to 1,500 millimeters. J **45**, 458 (1950) RP2158.

Bowman, H. A., Determination of very small changes in rate over intervals of several days in mechanical timepieces. J **45**, 218 (1950) RP2127.

Bozman, W. R., Corliss, C. H., Meggers, W. F., Trees, R. E., An intersystem transition in the first spectrum of beryllium. J **50**, 131 (1953) RP2399.

Bozman, W. R., Meggers, W. F., Scribner, B. F., Absorption and emission spectra of promethium. J **46**, 85 (1951) RP2179.

Bozman, W. R., Trees, R. E., Matrices of spin-orbit interaction of the electron configuration $d^4\,s$. J **58**, 95 (1957) RP2739.

Brabant, J. M., Caswell, R. S., Schwebel, A., Disintegration rate of carbon-14. J **53**, 27 (1954) RP2513.

Bradford, W. R., Wyckoff, H. O., Kennedy, R. J., Broad and narrow beam attenuation of 500 to 1,400-kilovolt X-rays in lead and concrete. J **41**, 223 (1948) RP1920.

Bradley, J. C., Haar, L., Friedman, A. S., Ideal gas thermodynamic functions of the isotopic hydrogen cyanides. J **56**, 197 (1956) RP2668.

Ideal gas thermodynamic functions of the isotopic hydrogen sulfides. J **55**, 285 (1955) RP2631.

Bradt, P., Dibeler, V. H., Mohler, F. L., A new technique for the mass spectrometric study of the pyrolysis products of polystyrene. J **50**, 201 (1953) RP2410.

Bradt, P., Madorsky, S. L., Straus, S., Concentration of isotopes of mercury in countercurrent molecular stills. J **41**, 205 (1948) RP1918.

Bradt, P., Mohler, F. L., Mass spectra of thermal degradation products of polymers. J **55**, 323 (1955) RP2637.

Bradt, P., Mohler, F. L., Dibeler, V. H., Mass spectrum of sulfur vapor. J **57**, 223 (1956) RP2713.

Branscomb, L. M., Smith, S. J., Atomic negative-ion-photodetachment cross-section and affinity measurements. J **55**, 165 (1955) RP2615.

Brauer, G. M., Copeland, H. I., Jr., Sweeney, W. T., Forziati, A. F., Setting reaction of zinc oxide and eugenol. J **55**, 133 (1955) RP2611.

Brauer, G. M., Schoonover, I. C., Sweeney, W. T., Effect of water on the induction period of the polymerization of methyl methacrylate. J **49**, 359 (1952) RP2372.

Breckenridge, R. G., Hosler, W. R., Titanium dioxide rectifiers. J **49**, 65 (1952) RP2344.

Breit, G., Friedman, F. L., Calculations on countercurrent electromigration. J **39**, 397 (1947) RP1836.

Brekke, G. N., Dunham, J. W., Thompson, G. N., Live loads on floors in buildings. (1952) BMS133.

Brenner, A., Microhardness tester for metals at elevated temperatures. J **46**, 126 (1951) RP2185.

Brenner, A., Burkhead, P., Jennings, C., Physical properties of electrodeposited chromium. J **40**, 31 (1948) RP1854.

Brenner, A., Burkhead, P., Seegmiller, E., Electrodeposition of tungsten alloys containing iron, nickel, and cobalt. J **39**, 351 (1947) RP1834.

Brenner, A., Couch, D. E., Williams, E. K., Electrodeposition of alloys of phosphorus with nickel or cobalt. J **44**, 109 (1950) RP2061.

Brenner, A., Kellogg, E., An electric gage for measuring the inside diameter of tubes. J **42**, 461 (1949) RP1986.

Magnetic measurement of the thickness of composite copper and nickel coatings on steel. J **40**, 295 (1948) RP1875.

Brenner, A., Riddell, G., Deposition of nickel and cobalt by chemical reduction. J **39**, 385 (1947) RP1835.

Brenner, A., Senderoff, S., A spiral contractometer for measuring stress in electrodeposits. J **42**, 89 (1949) RP1953.

Calculation of stress in electrodeposits from the curvature of a plated strip. J **42**, 105 (1949) RP1954.

Brewster, J. F., Isbell, H. S., Holt, N. B., Frush, H. L., Behavior of certain sugars and sugar alcohols in the presence of tetraborates—correlation of optical rotation and compound formation. J **40**, 129 (1948) RP1862.

Brickwedde, F. G., Armstrong, G. T., Scott, R. B., Vapor pressures of the methanes. J **55**, 39 (1955) RP2603.

Brickwedde, F. G., Jessup, R. S., Wechsler, M. T., Heat of fluorination of cobaltous fluoride, and the heats of a reaction of cobaltic fluoride with hydrogen and with bis(trifluoromethyl) benzene ($\alpha,\alpha,\alpha,\alpha',\alpha',\alpha'$-hexafluoroxylene). J **44**, 457 (1950) RP2092.

Brickwedde, F. G., Woolley, H. W., Scott, R. B., Compilation of thermal properties of hydrogen in its various isotopic and orthopara modifications. J **41**, 379 (1948) RP1932.

Brickwedde, L. H., Properties of aqueous solutions in perchloric acid. J **42**, 309 (1949) RP1971.

Bright, H. A., Bendigo, B. B., Bell, R. K., Spectrophotometric determination of bismuth in lead-base and tin-base alloys. J **47**, 252 (1951) RP2250.

Bright, H. A., Hague, J. L., Brown, E. D., Photometric determination of copper in iron and steel with diethyldithiocarbamate. J **47**, 380 (1951) RP2265.

Separation of titanium, tungsten, molybdenum, and niobium by anion exchange. J **53**, 261 (1954) RP2542.

Bright, H. A., Hague, J. L., Maczkowske, E. E., Determination of nickel, manganese, cobalt, and iron in high-temperature alloys, using anion-exchange separations. J **53**, 353 (1954) RP2552.

Bright, H. A., Hague, J. L., Paulson, R. A., Determination of nitrogen in steel. J **43**, 201 (1949) RP2021.

Brockman, M. R., Resistance of flow in Teflon and brass tubes. J **58**, 51 (1957) RP2734.

Brode, W. R., Wyman, G. M., Absorption spectra of thioindigo dyes in benzene and chloroform. J **47**, 170 (1951) RP2241.

Broida, H. P., Bass, A. M., A spectrophotometric atlas of the $^2\Sigma^+-^2\Pi$ transition of OH. (1953) C541.

Broida, H. P., Chapman, M. W., Bibliography on nitrogen 15. (1956) C575.

Broida, H. P., Morowitz, H. J., Selgin, M., Optical spectroscopic determination of hydrogen isotopes in aqueous mixtures. J **52**, 293 (1954) RP2503.

Brombacher, W. G., Lashof, T. W., Bibliography and index on dynamic pressure measurement. (1955) C558.

Brombacher, W. G., Smith, J. F., Van der Pyl, L. M., Guide to instrumentation literature. (1955) C567.

Brombacher, W. G., Wexler, A., Methods of measuring humidity and testing hygrometers. (1951) C512.

Brooks, D. B., Howard, F. L., Streets, R. E., Automotive antifreeze. (1956) C576.

Brooks, D. B., Streets, R. E., Automotive antifreezes. (1948) C474.

Brown, D. W., Florin, R. E., Wall, L. A., Hymo, L. A., Michaelsen, J. D., Factors affecting the thermal stability of polytetrafluoroethylene. J **53**, 121 (1954) RP2524.

Brown, D. W., Wall, L. A., Chemical activity of gamma-irradiated polymethyl methacrylate. J **57**, 131 (1956) RP2702.

Brown, E. D., Hague, J. L., Bright, H. A., Photometric determination of copper in iron and steel with diethyldithiocarbamate. J **47**, 380 (1951) RP2265.

Separation of titanium, tungsten, molybdenum, and niobium by anion exchange. J **53**, 261 (1954) RP2542.

Brown, E. H., Birmingham, B. W., Class, C. R., Schmidt, A. F., Vessels for the storage and transport of liquid hydrogen. J **58**, 243 (1957) RP2757.

Brown, L. M., Friedman, A. S., Beckett, C. W., Bibliography of research on deuterium and tritium compounds 1945 to 1952. (1956) C562.

Brown, L. M., Johnson, V. R., Friedman, A. S., Bibliography of research on deuterium and tritium compounds, 1953 and 1954. (1957) C562, Supplement 1.

Brownell, R. M., Forziati, F. H., Hunt, C. M., Surface areas of cottons and modified cottons before and after swelling as determined by nitrogen sorption. J **50**, 139 (1953) RP2401.

Bruce, C. S., Duck, J. T., Pierce, A. R., Effects of substitute fuels on automotive engines. J **41**, 135 (1948) RP1913.

Brunetti, C., Curtis, R. W., Printed circuit techniques. (1947) C468.

Buckley, F., Maryott, A. A., Influence of molecular shape on the dielectric constant of polar liquids. J **53**, 229 (1954) RP2539.

Table of dielectric constants and electric dipole moments of substances in the gaseous state. (1953) C537.

Bunting, E. N., Shelton, G. R., Creamer, A. S., Properties of barium-magnesium titanate dielectrics. J **41**, 17 (1948) RP1899.

Properties of calcium-barium titanate dielectrics, J **43**, 237 (1949) RP2025.

Bunting, E. N., Shelton, G. R., Creamer, A. S., Jaffe, B., Properties of beryllium-barium titanate dielectrics. J **47**, 15 (1951) RP2222.

Burdick, M. D., Lang, S. M., Maxwell, L. H., Porcelains within the beryllia field of the system beryllia-alumina-zirconia. J **45,** 366 (1950) RP2147.

Burdick, M. D., Parker, H. S., Roth, R. S., McGandy, E. L., An X-ray study of the system uranium monocarbide-uranium dicarbide-beryllium carbide. J **54,** 217 (1955) RP2584.

Burdick, M. D., Zweig, B., Moreland, R. E., Linear thermal expansion of artificial graphites to 1,370° C. J **47,** 35 (1951) RP2225.

Burkhead, P., Brenner, A., Jennings, C., Physical properties of electrodeposited chromium. J **40,** 31 (1948) RP1854.

Burkhead, P., Brenner, A., Seegmiller, E., Electrodeposition of tungsten alloys containing iron, nickel, and cobalt. J **39,** 351 (1947) RP1834.

Burnett, H. C., Schaum, J. H., Magnesium-rich side of the magnesium-zirconium constitution diagram. J **49,** 155 (1952) RP2352.

Burnett, H. C., Jr., Vacher, H. C., A note on the formation and structure of iron dendrites in a magnesium alloy. J **44,** 443 (1950) RP2090.

Bussey, H. E., Birnbaum, G., Measurement of variations in atmospheric refractive index with an airborne microwave refractometer. J **51,** 171 (1953) RP2447.

Bussey, W. S., Jensen, M. W., Index to the reports of the National Conference on Weights and Measures. From the first to the thirty-sixth—1905 to 1951. (1952) M203.

Butt, M. T., Streiff, A. J., Zimmerman, J. C., Soule, L. F., Sedlak, V. A., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of 30 hydrocarbons of the API-Standard and API-NBS series. J **41,** 323 (1948) RP1929.

Buzzard, R. W., Beryllium-uranium system. J **50,** 63 (1953) RP2389.

Buzzard, R. W., Cleaves, H. E., Hydrogen embrittlement of steel: Review of the literature. (1951) C511.

Buzzard, R. W., Fickle, D. P., Park, J. J., Silver-uranium system. J **52,** 149 (1945) RP2483.

Buzzard, R. W., Liss, R. B., Fickle, D. P., Titanium-uranium system in the region 0 to 30 atomic percent of titanium. J **50,** 209 (1953) RP2412.

Buzzard, R. W., Park, J. J., Gold-uranium system. J **53,** 291 (1954) RP2547.

Byers, F. C., Sager, E. E., Spectral absorbance of some aqueous solutions in the range 10° to 40° C. J **58,** 33 (1957) RP2731.

C

Cacheris, J. C., Kalmus, H. P., Dropkin, H. A., Nonquantized frequency-modulated altimeter. J **50,** 215 (1953) RP2413.

Cadwallader, E. A., Fookson, A., Mears, T. W., Howard, F. L., Aliphatic halide-carbonyl condensations by means of sodium. J **41,** 111 (1948) RP1909.

Cahill, W. F., Trees, R. E., Rabinowitz, P., Computation of Atomic energy levels: Spectrum of singly-ionized tantalum (Ta II). J **55,** 335 (1955) RP2639.

Callomon, I. G., Simha, R., Gaughan, M. B., Jeppson, H. H., Bibliography of recent research in the field of high polymers. (1950) C498.

Cameron, J. M., Shoub, H., Lee, T. G., Methods of testing small fire extinguishers. (1957) BMS150.

Camin, D. L., Forziati, A. F., Rossini, F. D., Density refractive index, boiling point, and vapor pressure of eight monoolefin (1-alkene), six pentadiene, and two cyclomonoolefin hydrocarbons. J **45,** 406 (1950) RP2151.

Canga, R., Shartiss, L., Surface tension of molten zinc borates. J **43,** 221 (1949) RP2023.

Canham, R. G., Bates, R. G., Resolution of the dissociation constants of *d*-tartaric acid from 0° to 50° C. J **47,** 343 (1951) RP2260.

Capps, F. M., Kirby, R. S., Harman, J. C., Jones, R. N., Effective radio ground-conductivity measurements in the United States. (1954) C546.

Capuano, R., Salzer, H. E., Zucker, R., Table of the zeros and weight factors of the first twenty Hermite polynomials. J **48,** 111 (1952) RP2294.

Carlson, E. T., A study of some strontium aluminates and calcium-strontium aluminate solid solutions. J **54,** 329 (1955) RP2595.
Hydrogarnet formation in the system lime-alumina-silica-water. J **56,** 327 (1956) RP2683.
Some properties of strontium hydroxide and its monohydrate. J **53,** 371 (1954) RP2554.

Carlson, E. T., Chaconas, T. J., Wells, L. S., Study of the system barium oxide-aluminum oxide-water at 30° C. J **45,** 381 (1950) RP2149.

Carlson, E. T., Peppler, R. B., Wells, L. S., Studies in the system magnesia-silica-water at elevated temperatures and pressures. J **51,** 179 (1953) RP2448.

Carlson. E. T., Wells, L. S., Barium aluminate hydrates. J **41,** 103 (1948) RP1908.
Hydration of aluminous cements and its relation to the phase equilibria in the system lime-alumina-water. J **57,** 335 (1956) RP2723.
Hydrothermal preparation of some strontium silicates. J **51,** 73 (1953) RP2433.

Carpenter, F. G., Deitz, V. R., Glass spheres for the measurement of the effective opening of testing sieves. J **47,** 139 (1951) RP2238.
Methods of sieve analysis with particular reference to bone char. J **45,** 328 (1950) RP2143.

Carpenter, F. G.. Lopez-Gonzalez, J. D., Deitz, V. R., Adsorption of nitrogen on carbon adsorbents at low pressures between 69° and 90° K. J **55,** 11 (1955) RP2600.

Carson, F. T., Worthington, V., Stiffness of paper. J **49,** 385 (1952) RP2376.

Carter, J., Weir, C. E., Rate of shrinkage of tendon collagen: Further effects of tannage and liquid environment on the activation constants of shrinkage. J **44,** 599 (1950) RP2106.

Cartwright, M. L., Forced oscillations in nonlinear systems. J **45,** 514 (1950) RP2166.

Carwile, N. L.. Digges, T. G., Irish, C. R., Effect of boron on the hardenability of high-purity alloys and commercial steels. J **41,** 545 (1948) RP1938.

Carwile, N. L., Geil, G. W., A reduction-of-area gage for use at low temperatures. J **43,** 527 (1949) RP2044.
Effect of low temperatures on the mechanical properties of a commercially pure titanium. J **54,** 91 (1955) RP2569.
Effect of strain-temperature history on the flow and fracture of ingot iron at low temperatures. J **48,** 399 (1952) RP2329.
Tensile properties of ingot iron at low temperatures. J **45,** 129 (1950) RP2119.

Carwile, N. L., Geil, G. W., Digges, T. G., Influence of nitrogen on the notch toughness of heat-treated 0.3-percent-carbon steels at low temperatures. J **48,** 193 (1952) RP2305.

Case, F. A., Washer, F. E., Calibration of precision airplane mapping cameras. J **45,** 1 (1950) RP2108.

Cassel, J., Kanagy, J. R., Electrophoresis of modified collagen. J **43,** 29 (1949) RP2001.
Studies on the purification of collagen. J **42,** 557 (1949) RP1992.

Caswell, R. S., Brabant, J. M., Schwebel, A., Disintegration rate of carbon-14. J **53,** 27 (1954) RP2513.

Catalán, M. A., Asymmetries of Zeeman patterns and *g*-values for neutral manganese. J **47,** 502 (1951) RP2278.

Cavallo, L., Seliger, H. H., The absolute standardization of radioisotopes by 4 π counting. J **47,** 41 (1951) RP2226.

Chaconas, T. J., Carlson, E. T., Wells, L. S., Study of the system barium oxide-aluminum oxide-water at 30° C. J **45,** 381 (1950) RP2149.

Chand, U., Formulas for the percentage points of the distribution of the arithmetic mean in random samples from certain symmetrical universes. J **43,** 79 (1949) RP2007.
On the derivation and accuracy of certain formulas for sample sizes and operating characteristics of nonsequential sampling procedures. J **47,** 491 (1951) RP2277.

Chapman, M. W., Broida, H. P., Bibliography on nitrogen 15. (1956) C575.

Cheney, R. K., Wacker, P. F., Specific heat, enthalpy, and entropy of uranyl fluoride. J **39,** 317 (1947) RP1832.

Chin, J., De Juren, J., Absolute calibration of the National Bureau of Standards photoneutron standard: II. Absorption in manganese sulfate. J **55,** 311 (1955) RP2635.

Chrzanowski, P., Cook, R. K., Absorption by sound-absorbent spheres. J **42,** 219 (1949) RP1963.

Chung, K. L., Contributions to the theory of Markov chains. J **50,** 203 (1953) RP2411.

Claassen, H. H., Benedict, W. S., Shaw, J. H., Absorption spectrum of water vapor between 4.5 and 13 microns. J **49,** 91 (1952) RP2347.

Clabaugh, W. S., Donovan, J. W., Gilchrist, R., Preparation of nickel chloride of high purity. J **52,** 73 (1954) RP2475.

Clabaugh, W. S., Leslie, R. T. Gilchrist, R., Preparation of titanium tetrachloride of high purity. J **55,** 261 (1955) RP2628.

Clabaugh, W. S., Murphy, T. J., Gilchrist, R., Separation of iodide, bromide, and chloride from one another and their subsequent determination. J **53,** 13 (1954) RP2511.

Clabaugh, W. S., Swiggard, E. M., Gilchrist, R., Preparation of barium titanyl oxalate tetrahydrate for conversion to barium titanate of high purity. J **56,** 289 (1956) RP2677.

Clark, A. P., Bond of concrete reinforcing bar. J **43,** 565 (1949) RP2050.

Clark, L. J., Hubbard, W. D., Hoffman, J. I., Crystalization of aluminum chloride in hydrochloric acid process for production of alumina from clay. J **47,** 269 (1951) RP2253.

Clarke, W. F., Levin, E. M., Wells, L. S., Plasticity and water retentivity of hydrated limes for structural purposes. (1956) BMS146.

Clarke, W. F., Wells, L. S., Levin, E. M., Effect of aging on the soundness of regularly hydrated dolomitic lime putties. (1952) BMS127.

Expansive characteristics of hydrated limes and the development of an autoclave test for soundness. J **41,** 179 (1948) RP1917.

Clarke, W. F., Wells, L. S., Newman, E. S., Bishop, D. L., Investigation of failures of white-coat plaster, (1951) BMS121.

Class, C. R., Birmingham, B. W., Brown, E. H., Schmidt, A. F., Vessels for the storage and transport of liquid hydrogen. J **58,** 243 (1957) RP2757.

Clatworthy, W. H., Contributions on partially balanced incomplete block designs with two associate classes. (1956) AMS47.

Partially balanced incomplete block designs with two associate classes and two treatments per block. J **54,** 177 (1955) RP2579.

Cleaves, H. E., Buzzard, R. W., Hydrogen embrittlement of steel: Review of the literature. (1951) C511.

Cleaves, H. E., Dahl, A. I., The freezing point of uranium. J **43,** 513 (1949) RP2042.

Cleek, G. W., Hamilton, E. H., Properties of barium titanium silicate glasses. J **57,** 317 (1956) RP2720.

Cleek, G. W., Hubbard, D., Deuterium and hydrogen electrode characteristics of lithia-silica glasses. J **49,** 267 (1952) RP2363.

Cleek, G. W., Hubbard, D., Rynders, G. F., Electrode function (pH response), hygroscopicity, and chemical durability of Na_2O-CaO-SiO_2 glasses. J **44,** 247 (1950) RP2076.

Cleek, G. W., Shermer, H. F., Rynders, G. F., Hubbard, D., Atypical pH response of some nonsilicate glasses. J **52,** 251 (1954) RP2497.

Coe, J. R., Jr., Swindells, F. F., Godfrey, T. B., Absolute viscosity of water at 20° C. J **48,** 1 (1952) RP2279.

Cogliano, J. A., Griffel, M., Jessup, R. S., Park, R. P., Apparent specific volume of polystyrene in benzene, toluene, ethylbenzene, and 2-butanone. J **52,** 217 (1954) RP2492.

Cohen, R. I., Linnig, F. J., Milliken, L. T., Determination of ash in GR–S synthetic rubbers and latices. J **47,** 135 (1951) RP2237.

Cohen, V., Axilrod, B. M., Sherman, M. A., Wolock, I., Effects of moderate biaxial stretch-forming on tensile and crazing properties of acrylic plastic glazing. J **49,** 331 (1952) RP2369.

Collett, C. T., Densities of five selected optical glasses. J **52,** 309 (1954) RP2506.

Simplification of calculations in routine density and volumetric determinations. J **52,** 201 (1954) RP2489.

Collett, C. T., Hughes, J. C., Morey, F. C., Measurement of the internal diameters of metallic capillary tubes. J **45,** 283 (1950) RP2134.

Cones, H. N., A high-voltage pulse generator and tests on an improved deflecting system of a cold-cathode oscillograph. J **57,** 143 (1956) RP2704.

Effect of a metal mast and guy wires on the performance of the 600-ohm multiple-wire delta antenna. J **46,** 113 (1951) RP2182.

Impedance characteristics of some experimental broad-band antennas for vertical incidence ionosphere sounding. J **43,** 71 (1949) RP2006.

Cones, H. N., Cottony, H. V., Watts, J. M., A 600-ohm multiple-wire delta antenna for ionosphere studies. J **44,** 475 (1950) RP2094.

Cones, H. N., Park, J. H., Surge voltage breakdown of air in a nonuniform field. J **56,** 201 (1956) RP2669.

Connor, W. S., Youden, W. J., Comparison of four national radium standards. Part 2. Statistical procedures and survey. [Part 1. Experimental procedures and results, by T. I. Davenport, W. B. Mann, C. C. McCraven, and C. C. Smith.] J **53,** 267 (1954) RP2544.

New experimental designs for paired observations. J **53,** 191 (1954) RP2532.

Cook, G. S., Corliss, E. L. R., Cavity pressure method for measuring the gain of hearing aids. J **40,** 85 (1948) RP1857.

Cook, M. I., Swanson, H. E., Gilfrich, N. T., Standard X-ray diffraction powder patterns. (1956) C539, Vol. 6.

Cook, R. K., Theory of Wagner ground balance for alternating-current bridges. J **40,** 245 (1948) RP1869.

Cook, R. K., Chrzanowski, P., Absorption by sound-absorbent spheres. J **42,** 219 (1949) RP1963.

Cooter, I. L., Pulse packing in magnetic recording wire. J **44,** 163 (1950) RP2067.

Cooter, I. L., Harris, W. P., Investigation of an alternating-current bridge for the measurement of core losses in ferromagnetic materials at high flux densities. J **57,** 103 (1956) RP2699.

Cooter, I. L., Taylor, J. K., Smith, R. E., Polarographic limiting currents. J **42,** 387 (1949) RP1978.

Cooter, I. L., Thomas, J. L., Peterson, C., Kotter, F. R., An absolute measurement of resistance by the Wenner method. J **43,** 291 (1949) RP2029.

Copeland, H. I., Jr., Brauer, G. M., Sweeney, W. T., Forziati, A. F., Setting reaction of zinc oxide and eugenol. J **55,** 133 (1955) RP2611.

Cordero, F., Dibeler, V. H., Diaphragm-type micromanometer for use on a mass spectrometer. J **46,** 1 (1951) RP2167.

Cordero, F., Matheson, H., Johnson, D. P., A nonlinear instrument diaphragm. J **58,** 333 (1957) RP2766.

Cordrey, D. J., Keegan, H. J., Belknap, M. A., Spectral transmissive properties of five selected optical glasses. J **52,** 305 (1954) RP2505.

Corliss, E. L. R., Hearing aids. (1953) C534.

Selection of hearing aids. (1951) C516.

Corliss, E. L. R., Cook, G. S., Cavity pressure method for measuring the gain of hearing aids. J **40,** 85 (1948) RP1857.

Corliss, C. H., Bozman, W. R., Meggers, W. F., Trees, R. E., An intersystem transition in the first spectrum of beryllium. J **50,** 131 (1953) RP2399.

Corliss, W. R., Crichlow, W Q., Smith, D. F., Morton, R. N., Worldwide radio noise levels expected in the frequency band 10 kilocycles to 100 megacycles. (1955) C557.

Corruccini, R. J., Annealing of platinum for thermometry. J **47,** 94 (1951) RP2232.

Differences between the International Temperature Scales of 1948 and 1927. J **43,** 133 (1949) RP2014.

Corruccini, R. J., Ginnings, D. C., Heat capacities at high temperatures of uranium, uranium trichloride, and uranium tetrachloride. J **39,** 309 (1947) RP1831.

Corruccini, R. J., Shenker, H., Modified 1913 reference tables for iron-constantan thermocouples. J **50,** 229 (1953) RP2415.

Corruccini, R. J., Shenker, H., Lauritzen, J. I., Jr., Reference tables for thermocouples. (1951) C508.

Corruccini, R. J., Shenker, H., Lauritzen, J. I., Jr., Lonberger, S. T., Reference tables for thermocouples. (1955) C561.

Costrell, L., Accurate determination of the dead-time and recovery characteristics of Geiger-Müller counters. J **42,** 241 (1949) RP1965.

Cottington, R. L., Hardy, R. C., Viscosity of deuterium oxide and water in the range 5° to 125° C. J **42,** 573 (1949) RP1994.

Cottington, R. L., Swindells, J. F., Hardy, R. C., Precise measurements with Bingham viscometers and Cannon master viscometers. J **52,** 105 (1954) RP2479.

Cottony, H. V., Cones, H. N., Watts, J. M., A 600-ohm multiple-wire delta antenna for ionosphere studies. J **44,** 475 (1950) RP2094.

Couch, D. E., Brenner, A., Williams, E. K., Electrodeposition of alloys of phosphorus with nickel or cobalt. J **44,** 109 (1950) RP2061.

Coughanour, L. W., DeProsse, V. A., Phase equilibria in the system MgO-TiO$_2$. J **51,** 85 (1953) RP2435.

Coughanour, L. W., Roth, R. S., Phase equilibrium relations in the systems titania niobia and zirconia-niobia. J **55,** 209 (1955) RP2621.

Coughanour, L. W., Roth, R. S., DeProsse, V. A., Phase equilibrium relations in the systems lime-titania and zirconia-titania. J **52,** 37 (1954) RP2470.

Coughanour, L. W., Roth, R. S., Marzullo, S., Sennett, F. E., Solid-state reactions and dielectric properties in the system magnesia-lime-tin oxide-titania. J **54,** 149 (1955) RP2576.

Solid-state reactions and dielectric properties in the systems magnesia-zirconia-titania and lime-zirconia-titania. J **54,** 191 (1955) RP2580.

Cragoe, C. S., Meyers, C. H., Mueller, E. F., Table and Mollier chart of the thermodynamic properties of 1,3-butadiene. J **39,** 507 (1947) RP1844.

Creamer, A. S., Bunting, E. N., Shelton, G. R., Properties of calcium-barium titanate dielectrics. J **43,** 237 (1949) RP2025.

Creamer, A. S., Bunting, E. N., Shelton, G. R., Jaffe, B., Properties of beryllium-barium titanate dielectrics. J **47,** 15 (1951) RP2222.

Creamer, A. S., Shelton, G. R., Bunting, E. N., Properties of barium-magnesium titanate dielectrics. J **41,** 17 (1948) RP1899.

Crean, L. E., Schiefer, H. F., Krasny, J. F., Improved single-unit Schiefer abrasion testing machine. J **42,** 481 (1949) RP1988.

Creitz, E. C., Smith, F. A., Infrared absorption spectra of the liquid butenes and 1,3-butadiene. J **43,** 365 (1949) RP2031.

Infrared studies of association in eleven alcohols. J **46,** 145 (1951) RP2187.

Crichlow, W. Q., Smith, D. F., Morton, R. N., Corliss, W. R., Worldwide radio noise levels expected in the frequency band 10 kilocycles to 100 megacycles. (1955) C557.

Cromwell, F. J., McAdam, D. J., Jr., Geil, G. W., Influence of low temperatures of the mechanical properties of 18:8 chromium-nickel steel. J **40,** 375 (1948) RP1882.

Cummings, J. W., Ryan, J. V., Hutton, A. C., Fire effects and fire control in nitrocellulose photographic-film storage. (1956) BMS145.

Curtis, H. L., Determination of curvature by an osculometer. J **44,** 131 (1950) RP2063.

Curtis, H. L., Roberts, H. S., An instrument for the rapid production of a decimal series of potentials and its application to ballistic measurements. J **41,** 45 (1948) RP1902.

Curtis, R. W., Brunetti, C., Printed circuit techniques. (1947) C468.

Curtiss, J. H., Acceptance sampling by variables, with special reference to the case in which quality is measured by average or dispersion. J **39,** 271 (1947) RP1827.

Curtiss, J. H., Newman, S. B., A statistical analysis of some mechanical properties of manila rope. J **39,** 551 (1947) RP1847.

Curtiss, L. F., Measurement of radioactive isotopes. (1948) C473.

Measurements of radioactivity. (1949) C476.

The Geiger-Müller counter. (1950) C490.

Curtiss, L. F., DeJuren, J. A., Padgett, D. W., Absolute calibration of the National Bureau of Standards photoneutron standard: I. J **55,** 63 (1955) RP2605.

Curtiss, L. F., Feister, I., Disintegration of antimony-124. J **40,** 315 (1948) RP1877.

Curtiss, L. F., Manov, G. G., The half-life of carbon 14. J **46,** 328 (1951) RP2203.

Cutkowsky, R. E., A Monte Carlo method for solving a class of integral equations. J **47,** 113 (1951) RP2234.

D

Dahl, A. I., Cleaves, H. E., The freezing point of uranium. J **43,** 513 (1949) RP2042.

Dahl, A. I., Fiock, E. F., Response characteristics of temperature-sensing elements for use in the control of jet engines. J **45,** 292 (1950) RP2136.

Dahl, A. I., Freeze, P. D., Laboratory evaluation of a method proposed by Gnam for measuring the temperature of rotating parts. J **41,** 601 (1948) RP1942.

Dahl, A. I., VanDusen, M. S., Freezing points of cobalt and nickel. J **39,** 291 (1947) RP1828.

Resistance-temperature relation and thermoelectric properties of uranium. J **39,** 53 (1947) RP1813.

Daniels, R. D., Jr., Wexler, A., Pressure-humidity apparatus. J **48,** 269 (1952) RP2312.

Darr, J. H., Mebs, R. W., Grimsley, J. D., Metal ultrasonic delay lines. J **51,** 209 (1953) RP2453.

Darr, J. H., Rosenberg, S. J., Stabilization of austenitic stainless steel. J **40,** 321 (1948) RP1878.

Davenport, T. I., Mann, W. B., McCraven, C. C., Smith, C. C., Comparison of four national radium standards. Part 1. Experimental procedures and results. [Part 2. Statistical procedures and survey, by W. S. Connor and W. J. Youden.] J **53,** 267 (1954) RP2544.

Davis, B. L., Printed circuit techniques: An adhesive tape-resistor system. (1952) C530.

Davis, F. J., Factors affecting operation of apparatus for counting alpha particles in an ion counting chamber. J **39,** 545 (1947) RP1846.

Davis, M. M., Hetzer, H. B., Comparative strengths of four organic bases in benzene. J **48,** 381 (1952) RP2326.

The behavior of bromphthalein magenta E (tetrabromophenolphthalein ethyl ester) with organic bases and its bearing on the Brønsted-Lowry and Lewis concepts of acidity. J **46,** 496 (1951) RP2219.

Titrations of bases with diphenyl phosphate in some aqueous and nonaqueous solvents. J **54,** 309 (1955) RP2593.

Davis, M. M., McDonald, E. A., Acid-base equilibrium constants for the reaction of tribenzylamine with picric acid and with trinitro-*m*-cresol in benzene, from spectrophotometric data. J **42,** 595 (1949) RP1997.

Davis, M. M., Schuhmann, P. J., Acid-base reactions in benzene and other organic solvents: Behavior of bromphthalein magenta with different classes of organic bases. J **39,** 221 (1947) RP1825.

Davis, M. M., Schuhmann, P. J., Lovelace, M. E., Acid-base reactions in organic solvents. Behavior of some halogenated derivatives of phenolsulfonephthalein with different classes of organic bases in benzene. J **41,** 27 (1948) RP1900.

Davis, P., Numerical computation of the transfinite diameter of two collinear line segments. J **58,** 155 (1957) RP2747.

Davis, P., Rabinowitz, P., Abscissas and weights for Gaussian quadratures of high order. J **56,** 35 (1956) RP2645.

Davis, R., Gibson, K. S., Haupt, G. W., Spectral energy distribution of the International Commission on Illumination light sources A, B, and C. J **50,** 31 (1953) RP2384.

Davis, R., Pope, C. I., Development of a photoresist for etching designs in glass. J **55,** 139 (1955) RP2612.

Techniques for ruling and etching precise scales in glass and their reproduction by photoetching with a new light-sensitive resist. (1955) C565.

Day, F. H., Thimble-chamber calibration on soft X-rays. J **41,** 295 (1948) RP1926.

X-ray calibration of radiation survey meters, pocket chambers, and dosimeters. (1951) C507.

Day, F. H., Taylor, L. S., Absorption of X-rays in air. J **40,** 393 (1948) RP1883.

Dean, H., Mohler, F. L., Dibeler, V. H., Williamson, L., Mass spectra of deuteroacetylenes, monodeuterobenzene, and deuteronaphthalenes. J **48,** 188 (1952) RP2304.

Dean, H. M., Mohler, F. L., Williamson, L., Total ionization of hydrocarbons from mass spectral data. J **45,** 235 (1950) RP2130.

Dean, H. M., Mohler, F. L., Williamson, L., Wise, C. E., Wells, E. J., Bloom, E. G., Mass spectra of nonanes. J **44,** 291 (1950) RP2078.

de Bruijn, N. G., Erdos, P., On a recursion formula and on some tauberian theorems. J **50,** 161 (1953) RP2404.

Decker, G. E., Bestul, A. B., White, H. S., Comparison of viscosities of rubbers from the McKee worker-consistometer and from the Mooney viscometer. J **46,** 283 (1951) RP2196.

de Hemptinne, M., Dibeler, V. H., Mohler, F. L., Mass spectra of the deuteroethylenes. J **53,** 107 (1954) RP2522.

Deitz, V. R., Bibliography of solid adsorbents 1943 to 1953. (1956) C566.

Color evaluation in the cane sugar industry. J **57,** 159 (1956) RP2706.

Deitz, V. R., Carpenter, F. G., Glass spheres for the measurement of the effective opening of testing sieves. J **47,** 139 (1951) RP2238.

Methods of sieve analysis with particular reference to bone char. J **45,** 328 (1950) RP2143.

Deitz, V. R., Higginson, H. R., Parker, C., Determination of sulfur in bone char. J **40,** 263 (1948) RP1871.

Deitz, V. R., Loebenstein, W. V., Surface-area determination by adsorption of nitrogen from nitrogen-helium mixtures. J **46,** 51 (1951) RP2174.

Deitz, V. R., Loebenstein, W. V., Gleysteen, L. F., Kinetic study of the reaction of carbon adsorbents with oxygen. J **42,** 33 (1949) RP1948.

Deitz, V. R., Lopez-Gonzales, J. D., Surface changes in an original and an activated bentonite. J **48,** 325 (1952) RP2319.

Deitz, V. R., Lopez-Gonzales, J. D., Carpenter, F. G., Adsorption of nitrogen on carbon adsorbents at low pressures between 69° and 90° K. J **55,** 11 (1955) RP2600.

Deitz, V. R., Pennington, N. L., Hoffman, H. L., Jr., Transmittancy of commercial sugar liquors: Dependence on concentration of total solids J **49,** 365 (1952) RP2373.

DeJuren, J., Chin, J., Absolute calibration of the National Bureau of Standards photoneutron standard: II. Absorption in manganese sulfate. J **55,** 311 (1955) RP2635.

DeJuren, J. A., Padgett, D. W., Curtiss, L. F., Absolute calibration of the National Bureau of Standards photoneutron standard: I. J **55,** 63 (1955) RP2605.

DeJuren, J. A., Rosenwasser, H., Absolute calibration of NBS standard thermal neutron density. J **52,** 93 (1954) RP2477.

Diffusion length of thermal neutrons in water. J **51,** 203 (1953) RP2452.

de Klerk, D., Hudson, R. P., Installation for adiabatic demagnetization experiments at the National Bureau of Standards. J **53,** 173 (1954) RP2530.

DeLaVergne, L., Attix, F. H., Plate-separation requirements for standard free-air ionization chambers. J **53,** 393 (1954) RP2558.

De Lollis, N. J., Ehrlich, P., Dielectric relaxation in a styrene-acrylonitrile copolymer during and after its polymerization. J **51,** 145 (1953) RP2444.

Denison, I. A., Romanoff, M., Behavior of experimental zinc-steel couples underground. J **40,** 301 (1948) RP1876.

Corrosion of galvanized steel in soils. J **49,** 299 (1952) RP2366.

Corrosion of low-alloy irons and steels in soils. J **49,** 315 (1952) RP2367.

Corrosion of nickel cast irons in soils. J **51,** 313 (1953) RP2459.

Effect of exposure to soils on the properties of asbestos-cement pipe. J **47,** 367 (1951) RP2264.

Soil-corrosion studies. 1946 and 1948; Copper alloys, lead, and zinc. J **44,** 259 (1950) RP2077.

Soil-corrosion studies. 1946: Ferrous metals and alloys. J **44,** 47 (1950) RP2057.

Denison, I. A., Schwerdtfeger, W. J., Geometric factors in electrical measurements relating to corrosion and its prevention. J **54,** 61 (1955) RP2566.

DeProsse, V. A., Coughanour, L. W., Phase equilibria in the system MgO-TiO_2. J **51,** 85 (1953) RP2435.

DeProsse, V. A., Coughanour, L. W., Roth, R. S., Phase equilibrium relations in the systems lime-titania and zirconia-titania. J **52,** 37 (1954) RP2470.

Dever, J. L., Douglas, T. B., Anhydrous sodium hydroxide: the heat content from 0° to 700° C, the transition temperature, and the melting point. J **53,** 81 (1954) RP2519.

Enthalpy and specific heat of four corrosion-resistant alloys at high temperatures. J **54,** 15 (1955) RP2560.

de Vogelaere, R., A method for the numerical integration of differential equations of second order without explicit first derivatives. J **54,** 119 (1955) RP2572.

Diamond, J. J., Hubbard, D., Thickness of glass electrodes. J **47,** 443 (1951) RP2270.

Dibeler, V. H., Mass spectra of the tetramethyl compounds of carbon, silicon, germanium, tin, and lead. J **49,** 235 (1952) RP2358.

Reduction of halomethanes with lithium aluminum hydride. J **44,** 363 (1950) RP2083.

Dibeler, V. H., Bradt, P., Mohler, F. L., A new technique for the mass spectrometric study of the pyrolysis products of polystyrene. J **50,** 201 (1953) RP2410.

Mass spectrum of sulfur vapor. J **57,** 223 (1956) RP2713.

Dibeler, V. H., Cordero, F., Diaphragm-type micromanometer for use on a mass spectrometer. J **46,** 1 (1951) RP2167.

Dibeler, V. H., Mohler, F. L., Analysis by the mass spectrometer of a liquified hydrocarbon mixture containing C_3–C_5 parafins and olefins J **39,** 149 (1947) RP1818.

Dissociation of SF_6, CF_4, and SiF_4 by electron impact. J **40,** 31 (1948) RP1853.

Mass spectra of some organo-lead and organo-mercury compounds. J **47,** 337 (1951) RP2259.

Mass spectra of the deuteromethanes. J **45,** 441 (1950) RP2155.

Dibeler, V. H., Mohler, F. L., de Hemptinne, M., Mass spectra of the deuteroethylenes. J **53,** 107 (1954) RP2522.

Dibeler, V. H., Mohler, F. L., Reese, R. M., Mass spectra of fluorocarbons. J **49,** 343 (1952) RP2370.

Dibeler, V. H., Mohler, F. L., Wells, E. J., Jr., Reese, R. M., Mass spectra of some simple isotopic molecules. J **45,** 288 (1950) RP2135.

Dibeler, V. H., Mohler, F. L., Williamson, L., Mass spectra of diborane-d_6 and ethane-d_6. J **44,** 489 (1950) RP2095.

Dibeler, V. H., Mohler, F. L., Williamson, L., Dean, H., Mass spectra of deuteroacetylenes, monodeuterobenzene, and deuteronaphtalenes. J **48,** 188 (1952) RP2304.

Dibeler, V. H., Mohler, F. L., Williamson, L., Reese, R. M., Mass spectrum of pentaborane (B_5H_9). J **43,** 97 (1949) RP2010.

Dibeler, V. H., Quinn, E. I., Mohler, F. L., Mass spectra of some lead alkyls. J **57,** 41 (1956) RP2692.

Dibeler, V. H., Reese, R. M., Selected positive and negative ions in the mass spectra of the monohalomethanes. J **54,** 127 (1955) RP2573.

Dibeler, V. H., Reese, R. M., Mohler, F. L., A survey of negative ions in mass spectra of polyatomic molecules. J **57,** 367 (1956) RP2725.

Ionization and dissociation of the trifluoromethyl halides by electron impact. J **57,** 113 (1956) RP2700.

Temperature variation of mass spectra of hydrocarbons. J **46,** 79 (1951) RP2178.

Dibeler, V. H., Shepherd, M., Thomas, R., Schumann, S., Experimental study of the Koppers-Hinckley-Podbielniak apparatus and method for the determination of conjugated dienes. J **39,** 435 (1947) RP1840.

Dibeler, V. H., Wise, C. E., Reese, R. M., Mohler, F. L., Introduction of measured liquid samples into the mass spectrometer. J **44,** 215 (1950) RP2072.

Dickson, G., Mitchell, J. A., Schoonover, I. C., Vacher, H. C., Some factors affecting the dimensional stability of the silver-tin-(copper-zinc) amalgams. J **52,** 185 (1954) RP2487.

Digges. T. G., Geil, G. W., Carwile, N. L., Influence of nitrogen on the notch toughness of heat-treated 0.3-percent-carbon steels at low temperatures. J **48,** 193 (1952) RP2305.

Digges, T. G., Irish, C. R., Carwile, N. L., Effect of boron on the hardenability of high-purity alloys and commercial steels. J **41,** 545 (1948) RP1938.

Digges, T. G., Jenkins, W. D., Creep of annealed and cold-drawn high-purity copper. J **47,** 272 (1951) RP2254.
Creep of high-purity copper. J **45,** 153 (1950) RP2121.
Effect of temperature on the tensile properties of high-purity nickel. J **48,** 313 (1952) RP2317.
Influence of prior strain history on the tensile properties and structures of high-purity copper. J **49,** 167 (1952) RP2354.
Influence of strain rate and temperature on the creep of cold-drawn ingot iron. J **43,** 117 (1949) RP2013.

Digges, T. G., Jenkins, W. D., Johnson, C. R., Creep of high-purity nickel. J **53,** 329 (1954) RP2551.
Effect of temperature on the tensile properties of a commercial and a high-purity 70-percent-nickel–30-percent-copper alloy. J **54,** 21 (1955) RP2561.
Tensile properties of copper, nickel, and 70-percent-copper–30-percent-nickel and 30-percent-copper–70-percent-nickel alloys at high temperatures. J **58,** 201 (1957) RP2753.

Digges, T. G., Reinhart, F. M., Influence of boron on some properties of experimental and commercial steels. J **39,** 67 (1947) RP1815.

Digges, T. G., Rosenberg, S. J., Heat treatment and properties of iron and steel. (1950) C495.

Dill, R. S., Achenbach, P. R., Performance of a coal-fired boiler converted to oil. (1948). BMS111.

Dill, R. S., Martin, H. R., Achenbach, P. R., Effect of edge insulation upon temperature and condensation on concrete-slab floors. (1953) BMS138.

Diniak, A. W., Weaver, E. R., A new computer for calculating the water content of gases. J **56,** 269 (1956) RP2674.

Doggett, J., Berger, M. J., Reflection and transmission of gamma radiation by barriers: Semianalytic Monte Carlo calculation. J **56,** 89 (1956) RP2653.
Response function of thallium-activated sodium-iodide scintillation counters. J **56,** 355 (1956) RP2686.

Domen, S., McElhinney, J., Zendle, B., A calorimeter for measuring the power in a high-energy X-ray beam. J **56,** 9 (1956) RP2642.

Donovan, J. W., Clabaugh, W. S., Gilchrist, R., Preparation of nickel chloride of high purity. J **52,** 73 (1954) RP2475.

Donsker, M. D., Kac, M., A sampling method for determining the lowest eigenvalue and the principal eigenfunction of Schrödinger's equation. J **44,** 551 (1950) RP2102.

Douglas, F. L., Haupt, G. W., Chromaticities of Lovibond glasses. J **39,** 11 (1947) RP1808.

Douglas, T. B., A cryoscopic study of the solubility of uranium in liquid sodium at 97.8° C. J **52,** 223 (1954) RP2493.

Douglas, T. B., Ball, A. F., Ginnings, D. C., Heat capacity of liquid mercury between 0° and 450° C; calculation of certain thermodynamic properties of the saturated liquid and vapor. J **46,** 334 (1951) RP2204.

Douglas, T. B., Dever, J. L., Anhydrous sodium hydroxide: the heat content from 0° to 700° C, the transition temperature, and the melting point. J **53,** 81 (1954) RP2519.
Enthalpy and specific heat of four corrosion-resistant alloys at high temperatures. J **54,** 15 (1955) RP2560.

Douglas, T. B., Furukawa, G. T., McCoskey, R. E., Ball, A. F. Calorimetric properties of normal heptane from 0° to 520° K. J **53,** 139 (1954) RP2526.

Douglas, T. B., Furukawa, G. T., McCoskey, R. E., Ginnings, D. C., Thermal properties of aluminum oxide from 0° to 1,200° K. J **57,** 67 (1956) RP2694.

Douglas, T. B., Ginnings, D. C., Ball, A. F., Heat capacity of sodium between 0° and 900° C, the triple point and heat of fusion. J **45,** 23 (1950) RP2110.

Douglas, T. B., Logan, W. M., Heat content of molybdenum disilicide from 0° to 900° C. J **53,** 91 (1954) RP2520.

Dressler, R. F., Entropy changes in rarefaction waves. J **57,** 265 (1956) RP2718.
Hydraulic resistance effect upon the dam-break functions. J **49,** 217 (1952) RP2356.
Turbulent flow in shock tubes of varying cross section. J **53,** 253 (1954) RP2541.

Driscoll, R. L., Thomas, H. A., Hipple, J. A., Measurement of the proton moment in absolute units. J **44,** 569 (1950) RP2104.

Dropkin, H. A., Kalmus, H. P., Cacheris, J. C., Nonquantized frequency-modulated altimeter. J **50,** 215 (1953) RP2413.

Dryden, M. R., Isbell, H. S., Snyder, C. F., Holt, N. B., Determination of molecular weights of dextrans by means of alkaline copper reagents. J **50,** 81 (1953) RP2393.

Dryden, M. R., Snyder, C. F., Isbell, H. S., Holt, N. B., Optical rotations, refractive indices, and densities of dextran solutions. J **53,** 131 (1954) RP2525.

Duck, J. T., Bruce, C. S., Pierce, A. R., Effects of substitute fuels on automotive engines. J **41,** 135 (1948) RP1913.

Duncan, B. C., Kushner, L. M., Hoffman, J. I., A viscometric study of the micelles of sodium dodecyl sulfate in dilute solutions. J **49,** 85 (1952) RP2346.

Dunham, J. W., Brekke, G. N., Thompson, G. N., Live loads on floors in buildings. (1952) BMS133.

Dunham, J. W., Ingberg, S. H., Thompson, J. P., Combustible contents in buildings. (1957) BMS149.

Dussinger, C. S., Mears, T. W., Fookson, A., Pomerantz, P., Rich, E. H., Howard, F. L., Syntheses and properties of two olefins, six paraffins, and their intermediates. J **44,** 299 (1950) RP2079.

E

Eaton, H. N., French, J. L., Self-siphonage of fixture traps. (1951) BMS126.

Eaton, H. N., French, J. L., Wyly, R. S., Wet venting of plumbing fixtures (1950). BMS119.

Eaton, H. N., Wyly, R. S., Capacities of plumbing stacks in buildings. (1952) BMS132.
Frost closure of roof vents in plumbing systems. (1954) BMS142.

Edelman, S., Jones, E., London, A., Long-tube method for field determination of sound-absorption coefficients. J **49,** 17 (1952) RP2339.

Ehrlich, M., Photographic dosimetry of X- and gamma rays. (1954) H57.
Scintillation spectrometry of low-energy bremsstrahlung. J **54,** 107 (1955) RP2571.

Ehrlich, P., A simple calculation of dielectric loss from dielectric dispersion for polar polymers. J **50,** 19 (1953) RP2382.
Dielectric properties of Teflon from room temperature to 314° C and from frequencies of 10^2 to 10^5 c/s. J **51,** 185 (1953) RP2449.

Ehrlich, P., De Lollis, N. J., Dielectric relaxation in a styrene-acrylonitrile copolymer during and after its polymerization. J **51,** 145 (1953) RP2444.

Eiseman, J. H., A study of laboratory Bunsen burners for natural gas. J **42,** 541 (1949) RP1991.

Eiseman, J. H., Potter, E. A., Accuracy of the Cutler-Hammer recording gas calorimeter when used with gases of high heating value. J **58,** 213 (1957) RP2754.

Ellenwood, R. C., Sorrows, H. E., Cathode heater compensation as applied to degenerative voltage-stabilized direct-current power supplies. J **43,** 251 (1949) RP2027.

Emerson, W. B., Determination of planeness and bending of optical flats. J **49,** 241 (1952) RP2359.

Emerson, W. B., Peters, C. G., Interference methods for producing and calibrating end standards. J **44,** 419 (1950) RP2089.

Enfield, A. W., Rasmussen, A. L., Hess, A., Advances in the design and application of the radiofrequency permeameter. J **56,** 261 (1956) RP2673.

Engel, O. G., Epitaxial deposits of metals evaporated on salt substrates. J **50,** 249 (1953) RP2416.
Mechanism of high-speed-waterdrop erosion of methyl methacrylate plastic. J **54,** 51 (1955) RP2565.
Waterdrop collisions with solid surfaces. J **54,** 281 (1955) RP2591.

Epstein, M. B., Barrow, G. M., Pitzer, K. S., Rossini, F. D., Heats, equilibrium constants, and free energies of formation of the dimethylcyclopentanes. J **43,** 245 (1949) RP2026.

Epstein, M. B., Mair, B. J., Willingham, C. B., Rossini, F. D., Separation of the 177° to 200° C fraction of petroleum and the isolation of normal undecane. J **42,** 139 (1949) RP1957.

Epstein, M. B., Pitzer, K. S., Rossini, F. D., Heats equilibrium constants, and free energies of formation of cyclopentene and cyclohexene. J **42,** 379 (1949) RP1976.

Erdos, P., de Bruijn, N. G., On a recursion formula and on some tauberian theorems. J **50,** 161 (1953) RP2404.

Eubank, W. R., Phase-equilibrium studies of the high-lime portion of the quinary system Na_2O-CaO-Al_2O_3-Fe_2-O_3-SiO_2. J **44,** 175 (1950) RP2069.

Eubank, W. R., Bogue, R. H., Preliminary study of portions of the systems Na_2O-CaO-Al_2O_3-F_2O_3, and Na_2O-CaO-Fe_2O_3-SiO_2. J **40,** 225 (1948) RP1867.
Studies on the flame photometer for the determination of Na_2O and K_2O in portland cement. J **43,** 173 (1949) RP2019.

Evans, D. N., Litvin, A., Figlia, A. C., Blaine, R. L., Properties of some masonry cement. J **51,** 11 (1953) RP2427.

Evans, W. H., Jacobsen, R., Munson, T. R., Wagman, D. D., Thermodynamic properties of the alkali metals. J **55,** 83 (1955) RP2608.

Evans, W. H., Munson, T. R., Wagman, D. D., Thermodynamic properties of some gaseous halogen compounds. J **55,** 147 (1955) RP2614.

Evans, W. H., Rossini, F. D., Wagman, D. D., Levine, S., Jaffe, I., Selected values of chemical thermodynamic properties. (1952) C500.

Evans, W. H., Wagman, D. D., Thermodynamics of some simple sulfur-containing molecules. J **49,** 141 (1952) RP2350.

F

Faick, C. A., Williams, A. E., Rynders, G. F., Effect of convection currents on the distribution of striae in pots of optical glass. J **42,** 153 (1949) RP1959.

Fano, L., Hilsenrath, J., Beckett, C. W., Benedict, W. S., Hoge, H. J., Masi, J. F., Nuttall, R. L., Touloukian, Y. S., Woolley, H. W., Tables of thermal properties of gases. (1955) C564.

Fano, L., Way, K., Scott, M. R., Thew, K., Nuclear Data (includes supplements 1, 2, and 3). (1950). C499.

Fano, U., Electric quadrupole coupling of the nuclear spin with the rotation of a polar diatomic molecule in an external electric field. J **40,** 215 (1948) RP1866.
Penetration of X- and gamma rays to extremely great depths. J **51,** 95 (1953) RP2439.

Fano, U., Spencer, L. V., Penetration and diffusion of X-rays. Calculation of spatial distributions by polynomial expansion. J **46,** 446 (1951) RP2213.

Feder, D. P., Conrady's chromatic condition. J **52,** 43 (1954) RP2471.
Tracing of skew rays. J **45,** 61 (1950) RP2113.

Feister, I., Curtiss, L. F., Disintegration of antimony-124. J **40,** 315 (1948) RP1877.

Ferry, J. D., Viscoelastic properties of polymer solutions. J **41,** 53 (1948) RP1903.

Fickle, D. P., Buzzard, R. W., Liss, R. B., Titanium-uranium system in the region 0 to 30 atomic percent of titanium. J **50,** 209 (1953) RP2412.

Fickle, D. P., Buzzard, R. W., Park, J. J., Silver-uranium system. J **52,** 149 (1954) RP2483.

Figlia, A. C., Evans, D. N., Litvin, A., Blaine, R. L., Properties of some masonry cement. J **51,** 11 (1953) RP2427.

Fillmore, C. L., Lang, S. M., Knudsen, F. P., Roth, R. S., High-temperature reactions of uranium dioxide with various metal oxides. (1956) C568.

Fillmore, C. L., Lang, S. M., Maxwell, L. H., The system beryllia-alumina-titania: Phase relations and general physical properties of three-component porcelains. J **48,** 298 (1952) RP2316.

Fillmore, C. L., Lang, S. M., Roth, R. S., Some properties of porcelains and phase relations in the ternary systems of beryllia and zirconia with titania, ceria and chromia. J **53,** 201 (1954) RP2534.

Fiock, E. F., Bibliography of books and published reports on gas turbines, jet propulsion, and rocket power plants. (1949) C482.

Fiock, E. F., Dahl, A. L., Response characteristics of temperature-sensing elements for use in the control of jet engines. J **45,** 292 (1950) RP2136.

Fiock, E. F., Halpern, C., Bibliography of books and published reports on gas turbines, jet propulsion, and rocket power plants. (1951) C509.
Bibliography of books and published reports on gas turbines, jet propulsion, and rocket power plants, January 1950 through December 1953. (1954) C509 Supplement.

Fiock, E. F., Shafer, M. R., Bovey, H. L., Van Lone, R. B., Correcting for density and viscosity of incompressible fluids in float-type flowmeters. J **47,** 227 (1951) RP2247.

Fishburn, C. C., Physical properties of some samples of asbestos-cement siding. (1951) BMS122.

Fleeman, J., Frantz, F. S., Jr., Film dosimetry of electrons in the energy range 0.5 to 1.4 million electron volts. J **48,** 117 (1952) RP2295.

Flieger, H. W., Jr., Masi, J. F., Wicklund, J. S., Heat capacity of gaseous perfluoropropane. J **52,** 275 (1954) RP2500.

Flieger, H. W., Jr., Wicklund, J. S., Masi, J. F., Heat capacity of gaseous hexafluoroethane. J **51,** 91 (1953) RP2437.

Florence, J. M., Allshouse, C. C., Glaze, F. W., Hahner, C. H., Absorption of near-infrared energy by certain glasses. J **45,** 121 (1950) RP2118.

Florence, J. M., Glaze, F. W., Black, M. H., Infrared transmittance of some calcium aluminate and germanate glasses. J **55,** 231 (1955) RP2625.
Transmission of near-infrared energy by some two- and three-component glasses. J **50,** 187 (1953) RP2408.

Florence, J. M., Glaze, F. W., Hahner, C. H., Stair, R., Transmittance of near-infrared energy by binary glasses. J **41,** 623 (1948) RP1945.

Florin, R. E., Wall, L. A., Brown, D. W., Hymo, L. A., Michaelsen, J. D., Factors affecting the thermal stability of polytetrafluoroethylene. J **53,** 121 (1954) RP2524.

Florman, E. F., A measurement of the velocity of propagation of very-high-frequency radio waves at the surface of the earth. J **54,** 335 (1955) RP2596.

Flynn, J. H., Launer, H. F., Wilson, W. K., Determination of glucose by means of sodium chlorite. J **51,** 237 (1953) RP2456.

Fookson, A., Cadwallader, E. A., Mears, T. W., Howard, F. L., Aliphatic halide-carbonyl condensations by means of sodium. J **41,** 111 (1948) RP1909.

Fookson, A., Mears, T. W., Pomerantz, P., Rich, E. H., Dussinger, C. S., Howard, F. L., Syntheses and properties of two olefins, six paraffins, and their intermediates. J **44,** 299 (1950) RP2079.

Fookson, A., Pomerantz, P., Mears, T. W., Rothberg, S., Howard, F. L., Synthesis and physical properties of several acetylenic hydrocarbons. J **52,** 51 (1954) RP2472.
Synthesis and physical properties of several aliphatic alicyclic hydrocarbons. J **52,** 59 (1954) RP2473.

Fookson, A., Pomerantz, P., Rich, E. H., Preparation and purification of hydrogen deuteride. J **47,** 31 (1951) RP2224.

Fookson, A., Pomerantz, P., Rothberg, S., Some characteristics of Stedman packing in the distillation of hydrogen and its isotopes. J **47,** 449 (1951) RP2271.

Forman, R., Rouse, G. F., Oxide cathode base metal studies. J **46,** 30 (1951) RP2171.

Forsythe, G. E., Solution of the telegrapher's equation with boundary conditions on only one characteristic. J **44,** 89 (1950) RP2059.

Fortet, R., On some functionals of Laplacian processes. J **48,** 32 (1952) RP2280.
On the estimation of an eigenvalue by an additive functional of the stochastic process, with special reference to the Kac-Donsker method. J **48,** 68 (1952) RP2286.
Random determinants. J **47,** 465 (1951) RP2274.

Forziati, A. F., Refractive index as a function of wavelengths for sixty API-NBS hydrocarbons. J **44,** 373 (1950) RP2085.

Forziati, A. F., Camin, D. L., Rossini, F. D., Density, refractive index, boiling point, and vapor pressure of eight monoolefin (1-alkene), six pentadiene, and two cyclomonoolefin hydrocarbons. J **45,** 406 (1950) RP2151.

Forziati, A. F., Copeland, H. I., Jr., Brauer, G. M., Sweeney, W. T., Setting reaction of zinc oxide and eugenol. J **55,** 133 (1955) RP2611.

Forziati, A. F., Norris, W. R., Rossini, F. D., Vapor pressures and boiling points of sixty API–NBS hydrocarbons. J **43,** 555 (1949) RP2049.

Forziati, A. F., Rossini, F. D., Alkylbenzenes in the C_9 fraction from seven representative crude petroleums. J **39,** 425 (1947) RP1839.

Physical properties of sixty API–NBS hydrocarbons. J **43,** 473 (1949) RP2038.

Forziati, F. H., Brownell, R. M., Hunt, C. M., Surface areas of cottons and modified cottons before and after swelling as determined by nitrogen sorption. J **50,** 139 (1953) RP2401.

Forziati, F. H., Rowen, J. W., Effect of changes in crystalline structure on the infrared absorption spectrum of cellulose. J **46,** 38 (1951) RP2172.

Forziati, F. H., Rowen, J. W., Plyler, E. K., Spectrophotometric determination of carboxyl in cellulose. J **46,** 288 (1951) RP2197.

Forziati, F. H., Schaffer, R., Appel, W. D., Reactions at wet-dry interfaces on fibrous materials. J **54,** 103 (1955) RP2570.

Forziati, F. H., Stone, W. K., Rowen, J. W., Appel, W. D., Cotton powder for infrared transmission measurements. J **45,** 109 (1950) RP2116.

Foster, H. D., Pinkston, E. R., Ingberg, S. H., Fire resistance of structural clay tile partitions. (1948) BMS113.

Fire resistance of walls of gravel-aggregate concrete masonry units. (1951) BMS120.

Fire resistance of walls of lightweight-aggregate concrete masonry units. (1950) BMS117.

Fox, G., Stone, W. K., Schiefer, H. F., Stress-strain relationships in yarns subjected to rapid impact loading: 1. Equipment, testing procedure, and typical results. J **54,** 269 (1955) RP2589.

Francisco, A. C., Richmond, J. C., The use of plastic replicas in evaluating surface texture of enamels. J **42,** 499 (1949) RP1985

Franklin, P. J., French, D. M., Nyberg, W. C., Development of the National Bureau of Standards casting resin. (1950) C493.

Frantz, F. S., Jr., Fleeman, J., Film dosimetry of electrons in the energy range 0.5 to 1.4 million electron volts. J **48,** 117 (1952) RP2295.

Fraser, F. M., Prosen, E. J., Heats of combustion and isomerization of six pentadienes and spiropentane. J **54,** 143 (1955) RP2575.

Heats of combustion of liquid *n*-hexadecane, 1-hexadecene, *m*-decylbenzene, *n*-decylcyclohexane, *n*-decylcyclopentane, and the variation heat of combustion with chain length. J **55,** 329 (1955) RP2638.

Fred, M., Meggers, W. F., Tomkins, F. S., Emission spectra of actinium. J **58,** 297 (1957) RP2763.

Freeman, J. J., Noise spectrum of a diode with a retarding field. J **42,** 75 (1949) RP1952.

The field generated by an arbitrary current distribution within a waveguide. J **44,** 193 (1950) RP2070.

Theory and design of a cavity attenuator. J **40,** 235 (1948) RP1868.

Freeze, P. D., Bibliography on the measurement of gas temperatures. (1951) C513.

Freeze, P. D., Dahl, A. I., Laboratory evaluation of a method proposed by Gnam for measuring the temperatures of rotating parts. J **41,** 601 (1948) RP1942.

French, D. M., Franklin, P. J., Nyberg, W. C., Development of the National Bureau of Standards castings resin. (1950) C493.

French, J. C., Electrode deterioration in transmit-receive tubes. J **45,** 310 (1950) RP2139.

French, J. L., Stack venting of plumbing fixtures. (1950) BMS118.

French, J. L., Eaton, H. N., Self-siphonage of fixture traps. (1951) BMS126.

French, J. L., Eaton, H. N., Wyly, R. S., Wet venting of plumbing fixtures. (1950) BMS119.

Friedman, A. S., Intermolecular forces in air. J **58,** 93 (1957) RP2738.

Friedman, A. S., Bradley, J. C., Haar, L., Ideal gas thermodynamic functions of the isotopic hydrogen cyanides. J **56,** 197 (1956) RP2668.

Friedman, A. S., Brown, L. M., Beckett, C. W., Bibliography of research on deuterium and tritium compounds 1945 to 1952. (1956) C562.

Friedman, A. S., Haar, L., Bradley, J. C., Ideal gas thermodynamic functions of the isotopic hydrogen sulfides. J **55,** 285 (1955) RP2631.

Friedman, A. S., Johnson, V. R., Brown, L. M., Bibliography of research on deuterium and tritium compounds, 1953 and 1954. (1957) C562, Supplement 1.

Friedman, F. L., Breit, G., Calculations on countercurrent electromigration. J **39,** 397 (1947) RP1836.

Frush, H. L., Isbell, H. S., Amides of glucuronic, galacturonic, and mannuronic acids. J **41,** 609 (1948) RP1943.

Amino derivatives of mannuronic acid. J **41,** 11 (1948) RP1898.

Determination of carbon 14 in the terminal positions of sugars: Preparation of D-arabinose-5-C^{14} from D-fructose-1,6-C^{14}. J **51,** 167 (1953) RP2446.

Macromethods for reducing aldonic lactones to sugars: the preparation of L-glucose. J **54,** 267 (1955) RP2588.

Mechanisms for the formation of acetylglycosides and orthoesters from acetylglycosyl halides. J **43,** 161 (1949) RP2018.

Mechanisms for the mutarotation and hydrolysis of glycosylamines and the mutarotation of the sugars. J **46,** 132 (1951) RP2186.

Mutarotation, hydrolysis, and structure of D-galactosylamines. J **47,** 239 (1951) RP2248.

Note on the stabilization of acetylglycosyl halides and sugar acetates. J **44,** 173 (1950) RP2068.

Preparation of D-arabinose-1-C^{14} and D-ribose-1-C^{14}. J **51,** 307 (1953) RP2458.

Synthesis of lactose-1-C^{14} and lactobionic-1-C^{14} delta lactone from 3-β-D-galactopyranosyl-α-D-arabinose. J **50,** 133 (1953) RP2400.

Frush, H. L., Isbell, H. S., Brewster, J. F., Holt, N. B., Behavior of certain sugars and sugar alcohols in the presence of tetraborates—correlation of optical rotation and compound formation. J **40,** 129 (1948) RP1862.

Frush, H. L., Isbell, H. S., Holt, N. B., Preparation of D-arabinose-5-C^{14} from D-glucose-6-C^{14}. J **57,** 95 (1956) RP2697.

Synthesis of D-galactose-1-C^{14} and D-talose-1-C^{14}. J **53,** 217 (1954) RP2536.

Synthesis of α-D-xylose-1-C^{14} and β-D-lyxose-1-C^{14}. J **53,** 325 (1954) RP2550.

Frush, H. L., Isbell, H. S., Karabinos, J. V., Holt, N. B., Schwebel, A., Galkowski, T. T., Synthesis of D-glucose-1-C^{14} and D-mannose-1-C^{14}. J **48,** 163 (1952) RP2301.

Frush, H. L., Isbell, H. S., Stewart, J. E., Moyer, J. D., Smith, F. A., Infrared spectra of D-talose monobenzoate and related substances. J **57,** 179 (1956) RP2708.

Frush, H. L., Schaffer, R., Isbell, H. S., Synthesis of α-D-glucose-2-C^{14}, α-D-mannose-2-C^{14}, and α-D-galactose-2-C^{14}. J **54,** 201 (1955) RP2581.

Furukawa, G. T., Douglas, T. B., McCoskey, R. E., Ball, A. F., Calorimetric properties of normal heptane from 0° to 520° K. J **53,** 139 (1954) RP2526.

Furukawa, G. T., Douglas, T. B., McCoskey, R. E., Ginnings, D. C., Thermal properties of aluminum oxide from 0° to 1,200° K. J **57,** 67 (1956) RP2694.

Furukawa, G. T., Ginnings, D. C., McCoskey, R. E., Nelson, R. A., Calorimetric properties of diphenyl ether from 0° to 570° K. J **46,** 195 (1951) RP2191.

Furukawa, G. T., McCoskey, R. E., Calorimetric properties of 41° and 122° F polybutadienes. J **51,** 321 (1953) RP2460.

Furukawa, G. T., McCoskey, R. E., King, G. J., Calorimetric properties of benzoic acid from 0° to 410° K. J **47,** 256 (1951) RP2251.

Calorimetric properties of polytetrafluoroethylene (Teflon) from 0° to 365° K. J **49,** 273 (1952) RP2364.

Thermal properties of some butadiene-styrene copolymers. J **50,** 357 (1953) RP2425.

Furukawa, G. T., McCoskey, R. E., Reilly, M. L., Heat capacity, heats of fusion and vaporization, and vapor pressure of tetrafluoroethylene. J **51,** 69 (1953) RP2432.

Heat capacity, heats of transitions, fusion, and vaporization, and vapor pressure of octafluorocyclobutane. J **52,** 11 (1954) RP2466.

Heat capacity of some butadiene-styrene copolymers from 0° to 330° K. J **55,** 127 (1955) RP2610.

Furukawa, G. T., McCoskey, R. E., Reilly, M. L., Harman, A. W., Heat capacity; heats of fusion, vaporization, and transition; and vapor pressure of *N*-dimethylaminodiborane, $(CH_3)_2NB_2H_5$. J **55,** 201 (1955) RP2620.

Furukawa, G. T., Park, R. P., Heat capacity, heats of fusion and vaporization, and vapor pressure of decaborane ($B_{10}H_{14}$). J **55,** 255 (1955) RP2627.

Furukawa, G. T., Reilly, M. L., Heat capacity of polyisobutylene from 0° to 380° K. J **56,** 285 (1956) RP2676.

Futterman, W., Osborne, E., Saxon, D. S., A numerical solution of Shrödinger's equation in the continuum. J **52,** 259 (1954) RP2498.

Fuyat, R. K., Swanson, H. E., Standard X-ray diffraction powder patterns. (1953) C539, Vol. II.

Fuyat, R. K., Swanson, H. E., Ugrinic, G. M., Standard X-ray diffraction powder patterns. (1954) C539, Vol. III.

Standard X-ray diffraction powder patterns. (1955) C539, Vol. IV.

G

Gailar, N., Plyler, E. K., Near infrared absorption spectra of deuterated acetylene. J **47,** 248 (1951) RP2249.

The $3\gamma_3$ bands of carbon disulfide and carbon dioxide. J **48,** 392 (1952) RP2327.

Gailar, N. M., Plyler, E. K., Wiggins, T. A., Some accurately measured infrared wavelengths for calibration of grating spectrometers. J **48,** 221 (1952) RP2309.

Galkowski, T. T., Isbell, H. S., Karabinos, J. V., Frush, H. L., Holt, N. B., Schwebel, A., Synthesis of D-glucose-1-C^{14} and D-mannose-1-C^{14}. J **48,** 163 (1952) RP2301.

Gardner, I. C., Relation between entrance and exit pupils of telescopic systems. J **43,** 157 (1949) RP2017.

Validity of the cosine-fourth-power law of illumination. J **39,** 213 (1947) RP1824.

Gardner, I. C., Hahner, C. H., Research and development in applied optics and optical glass at the National Bureau of Standards: A review and bibliography. (1949) M194.

Gardner, I. C., Washer, F. E., Lenses of extremely wide angle for airplane mapping. J **40,** 93 (1948) RP1858.

Method for determining the resolving power of photographic lenses. (1953) C533.

Garfinkel, S. B., Wexler, A., Jones, F. E., Hasegawa, S., Krinsky, A., A fast responding electric hygrometer. J **55,** 71 (1955) RP2606.

Gaughan, M. B., Simha, R., Callomon, I. G., Jeppson, H. H., Bibliography of recent research in the field of high polymers. (1950) C498.

Gautier, T., Jr., Sargent, C. J., Prediction of the likelihood of interference at frequencies of 30 to 42 megacycles in Alaska. J **52,** 21 (1954) RP2468.

Geib, M. N., Sigler, P. A., Boone, T. H., Measurement of the slipperiness of walkway surfaces. *J* **40,** 339 (1948) RP1879.

Geil, G. W., Carwile, N. L., A reduction-of-area gage for use at low temperatures. J **43,** 527 (1949) RP2044.

Effect of low temperatures on the mechanical properties of a commercially pure titanium. J **54,** 91 (1955) RP2569.

Effect of strain-temperature history on the flow and fracture of ingot iron at low temperatures. J **48,** 399 (1952) RP2329.

Tensile properties of ingot iron at low temperatures. J **45,** 129 (1950) RP2119.

Geil, G. W., Carwile, N. L., Digges, T. G., Influence of nitrogen on the notch toughness of heat-treated 0.3-percent-carbon steels at low temperatures. J **48,** 193 (1952) RP2305.

Geil, G. W., McAdam, D. J., Jr., Cromwell, F. J., Influence of low temperatures of the mechanical properties of 18:8 chromium-nickel steel. J **40,** 375 (1948) RP1882.

Geller, R. F., Lang, S. M., Maxwell, L. H., Some physical properties of porcelains in the systems magnesia-beryllia-zirconia and magnesia-beryllia-thoria and their phase relations. J **43,** 429 (1949) RP2034.

Gibson, K. S., Spectrophotometry (200 to 1,000 millimicrons). (1949) C484.

Gibson, K. S., Belknap, M. A., Permanence of glass standards of spectral transmittance. J **44,** 463 (1950) RP2093.

Gibson, K. S., Davis, R., Haupt, G. W., Spectral energy distribution of the International Commission on Illumination light sources A, B, and C. J **50,** 31 (1953) RP2384.

Gilchrist, R., Clabaugh, W. S., Donovan, J. W., Preparation of nickel chloride of high purity. J **52,** 73 (1954) RP2475.

Gilchrist, R., Clabaugh, W. S., Leslie, R. T., Preparation of titanium tetrachloride of high purity. J **55,** 261 (1955) RP2628.

Gilchrist, R., Clabaugh, W. S., Swiggard, E. M., Preparation of barium titanyl oxalate tetrahydrate for conversion to barium titanate of high purity. J **56,** 289 (1956) RP2677.

Gilchrist, R., Johannesen, R. B., Gordon, C. L., Stewart, J. E., Application of infrared spectroscopy to the determination of impurities in titanium tetrachloride. J **53,** 197 (1954) RP2533.

Gilchrist, R., Murphy, T. J., Clabaugh, W. S., Separation of iodide, bromide, and chloride from one another and their subsequent determination. J **53,** 13 (1954) RP2511.

Gilfrich, J. B., Newman, E. S., Wells, L. S., Heat generation in the setting of magnesium oxychloride cements. J **49,** 377 (1952) RP2375.

Gilfrich, N. T., Swanson, H. E., Cook, M. I., Standard X-ray diffraction powder patterns. (1956) C539, Vol. 6.

Gilfrich, N. T., Swanson, H. E., Ugrinic, G. M., Standard X-ray diffraction powder patterns. (1955) C539, Vol. V.

Ginnings, D. C., Ball, A. F., Vier, D. T., Calorimetric determination of the half-life of polonium. J **50,** 75 (1953) RP2392.

Ginnings, D. C., Corruccini, R. J., Heat capacities at high temperature of uranium, uranium trichloride, and uranium tetrachloride. J **39,** 309 (1947) RP1831.

Ginnings, D. C., Douglas, T. B., Ball, A. F., Heat capacity of liquid mercury between 0° and 450° C; calculation of certain thermodynamic properties of the saturated liquid and vapor. J **46,** 334 (1951) RP2204.

Heat capacity of sodium between 0° and 900° C, the triple point and heat of fusion. J **45,** 23 (1950) RP2110.

Ginnings, D. C., Furukawa, G. T., Douglas, T. B., McCoskey, R. E., Thermal properties of aluminum oxide from 0° to 1,200° K. J **57,** 67 (1956) RP2694.

Ginnings, D. C., Furukawa, G. T., McCoskey, R. E., Nelson, R. A., Calorimetric properties of diphenyl ether from 0° to 570° K. J **46,** 195 (1951) RP2191.

Ginnings, D. C., Nuttall, R. L., Thermal conductivity of nitrogen from 50° to 500° C and 1 to 100 atmospheres. J **58,** 271 (1957) RP2760.

Ginnings, D. C., Osborne, N. S., Measurements of heat of vaporization and heat capacity of a number of hydrocarbons. J **39,** 453 (1947) RP1841.

Glasgow, A. R., Jr., Analysis of mixtures of olefin hydrocarbons produced by codimerization of butenes. J **46,** 43 (1951) RP2173.

Glasgow, A. R., Jr., Ross, G. S., Purification of substances by a process of freezing and fractional melting under equilibrium conditions. J **57,** 137 (1956) RP2703.

Glasgow, A. R., Jr., Willingham, C. B., Rossini, F. D., Hydrocarbons in the 108° to 116° C fraction of petroleum. J **44,** 141 (1950) RP2065.

Separation of 2,3-dimethylpentane, 1,*cis*-3-dimethylcyclopentane, and 3-ethylpentane from petroleum. J **44,** 411 (1950) RP2088.

Glaze, F. W., Florence, J. M., Allshouse, C. C., Hahner, C. H., Absorption of near-infrared energy by certain glasses. J **45,** 121 (1950) RP2118.

Glaze, F. W., Florence, J. M., Black, M. H., Infrared transmittance of some calcium aluminate and germanate glasses. J **55,** 231 (1955) RP2625.

Transmission of near-infrared energy of some two- and three-component glasses. J **50,** 187 (1953) RP2408.

Glaze, F. W., Florence, J. M., Hahner, C. H., Stair, R., Transmittance of near infrared energy by binary glasses. J **41,** 623 (1948) RP1945.

Glaze, F. W., Hahner, C. H., Optical glass at the National Bureau of Standards. (1948) C469.

Gleysteen, L. F., Loebenstein, W. V., Deitz, V. R., Kinetic study of the reaction of carbon adsorbents with oxygen. J **42,** 33 (1949) RP1948.

Gleyzal, A., An algorithm for solving the transportation problem. J **54,** 213 (1955) RP2583.

Goalwin, D. S., Fire resistance of concrete floors. (1952) BMS134.

Properties of cavity walls. (1953) BMS136.

Godfrey, T. B., Swindells, J. F., Coe, J. R., Jr., Absolute viscosity of water at 20° C. J **48,** 1 (1952) RP2279.

Goldberg, K., A matrix with real characteristic roots. J **56,** 87 (1956) RP2652.

Goldman, R. G., Hubbard, D., Heterogeneous equilibria at the glass electrode-solution interface. J **48,** 428 (1952) RP2333.

pH response of nonhygroscopic glasses. J **48,** 370 (1952) RP2324.

Goldstein, J. M., Armstrong, G. T., Roberts, D. E., Liquid-vapor phase equilibria in solutions of oxygen and nitrogen at pressures below one atmosphere. J **55,** 265 (1955) RP2629.

Golovato, E., McMurdie, H. F., Study of the modifications of manganese dioxide. J **41,** 589 (1948) RP1941.

Goodman, S., Radiant-heat transfer between nongray parallel plates. J **58,** 37 (1957) RP2732.

Gordon, C. L., Johannesen, R. B., Stewart, J. E., Gilchrist, R., Application of infrared spectroscopy to the determination of impurities in titanium tetrachloride. J **53,** 197 (1954) RP2533.

Gould, R. E., Standard time throughout the world. (1950) C496.

Grauer, O. H., Hamilton, E. H., An improved apparatus for the determination of liquidus temperature and rates of crystal growth in glasses. J **44,** 495 (1950) RP2096.

Grauer, O. H., Hamilton, E. H., Zabawsky, Z., Hahner, C. H., Changes in the indices of refraction and liquidus of a barium crown glass produced by the partial substitution of some oxides. J **40,** 361 (1948) RP1881.

Grauer, O. H., Rynders, G. F., Hubbard, D., Electrode function (pH response) of the soda-silica glasses. J **41,** 273 (1948) RP1923.

Grebber, K., Karabinos, J. V., A study of the diphenylamine test for aliphatic nitrocompounds. J **49,** 163 (1952) RP2353.

Green, J. W., An expansion method for parabolic partial differential equations. J **51,** 127 (1953) RP2441.

Greene, F. M., Calibration of commercial radio field-strength meters at the National Bureau of Standards. (1951) C517.

Influence of the ground on the calibration and use of VHF field-intensity meters. J **44,** 123 (1950) RP2062.

Greene, F. M., Solow, M., Development of very-high-frequency field-intensity standards. J **44,** 527 (1950) RP2100.

Greenfeld, S. H., Effects of mineral additives on the durability of coating-grade roofing asphalts. (1956) BMS147.

Greenough, M. L., Williams, W. E., An electronic circuit for measuring the displacement of pressure-sensitive diaphragms. J **46,** 5 (1951) RP2168.

Greenspan, M., Stang, A. H., Perforated cover plates for steel columns: Summary of compressive properties. J **40**, 347 (1948) RP1880.

Griffel, M., Jessup, R. S., Cogliano, J. A., Park, R. P., Apparent specific volume of polystyrene in benzene, toluene, ethylbenzene, and 2-butanone. J **52,** 217 (1954) RP2492.

Grimsley, J. D., Mebs, R. W., Darr, J. H., Metal ultrasonic delay lines. J **51,** 209 (1953) RP2453.

Grodstein, G. W., X-ray attenuation coefficients from 10 kev to 100 Mev. (1957) C583.

Grove, G. R., Measurement of cesium-137 and cobalt-60 gamma radiation with a pressure ionization chamber. J **48,** 147 (1952) RP2298.

Grover, F. W., A study of absolute standards of mutual inductance and in particular the three-section National Bureau of Standards type. J **53,** 297 (1954) RP2548.

Gumbel, E. J., Statistical theory of extreme values and some practical applications. A series of lectures. (1954) AMS33.

H

Haar, L., Bradley, J. C., Friedman, A. S., Ideal gas thermodynamic functions of the isotopic hydrogen cyanides. J **56,** 197 (1956) RP2668.

Ideal gas thermodynamic functions of the isotopic hydrogen sulfides. J **55,** 285 (1955) RP2631.

Haas, P. H., A radio-frequency permeameter. J **51,** 221 (1953) RP2454.

Haas, P. H., Harrington, R. D., Powell, R. C., A re-entrant cavity for measurement of complex permeability in the very-high-frequency region. J **56,** 129 (1956) RP2657.

Haas, P. H., Kostyshyn, B., Discussion of current-sheet approximations in reference to high-frequency magnetic measurements. J **52,** 279 (1954) RP2501.

Hague, J. L., Brown, E. D., Bright, H. A., Photometric determination of copper in iron and steel with diethyldithiocarbamate. J **47,** 380 (1951) RP2265.

Separation of titanium, tungsten, molybdenum, and niobium by anion exchange. J **53,** 261 (1954) RP2542.

Hague, J. L., Maczkowske, E. E., Bright, H. A., Determination of nickel, manganese, cobalt, and iron in high-temperature alloys, using anion-exchange separations. J **53,** 353 (1954) RP2552.

Hague, J. L., Paulson, R. A., Bright, H. A., Determination of nitrogen in steel. J **43,** 201 (1949) RP2021.

Hahner, C. H., Florence, J. M., Allshouse, C. C., Glaze, F. W., Absorption of near-infrared energy by certain glasses. J **45,** 121 (1950) RP2118.

Hahner, C. H., Florence, J. M., Glaze, F. W., Stair, R., Transmittance of near infrared energy by binary glasses. J **41,** 623 (1948) RP1945.

Hahner, C. H., Gardner, I. C., Research and development in applied optics and optical glass at the National Bureau of Standards: A review and bibliography. (1949) M194.

Hahner, C. H., Glaze, F. W., Optical glass at the National Bureau of Standards. (1948) C469.

Hahner, C. H., Hamilton, E. H., Grauer, O. H., Zabawsky, Z., Changes in the indices of refraction and liquidus of a barium crown glass produced by the partial substitution of some oxides. J **40,** 361 (1948) RP1881.

Hakkarinen, W., Lowell, P. D., Randall, D. L., National Bureau of Standards mobile low-level sounding system. J **50,** 7 (1953) RP2381.

Hall, W. G., Marton, L., Marton, C., Electron physics tables. (1956) C571.

Halpern, C., Fiock, E. F., Bibliography of books and published reports on gas turbines, jet propulsion, and rocket power plants. (1951) C509.

Bibliography of books and published reports on gas turbines, jet propulsion, and rocket power plants, January 1950 through December 1953. (1954) C509 Supplement.

Halpern, C., Ruegg, F. W., Gravimetric analysis of exhaust gas from gas turbine combustion chambers. J **45,** 113 (1950) RP2117.

Hamer, W. J., An improved method for measurement of gel strength and data on starch gels. J **39,** 29 (1947) RP1810.

Anodic current efficiency in the counter-flow electrolysis of uranyl chloride solutions. J **39,** 141 (1947) RP1817.

Correlations of the gel strength of paste walls and the shelf life of electric dry cells. J **40,** 251 (1948) RP1870.

Hamer, W. J., Morehouse, C. K., Vinal, G. W., Effect of inhibitors on the corrosion of zinc in dry-cell electrolytes. J **40,** 151 (1948) RP1863.

Hamilton, E. H., Cleek, G. W., Properties of barium titanium silicate glasses. J **57,** 317 (1956) RP2720.

Hamilton, E. H., Grauer, O. H., An improved apparatus for the determination of liquidus temperature and rates of crystal growth in glasses. J **44,** 495 (1950) RP2096.

Hamilton, E. H., Grauer, O. H., Zabawsky, Z., Hahner, C. H., Changes in the indices of refraction and liquidus of a barium crown glass produced by the partial substitution of some oxides. J **40,** 361 (1948) RP1881.

Hammersley, J. M., Tables of complete elliptic integrals. J **50,** 43 (1953) RP2386.

Hammond, H. K., III, Newman, S. B., Riddell, H. F., Becker value of manila rope by photoelectric reflectometry. J **51,** 141 (1953) RP2443.

Hammond, H. K., III, Nimeroff, I., Measurement of sixty-degree specular gloss. J **44,** 585 (1950) RP2105.

Hammond, L. D., Determination of lactose alone and in the presence of sucrose by the method of Munson and Walker. J **41,** 211 (1948) RP1919.

Hanks, G. A., Weissberg, S. G., A convenient small osmometer. J **49,** 393 (1952) RP2377.

Hardy, R. C., Cottington, R. L., Viscosity of deuterium oxide and water in the range 5° to 125° C J **42,** 573 (1949) RP1994.

Hardy, R. C., Swindells, J. F., Cottington, R. L., Precise measurements with Bingham viscometers and Cannon master viscometers. J **52,** 105 (1954) RP2479.

Harman, A. W., Furukawa, G. T., McCoskey, R. E., Reilly, M. L., Heat capacity; heats of fusion, vaporization, and transition; and vapor pressure of N-dimethylaminodiborane, $(CH_3)_2NB_2H_5$). J **55,** 201 (1955) RP2620.

Harman, J. C., Kirby, R. S., Capps, F. M., Jones, R. N., Effective radio ground-conductivity measurements in the United States. (1954) C546.

Harrington, R. D., Powell, R. C., Haas, P. H., A reentrant cavity for measurement of complex permeability in the very-high-frequency region. J **56,** 129 (1956) RP2657.

Harris, W. P., Cooter, I. L., Investigation of an alternating-current bridge for the measurement of core losses in ferromagnetic materials at high flux densities. J **56,** 103 (1956) RP2699.

Harrison, G. R., Kiess, C. C., Hitchcock, W. J., Preliminary list of levels and *g*-values for Ta II. J **44,** 245 (1950) RP2075.

Harrison, W. N., Moore, D. G., Fifteen-year exposure test of porcelain enamels. (1957) BMS148.
Weather resistance of porcelain enamels exposed for seven years. J **42,** 43 (1949) RP1949.

Harrison, W. N., Strauss, S. W., Moore, D. G., Richards, L. E., Fundamental factors controlling electrical resistivity in vitreous ternary lead silicates. J **56,** 135 (1956) RP2658.

Hart, V. E., Molecular weights of thermally degraded polymethyl methacrylate. J **56,** 67 (1956) RP2649.

Hart, V. E., Madorsky, S. L., Straus, S., Pyrolysis of cellulose in a vacuum. J **56,** 343 (1956) RP2685.

Hart, V. E., Madorsky, S. L., Straus, S., Sedlak, V. A., Thermal degradation of tetrafluoroethylene and hydrofluoroethylene polymers in a vacuum. J **51,** 327 (1953) RP2461.

Hartree, D. R., Huskey, H. D., On the precision of a certain procedure of numerical integration. J **42,** 57 (1949) RP1950.

Hartsfield, W. L., Ostrow, S. M., Silberstein, R., Back-scatter observations by the Central Radio Propagation Laboratory—August 1947 to March 1948. J **44,** 199 (1950) RP2071.

Harvey, M. M., Trees, R. E., Low even configurations of the first spectrum of molybdenum (Mo I). J **49,** 397 (1952) RP2378.

Harvey, M. R., Stewart, J. E., Achhammer, B. G., Index of refraction and particle size as factors in the infrared spectrophotometry of polyvinyl chloride. J **56,** 225 (1956) RP2670.

Hasegawa, S., Wexler, A., Relative humidity-temperature relationships of some saturated salt solutions in the temperature range 0° to 50° C. J **53,** 19 (1954) RP2512.

Hasegawa, S., Wexler, A., Garfinkel, S. B., Jones, F. E., Krinsky, A., A fast responding electric hygrometer. J **55,** 71 (1955) RP2606.

Hattiangdi, G. S., Characterization of some commercial soaps by X-ray diffraction. J **42,** 331 (1949) RP1972.

Hattiangdi, G. S., Swerdlow, M., Characterization of alkali soaps by electron microscopy. J **42,** 343 (1949) RP1973.

Hattiangdi, G. S., Walton, W. W., Hoffman, J. I., Some physical chemical properties of aqueous solutions of soaps and soapless detergents. J **42,** 361 (1949) RP1974.

Haupt, G. W., An alkaline solution of potassium chromate as a transmittance standard in the ultraviolet. J **48,** 414 (1952) RP2331.

Haupt, G. W., Davis, R., Gibson, K. S., Spectral energy distribution of the International Commission on Illumination light sources A, B, and C. J **50,** 31 (1953) RP2384.

Haupt, G. W., Douglas, F. L., Chromaticities of Lovibond glasses. J **39,** 11 (1947) RP1808.

Haven, C. E., Strang, A. G., Assembled polygon for the calibration of angle blocks. J **50,** 45 (1953) RP2387.

Hayward, R. W., Hoppes, D. D., Mann, W. B., Branching ratio in the decay of polonium-210. J **54,** 47 (1955) RP2564.

Herbstreit, J. W., Barsis, A. P., Hornberg, K. O., Cheyenne Mountain tropospheric propagation experiments. (1955) C554.

Hermach, F. L., Thermal converters as ac-dc transfer standards for current and voltage measurements at audio frequencies. J **48,** 121 (1952) RP2296.

Hermach, F. L., Williams, E. S., Multirange, audio-frequency thermocouple instruments of high accuracy. J **52,** 227 (1954) RP2494.

Herrick, S., Tables for rocket and comet orbits. (1953) AMS20.

Herschman, H. K., Thomas, C., Fatigue characteristics of electroformed sheets with and without iron backing. J **43,** 477 (1949) RP2039.

Herson, J. L., Measurement of the disintegration rate of sodium^{22} by the coincidence method. J **43,** 543 (1949) RP2047.

Hess, A., Rasmussen, A. L., Enfield, A. W., Advances in the design and application of the radiofrequency permeameter. J **56,** 261 (1956) RP2673.

Hessing, H., Logan, H. L., Stress-corrosion tests on high-strength aluminum alloy sheet. J **41,** 69 (1948) RP1905.
Stress corrosion of wrought magnesium base alloys. J **44,** 233 (1950) RP2074.

Hestenes, M. R., Karush, W., A method of gradients for the calculation of the characteristic roots and vectors of a real symmetric matrix. J **47,** 45 (1951) RP2227.
Solutions of $Ax=\lambda Bx$. J **47,** 471 (1951) RP2275.

Hestenes, M. R., Rosser, J. B., Lanczos, C., Karush, W., Separation of close eigenvalues of a real symmetric matrix. J **47,** 291 (1951) RP2256.

Hestenes, M. R., Stiefel, E., Methods of conjugate gradients for solving linear systems. J **49,** 409 (1952) RP2379.

Hetzer, H. B., Davis, M. M., Comparative strengths of four organic bases in benzene. J **48,** 381 (1952) RP2326.
The behavior of bromophthalien magenta E (tetrabromophenolphthalein ethyl ester) with organic bases and its bearing on the Brønsted-Lowry and Lewis concepts of acidity. J **46,** 496 (1951) RP2219.
Titrations of bases with diphenyl phosphate in some aqueous and nonaqueous solvents. J **54,** 309 (1955) RP2593.

Hidnert, P., Thermal expansion of five selected optical glasses. J **52,** 311 (1954) RP2507.
Thermal expansion of some nickel alloys, J **58,** 89 (1957) RP2737.

Hidnert, P., Kirby, R. K., A new method for determining linear thermal expansion of invar geodetic surveying tapes. J **50,** 179 (1953) RP2407.
Thermal expansion and phase transformations of low-expanding cobalt-iron-chromium alloys. J **55,** 29 (1955) RP2602.

Hidnert, P., Krider, H. S., Thermal expansion of aluminum and some aluminum alloys. J **48,** 209 (1952) RP2308.
Thermal expansion of some copper alloys. J **39,** 419 (1947) RP1838.

Hidnert, P., Peffer, E. L., Density of solids and liquids. (1950) C487.

Hidnert, P., Souder, W., Thermal expansion of solids. (1950) C486.

Higginson, H. R., Deitz, V. R., Parker, C., Determination of sulfur in bone char. J **40,** 263 (1948) RP1871.

Hilsenrath, J., Beckett, C. W., Benedict, W. S., Fano, L., Hoge, H. J., Masi, J. F., Nuttall, R. L., Touloukian, Y. S., Woolley, H. W., Tables of thermal properties of gases. (1955) C564.

Hipple, J. A., Thomas, H. A., Driscoll, R. L., Measurement of the proton moment in absolute units. J **44,** 569 (1950) RP2104.

Hitchcock, W. J., Kiess, C. C., Harrison, G. R., Preliminary list of levels and g-values for Ta II. J **44,** 245 (1950) RP2075.

Hobbs, E. V., Levy, S., Kroll, W. D., Mordfin, L., Damping of elastically supported element in a vacuum tube. J **50,** 71 (1953) RP2391.

Hobbs, E. V., Levy, S., McPherson, A. E., Calibration of accelerometers. J **41,** 359 (1948) RP1930.

Hobbs, R. B., Richey, G. G., McKenna, E. H., Methods and equipment for testing printed-enamel felt-base floor covering. (1952) BMS130.

Hobbs, R. B., Steiner, E. T., Hosterman, E. R., Laboratory and service tests of hand luggage. (1949) M193.

Hockman, A., Kessler, D. W., Thermal and moisture expansion studies of some domestic granites. J **44,** 395 (1950) RP2087.

Hodge, O. J., Fire tests of bulb-type carbon-tetrachloride fire extinguishers. (1951) M197.

Hoffman, A. J., On approximate solutions of systems of linear inequalities. J **49,** 263 (1952) RP2362.

Hoffman, A. J., Taussky, O., A characterization of normal matrices. J **52,** 17 (1954) RP2467.

Hoffman, H. L., Jr., Deitz, V. R., Pennington, N. L., Transmittancy of commercial sugar liquors: Dependence on concentration of total solids. J **49,** 365 (1952) RP2373.

Hoffman, J. D., Axilrod, B. M., Dielectric relaxation for spherical molecules in a crystalline field: Theory for two simple models. J **54,** 357 (1955) RP2598.

Theory of dielectric relaxation for the three-dimensional polar rotator: Lattice models leading to bimodal loss curves. J **58,** 61 (1957) RP2735.

Hoffman, J. D., Weir, C. E., Compressibilities of long-chain normal hydrocarbons. J **55,** 307 (1955) RP2634.

Hoffman, J. I., Clark, L. J., Hubbard, W. D., Crystallization of aluminum chloride in hydrochloric acid process for production of alumina from clay. J 47. 269 (1951) RP2253.

Hoffman, J. I., Hattiangdi, G. S., Walton, W. W., Some physical chemical properties of aqueous solutions of soaps and soapless detergents. J **42,** 361 (1949) RP1974.

Hoffman, J. I., Kushner, L. M., Duncan, B. C., A viscometric study of the micelles of sodium dodecyl sulfate in dilute solutions. J **49,** 85 (1952) RP2346.

Hoffman, R., Newman, E. S., Heats of formation of hexacalcium dialumino ferrite and dicalcium ferrite. J **56,** 313 (1956) RP2681.

Hoge, H. J., Vapor pressure and fixed points of oxygen and heat capacity in the critical region. J **44,** 321 (1950) RP2081.

Hoge, H. J., Arnold, R. D., Vapor pressures of hydrogen deuterium, and hydrogen deuteride, and dew-point pressures of their mixtures. J **47,** 63 (1951) RP2228.

Hoge, H. J., Hilsenrath, J., Beckett, C. W., Benedict, W. S., Fano, L., Masi, J. F., Nuttall, R. L., Touloukian, Y. S., Woolley, H. W., Tables of thermal properties of gases. (1955) C564.

Hoge, H. J., Lassiter, J. W., Critical temperatures, pressures, and volume of hydrogen, deuterium, and hydrogen deuteride. J **47,** 75 (1951) RP2229.

Hoge, H. J., Meyers, C. H., McCoskey, R. E., Charts of compressibility factors and charts showing quantities delivered by commercial cylinders, for hydrogen, nitrogen, and oxygen. (1948) M191.

Holler, H. D., Some electrical relations in galvanic couples. J **45,** 373 (1950) RP2148.

The role of current distribution in cathodic protection. J **47,** 1 (1951) RP2220.

Holly, S. F., Hubbard, D., Black, M. H., Rynders, G. F., Electrode function (pH response), hygroscopicity, and chemical durability of soda-potash-silica glasses. J **46,** 168 (1951) RP2189.

Holm, V. C. F., Krynitsky, A. I., Observations on the control of grain size in magnesium casting alloys. J **39,** 265 (1947) RP1826.

Holt, N. B., Isbell, H. S., Brewster, J. F., Frush, H. L., Behavior of certain sugars and sugar alcohols in the presence of tetraborates—correlation of optical rotation and compound formation. J **40,** 129 (1948) RP1862.

Holt, N. B., Isbell, H. S., Frush, H. L., Preparation of D-arabinose-5-C^{14} from D-glucose-6-C^{14}. J **57,** 95 (1956) RP2697.

Synthesis of α-D-xylose-1-C^{14} and β-D-lyxose-1-C^{14}. J **53,** 325 (1954) RP2550.

Synthesis of D-galactose-1-C^{14} and D-talose-1-C^{14}. J **53,** 217 (1954) RP2536.

Holt, N. B., Isbell, H. S., Karabinos, J. V., Frush, H. L., Schwebel, A., Galkowski, T. T., Synthesis of D-glucose-1-C^{14} and D-mannose-1-C^{14}. J **48,** 163 (1952) RP2301.

Holt, N. B., Isbell, H. S., Snyder, C. F., Dryden, M. R., Determination of molecular weights of dextrans by means of alkaline copper reagents. J **50,** 81 (1953) RP2393.

Holt, N. B., Snyder, C. F., Isbell, H. S., Dryden, M. R., Optical rotations, refractive indices, and densities of dextran solutions. J **53,** 131 (1954) RP2525.

Holt, W. L., Knox, E. O., Roth, F. L., Strain tester for rubber. J **41,** 95 (1948) RP1907.

Hopper, N. J., Pepperman, D. H., Periodicals and serials received in the Library of the National Bureau of Standards, April 1955. (1955) C563.

Hoppes, D. D., Hayward, R. W., Mann, W. B., Branching ratio in the decay of polonium-210. J **54,** 47 (1955) RP2564.

Hornberg, K. O., Barsis, A. P., Herbstreit, J. W., Cheyenne Mountain tropospheric propagation experiments. (1955) C554.

Horowitz, E., Tryon, M., Mandel, J., Determination of natural rubber in GR-S—natural rubber vulcanizates by infrared spectroscopy. J **55,** 219 (1955) RP2623.

Hosler, W. R., Breckenridge, R. G., Titanium dioxide rectifiers. J **49,** 65 (1952) RP2344.

Hosterman, E. R., Steiner, E. T., Aging of Karakul and seal fur skins. J **45,** 317 (1950) RP2141.

Hosterman, E. R., Steiner, E. T., Hobbs, R. B., Laboratory and service tests of hand luggage. (1949) M193.

Howard, F. L., Brooks, D. B., Streets, R. E., Automotive antifreeze. (1956) C576.

Howard, F. L., Cadwallader, E. A., Fookson, A., Mears, T. W., Aliphatic halide-carbonyl condensations by means of sodium. J **41,** 111 (1948) RP1909.

Howard, F. L., Levedahl, W. J., An apparatus for studying autoignition of engine fuels: Results with normal heptane and normal hexane. J **46,** 301 (1951) RP2200.

Howard, F. L., Mears, T. W., Fookson, A., Pomerantz, P., Rich, E. H., Dussinger, C. S., Syntheses and properties of two olefins, six paraffins, and their intermediates. J **44,** 299 (1950) RP2079.

Howard, F. L., Pomerantz, P., Fookson, A., Mears, T. W., Rothberg, S., Synthesis and physical properties of several acetylenic hydrocarbons. J **52,** 51 (1954) RP2472.

Synthesis and physical properties of several aliphatic and alicyclic hydrocarbons. J **52,** 59 (1954) RP2473.

Howard, F. L., Pomerantz, P., Mears, T. W., Separation and identification of the major C_7 to C_{10} components of triptene residue. J **42,** 617 (1949) RP1999.

Howard, W. J., Sogn, L. T., Mechnical production of very thin oscillator plates. J **43,** 459 (1949) RP2036.

Howe, H. H., Wait, J. R., Amplitude and phase curves for ground-wave propagation in the band 200 cycles per second to 500 kilocycles. (1956) C574.

Hubbard, D., Effect of temperature on the electrical resistance and voltage departures (errors) of glass electrodes, and upon the hygroscopicity of glass. J **50,** 337 (1953) RP2423.

Hubbard, D., Black, M. H., Holley, S. F., Rynders, G. F., Electrode function (pH response), hygroscopicity, and chemical durability of soda-potash-silica glasses. J **46,** 168 (1951) RP2189.

Hubbard, D., Black, M. H., Rynders, G. F., Electrode function (pH response), hygroscopicity, and chemical durability of soda-lead oxide-silica glasses. J **45,** 430 (1950) RP2154.

Hubbard, D., Cleek, G. W., Deuterium and hydrogen electrode characteristics of lithia-silica glasses. J **49,** 267 (1952) RP2363.

Hubbard, D., Cleek, G. W., Rynders, G. F., Electrode function (pH response), hygroscopicity, and chemical durability of Na_2O-CaO-SiO_2 glasses. J **44,** 247 (1950) RP2076.

Hubbard, D., Diamond, J. J., Thickness of glass electrodes. J **47,** 443 (1951) RP2270.

Hubbard, D., Goldman, R. G., Heterogeneous equilibria at the glass electrode-solution interface. J **48,** 428 (1952) RP2333.
pH response of nonhydroscopic glasses. J **48,** 370 (1952) RP2324.

Hubbard, D., O'Leary, M. J., Some properties of a glass used in paper manufacture. J **55,** 1 (1955) RP2599.

Hubbard, D., Pike, R. G., An interferometer procedure applied to the study of the chemical durability of silicates, enamels, and metals. J **50,** 87 (1953) RP2394.

Hubbard, D., Rynders, G. F., Chemical durability, specular gloss, and transmittance of optical glasses. J **41,** 477 (1948) RP1933.
Effect of annealing and other heat treatments on the pH response of the glass electrode. J **40,** 105 (1948) RP1859.
Thickness of inhibiting films on glass electrode surfaces. J **41,** 163 (1948) RP1915.
Voltage anomalies of the glass electrode and the chemical durability of the glass. J **39,** 561 (1947) RP1848.

Hubbard, D., Rynders, G. F., Grauer, O. H., Electrode function (pH response) of the soda-silica glasses. J **41,** 273 (1948) RP1923.

Hubbard, D., Shermer, H. F., Rynders, G. F., Cleek, G. W., Atypical pH response of some nonsilicate glasses. J **52,** 251 (1954) RP2497.

Hubbard, W. D., Clark, L. J., Hoffman, J. I., Crystallization of aluminum chloride in hydrochloric acid process for production of alumina from clay. J **47,** 269 (1951) RP2253.

Hudson, R. P., Ambler, E., An examination of the helium vapor-pressure scale of temperature using a magnetic thermometer. J **56,** 99 (1956) RP2654.
An examination of the 1955 helium vapor-pressure scales of temperature. J **57,** 23 (1956) RP2689.

Hudson, R. P., de Klerk, D., Installation for adiabatic demagnetization experiments at the National Bureau of Standards. J **53,** 173 (1954) RP2530.

Hudson, R. P., McLane, C. K., Tables for use in the interpretation of paramagnetic behavior below 1° K; for the chromic alums (J=3/2). J **52,** 33 (1954) RP2469.

Hughes, J. C., Testing of hydrometers. (1954) C555.

Hughes, J. C., Collett, C. T., Morey, F. C., Measurement of the internal diameters of metallic capillary tubes. J **45,** 283 (1950) RP2134.

Humphreys, C. J., Infrared emission spectrum of calcium. J **47,** 262 (1951) RP2252.
The sixth series in the spectrum of atomic hydrogen. J **50,** 1 (1953) RP2380.

Humphreys, C. J., Kostkowski, H. J., Infrared spectra of noble gases (12000 to 19000 A). J **49,** 73 (1952) RP2345.

Humphreys, C. J., Plyler, E. K., Flame spectrum of aceytlene from 1 to 5 microns. J **42,** 567 (1949) RP1993.
Infrared absorption spectrum of carbon disulfide. J **39,** 59 (1947) RP1814.
Infrared emission spectra of flames. J **40,** 449 (1948) RP1890.
Use of radiation from incandescent particles as an indication of flame temperature. J **47,** 456 (1951) RP2272.

Hunt, C. M., Blaine, R. L., Rowen, J. W., Submicroscopic structure of cellulose from nitrogen sorption measurements. J **43,** 547 (1949) RP2048.

Hunt, C. M., Forziati, F. H., Brownell, R. M., Surface areas of cottons and modified cottons before and after swelling as determined by nitrogen sorption. J **50,** 139 (1953) RP2401.

Hunt, C. M., Rowen, J. W., Plyler, E. K., Absorption spectra in the detection of chemical changes in cellulose and cellulose derivatives. J **39,** 133 (1947) RP1816.

Hunt, C. M., Weir, C. E., Blaine, R. L., Behavior of cements and related materials under hydrostatic pressures up to 10,000 atmospheres. J **56,** 39 (1956) RP2646.

Huskey, H. D., Hartree, D. R., On the precision of a certain procedure of numerical integration. J **42,** 57 (1949) RP1950.

Hutton, A. C., Ryan, J. V., Cummings, J. W., Fire effects and fire control in nitrocellulose photographic-film storage. (1956) BMS145.

Hymo, L. A., Florin, R. E., Wall, L. A., Brown, D. W., Michaelsen, J. D., Factors affecting the thermal stability of polytetrafluoroethylene. J **53,** 121 (1954) RP2524.

I

Iberall, A. S., Attenuation of oscillatory pressures in instrument lines. J **45,** 85 (1950) RP2115.
Permeability of glass wool and other highly porous media. J **45,** 398 (1950) RP2150.

Ingberg, S. H., Fire tests of brick walls. (1954) BMS143.

Ingberg, S. H., Dunham, J. W., Thompson, J. P., Combustible contents in buildings. (1957) BMS149.

Ingberg, S. H., Foster, H. D., Pinkston, E. R., Fire resistance of structural clay tile partitions. (1948) BMS113.
Fire resistance of walls of gravel-aggregate concrete masonry units. (1951) BMS120.
Fire resistance of walls of lightweight-aggregate concrete masonry units. (1950) BMS117.

Irish, C. R., Digges, T. G., Carwile, N. L., Effect of boron on the hardenability of high-purity alloys and commercial steels. J **41,** 545 (1948) RP1938.

Irish, C. R., Rosenberg, S. J., Solubility of carbon in 18-percent-chromium–10-percent-nickel austenite. J **48,** 40 (1952) RP2281.

Isbell, H. S., System for classification of structurally related carbohydrates. J **57,** 171 (1956) RP2707.

Isbell, H. S., Brewster, J. F., Holt, N. B., Frush, H. L., Behavior of certain sugars and sugar alcohols in the presence of tetraborates—correlation of optical rotation and compound formation. J **40,** 129 (1948) RP1862.

Isbell, H. S., Frush, H. L., Amides of glucuronic, galacturonic, and mannuronic acids. J **41,** 609 (1948) RP1943.
Amino derivatives of mannuronic acid. J **41,** 11 (1948) RP1898.
Determination of carbon 14 in the terminal positions of sugars: Preparation of D-arabinose-5-C^{14} from D-fructose-1,6-C^{14}. J **51,** 167 (1953) RP2446.
Macromethods for reducing aldonic lactones to sugars: The preparation of L-glucose. J **54,** 267 (1955) RP2588.
Mechanisms for the formation of acetylglycosides and orthoesters from acetylglycosyl halides. J **43,** 161 (1949) RP2018.
Mechanisms for the mutarotation and hydrolysis of the glycosylamines and the mutarotation of the sugars. J **46,** 132 (1951) RP2186.
Mutarotation, hydrolysis, and structure of D-galactosylamines. J **47,** 239 (1951) RP2248.
Note on the stabilization of acetylglycosyl halides and sugar acetates. J **44,** 173 (1950) RP2068.
Preparation of D-arabinose-1-C^{14} and D-ribose-1-C^{14}. J **51,** 307 (1953) RP2458.
Synthesis of lactose-1-C^{14} and lactobionic-1-C^{14} delta lactone from 3-β-D-galactopyranosyl-α-D-arabinose. J **50,** 133 (1953) RP2400.

Isbell, H. S., Frush, H. L., Holt, N. B., Synthesis of α-D-xylose-1-C^{14} and β-D-lyxose-1-C^{14}. J **53,** 325 (1954) RP2550.
Synthesis of D-galactose-1-C^{14} and D-talose-1-C^{14}. J **53,** 217 (1954) RP2536.

Isbell, H. S., Frush, H. L., Schaffer, R., Synthesis of α-D-glucose-2-C^{14}, α-D-mannose-2-C^{14}, and α-D-galactose-2-C^{14}. J **54,** 201 (1955) RP2581.

Isbell, H. S., Holt, N. B., Frush, H. L., Preparation of D-arabinose-5-C^{14} from D-glucose-6-C^{14}. J **57,** 95 (1956) RP2697.

Isbell, H. S., Karabinos, J. V., Preparation of D-mannitol-C^{14} and its conversion to D-fructose-1-(and 6)-C^{14} acetobacter suboxydans. J **48,** 438 (1952) RP2334.

Isbell, H. S., Karabinos, J. V., Frush, H. L., Holt, N. B., Schwebel, A., Galkowski, T. T., Synthesis of D-glucose-1-C^{14} and D-mannose-1-C^{14}. J **48,** 163 (1952) RP2301.

Isbell, H. S., Schaffer, R., Improved synthesis of sodium D-glucuronate-6-C^{14} and of D-glucose-6-C^{14}. J **56,** 191 (1956) RP2667.
Synthesis of β-gentiobiose-1-C^{14}. J **57,** 333 (1956) RP2722.

Isbell, H. S., Schwebel, A., Moyer, J. D., Determination of carbon-14 in solutions of C^{14}-labeled materials by means of a proportional counter. J **53,** 221 (1954) RP2537.

Isbell, H. S., Snyder, C. F., Dryden, M. R., Holt, N. B., Optical rotations, refractive indices, and densities of dextran solutions. J **53,** 131 (1954) RP2525.

Isbell, H. S., Snyder, C. F., Holt, N. B., Dryden, M. R., Determination of molecular weights of dextrans by means of alkaline copper reagents. J **50,** 81 (1953) RP2393.

Isbell, H. S., Stewart, J. E., Frush, H. L., Moyer, J. D., Smith, F. A., Infrared spectra of D-talose monobenzoate and related substances. J **57,** 179 (1956) RP2708.

Isbell, H. S., Walton, W. W., Barium 2-ketolactobionate and the corresponding barium bromide double salt. J **41,** 119 (1948) RP1910.
The preparation of calcium melibionate. J **42,** 383 (1949) RP1977.

J

Jacobson, R., Evans, W. H., Munson, T. R., Wagman, D. D., Thermodynamic properties of the alkali metals. J **55,** 83 (1955) RP2608.

Jaffe, B., Bunting, E. N., Shelton, G. R., Creamer, A. S., Properties of beryllium-barium titanate dielectrics. J **47,** 15 (1951) RP2222.

Jaffe, B., Roth, R. S., Marzullo, S., Properties of piezoelectric ceramics in the solid-solution series lead titanate-lead zirconate-lead oxide: Tin oxide and lead titanate-lead hafnate. J **55,** 239 (1955) RP2626.

Jaffe, B. S., Stang, A. H., Bending tests of large welded-steel box girders at different temperatures. J **41,** 483 (1948) RP1934.
Perforated cover plates for steel columns; compressive properties of plates having ovaloid, elliptical, and "square" perforations. J **40,** 121 (1948) RP1861.

Jaffe, I., Rossini, F. D., Wagman, D. D., Evans, W. H., Levine, S., Selected values of chemical thermodynamic properties. (1952) C500.

Janes, H. B., An analysis of within-the-hour fading in 100- to 1,000-Mc transmissions. J **54,** 231 (1955) RP2585.

Janes, M. E., Streiff, A. J., Soule, L. F., Kennedy, C. M., Sedlak, V. A., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of twenty-nine hydrocarbons of the API–Standard and API-NBS series. J **45,** 173 (1950) RP2122.

Jenkins, W. D., Creep of high-purity aluminum. J **46,** 310 (1951) RP2201.

Jenkins, W. D., Digges, T. G., Creep of annealed and cold-drawn high-purity copper. J **47,** 272 (1951) RP2254.
Creep of high-purity copper. J **45,** 153 (1950) RP2121.
Effect of temperature on the tensile properties of high-purity nickel. J **48,** 313 (1952) RP2317.
Influence of prior strain history on the tensile properties and structures of high-purity cooper. J **49,** 167 (1952) RP2354.
Influence of strain rate and temperature on the creep of cold-drawn ingot iron. J **43,** 117 (1949) RP2013.

Jenkins, W. D., Digges, T. G., Johnson, C. R., Creep of high-purity nickel. J **53,** 329 (1954) RP2551.
Effect of temperature on the tensile properties of a commercial and a high-purity 70-percent-nickel–30-percent-copper alloy. J **54,** 21 (1955) RP2561.
Tensile properties of copper, nickel, and 70-percent-copper–30-percent-nickel and 30-percent-copper–70-percent-nickel alloys at high temperatures. J **58,** 201 (1957) RP2753.

Jennings, C., Brenner, A., Burkhead, P., Physical properties of electrodeposited chromium. J **40,** 31 (1948) RP1854.

Jensen, M. W., Bussey, W. S., Index to the reports of the National Conference on Weights and Measures. (From the first to the thirty-sixth—1905 to 1951. (1952) M203.

Jeppson, H. H., Simha, R., Callomon, I. G., Gaughan, M. B., Bibliography of recent research in the field of high polymers. (1950) C498.

Jessup, R. S., A new Bunsen-type calorimeter. J **55,** 317 (1955) RP2636.

Jessup, R. S., Brickwedde, F. G., Wechsler, M. T., Heat of fluorination of cobaltous fluoride, and the heats of reaction of cobaltic fluoride with hydrogen and with bis(trifluoromethyl)benzene (α,α,α,α′,α′,α′,-hexafluoroxylene). J **44,** 457 (1950) RP2092.

Jessup, R. S., Griffel, M., Cogliano, J. A., Park, R. P., Apparent specific volume of polystyrene in benzene, toluene, ethylbenzene, and 2-butanone. J **52,** 217 (1954) RP2492.

Jessup, R. S., Nelson, R. A., Heats of combustion and formation of liquid ethylenimine. J **48,** 206 (1952) RP2307.

Jessup, R. S., Nelson, R. A., Roberts, D. E., Heats of copolymerization of butadiene and styrene from measurements of heats of combustion. J **48,** 275 (1952) RP2313.

Jessup, R. S., Prosen, E. J., Heats of combustion and formation of cellulose and nitrocellulose (cellulose nitrate). J **44,** 387 (1950) RP2086.

Jessup, R. S., Roberts, D. E., Heat of combustion of phenyl-beta-naphthylamine (N-phenyl-2-naphthylamine). J **40,** 281 (1948) RP1873.
Heat of polymerization of alpha-methylstyrene from heats of combustion of monomer and four polymer fractions. J **46,** 11 (1951) RP2169.

Jessup, R. S. Weaver, E. R., Gas calorimeter tables. (1948) C464.

Jickling, R. M., Selby, M. C., Wolzein, E. C., Coaxial radio-frequency connectors and their electrical quality. J **52,** 121 (1954) RP2480.

Johannesen, R. B., Gordon, C. L., Stewart, J. E., Gilchrist, R., Application of infrared spectroscopy to the determination of impurities in titanium tetrachloride. J **53,** 197 (1954) RP2533.

Johler, J. R., Kellar, W. J., Walters, L. C., Phase of the low radiofrequency ground wave. (1956) C573.

Johnson, C. R., Jenkins, W. D., Diggers, T. G., Creep of high-purity nickel. J **53,** 329 (1954) RP2551.
Effect of temperature on the tensile properties of a commercial and a high-purity 70-percent-nickel–30-percent-copper alloy. J **54,** 21 (1955) RP2561.
Tensile properties of copper, nickel, and 70-percent-copper–30-percent-nickel and 30-percent-copper–70-percent-nickel alloys at high temperatures. J **58,** 201 (1957) RP2753

Johnson, D. P., Cordero, F., Matheson, H., A nonlinear instrument diaphragm. J **58,** 333 (1957) RP2766.

Johnson, V. R., Brown, L. M., Friedman, A. S., Bibliography of research on deuterium and tritium compounds, 1953 and 1954. (1957) C562, Supplement 1.

Johnson, W. E., An analogue computer for the solution of the radio refractive-index equation. J **51,** 335 (1953) RP2462.

Johnson, W. H., Prosen, E. J., Rossini, F. D., Heats of combustion and isomerization of the eight C_8H_{16} alkylcyclohexanes. J **39,** 49 (1947) RP1812.
Heats of combustion and isomerization of the six C_7H_{14} alkylcyclopentanes. J **42,** 251 (1949) RP1966.
Heats of formation and isomerization of the eight C_8H_{12} alkylcyclohexanes in the liquid and gaseous states. J **39,** 173 (1947) RP1821.

Johnston, R. G., Stair, R., Effects of recent knowledge of atomic constants and of humidity on the calibrations of the National Bureau of Standards thermal-radiation standards. J **53,** 211 (1954) RP2535.
Preliminary spectroradiometric measurements of the solar constant. J **57,** 205 (1956) RP2710.
Ultraviolet spectral radiant energy reflected from the moon. J **51,** 81 (1953) RP2434.

Johnston, R. G., Stair, R., Bagg, T. C., Continuous measurement of atmospheric ozone by an automatic photoelectric method. J **52,** 133 (1954) RP2481.

Spectral distribution of energy from the sun. J **53,** 113 (1954) RP2523.

Jones, E., Edelman, S., London, A., Long-tube method for field determination of sound-absorption coefficients. J **49,** 17 (1952) RP2339.

Jones, F. E., Wexler, A., Garfinkel, S. B., Hasegawa, S., Krinsky, A., A fast responding electric hygrometer. J **55,** 71 (1955) RP2606.

Jones, R. N., Kirby, R. S., Harman, J. C., Capps, F. M., Effective radio ground-conductivity measurements in the United States. (1954) C546.

Judd, D. B., A comparison of direct colorimetry of titanium pigments with their indirect colorimetry based on spectrophotometry and a standard observer. J **43,** 227 (1949) RP2024.

Color perceptions of deuteranopic and protanopic observers. J **41,** 247 (1948) RP1922.

Colorimetry. (1950) C478.

Response functions for types of vision according to the Müller theory. J **42,** 1 (1949) RP1946.

The 1949 scale of color temperature. J **44,** 1 (1950) RP2053.

Judd, D. B., Kelly, K. L., The ISCC-NBS method of designating colors and a dictionary of color names. (1955) C553.

Judd, D. B., Plaza, L., Belknap, M. A., A suggested relocation and respacing of the Union colorimeter scale for lubricating oil and petrolatum. J **44,** 559 (1950) RP2103.

Judson, L. V., Calibration of line standards of length and measuring tapes at the National Bureau of Standards. (1956) C572.

Units and systems of weights and measures (their origin, development, and present status). (1956) C570.

Units of weight and measure (United States customary and metric), definitions and tables of equivalents. (1955) M214.

K

Kac, M., Donsker, M. D., A sampling method for determining the lowest eigenvalue and the principal eigenfunction of Schrödinger's equation. J **44,** 551 (1950) RP2102.

Kalmus, H. P., Cacheris, J. C., Dropkin, H. A., Nonquantized frequency-modulated altimeter. J **50,** 215 (1953) RP2413.

Kanagy, J. R., Influence of temperature on the adsorption of water vapor by collagen and leather. J **44,** 31 (1950) RP2056.

Specific heats of collagen and leather. J **55,** 191 (1955) RP2618.

Kanagy, J. R., Cassel, J. M., Electrophoresis of modified collagen. J **43,** 29 (1949) RP2001.

Studies on the purification of collagen. J **42,** 557 (1949) RP1992.

Kanagy, J. R., Vickers, R. A., III, Factors affecting the water-vapor permeability of leather. J **44,** 347 (1950) RP2082.

Karabinos, J. V., Grebber, K., A study of the diphenylamine test for aliphatic nitrocompounds. J **49,** 163 (1952) RP2353.

Karabinos, J. V., Isbell, H. S., Preparation of D-mannitol-C^{14} and its conversion to D-fructose-1-(and 6)-C^{14} by acetobacter suboxydans. J **48,** 438 (1952) RP2334.

Karabinos, J. V., Isbell, H. S., Frush, H. L., Holt, N. B., Schwebel, A., Galkowski, T. T., Synthesis of D-glucose-1-C^{14} and D-mannose-1-C^{14}. J **48,** 163 (1952) RP2301.

Karabinos, J. V., Paulson, R. A., Smith, W. H., Thiophosphation of 2-methyl-2-nitro-1-propanol and the preparation of monothio-phosphoric acid. J **48,** 322 (1952) RP2318.

Karr, P. R., Effective circuit bandwidth for noise with a power-law spectrum. J **51,** 93 (1953) RP2438.

Radiation properties of spherical antennas as a function of the location of the driving force. J **46,** 422 (1951) RP2211.

Karush, W., Hestenes, M. R., A method of gradients for the calculation of the characteristic roots and vectors of a real symmetric matrix. J **47,** 45 (1951) RP2227.

Solutions of $Ax=\lambda Bx$. J **47,** 471 (1951) RP2275.

Karush, W., Rosser, J. B., Lanczos, C., Hestenes, M. R., Separation of close eigenvalues of a real symmetric matrix. J **47,** 291 (1951) RP2256.

Keegan, H. J., Belknap, M. A., Cordrey, D. J., Spectral transmissive properties of five selected optical glasses. J **52,** 305 (1954) RP2505.

Kellar, W. J., Johler, J. R., Walters, L. C., Phase of the low radiofrequency ground wave. (1956) C573.

Kellogg, E., Brenner, A., An electric gage for measuring the inside diameter of tubes. J **42,** 461 (1949) RP1986.

Magnetic measurement of the thickness of composite copper and nickel coatings on steel. J **40,** 295 (1948) RP1875.

Kelly, K. L., Judd, D. B., The ISCC-NBS method of designating colors and a dictionary of color names. (1955) C553.

Kennedy, C. M., Streiff, A. J., Soule, L. F., Janes, M. E., Sedlak, V. A., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of twenty-nine hydrocarbons of the API-Standard and API-NBS series. J **45,** 173 (1950) RP2122.

Kennedy, R. J., Miller, W., Measurement of field distortion in free-air ionization chambers by analog method. J **55,** 291 (1955) RP2632.

Kennedy, R. J., Wyckoff, H. O., Concrete as a protective barrier for gamma rays from radium. J **42,** 431 (1949) RP1983.

Kennedy, R. J., Wyckoff, H. O., Bradford, W. R., Broad- and narrow-beam attenuation of 500- to 1,400-kilovolt X-rays in lead and concrete. J **41,** 223 (1948) RP1920.

Kennedy, R. J., Wyckoff, H. O., Snyder, W. A., Concrete as a protective barrier for gamma rays from cobalt-60. J **44,** 157 (1950) RP2066.

Kerns, D. M., Analysis of symmetrical wave-guide junctions. J **46,** 267 (1951) RP2195.

Analysis of the direct-current bolometer bridge. J **43,** 581 (1949) RP2051.

Basis of the application of network equations to waveguide problems. J **42,** 515 (1949) RP1990.

Determination of efficiency of microwave bolometer mounts from impedance data. J **42,** 579 (1949) RP1995.

Kessler, D. W., Anderson, R. E., Influence of the wash from bronze on the weathering of marble. (1953) BMS137.

Stone exposure test walls. (1951) BMS125.

Studies of stone-setting mortars. (1953) BMS139.

Kessler, D. W., Hockman, A., Thermal and moisture expansion studies of some domestic granites. J **44,** 395 (1950) RP2087.

Kessler, K. G., Meggers, W. F., Arc and spark spectra of ruthenium. J **55,** 97 (1955) RP2609.

Kessler, K. G., Meggers, W. F., Moore, C. E., Extension of the arc spectra of palladium and platinum (6500 to 12000 A). J **53,** 225 (1954) RP2538.

Keulegan, G. H., Characteristics of internal solitary waves. J **51,** 133 (1953) RP2442.

Gradual damping of solitary waves. J **40,** 487 (1948) RP1895.

Hydrodynamic effects of gales on Lake Erie. J **50,** 99 (1953) RP2396.

Hydrodynamics of cathode films. J **47,** 156 (1951) RP2240.

Interfacial instability and mixing in stratified flows. J **43,** 487 (1949) RP2040.

Wind tides in small closed channels. J **46,** 358 (1951) RP2207.

Kiess, C. C., Description and analysis of the first spectrum of chromium, Cr I. J **51,** 247 (1953) RP2457.

Description and analysis of the second spectrum of chromium, Cr II. J **47,** 285 (1951) RP2266.

New descriptions and analyses of the third and fourth spectra of zirconium, Zr III and Zr IV. J **56,** 167 (1956) RP2663.

Wavelengths of rotational lines in the water-vapor bands of 0.93 and 1.13 microns. J **48,** 377 (1952) RP2325.

Kiess, C. C., Harrison, G. R., Hitchcock, W. J., Preliminary list of levels and *g*-values for Ta II. J **44,** 245 (1950) RP2075.

Kiess, C. C., Shortley, G., Zeeman effect and *g*-values for neutral nitrogen and oxygen. J **42,** 183 (1949) RP1961.

Kilday, M. V., A quantitative study of the carbon monoxide formed during the absorption of oxygen by alkaline pyrogallol. J **45,** 43 (1950) RP2112.

Kilduff, T. J., Oehler, R., Treatment of leather with synthetic resins. J **42,** 63 (1949) RP1951.

Kilpatrick, J. E., Beckett, C. W., Prosen, E. J., Pitzer, K. S., Rossini, F. D., Heats, equilibrium constants, and free energies of formation of the C_3 to C_5 diolefins, styrene, and the methylstyrenes. J **42,** 225 (1949) RP1964.

Kilpatrick, J. E., Werner, H. G., Beckett, C. W., Pitzer, K. S., Rossini, F. D., Heats, equilibrium constants, and free energies of formation of the alkylcyclopentanes and alkylcyclohexanes. J **39,** 523 (1947) RP1845.

King, G. J., Furukawa, G. T., McCoskey, R. E., Calorimetric properties of benzoic acid from 0° to 410° K. J **47,** 256 (1951) RP2251.
Calorimetric properties of polytetrafluoroethylene (Teflon) from 0° to 365° K. J **49,** 273 (1952) RP2364.
Thermal properties of some butadiene-styrene copolymers. J **50,** 357 (1953) RP2425.

Kirby, R. K., Thermal expansion of polytetrafluoroethylene (Teflon) from −190° to +300° C. J **57,** 91 (1956) RP2696.

Kirby, R. K., Hidnert, P., A new method for determining linear thermal expansion of invar geodetic surveying tapes. J **50,** 179 (1953) RP2407.
Thermal expansion and phase transformations of low-expanding cobalt-iron-chromium alloys. J **55,** 29 (1955) RP2602.

Kirby, R. S., Harman, J. C., Capps, F. M., Jones, R. N., Effective radio ground-conductivity measurements in the United States. (1954) C546.

Kirk, F. S., Manov, G. G., Schuette, K. E., Ionization constant of 5-5′-diethylbarbituric acid from 0° to 60° C. J **48,** 84 (1952) RP2289.

Kirn, F. S., Wyckoff, H. O., Standard ionization-chamber requirements for 250- to 500-kilovolt X-rays. J **58,** 111 (1957) RP2741.

Kisliuk, P., Townes, C. H., Molecular microwave spectra tables. J **44,** 611 (1950) RP2107 and (1952) C518.

Kissinger, H. E., Variation of peak temperature with heating rate in differential thermal analysis. J **57,** 217 (1956) RP2712.

Kleinschmidt, L. R., Chromatographic method for the fractionation of asphalt into distinctive groups of components. J **54,** 163 (1955) RP2577.

Kline, G. M., Plastics research and technology at the National Bureau of Standards: A review and bibliography. (1950) C494.

Kline, G. M., Achhammer, B. G., Reinhart, F. W., Mechanism of the degradation of polyamides. J **46,** 391 (1951) RP2210.

Klug, H. J., Ruegg, F. W., Analytical and experimental studies with idealized gas turbine combustors. J **49,** 279 (1952) RP2365.

Knowles, H. B., Lundell, G. E. F., The volumetric determination of columbium. J **42,** 405 (1949) RP1980.

Knowlton, J. W., Prosen, E. J., Heat of combustion and formation of cyanogen. J **46,** 489 (1951) RP2218.

Knowlton, J. W., Rossini, F. D., Heats of combustion and formation of cyclopropane. J **43,** 113 (1949) RP2012.

Knox, E. O., Holt, W. L., Roth, F. L., Strain tester for rubber. J **41,** 95 (1948) RP1907.

Knudsen, F. P., Lang, S. M., Fillmore, C. L., Roth, R. S., High-temperature reactions of uranium dioxide with various metal oxides. (1956) C568.

Koch, H. W., Wyckoff, J. M., Response of a sodium-iodide scintillation spectrometer to 10- to 20-million-electron-volt electrons and X-rays. J **56,** 319 (1956) RP2682.

Kostkowski, H. J., Humphreys, C. J., Infrared spectra of noble gases (12000 to 19000 A). J **49,** 73 (1952) RP2345.

Kostyshyn, B., Haas, P. H., Discussion of current-sheet approximations in reference to high-frequency magnetic measurements. J **52,** 279 (1954) RP2501.

Kotter, F. R., Location of the galvanometer branch for maximum sensitivity of the Wheatstone bridge. J **40,** 401 (1948) RP1884.

Kotter, F. R., Thomas, J. L., Peterson, C., Cooter, I. L., An absolute measurement of resistance by the Wenner method. J **43,** 291 (1949) RP2029.

Krasny, J. F., Schiefer, H. F., Note on the disintegration of wool in abrasion tests. J **44,** 9 (1950) RP2054.

Krasny, J. F., Schiefer, H. F., Crean, L. E., Improved single-unit Schiefer abrasion testing machine. J **42,** 481 (1949) RP1988.

Krider, H. S., Hidnert, P., Thermal expansion of aluminum and some aluminum alloys. J **48,** 209 (1952) RP2308.
Thermal expansion of some copper alloys. J **39,** 419 (1947) RP1838.

Krinsky, A., Wexler, A., Garfinkel, S. B., Jones, F. E., Hasegawa, S., A fast responding electric hygrometer. J **55,** 71 (1955) RP2606.

Kroll, W. D., Instability in shear of simply supported square plates with reinforced hole. J **43,** 465 (1949) RP2037.

Kroll, W. D., Levy, S., Errors introduced by finite space and time increments in dynamic response computation. J **51,** 57 (1953) RP2431.
Response of accelerometers to transient accelerations. J **45,** 303 (1950) RP2138.

Kroll, W. D., Levy, S., Hobbs, E. V., Mordfin, L., Damping of elastically supported element in a vacuum tube. J **50,** 71 (1953) RP2391.

Kroll, W. D., Levy, S., Wooley, R. M., Instability of simply supported square plate with reinforced circular hole in edge compression. J **39,** 571 (1947) RP1849.

Krynitsky, A. I., Holm, V. C. F., Observations on the control of grain size in magnesium casting alloys. J **39,** 265 (1947) RP1826.

Krynitsky, A. I., Stern, H., Effect of boron on the structure and some physical properties of plain cast irons. J **42,** 465 (1949) RP1987.

Ku, P. M., Trimble, T. F., Scavenging characteristics of a two-stroke-cycle engine as determined by skip-cycle operation. J **57,** 325 (1956) RP2721.

Kushner, L. M., Duncan, B. C., Hoffman, J. I., A viscometric study of the micelles of sodium dodecyl sulfate in dilute solutions. J **49,** 85 (1952) RP2346.

L

Lachenbruch, S. H., Marton, L., Electron optical observation of magnetic fields. J **43,** 409 (1949) RP2033.

Lachenbruch, S. H., Marton, L., Simpson, J. A., Electron-optical shadow method of magnetic-field mapping. J **52,** 97 (1954) RP2478.

Lalos, G. T., A sonic-flow pyrometer for measuring gas temperatures. J **47,** 179 (1951) RP2242.

Lamb, J. J., Albrecht, I., Axilrod, B. M., Mechanical properties of laminated plastics at −70°, 77°, and 200° F. J **43,** 257 (1949) RP2028.

Lamb, M. A., Plyler, E. K., Infrared spectrum of bromochlorofluoromethane. J **46,** 382 (1951) RP2208.
Infrared spectrum of chlorofluoromethane. J **45,** 204 (1950) RP2125.

Lanczos, C., An iteration method for the solution of the eigenvalue problem of linear differential and integral operators. J **45,** 255 (1950) RP2133.
Solution of systems of linear equations by minimized iterations. J **49,** 33 (1952) RP2341.

Lanczos, C., Rosser, J. B., Hestenes, M. R., Karush, W., Separation to close eigenvalues of a real symmetric matrix. J **47,** 291 (1951) RP2256.

Lang, S. M., An annotated bibliography of selected references on the solid-state reactions of the uranium oxides. (1953) C535.

Lang, S. M., Fillmore, C. L., Maxwell, L. H., The system beryllia-alumina-titania: Phase relations and general physical properties of three-component porcelains. J **48,** 298 (1952) RP2316.

Lang, S. M., Knudsen, F. P., Fillmore, C. L., Roth, R. S., High-temperature reactions of uranium dioxide with various metal oxides. (1956) C568.

Lang, S. M., Maxwell, L. H., Burdick, M. D., Porcelains within the beryllia field of the system beryllia-alumina-zirconia. J **45,** 366 (1950) RP2147

Lang, S. M., Maxwell, L. H., Geller, R. F., Some physical properties of porcelains in the systems magnesia-beryllia-zirconia and magnesia-beryllia-thoria and their phase relations. J **43,** 429 (1949) RP2034.

Lang, S. M., Roth, R. S., Fillmore, C. L., Some properties of porcelains and phase relations in the ternary systems of beryllia and zirconia with titania, ceria, and chromia. J **53,** 201 (1954) RP2534

Lashof, T. W., Brombacher, W. G., Bibliography and index on dynamic pressure measurement. (1955) C558.

Lashof, T. W., Macurdy, L. B., Precision laboratory standards of mass and laboratory weights. (1954) C547, Sec. 1.

Lassiter, J. W., Hoge, H. J., Critical temperatures, pressures, and volumes of hydrogen, deuterium, and hydrogen deuteride. J **47,** 75 (1951) RP2229.

Launer, H. F., Light-sensitive papers as controls for testing textile colorfastness and stability of materials under arc lamp exposure. J **41,** 169 (1948) RP1916.

Launer, H. F., Wilson, W. K., Flynn, J. H., Determination of glucose by means of sodium chlorite. J **51,** 237 (1953) RP2456.

Lauritzen, J. I., Jr., Shenker, H., Corruccini, R. J., Reference tables for thermocouples. (1951) C508.

Lauritzen, J. I., Jr., Shenker, H., Corruccini, R. J., Lonberger, S. T., Reference tables for thermocouples. (1955) C561.

Lee, T. G., Shoub, H., Cameron, J. M., Methods of testing small fire extinguishers. (1957) BMS150.

Lengel, J. H., Bloom, E. G., Mohler, F. L., Wise, C. E., Mass spectra of octanes. J **41,** 129 (1948) RP1912.

Metastable transitions in mass spectra of fifty-six hydrocarbons. J **40,** 437 (1948) RP1888.

Lengel, J. H., Mohler, F. L., Bloom, E. G., Wells, E. J., Jr., Wise, C. E., Doubly charged ion spectra in mass spectra of hydrocarbons. J **42,** 369 (1949) RP1975.

Leser, W. H., Weir, C. E., Wood, L. A., Crystallization and second-order transitions in silicone rubbers. J **44,** 367 (1950) RP2084.

Leslie, R. T., Clabaugh, W. S., Gilchrist, R., Preparation of titanium tetrachloride of high purity. J **55,** 261 (1955) RP2628.

Levedahl, W. J., Effects of pressure and other variables on determinations of octane number. J **45,** 148 (1950) RP2120.

Levedahl, W. J., Howard, F. L., An apparatus for studying autoignition of engine fuels: Results with normal heptane and normal hexane. J **46,** 301 (1951) RP2200.

Levin, E. M., Nomograms for obtaining the compound composition of hydrated limes from the oxide analysis. (1949) M196.

Levin, E. M., Clarke, W. F., Wells, L. S., Plasticity and water retentivity of hydrated limes for structural purposes. (1956) BMS146.

Levin, E. M., McMurdie, H. F., The system $BaO-B_2O_3$. J **42,** 131 (1949) RP1956.

Levin, E. M., Ugrinic, G. M., The system barium oxide-boric oxide-silica. J **51,** 37 (1953) RP2430.

Levin, E. M., Wells, L. S., Clarke, W. F., Effect of aging on the soundness of regularly hydrated dolomitic lime putties. (1952) BMS127.

Expansive characteristics of hydrated limes and the development of an autoclave test for soundness. J **41,** 179 (1948) RP1917.

Levine, S., Rossini, F. D., Wagman, D. D., Evans, W. H., Jaffe, I., Selected values of chemical thermodynamic properties. (1952) C500.

Levy, S., Bouche, R. R., Calibration of vibration pickups by the reciprocity method. J **57,** 227 (1956) RP2714.

Levy, S., Hobbs, E. V., Kroll, W. D., Mordfin, L., Damping of elastically supported element in a vacuum tube. J **50,** 71 (1953) RP2391.

Levy, S., Kroll, W. D., Errors introduced by finite space and time increments in dynamic response computation. J **51,** 57 (1953) RP2431.

Response of accelerometers to transient accelerations. J **45,** 303 (1950) RP2138.

Levy, S., McPherson, A. E., Hobbs, E. V., Calibration of accelerometers. J **41,** 359 (1948) RP1930.

Levy, S., Smith, F. C., Stress distribution near reinforced circular hole loaded by pin. J **42,** 397 (1949) RP1979.

Levy, S., Woolley, R. M., Kroll, W. D., Instability of simply supported square plate with reinforced circular hole in edge compression. J **39,** 571 (1947) RP1849.

Lieblein, J., Properties of certain statistics involving the closest pair in a sample of three observations. J **48,** 255 (1952) RP2311.

Lieblein, J., Zelen, M., Statistical investigation of the fatigue life of deep-groove ball bearings. J **57,** 273 (1956) RP2719.

Linnig, F. J., Milliken, L. T., Cohen, R. I., Determination of ash in GR-S synthetic rubbers and latices. J **47,** 135 (1951) RP2237.

Liss, R. B., Buzzard, R. W., Fickle, D. P., Titanium-uranium system in the region 0 to 30 atomic percent of titanium. J **50,** 209 (1953) RP2412.

Litvin, A., Evans, D. N., Figlia, A. C., Blaine, R. L., Properties of some masonry cement. J **51,** 11 (1953) RP2427.

Loebenstein, W. V., Deitz, V. R., Surface-area determination by adsorption of nitrogen from nitrogen-helium mixtures. J **46,** 51 (1951) RP2174.

Loebenstein, W. V., Gleysteen, L. F., Dietz, V. R., Kinetic study of the reactions of carbon adsorbents with oxygen. J **42,** 33 (1949) RP1948.

Loebenstein, W. V., Pennington, N. L., Fundamental aspects of the reaction of oxygen with carbon adsorbents. J **43,** 87 (1949) RP2009.

Loftus, T. P., Mann, W. B., Paolella, L. F., Stockman, L. L., Youden, W. J., Comparisons of national radium standards. J **58,** 169 (1957) RP2749.

Logan, H. L., Effect of chromium plating on the endurance limit of steels used in aircraft. J **43,** 101 (1949) RP2011.

Effect of chromium plating on the plastic deformation of SAE 4130 steel. J **46,** 472 (1951) RP2216.

Film-rupture mechanism of stress corrosion. J **48,** 99 (1952) RP2291.

Relationship between crystal orientation and stress-corrosion cracking in alpha and beta brasses. J **56,** 159 (1956) RP2662.

Logan, H. L., Hessing, H., Stress corrosion of wrought magnesium base alloys. J **44,** 233 (1950) RP2074.

Stress-corrosion tests on high-strength aluminum alloy sheet. J **41,** 69 (1948) RP1905.

Logan, W. M., Douglas, T. B., Heat content of molybdenum disilicide from 0° to 900° C. J **53,** 91 (1954) RP2520.

Lonberger, S. T., Shenker, H., Lauritzen, J. I., Jr., Corruccini, R. J., Reference tables for thermocouples. (1955) C561.

London, A., Transmission of reverberant sound through double walls. J **44,** 77 (1950) RP2058.

Transmission of reverberant sound through single walls. J **42,** 605 (1949) RP1998.

London, A., Jones, E., Edelman, S., Long-tube method for field determination of sound-absorption coefficients. J **49,** 17 (1952) RP2339.

Lopez-Gonzalez, J. D., Carpenter, F. G., Deitz, V. R., Adsorption of nitrogen on carbon adsorbents at low pressures between 69° and 90° K. J **55,** 11 (1955) RP2600.

Lopez-Gonzalez, J. D., Deitz, V. R., Surface changes in an original and an activated bentonite. J **48,** 325 (1952) RP2319.

Lovelace, M. E., Davis, M. M., Schuhmann, P. J., Acid-base reactions in organic solvents. Behavior of some halogenated derivatives of phenolsulfonephthalein with different classes of organic bases in benzene. J **41,** 27 (1948) RP1900.

Lowell, P. D., Hakkarinen, W., Randall, D. L., National Bureau of Standards mobile low-level sounding system. J **50,** 7 (1953) RP2381.

Lubkin, S., A method of summing infinite series. J **48,** 228 (1952) RP2310.

Lukacs, E., Maximum likelihood estimates of position derived from measurements performed by hyperbolic instruments. J **47,** 197 (1951) RP2244.

Lukacs, E., Szasz, O., Nonnegative trigonometric polynomials and certain rational characteristic functions. J **52,** 153 (1954) RP2484.

Some nonnegative trigonometric polynomials connected with a problem in probability. J **48,** 139 (1952) RP2297.

Lundell, G. E. F., Knowles, H. B., The volumetric determination of columbium. J **42,** 405 (1949) RP1980.

Luxenberg, H., Torsion of anisotropic elastic cylinders by forces applied on the lateral surface. J **50,** 263 (1953) RP2417.

Mc

McAdam, D. J., Jr., Geil, G. W., Cromwell, F. J., Influence of low temperatures of the mechanical properties of 18:8 chromium-nickel steel. J **40,** 375 (1948) RP1882.

McCamy, C. S., A five-band recording spectroradiometer. J **56,** 293 (1956) RP2678.

McCoskey, R. E., Douglas, T. B., Furukawa, G. T., Ball, A. F., Calorimetric properties of normal heptane from 0° to 520° K. J **53,** 139 (1954) RP2526.

McCoskey, R. E., Furukawa, G. T., Calorimetric properties of 41° and 122° F polybutadienes. J **51,** 321 (1953) RP2460.

McCoskey, R. E., Furukawa, G. T., Douglas, T. B., Ginnings, D. C., Thermal properties of aluminum oxide from 0° to 1,200° K. J **57,** 67 (1956) RP2694.

McCoskey, R. E., Furukawa, G. T., Ginnings, D. C., Nelson, R. A., Calorimetric properties of diphenyl ether from 0° to 570° K. J **46,** 195 (1951) RP2191.

McCoskey, R. E., Furukawa, G. T., King, G. J., Calorimetric properties of benzoic acid from 0° to 410° K. J **47,** 256 (1951) RP2251.

Calorimetric properties of polytetrafluoroethylene (Teflon) from 0° to 365° K. J **49,** 273 (1952) RP2364.

Thermal properties of some butadiene-styrene copolymers. J **50,** 357 (1953) RP2425.

McCoskey, R. E., Furukawa, G. T., Reilly, M. L., Heat capacity, heats of fusion and vaporization, and vapor pressure of tetrafluoroethylene. J **51,** 69 (1953) RP2432.

Heat capacity, heats of transitions, fusion, and vaporization, and vapor pressure of octafluorocyclobutane. J **52,** 11 (1954) RP2466.

Heat capacity of some butadiene-styrene copolymers from 0° to 330° K. J **55,** 127 (1955) RP2610.

McCoskey, R. E., Furukawa, G. T., Reilly, M. L., Harman, A. W., Heat capacity, heats of fusion, vaporization, and transition; and vapor pressure of *N*-dimethylaminodiborane, $(CH_3)_2NB_2H_5$. J **55,** 201 (1955) RP2620.

McCoskey, R. E., Hoge, H. J., Meyers, C. H., Charts of compressibility factors and charts showing quantities delivered by commercial cylinders, for hydrogen, nitrogen, and oxygen. (1949) M191.

McCrackin, F. L., Schiefer, H. F., Smith, J. C., Stone, W. K., Stress-strain relationships in yarns subjected to rapid impact loading: 2. Breaking velocities, strain energies, and theory neglecting wave propagation. J **54,** 277 (1955) RP2590.

McCrackin, F. L., Smith, J. C., Schiefer, H. F., Stress-strain relationships in yarns subjected to rapid impact loading: 3. Effect of wave propagation. J **55,** 19 (1955) RP2601.

McCrackin, F. L., Smith, J. C., Schiefer, H. F., Stone, W. K., Towne, K. M., Stress-strain relationships in yarns subjected to rapid impact loading: 4. Transverse impact tests. J **57,** 83 (1956) RP2695.

McCraven, C. C., Davenport, T. I., Mann, W. B., Smith, C. C., Comparison of four national radium standards. Part 1. Experimental procedures and results. [Part 2. Statistical procedures and survey, by W. S. Connor and W. J. Youden]. J **53,** 267 (1954) RP2544.

McCulloch, F. W., Walton, W. W., Smith, W. H., Determination of small amounts of oxygen in organic compounds. J **40,** 443 (1948) RP1889.

McDonald, E. A., Davis, M. M., Acid-base equilibrium constants for the reaction of tribenzylamine with picric acid and with trinitro-*m*-cresol in benzene, from spectrophotometric data. J **42,** 595 (1949) RP1997.

McDonald, E. J., Refractive indices of maltose solutions. J **46,** 165 (1951) RP2188.

Stability of dextrose solutions of varying pH. J **45,** 200 (1950) RP2124.

McDonald, E. J., Perry, R. E., Jr., A method for corn-sirup analysis involving selective adsorption. J **47,** 363 (1951) RP2263.

McDonald, E. J., Turcotte, A. L., Density and refractive indices of lactose solutions. J **41,** 63 (1948) RP1904.

McDorman, O. N., Schwerdtfeger, W. J., Potential and current requirements for the cathodic protection of steel in soils. J **47,** 104 (1951) RP2233.

McElhinney, J., Zendle, B., Domen, S., A calorimeter for measuring the power in a high-energy X-ray beam. J **56,** 9 (1956) RP2642.

McGandy, E. L., Burdick, M. D., Parker, H. S., Roth, R. S., An X-ray study of the system uranium monocarbide-uranium dicarbide-beryllium carbide. J **54,** 217 (1955) RP2584.

McKee, S. A., An indentation method for measuring wear. J **39,** 155 (1947) RP1819.

McKee, S. A., Swindells, J. F., White, H. S., Mountjoy, W., Laboratory wear tests with automotive gear lubricants. J **42,** 125 (1949) RP1955.

McKee, S. A., White, H. S., The McKee workerconsistometer with constant-speed drives. J **46,** 18 (1951) RP2170.

McKenna, E. H., Richey, G. G., Hobbs, R. B., Methods and equipment for testing printed-enamel felt-base floor covering. (1952) BMS130.

McLane, C. K., Hudson, R. P., Tables for use in the interpretation of paramagnetic behavior below 1° K; for the chromic alums ($J=3/2$). J **52,** 33 (1954) RP2469.

McMurdie, H. F., Golovato, E., Study of modifications of manganese dioxide. J **41,** 589 (1948) RP1941.

McMurdie, H. F., Levin, E. M., The system BaO-B_2O_3. J **42,** 131 (1949) RP1956.

McMurdie, H. F., Sullivan, B. M., Crystal forms of chromium orthophosphate. J **48,** 159 (1952) RP2300.

McMurdie, H. F., Sullivan, B. M., Mauer, F. A., High-temperature X-ray study of the system Fe_3O_4-Mn_3O_4. J **45,** 35 (1950) RP2111.

McPherson, A. E., Levy, S., Hobbs, E. V., Calibration of accelerometers. J **41,** 359 (1948) RP1930.

McPherson, A. E., Ramberg, W., Experimental verification of theory of landing impact. J **41,** 509 (1948) RP1936.

M

Macurdy, L. B., Lashof, T. W., Precision laboratory standards of mass and laboratory weights. (1954) C547, Sec. 1.

Maczkowske, E. E., Hague, J. L., Bright, H. A., Determination of nickel, manganese, cobalt, and iron in high-temperature alloys, using anion-exchange separations. J **53,** 353 (1954) RP2552.

Madorsky, S. L., A multicolumn countercurrent molecular still. J **44,** 135 (1950) RP2064.

Madorsky, S. L., Bradt, P., Straus, S., Concentration of isotopes of mercury in countercurrent molecular stills. J **41,** 205 (1948) RP1918.

Madorsky, S. L., Hart, V. E., Straus, S., Pyrolysis of cellulose in a vacuum. J **56,** 343 (1956) RP2685.

Madorsky, S. L., Hart, V. E., Straus, S., Sedlak, V. A., Thermal degradation of tetrafluoroethylene and hydrofluoroethylene polymers in a vacuum. J **51,** 327 (1953) RP2461.

Madorsky, S. L., Straus, S., Concentration of copper 63 by countercurrent electromigration method. J **41,** 41 (1948) RP1901.

Pyrolysis of styrene, acrylate, and isoprene polymers in a vacuum. J **50,** 165 (1953) RP2405.

Pyrolytic fractionation of polystyrene in a high vacuum and mass spectrometer analysis of some of the fractions. J **40,** 417 (1948) RP1886.

Thermal degradation of polymers as a function of a molecular structure. J **53,** 361 (1954) RP2553.

Thermal degradation of polychlorotrifluoroethylene, poly-α,β,β-trifluorostyrene, poly-*p*-xylylene in a vacuum. J **55,** 223 (1955) RP2624.

Madorsky, S. L., Straus, S., Thompson, D., Williamson, L., Pyrolysis of polyisobutene (vistanex), polyisoprene, polybutadiene, GR-S, and polyethylene in a high vacuum. J **42,** 499 (1949) RP1989.

Magill, A. A., Variation in distortion with magnification. J **54,** 135 (1955) RP2574.

Mair, B. J., Epstein, M. B. Willingham, C. B., Rossini, F. D., Separation of the 177° to 200° C fraction of petroleum and the isolation of normal undecane. J **42,** 139 (1949) RP1957.

Malitson, I. H., Stephens, R. E., Index of refraction of magnesium oxide. J **49,** 249 (1952) RP2360.

Malitson, I., Weir, C., Spinner, S., Rodney, W., Optical and volumetric relaxation effects in glass following removal of high hydrostatic pressures. J **58,** 189 (1957) RP2751.

Malmberg, C. G., Maryott, A. A., Dielectric constant of water from 0° to 100° C. J **56,** 1 (1956) RP2641.
Dielectric constants of aqueous solutions of dextrose and sucrose. J **45,** 299 (1950) RP2137.

Mandel, J., Mann, C. W., A statistical solution of a problem arising in the sampling of leather. J **46,** 99 (1951) RP2180.

Mandel, J., Martin, G. M., Stiehler, R. D., Aerological sounding balloons. J **53,** 383 (1954) RP2557.

Mandel, J., Stiehler, R. D., Sensitivity—a criterion for the comparison of methods of test. J **53,** 155 (1954) RP2527.

Mandel, J., Stromberg, R. R., Swerdlow, M., Electron microscopy of synthetic elastomer latices. J **50,** 299 (1953) RP2419.

Mandel, J., Tryon, M., Horowitz, E., Determination of natural rubber in GR-S—natural rubber vulcanizates by infrared spectroscopy. J **55,** 219 (1955) RP2623.

Mandelkern, L., Martin, G. M., Quinn, F. A., Jr., Glassy state transitions of poly-(chlorotrifluoroethylene), poly-(vinylidene fluoride), and their copolymers. J **58,** 137 (1957) RP2745.

Mandelkern, L., Newton, C. J., Roberts, D. E., Preferred orientation in stark rubber. J **55,** 143 (1955) RP2613.

Mandelkern, L., Roberts, D. E., Nature of stark rubber. J **54,** 167 (1955) RP2578.

Mann, C. W., Mandel, J., A statistical solution of a problem arising in the sampling of leather. J **46,** 99 (1951) RP2180.

Mann, D. E., Acquista, N., Plyler, E. K., Vibrational spectra of tetrafluoroethylene and tetrachloroethylene. J **52,** 67 (1954) RP2474.

Mann, H. B., Introduction to the theory of stochastic processes depending on a continuous parameter. (1953) AMS24.

Mann, W. B., Use of Callendar's "radio-balance" for the measurement of the energy emission from radioactive sources. J **52,** 177 (1954) RP2486.
A radiation balance for the macrocalorimetric comparison of four national radium standards. J **53,** 277 (1954) RP2545.

Mann, W. B., Davenport, T. I., McCraven, C. C., Smith, C. C., Comparison of four national radium standards. Part 1. Experimental procedures and results. [Part 2. Statistical procedures and survey, by W. S. Connor and W. J. Youden]. J **53,** 267 (1954) RP2544.

Mann, W. B., Hayward, R. W., Hoppes, D. D., Branching ratio in the decay of polonium-210. J **54,** 47 (1955) RP2564.

Mann, W. B., Loftus, T. P., Paolella, L. F., Stockmann, L. L., Youden, W. J., Comparisons of national radium standards. J **58,** 169 (1957) RP2749.

Mann, W. B., Seliger, H. H., Efficiency of 4π-crystal-scintillation counting: 2. Dead-time and coincidence corrections. J **57,** 257 (1956) RP2717.
Refinements in radioactive standardization by 4π beta counting. J **50,** 197 (1953) RP2409.

Mannos, M., Eigenvectors of matric polynomials. J **51,** 33 (1953) RP2429.

Manov, G. G., Curtiss, L. F., The half-life of carbon 14. J **46,** 328 (1951) RP2203.

Manov, G. G., Schuette, K. E., Kirk, F. S., Ionization constant of 5-5'-diethylbarbituric acid from 0° to 60° C. J **48,** 84 (1952) RP2289.

Maron, F. W., Prosen, E. J., Rossini, F. D., Heat of isomerization of the two butadienes. J **42,** 269 (1949) RP1968.
Heats of combustion, formation, and isomerization of ten C_4 hydrocarbons. J **46,** 106 (1951) RP2181.

Martin, G. M., Mandel, J., Stiehler, R. D., Aerological sounding balloons. J **53,** 383 (1954) RP2557.

Martin, G. M., Mandelkern, L., Quinn, F. A., Jr., Glassy state transitions of poly-(chlorotrifluoroethylene), poly-(vinylidene fluoride), and their copolymers. J **58,** 137 (1957) RP2745.

Martin, H. R., Achenbach, P. R., Dill, R. S., Effect of edge insulation upon temperature and condensation on concrete-slab floors. (1953) BMS138.

Marton, C., Marton, L., Hall, W. G., Electron physics tables. (1956) C571.

Marton, C., Sass, S., Swerdlow, M., Van Bronkhorst, A., Meryman, H., Bibliography of electron microscopy. (1950) C502.

Marton, L., Lachenbruch, S. N., Electron optical observation of magnetic fields. J **43,** 409 (1949) RP2033.

Marton, L., Marton, C., Hall, W. G., Electron physics tables. (1956) C571.

Marton, L., Morgan, M. M., Schubert, D. C., Shah, J. R., Simpson, J. A., Electron-optical bench. J **47,** 461 (1951) RP2273.

Marton, L., Simpson, J. A., Lachenbruch, S. H., Electron-optical shadow method of magnetic-field mapping. J **52,** 97 (1954) RP2478.

Maryott, A. A., Acid-base equilibrium constant and dipole moment of tribenzylammonium picrate in benzene from measurements of dielectric constant. J **41,** 7 (1948) RP1897.
Dipole moments and molecular association of some picrates of primary, secondary, and tertiary amines in benzene and dioxane. J **41,** 1 (1948) RP1896.

Maryott, A. A., Buckley, F., Influence of molecular shape on the dielectric constant of polar liquids. J **53,** 229 (1954) RP2539.
Table of dielectric constants and electric dipole moments of substances in the gaseous state. (1953) C537.

Maryott, A. A., Malmberg, C. G., Dielectric constant of water from 0° to 100° C. J **56,** 1 (1956) RP2641.
Dielectric constants of aqueous solutions of dextrose and sucrose. J **45,** 299 (1950) RP2137.

Maryott, A. A., Smith, E. R., Table of dielectric constants of pure liquids. (1951) C514.

Marzullo, S., Coughanour, L. W., Roth, R. S., Sennett, F. E., Solid-state reactions and dielectric properties in the system magnesia-lime-tin oxide-titania. J **54,** 149 (1955) RP2576.
Solid-state reactions and dielectric properties in the systems magnesia-zirconia-titania and lime-zirconia-titania. J **54,** 191 (1955) RP2580.

Marzullo, S., Jaffe, B., Roth, R. S., Properties of piezoelectric ceramics in the solid-solution series lead titanate-lead zirconate-lead oxide: Tin oxide and lead titanate-lead hafnate. J **55,** 239 (1955) RP2626.

Masi, J. F., Flieger, H. W., Jr., Wicklund, J. S., Heat capacity of gaseous perfluoropropane. J **52,** 275 (1954) RP2500.

Masi, J. F., Hilsenrath, J., Beckett, C. W., Benedict, W. S., Fano, L., Hoge, H. J., Nuttall, R. L., Touloukian, Y. S., Woolley, H. W., Tables of thermal properties of gases. (1955) C564.

Masi, J. F., Petkof, B., Heat capacity of gaseous carbon dioxide. J **48,** 179 (1952) RP2303.

Masi, J. F., Wicklund, J. S., Flieger, H. W., Jr., Heat capacity of gaseous hexafluoroethane. J **51,** 91 (1953) RP2437.

Matchett, S. W., Middleton, H. K., Hydraulic research in the United States. (1951) M201, (1952) M205, (1953) M208.

Matheson, H., Cordero, F., Johnson, D. P., A nonlinear instrument diaphragm. J **58,** 333 (1957) RP2766.

Mauer, F. A., McMurdie, H. F., Sullivan, B. M., High-temperature X-ray study of the system Fe_3O_4-Mn_3O_4. J **45,** 35 (1950) RP2111.

Maxwell, L. H., Lang, S. M., Burdick, M. D., Porcelains within the beryllia field of the system beryllia field of the system beryllia-alumina-zirconia. J **45,** 366 (1950) RP2147.

Maxwell, L. H., Lang, S. M., Fillmore, C. L., The system beryllia-alumina-titania: Phase relations and general physical properties of three component porcelains. J **48,** 298 (1952) RP2316.

Maxwell, L. H., Lang, S. M., Geller, R. F., Some physical properties of porcelains in the systems magnesia-beryllia-zirconia and magnesia-beryllia-thoria and their phase relations. J **43,** 429 (1949) RP2034.

Mears, T. W., Cadwallader, E. A., Fookson, A., Howard, F. L., Aliphatic halide-carbonyl condensations by means of sodium. J **41,** 111 (1948) RP1909.

Mears, T. W., Fookson, A., Pomerantz, P., Rich, E. H., Dussinger, C. S., Howard, F. L., Syntheses and properties of two olefins, six paraffins, and their intermediates. J **44,** 299 (1950) RP2079.

Mears, T. W., Pomerantz, P., Fookson, A., Rothberg, S., Howard, F. L., Synthesis and physical properties of several acetylenic hydrocarbons. J **52,** 51 (1954) RP2472.

Synthesis and physical properties of several aliphatic and alicyclic hydrocarbons. J **52,** 59 (1954) RP2473.

Mears, T. W., Pomerantz, P., Howard, F. L., Separation and identification of the major C_7 to C_{10} components of triptene residue. J **42,** 617 (1949) RP1999.

Mebs, R. W., Darr, J. H., Grimsley, J. D., Metal ultrasonic delay lines. J **51,** 209 (1953) RP2453.

Mebs, R. W., Roeser, W. F., Solders and soldering. (1950) C492.

Meggers, E. R., Selected bibliography on building construction and maintenance. (1956) BMS140, 2d ed.

Meggers, W. F., A description of the arc and spark spectra of rhenium. J **49,** 187 (1952) RP2355.

Multiplets and terms in technetium spectra. J **47,** 7 (1951) RP2221.

Meggers, W. F., Bozman, W. R., Corliss, C. H., Trees, R. E., An intersystem transition in the first spectrum of beryllium. J **50,** 131 (1953) RP2399.

Meggers, W. F., Fred, M., Tomkins, F. S., Emission spectra of actinium. J **58,** 297 (1957) RP2763.

Meggers, W. F., Kessler, K. G., Arc and spark spectra of ruthenium. J **55,** 97 (1955) RP2609.

Meggers, W. F., Kessler, K. G., Moore, C. E., Extension of the arc spectra of palladium and platinum (6500 to 12000 A). J **53,** 225 (1954) RP2538.

Meggers, W. F., Murphy, R. J., Arc spectra of gallium, indium, and thallium. J **48,** 334 (1952) RP2320.

Meggers, W. F., Scribner, B. F., Arc and spark spectra of technetium. J **45,** 476 (1950) RP2161.

Meggers, W. F., Scribner, B. F., Bozman, W. R., Absorption and emission spectra of promethium. J **46,** 85 (1951) RP2179.

Meggers, W. F., Shenstone, A. G., Moore, C. E., First spectrum of arsenic. J **45,** 346 (1950) RP2144.

Meggers, W. F., Stanley, R. W., Wavelengths from iron-halide lamps. J **58,** 41 (1957) RP2733.

Meggers, W. F., Westfall, F. O., Lamps and wavelengths of mercury 198. J **44,** 447 (1950) RP2091.

Meryman, H., Marton, C., Sass, S., Swerdlow, M., Van Bronkhorst, A., Bibliography of electron microscopy. (1950) C502.

Meyers, C. H., Pressure-volume-temperature data for oxygen. J **40,** 457 (1948) RP1891.

Table and Mollier chart for ammonia below −60° F. (1948) C472.

Meyers, C. H., Cragoe, C. S., Mueller, E. F., Table and Mollier chart of the thermodynamic properties of 1,3-butadiene. J **39,** 507 (1947) RP1844.

Meyers, C. H., Hoge, H. J., McCoskey, R. E., Charts of compressibility factors and charts showing quantities delivered by commercial cylinders, for hydrogen, nitrogen, and oxygen. (1948) M191.

Meyerson, M. R., Rosenberg, S. J., A study of the final stages of the austenite to martensite transformation in SAE 1050 steel. J **55,** 177 (1955) RP2616.

Michaelsen, J. D., Florin, R. E., Wall, L. A., Brown, D. W., Hymo, L. A., Factors affecting the thermal stability of polytetrafluoroethylene. J **53,** 121 (1954) RP2524.

Michaelsen, J. D., Wall, L. A., Further studies on the pyrolysis of polytetrafluoroethylene in the presence of various gases. J **58,** 327 (1957) RP2765.

Thermal decomposition of polytetrafluoroethylene in various gaseous atmospheres. J **56,** 27 (1956) RP2644.

Middleton, H. K., Hydraulic research in the United States, (1954) M210, (1955) M215. Hydraulic research in the United States, (including contributions from Canadian Laboratories), (1956) M218.

Middleton, H. K., Matchett, S. W., Hydraulic Research in the United States. (1951) M201, (1952) M205, (1953) M208.

Mientka, W., Wait, J. R., Slotted-cylinder antenna with a dielectric coating. J **58,** 287 (1957) RP2762.

Mikesell, R. P., Scott, R. B., Heat conduction through insulating supports in very low temperature equipment. J **57,** 371 (1956) RP2726.

Miller, J. A., Ramberg, W., Stress-strain relation in shear from twisting test of annulus. J **50,** 125 (1953) RP2398.

Twisted square plate method and other methods for determining the shear stress-strain relation of flat sheet. J **50,** 111 (1953) RP2397.

Miller, R. G., Bates, R. G., Bower, V. E., Smith, E. G., pH of solutions of potassium hydrogen *d*-tartrate from 0° 60° C. J **47,** 433 (1951) RP2268.

Miller, W., Kennedy, R. J., Measurement of field distortion in free-air ionization chambers by analog method. J **55,** 291 (1955) RP2632.

Milliken, L. T., Linnig, F. J., Cohen, R. I., Determination of ash in GR–S synthetic rubbers and latices. J **47,** 135 (1951) RP2237.

Milne, W. E., A note on the numerical integration of differential equations. J **43,** 537 (1949) RP2046.

Note on the Runge-Kutta method. J **44,** 549 (1950) RP2101.

Numerical determination of characteristic numbers. J **45,** 245 (1950) RP2132.

The remainder in linear methods of approximation. J **43,** 501 (1949) RP2041.

Minton, G. H., Techniques in high-resolution coincidence counting. J **57,** 119 (1956) RP2701.

Missimer, J. K., O'Leary, M. J., Scribner, B. W., Resin bonding of offset papers containing mineral fillers. J **47,** 357 (1951) RP2262.

Missimer, J. K., Scribner, B. W., Shaw, M. B., O'Leary, M. J., Resin bonding of hardwood fibers in offset papers. J **45,** 208 (1950) RP2126.

Missimer, J. K., Weber, C. G., Shaw, M. B., O'Leary, M. J., Resin bonding and strength development in offset papers. J **40,** 427 (1948) RP1887.

Mitchell, J. A., Schoonover, I. C., Dickson, G., Vacher, H. C., Some factors affecting the dimensional stability of the silver-tin-(copper-zinc) amalgams. J **52,** 185 (1954) RP2487.

Mitchell, N. D., Fire tests of gunite slabs and partitions. (1952) BMS131.

Fire tests of steel columns protected with siliceous aggregate concrete. (1951) BMS124.

Fire tests of wood-framed walls and partitions with asbestos-cement facings. (1951) BMS123.

Mitchell, N. D., Bender, E. D., Ryan, J. V., Fire resistance of shutters for moving-stairway openings. (1952) BMS129.

Mitchell, N. D., Ryan, J. V., Fire tests of steel columns encased with gypsum lath and plaster. (1953) BMS135.

Mohler, F. L., Bloom, E. G., Lengel, J. H., Wise, C. E., Mass spectra of octanes. J **41,** 129 (1948) RP1912.

Metastable transitions in mass spectra of fifty-six hydrocarbons. J **40,** 437 (1948) RP1888.

Mohler, F. L., Bloom, E. G., Wells, E. J., Jr., Lengel, J. H., Wise, C. E., Doubly charged ion spectra in mass spectra of hydrocarbons. J **42,** 369 (1949) RP1975.

Mohler, F. L., Bloom, E. G., Williamson, L., Wise, C. E., Wells, E. J., Mass spectra of C_5H_8 isomers. J **43,** 533 (1949) RP2045.

Mohler, F. L., Bloom, E. G., Wise, C. E. Wells, E. J., Metastable transitions in mass spectra of hydrocarbons. J **43,** 65 (1949) RP2005.

Mohler, F. L., Bradt, P., Mass spectra of thermal degradation products of polymers. J **55,** 323 (1955) RP2637.

Mohler, F. L., Bradt, P., Dibeler, V. H., A new technique for the mass spectrometric study of the pyrolysis products of polystyrene. J **50,** 201 (1953) RP2410.

Mass spectrum of sulfur vapor. J **57,** 223 (1956) RP2713.

Mohler, F. L., Dibeler, V. H., Analysis by the mass spectrometer of a liquified hydrocarbon mixture containing C_3-C_5 paraffins and olefins. J **39,** 149 (1947) RP1818.

Dissociation of SF_6, CF_4, and SiF_4 by electron impact. J **40,** 25 (1948) RP1853.

Mass spectra of some organo-lead and organo. mercury compounds. J **47,** 337 (1951) RP2259-

Mass spectra of the deuteromethanes. J **45,** 441 (1950) RP2155.

Mohler, F. L., Dibeler, V. H., de Hemptinne, M., Mass spectra of the deuteroethylenes. J **53,** 107 (1954) RP2522.

Mohler, F. L., Dibeler, V. H., Reese, R. M., Ionization and dissociation of the trifluoromethyl halides by electron impact. J **57**, 113 (1956) RP2700.

Mass spectra of fluorocarbons. J **49**, 343 (1952) RP2370.

Mohler, F. L., Dibeler, V. H., Wells, E. J., Jr., Reese, R. M., Mass spectra of some simple isotopic molecules. J **45**, 288 (1950) RP2135.

Mohler, F. L., Dibeler, V. H., Williamson, L., Mass spectra of diborane-d_6 and ethane-d_6. J **44**, 489 (1950) RP2095.

Mohler, F. L., Dibeler, V. H., Williamson, L., Dean, H., Mass spectra of deuteroacetylenes, monodeuterobenzene, and deuteronaphthalenes. J **48**, 188 (1952) RP2304.

Mohler, F. L., Dibeler, V. H., Williamson, L., Reese, R. M., Mass spectra of pentaborane (B_5H_9). J **43**, 97 (1949) RP2010.

Mohler, F. L., Quinn, E. I., Dibeler, V. H., Mass spectra of some lead alkyls. J **57**, 41 (1956) RP2692.

Mohler, F. L., Reese, R. M., Dibeler, V. H., A survey of negative ions in mass spectra of polyatomic molecules. J **57**, 367 (1956) RP2725.

Temperature variation of mass spectra of hydrocarbons. J **46**, 79 (1951) RP2178.

Mohler, F. L., Williamson, L., Dean, H. M., Total ionization of hydrocarbons from mass spectral data. J **45**, 235 (1950) RP2130.

Mohler, F. L., Williamson, L., Wise, C. E., Wells, E. J., Dean, H. M., Bloom, E. G., Mass spectra of nonanes. J **44**, 291 (1950) RP2078.

Mohler, F. L., Wise, C. E., Reese, R. M., Dibeler, V. H., Introduction of measured liquid samples into the mass spectrometer. J **44**, 215 (1950) RP2072.

Moon, C., Sparks, C. M., Standards for low values of direct capacitance. J **41**, 497 (1948) RP1935.

Moore, C. E., An ultraviolet multiplet table. (1950) C488, Section 1 and (1952) C488, Section 2.

Atomic energy levels (as derived from the analyses of optical spectra). (1949) Volume I and (1952) Volume II, C467.

Moore, C. E., Kessler, K. G., Meggers, W. F., Extension of the arc spectra of palladium and platinum (6500 to 12000 A). J **53**, 225 (1954) RP2538.

Moore, C. E., Meggers, W. F., Shenstone, A. G., First spectrum of arsenic. J **45**, 346 (1950) RP2144.

Moore, C. E., Russell, H. N., Binding energies for electrons of different types. J **48**, 61 (1952) RP2285.

First spectrum of barium, Ba I. J **55**, 299 (1955) RP2633.

Moore, D. G., Harrison, W. N., Fifteen-year exposure test of porcelain enamels. (1957) BMS148.

Weather resistance of porcelain enamels exposed for seven years. J **42**, 43 (1949) RP1949.

Moore, D. G., Strauss, S. W., Harrison, W. N., Richards, L. E., Fundamental factors controlling electrical resistivity in vitreous ternary lead silicates. J **56**, 135 (1956) RP2658.

Mordfin, L., Levy, S., Hobbs, E. V., Kroll, W. D., Damping of elastically supported element in a vacuum tube. J **50**, 71 (1953) RP2391.

Morehouse, C. K., Hamer, W. J., Vinal, G. W., Effect of inhibitors on the corrosion of zinc in dry-cell electrolytes. J **40**, 151 (1948) RP1863.

Moreland, R. E., Burdick, M. D., Zweig, B., Linear thermal expansion of artificial graphites to 1,370° C. J **47**, 35 (1951) RP2225.

Morey, F. C., Collett, C. T., Hughes, J. C., Measurement of the internal diameters of metallic capillary tubes. J **45**, 283 (1950) RP2134.

Morgan, M. M., Marton, L., Schubert, D. C., Shah, J. R., Simpson, J. A., Electron-optical bench. J **47**, 461 (1951) RP2273.

Morowitz, H. J., Broida, H. P., Selgin, M., Optical spectroscopic determination of hydrogen isotopes in aqueous mixtures. J **52**, 293 (1954) RP2503.

Morton, R. N., Crichlow, W. Q., Smith, D. F., Corliss, W. R., Worldwide radio noise levels expected in the frequency band 10 kilocycles to 100 megacycles. (1955) C557.

Mountjoy, W., McKee, S. A., Swindells, J. F., White, H. S., Laboratory wear tests with automotive gear lubricants. J **42**, 125 (1949) RP1955.

Moyer, J. D., Isbell, H. S., Stewart, J. E., Frush, H. L., Smith, F. A., Infrared spectra of D-talose monobenzoate and related substances. J **57**, 179 (1956) RP2708.

Moyer, J. D., Schwebel, A., Isbell, H. S., Determination of carbon-14 in solutions of C^{14}-labeled materials by means of a proportional counter. J **53**, 221 (1954) RP2537.

Mueller, E. F., Meyers, C. H., Cragoe, C. S., Table and Mollier chart of the thermodynamic properties of 1,3-butadiene. J **39**, 507 (1947) RP1844.

Munson, T. R., Evans, W. H., Jacobson, R., Wagman, D. D., Thermodynamic properties of the alkali metals. J **55**, 83 (1955) RP2608.

Munson, T. R., Evans, W. H., Wagman, D. D., Thermodynamic properties of some gaseous halogen compounds. J **55**, 147 (1955) RP2614.

Murphy, A., Wait, J. R., Influence of a ridge on the low-frequency ground wave. J **58**, 1 (1957) RP2727.

Murphy, E. T., Streiff, A. J., Zimmerman, J. C., Soule, L. F., Sedlak, V. A., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of *n*-decane, 4 alkylcyclopentanes, 9 alkylcyclohexanes, 2 monoolefins, 1,2-butadiene and 2-butyne of the API-Standard and API-NBS series. J **39**, 321 (1947) RP1833.

Murphy, R. J., Extension of the first spectrum of rhodium (Rh I). J **49**, 371 (1952) RP2374.

Murphy, R. J., Meggers, W. F., Arc spectra of gallium, indium, and thallium. J **48**, 334 (1952) RP2320.

Murphy, T. J., Clabaugh, W. S., Gilchrist, R., Separation of iodide, bromide, and chloride from one another and their subsequent determination. J **53**, 13 (1954) RP2511.

N

Naylor, R. E., Allen, H. C., Jr., Plyler, E. K., The deuterium-sulfide band at 4,590 cm^{-1}. J **53**, 321 (1954) RP2549.

Nelms, A. T., Energy loss and range of electrons and positrons. (1956) C577.

Graphs of the Compton energy-angle relationship and the Klein-Nishina formula from 10 kev to 500 Mev. (1953) C542.

Nelms, A. T., Oppenheim, I., Data on the atomic form factor: Computation and survey. J **55**, 53 (1955) RP2604.

Nelson, R. A., Furukawa, G. T. Ginnings, D. C., McCoskey, R. E., Calorimetric properties of diphenyl ether from 0° to 570° K. J **46**, 195 (1951) RP2191.

Nelson, R. A., Jessup, R. S., Heats of combustion and formation of liquid ethylenimine. J **48**, 206 (1952) RP2307.

Nelson, R. A., Jessup, R. S., Roberts, D. E., Heats of copolymerization of butadiene and styrene from measurements of heats of combustion. J **48**, 275 (1952) RP2313.

Nelson, R. C., Plyler, E. K., Benedict, W. S., Absorption spectra of methane in the near infrared. J **41**, 615 (1948) RP1944.

Newkirk, T. F., Effect of SO_3 on the alkali compounds of portland cement clinker. J **47**, 349 (1951) RP2261.

Newman, E. S., A study of the determination of the heat of hydration of portland cement. J **45**, 411 (1950) RP2152.

A study of the system magnesium oxide-magnesium chloride-water and the heat of formation of magnesium oxychloride. J **54**, 347 (1955) RP2597.

Heats of formation of xonotlite, hillebrandite, and foshagite. J **57**, 27 (1956) RP2690.

Newman, E. S., Gilfrich, J. B., Wells, L. S., Heat generation in the setting of magnesium oxychloride cements. J **49**, 377 (1952) RP2375.

Newman, E. S., Hoffman, R., Heats of formation of hexacalcium dialumino ferrite and dicalcium ferrite. J **56**, 313 (1956) RP2681.

Newman, E. S., Peppler, R. B., Heat of solution of zinc oxide in 2 N hydrochloric acid. J **46**, 121 (1951) RP2183.

Heats of formation of some barium aluminates. J **47**, 439 (1951) RP2269.

Newman, E. S., Shartsis, L., Some energy relations in the systems PbO-B_2O_3 and PbO-SiO_2. J **40**, 471 (1948) RP1893.

Newman, E. S., Wells, L. S., Heats of hydration and pozzolan content of portland-pozzolan cements. J **49**, 55 (1952) RP2342.

Newman, E. S., Wells, L. S., Clarke, W. F., Bishop, D. L., Investigation of failures of white-coat plaster. (1951) BMS121.

Newman, S. B., Pigmentation in bristle and horsehair. J **48,** 287 (1952) RP2315.

Newman, S. B., Borysko, E., Swerdlow, M., Ultramicrotomy by a new method. J **43,** 183 (1949) RP2020.

Newman, S. B., Curtiss, J. H., A statistical analysis of some mechanical properties of manila rope. J **39,** 551 (1947) RP1847.

Newman, S. B., Hammond, H. K., III, Riddell, H. F., Becker value of manila rope by photoelectric reflectometry. J **51,** 141 (1953) RP2443.

Newman, S. B., Souder, W., Measurement of the thickness of capacitor paper. (1952) C532.

Newman, S. B., Wolcock, I., Optical studies of crazed plastic surfaces. J **58,** 339 (1957) RP2767.

Newton, C. J., Mandelkern, L., Roberts, D. E., Preferred orientation in stark rubber. J **55,** 143 (1955) RP2613.

Newton, C. J., Vacher, H. C., Correlation of polarized light phenomena with the orientation of some metal crystals. J **53,** 1 (1954) RP2510.

Nimeroff, I., Analysis of goniophotometric reflection curves. J **48,** 441 (1952) RP2335.

Two-parameter gloss methods. J **58,** 127 (1957) RP2744.

Nimeroff, I., Hammond, H. K., III, Measurement of sixty-degree specular gloss. J **44,** 585 (1950) RP2105.

Nimeroff, I., Wilson, S. W., A colorimeter for pyrotechnic smokes. J **52,** 195 (1954) RP2488.

Nobel, L. D. C., Selected bibliography on building construction and maintenance. (1954) BMS140.

Norris, W. R., Forziati, A. F., Rossini, F. D., Vapor pressures and boiling points of sixty API–NBS hydrocarbons. J **43,** 555 (1949) RP2049.

Nowak, M., Plyler, E. K., Blaine, L. R., Reference wavelengths for calibrating prism spectrometers. J **58,** 195 (1957) RP2752.

Nuttall, R. L., Ginnings, D. C., Thermal conductivity of nitrogen from 50° to 500° C and 1 to 100 atmospheres. J **58,** 271 (1957) RP2760.

Nuttall, R. L., Hilsenrath, J., Beckett, C. W., Benedict, W. S., Fano, L., Hoge, H. J., Masi, J. F., Touloukian, Y. S., Woolley, H. W., Tables of thermal properties of gases. (1955) C564.

Nyberg, W. C., Franklin, P. J., French, D. M., Development of the National Bureau of Standards casting resin. (1950) C493.

O

Oehler, R., Kilduff, T. J., Treatment of leather with synthetic resins. J **42,** 63 (1949) RP1951.

O'Leary, M. J., Hubbard, D., Some properties of a glass used in paper manufacture. J **55,** 1 (1955) RP2599.

O'Leary, M. J., Scribner, B. W., Missimer, J. K., Resin bonding of offset papers containing mineral fillers. J **47,** 357 (1951) RP2262.

O'Leary, M. J., Scribner, B. W., Shaw, M. B., Missimer, J. K., Resin bonding of hardwood fibers in offset papers. J **45,** 208 (1950) RP2126.

O'Leary, M. J., Weber, C. G., Shaw, M. B., Missimer, J. K., Resin bonding and strength development in offset papers. J **40,** 427 (1948) RP1887.

Oppenheim, I., Nelms, A. T., Data on the atomic form factor: Computation and survey. J **55,** 53 (1955) RP2604.

Ordway, F., Techniques for growing and mounting small single crystals of refractory compounds. J **48,** 152 (1952) RP2299.

Orem, T. H., Atmospheric exposure tests of nailed sheet-metal building materials. (1952) BMS128.

Influence of crystallographic orientation on the corrosion rate of aluminum in acids and alkalies. J **58,** 157 (1957) RP2748.

Osborne, E., Futterman, W., Saxon, D. S., A numerical solution of Schrödinger's equation in the continuum. J **52,** 259 (1954) RP2498.

Osborne, N. S., Ginnings, D. C., Measurements of heat of vaporization and heat capacity of a number of hydrocarbons. J **39,** 453 (1947) RP1841.

Ostrow, S. M., Hartsfield, W. L., Silberstein, R., Back-scatter of observations by the Central Radio Propagation Laboratory—August 1947 to March 1948. J **44,** 199 (1950) RP2071.

Ostrowski, A. M., On nearly triangular matrices. J **52,** 319 (1954) RP2509.

P

Padgett, D. W., DeJuren, J. A., Curtiss, L. F., Absolute calibration of the National Bureau of Standards photoneutron standard: I. J **55,** 63 (1955) RP2605.

Page, B. L., Calibration of meter line standards of length at the National Bureau of Standards. J **54,** 1 (1955) RP2559.

Relative dimensional stabilities of a selected series of stainless-steel decimeter bars, J **58,** 119 (1957) RP2742.

Page, C. H., Frequency conversion with nonlinear reactance. J **58,** 227 (1957) RP2755.

Frequency conversion with positive nonlinear resistors. J **56,** 179 (1956) RP2664.

Paige, L. J., Taussky, O., Simultaneous linear equations and the determination of eigenvalues. (1953) AMS29.

Paolella, L. F., Loftus, T. P., Mann, W. B., Stockmann, L. L., Youden, W. J., Comparisons of national radium standards. J **58,** 169 (1957) RP2749.

Park, J. H., A fifty-fold momentary beam intensification for a high-voltage cold-cathode oscillograph. J **47,** 87 (1951) RP2231.

Shunts and inductors for surge current measurements. J **39,** 191 (1947) RP1823.

Park, J. H., Cones, H. N., Surge voltage breakdown of air in a nonuniform field. J **56,** 201 (1956) RP2669.

Park, J. J., Buzzard, R. W., Gold-uranium system. J **53,** 291 (1954) RP2547.

Park, J. J., Buzzard, R. W., Fickle, D. P., Silver-uranium system. J **52,** 149 (1954) RP2483.

Park, R. P., Furukawa, G. T., Heat capacity, heats of fusion and vaporization, and vapor pressure of decaborane ($B_{10}H_{14}$). J **55,** 255 (1955) RP2627.

Park, R. P., Griffel, M., Jessup, R. S., Cogliano, J. A., Apparent specific volume for polystyrene in benzene, toluene, ethylbenzene, and 2-butanone. J **52,** 217 (1954) RP2492.

Parker, C., Dietz, V. R., Higginson, H. R., Determination of sulfur in bone char. J **40,** 263 (1948) RP1871.

Parker, H. S., Burdick, M. D., Roth, R. S., McGandy, E. L., An X-ray study of the system uranium monocarbide-uranium dicarbide-beryllium carbide. J **54,** 217 (1955) RP2584.

Paulson, R. A., Hague, J. L., Bright, H. A., Determination of nitrogen in steel. J **43,** 201 (1949) RP2021.

Paulson, R. A., Karabinos, J. V., Smith, W. H., Thiophosphation of 2-methyl-2-nitro-1-propanol and the preparation of monothiophosphoric acid. J **48,** 322 (1952) RP2318.

Pawley, M. G., Wide-range phase control attenuation by adjustable impedance in a resistance-loaded bridged-tee network. J **45,** 193 (1950) RP2123.

Peffer, E. L., Blair, M. G., Testing of hydrometers. (1949) C477.

Peffer, E. L., Hidnert, P., Density of solids and liquids. (1950) C487.

Pennington, N. L., Deitz, V. R., Hoffman, H. L., Jr., Transmittancy of commercial sugar liquors: Dependence on concentration of total solids. J **49,** 365 (1952) RP2373.

Pennington, N. L., Loebenstein, W. V., Fundamental aspects of the reaction of oxygen with carbon adsorbents. J **43,** 87 (1949) RP2009.

Pepperman, D. H., Hopper, N. J., Periodicals and serials received in the Library of the National Bureau of Standards, April 1955. (1955) C563.

Peppler, R. B., The system of lime, silica, and water at 180° C. J **54,** 205 (1955) RP2582.

Peppler, R. B., Carlson, E. T., Wells, L. S., Studies in the system magnesia-silica-water at elevated temperatures and pressures. J **51,** 179 (1953) RP2448.

Peppler, R. B., Newman, E. S., Heat of solution of zinc oxide in 2 N hydrochloric acid. J **46,** 121 (1951) RP2183.

Heats of formation of some barium aluminates. J **47,** 439 (1951) RP2269.

Peppler, R. B., Wells, L. S., The system of lime, alumina, and water from 50° to 250° C. J **52,** 75 (1954) RP2476.

Perloff, A., Posner, A. S., Apatites deficient in divalent cations. J **58,** 279 (1957) RP2761.

Perls, T. A., Sherrard, E. S., Frequency response of second-order systems with combined coulomb and viscous damping. J **57,** 45 (1956) RP2693.

Perry, R. E., Jr., McDonald, E. J., A method for corn-sirup analysis involving selective adsorption. J **47,** 363 (1951) RP2263.

Peters, C. G., Emerson, W. B., Interference methods for producing and calibrating end standards. J **44,** 419 (1950) RP2089.

Peters, C. W., Plyler, E. K., Wavelengths for calibration of prism spectrometers. J **45,** 462 (1950) RP2159.

Petersen, P. H., Properties of some lightweight-aggregate concretes with and without an air-entraining admixture. (1948) BMS112.

Peterson, C., Thomas, J. L., Cooter, I. L., Kotter, F. R., An absolute measurement of resistance by the Wenner method. J **43,** 291 (1949) RP2029.

Peterson, R. P., Uniformly best constant risk and minimax point estimates. J **48,** 49 (1952) RP-2282.

Petkof, B., Masi, J. F., Heat capacity of gaseous carbon dioxide. J **48,** 179 (1952) RP2303.

Phelan, V. B., Care and repair of the house. (1950), C489.

Pierce, A. R., Bruce, C. S., Duck, J. T., Effects of substitute fuels on automotive engines. J **41,** 135 (1948) RP1913.

Pike, R. G., Hubbard, D., An interferometer procedure applied to the study of the chemical durability of silicates, enamels, and metals. J **50,** 87 (1953) RP2394.

Pike, R. G., Van Valkenburg, A., Synthesis of mica. J **48,** 360 (1952) RP2323.

Pinching, G. D., Bates, R. G., Acidic dissociation constant and related thermodynamic quantities for monoethanolammonium ion in water from 0° to 50° C. J **46,** 349 (1951) RP2205.

Acidic dissociation constant of ammonium ion at 0° to 50° C, and the base strength of ammonia. J **42,** 419 (1949) RP1982.

Dissociation constants of weak bases from electro-motive-force measurements of solutions of partially hydrolyzed salts. J **43,** 519 (1949) RP-2043.

First dissociation constant of succinic acid from 0° to 50° C and related thermodynamic quantities. J **45,** 444 (1950) RP2156.

Second dissociation constant of oxalic acid from 0° to 50° C and the pH of certain oxalate buffer solutions. J **40,** 405 (1948) RP1885.

Second dissociation constant of succinic acid from 0° to 50° C. J **45,** 322 (1950) RP2142.

Pinching, G. D., Bates, R. G., Smith, E. R., pH standards of high acidity and high alkalinity and the practical scale of pH. J **45,** 418 (1950) RP2153.

Pinkston, E. R., Foster, H. D., Ingberg, S. H., Fire resistance of structural clay tile partitions. (1948) BMS113.

Fire resistance of walls of gravel-aggregate concrete masonry units. (1951) BMS120.

Fire resistance of walls of lightweight-aggregate concrete masonry units. (1950) BMS117.

Pitzer, K. S., Epstein, M. B., Barrow, G. M., Rossini, F. D., Heats, equilibrium constants, and free energies of formation of the dimethylcyclopentanes. J **43,** 245 (1949) RP2026.

Pitzer, K. S., Epstein, M. B., Rossini, F. D., Heats, equilibrium constants, and free energies of formation of cyclopentene and cyclohexene. J **42,** 379 (1949) RP1976.

Pitzer, K. S., Kilpatrick, J. E., Beckett, C. W., Prosen, E. J., Rossini, F. D., Heats, equilibrium constants, and free energies of formation of the C_3 to C_5 diolefins, styrene, and the methylstyrenes. J **42,** 225 (1949) RP1964.

Pitzer, K. S., Kilpatrick, J. E., Werner, H. G., Beckett, C. W., Rossini, F. D., Heats, equilibrium constants and free energies of formation of the alkylcyclopentanes and alkylcyclohexanes. J **39,** 523 (1947) RP1845.

Plaza, L., Judd, D. B., Belknap, M. A., A suggested relocation and respacing of the Union colorimeter scale for lubricating oil and petrolatum. J **44,** 559 (1950) RP2103.

Plyler, E. K., Infrared prism spectrometry from 24 to 40 microns. J **41,** 125 (1948) RP1911.

Infrared radiation from a Bunsen flame. J **40,** 113 (1948) RP1860.

Infrared spectra of methanol, ethanol, and *n*-propanol. J **48,** 281 (1952) RP2314.

Plyler, E. K., Acquista, N., Calibrating wavelengths in the region from 0.6 to 2.6 microns. J **49,** 13 (1952) RP2338.

Infrared absorption spectra of cyclohydrocarbons. J **43,** 37 (1949) RP2002.

Infrared absorption spectra of five halomethanes. J **48,** 992 (1952) RP2290.

Infrared measurements from 50 to 125 microns. J **56,** 149 (1956) RP2660.

Infrared properties of cesium bromide prisms. J **49,** 61 (1952) RP2343.

Plyler, E. K., Allen, H. C., Jr., Infrared spectrum of hydrogen sulfide in the 6,290-cm^{-1} region. J **52,** 205 (1954) RP2490.

Plyler, E. K., Allen, H. C., Jr., Blaine, L. R., Vibrational constants of acetylene-d_2. J **56,** 279 (1956) RP2675.

Plyler, E. K., *Allen, H. C., Jr., Naylor, R. E.,* The deuterium-sulfide band at 4,590 cm^{-1}. J **53,** 321 (1954) RP2549.

Plyler, E. K., Allen, H. C., Jr., Tidwell, E. D., Infrared spectra of polychlorobenzenes. J **58,** 255 (1957) RP2758.

Infrared spectrum of acetylene. J **57,** 213 (1956) RP2711.

Plyler, E. K., Benedict, W. S., Absorption spectra of water vapor and carbon dioxide in the region of 2.7 microns. J **46,** 246 (1951) RP2194.

Fine structure in some infrared bands of methylene halides. J **49,** 1 (1952) RP2336.

Infrared emission spectra of cyanide and dicarbon radicals. J **53,** 161 (1954) RP2528.

Infrared spectra of eighteen halogen-substituted methanes. J **47,** 202 (1951) RP2245.

Plyler, E. K., Benedict, W. S., Bass, A. M., Flame-emission spectrum of water vapor in the 1.9-micron region. J **52,** 161 (1954) RP2485.

Plyler, E. K., Blaine, L. R., Nowak, M., Reference wavelengths for calibrating prism spectrometers. J **58,** 195 (1957) RP2752.

Plyler, E. K., Blaine, L. R., Tidwell, E. D., Infrared absorption and emission spectra of carbon monoxide in the region from 4 to 6 microns. J **55,** 183 (1955) RP2617.

Precise measurement of wavelengths in infrared spectra. J **55,** 279 (1955) RP2630.

Plyler, E. K., Forziati, F. H., Rowen, J. W., Spectrophotometric determination of carboxyl in cellulose. J **46,** 288 (1951) RP2197.

Plyler, E. K., Gailar, N., The $3\gamma_3$ bands of carbon disulfide and carbon dioxide. J **48,** 392 (1952) RP2327.

Near infrared absorption spectra of deuterated acetylene. J **47,** 248 (1951) RP2249.

Plyler, E. K., Gailar, N. M., Wiggins, T. A., Some accurately measured infrared wavelengths for calibration of grating spectrometers. J **48,** 221 (1952) RP2309.

Plyler, E. K., Humphreys, C. J., Flame spectrum of acetylene from 1 to 5 microns. J **42,** 567 (1949) RP1993.

Infrared absorption spectrum of carbon disulfide. J **39,** 59 (1947) RP1814.

Infrared emission spectra of flames. J **40,** 449 (1948) RP1890.

Use of radiation from incandescent particles as an indication of flame temperature. J **47,** 456 (1951) RP2272.

Plyler, E. K., Lamb, M. A., Infrared spectrum of bromochlorofluoromethane. J **46,** 382 (1951) RP2208.

Infrared spectrum of chlorofluoromethane. J **45,** 204 (1950) RP2125.

Plyler, E. K., Mann, D. E., Acquista, N., Vibrational spectra of tetrafluoroethylene and tetrachloroethylene. J **52,** 67 (1954) RP2474.

Plyler, E. K., Nelson, R. C., Benedict, W. S., Absorption spectra of methane in the near infrared. J **41,** 615 (1948) RP1944.

Plyler, E. K., Peters, C. W., Wavelengths for calibration of prism spectrometers. J **45,** 462 (1950) RP2159.

Plyler, E. K., Rowen, J. W., Effect of deuteration, oxidation, and hydrogen-bonding on the infrared spectrum of cellulose. J **44,** 313 (1950) RP2080.

Plyler, E. K., Rowen, J. W., Hunt, C. M., Absorption spectra in the detection of chemical changes in cellulose and cellulose derivatives. J **39,** 133 (1947) RP1816.

Plyler, E. K., Simpson, D., Infrared spectra of pentachlorofluoroethane, 1,2-dichlorotetrafluoroethane, and 1-bromo-2-fluoroethane. J **50**, 223 (1953) RP2414.

Plyler, E. K., Smith, W. H., Acquista, N., Infrared spectra of bromochloromethane, dibromomethane, tribromochloromethane, and tetrabromomethane. J **44**, 503 (1950) RP2097.

Plyler, E. K., Tilton, L. W., Refractivity of lithium fluoride with application to the calibration of infrared spectrometers. J **47**, 25 (1951) RP2223.

Plyler, E. K., Tilton, L. W., Stephens, R. E., Refractive indices of thallium bromide-iodide crystals for visible and infrared radiant energy. J **43**, 81 (1949) RP2008.

Pollard, R. E., Sieve tests of metal powders. J **39**, 487 (1947) RP1843.

Subsieve particle-size measurement of metal powders by air elutriation. J **51**, 17 (1953) RP2428.

Pomerantz, P., Synthesis and physical properties of *n*-heptane and 2,2,4-trimethylpentane. J **48**, 76 (1952) RP2287.

Pomerantz, P., Fookson, A., Mears, T. W., Rothberg, S., Howard, F. L., Synthesis and physical properties of several acetylenic hydrocarbons. J **52**, 51 (1954) RP2472.

Synthesis and physical properties of several aliphatic and alicyclic hydrocarbons. J **52**, 59 (1954) RP2473.

Pomerantz, P., Fookson, A., Rich, E. H., Preparation and purification of hydrogen deuteride. J **47**, 31 (1951) RP2224.

Pomerantz, P., Fookson, A., Rothberg, S., Some characteristics of Stedman packing in the distillation of hydrogen and its isotopes. J **47**, 449 (1951) RP2271.

Pomerantz, P., Mears, T. W., Fookson, A., Rich, E. H., Dussinger, C. S., Howard, F. L., Syntheses and properties of two olefins, six paraffins, and their intermediates. J **44**, 299 (1950) RP2079.

Pomerantz, P., Mears, T. W., Howard, F. L., Separation and identification of the major C_7 to C_{10} components of triptene residue. J **42**, 617 (1949) RP1999.

Pope, C. I., Davis, R., Development of a photoresist for etching designs in glass. J **55**, 139 (1955) RP2612.

Techniques for ruling and etching precise scales in glass and their reproduction by photoetching with a new light-sensitive resist. (1955) C565.

Posner, A. S., Perloff, A., Apatites deficient in divalent cations. J **58**, 279 (1957) RP2761.

Potter, E. A., Eiseman, J. H., Accuracy of the Cutler-Hammer recording gas calorimeter when used with gases of high heating value. J **58**, 213 (1957) RP2754.

Powell, R. C., Harrington, R. D., Haas, P. H., A re-entrant cavity for measurement of complex permeability in the very-high-frequency region. J **56**, 129 (1956) RP2657.

Powell, R. L., Blanpied, W. A., Thermal conductivity of metals and alloys at low temperatures: A review of the literature. (1954) C556.

Prosen, E. J., Fraser, F. M., Heats of combustion and isomerization of six pentadienes and spiropentane. J **54**, 143 (1955) RP2575.

Heats of combustion of liquid *n*-hexadecane, 1-hexadecene, *n*-decylbenzene, *n*-decylcyclohexane, *n*-decylcyclopentane, and the variation of heat of combustion with chain length. J **55**, 329 (1955) RP2638.

Prosen, E. J., Jessup, R. S., Heats of combustion and formation of cellulose and nitrocellulose (cellulose nitrate). J **44**, 387 (1950) RP2086.

Prosen, E. J., Johnson, W. H., Rossini, F. D., Heats of combustion and isomerization of the eight C_8H_{16} alkylcyclohexanes. J **39**, 49 (1947) RP1812.

Heats of combustion and isomerization of the six C_7H_{14} alkylcyclopentanes. J **42**, 251 (1949) RP1966.

Heats of formation and isomerization of the eight C_8H_{12} alkylcyclohexanes in the liquid and gaseous states. J **39**, 173 (1947) RP1821.

Prosen, E. J., Kilpatrick, J. E., Beckett, C. W., Pitzer, K. S., Rossini, F. D., Heats, equilibrium constants, and free energies of formation of the C_3 to C_5 diolefins, styrene, and the methylstyrenes. J **42**, 225 (1949) RP1964.

Prosen, E. J., Knowlton, J. W., Heat of combustion and formation of cyanogen. J **46**, 489 (1951) RP2218.

Prosen, E. J., Maron, F. W., Rossini, F. D., Heat of isomerization of the two butadienes. J **42**, 269 (1949) RP1968.

Heats of combustion, formation, and isomerization of ten C_4 hydrocarbons. J **46**, 106 (1951) RP2181.

Q

Quick, G. W., Bennett, J. A., Mechanical failures of metals in service. (1954) C550.

Quinn, E. I., Dibeler, V. H., Mohler, F. L., Mass spectra of some lead alkyls. J **57**, 41 (1956) RP2692.

Quinn, F. A., Jr., Bekkedahl, N., Zimmerman, E. W., Vulcanization of synthetic rubbers by the Peachey process. J **40**, 1 (1948) RP1850.

Quinn, F. A., Jr., Mandelkern, L., Martin, G. M., Glassy state transitions of poly-(chlorotrifluoroethylene), poly-(vinylidene fluoride), and their copolymers. J **58**, 137 (1957) RP2745.

R

Rabinowitz, P., Davis, P., Abscissas and weights for Gaussian quadratures of high order. J **56**, 35 (1956) RP2645.

Rabinowitz, P., Trees, R. E., Cahill, W. F., Computation of atomic energy levels: Spectrum of singly-ionized tantalum (Ta II). J **55**, 335 (1955) RP2639.

Ramberg, W., Transient vibration in an airplane wing obtained by several methods. J **42**, 437 (1949) RP1984.

Ramberg, W., McPherson, A. E., Experimental verification of theory of landing impact. J **41**, 509 (1948) RP1936.

Ramberg, W., Miller, J. A., Stress-strain relation in shear from twisting test of annulus. J **50**, 125 (1953) RP2398.

Twisted square plate method and other methods for determining the shear stress-strain relation of flat sheet. J **50**, 111 (1953) RP2397.

Randall, D. L., Lowell, P. D., Hakkarinen, W., National Bureau of Standards mobile low-level sounding system. J **50**, 7 (1953) RP2381.

Rasmussen, A. L., Enfield, A. W., Hess, A., Advances in the design and application of the radiofrequency permeameter. J **56**, 261 (1956) RP2673.

Reese, R. M., Dibeler, V. H., Selected positive and negative ions in the mass spectra of the monohalomethanes. J **54**, 127 (1955) RP2573.

Reese, R. M., Dibeler, V. H., Mohler, F. L., A survey of negative ions in mass spectra of polyatomic molecules. J **57**, 367 (1956) RP2725.

Ionization and dissociation of the trifluoromethyl halides by electron impact. J **57**, 113 (1956) RP2700.

Temperature variation of mass spectra of hydrocarbons. J **46**, 79 (1951) RP2178.

Reese, R. M., Dibeler, V. H., Mohler, F. L., Wells, E. J., Jr., Mass spectra of some simple isotopic molecules. J **45**, 288 (1950) RP2135.

Reese, R. M., Dibeler, V. H., Mohler, F. L., Williamson, L., Mass spectrum of pentaborane (B_5H_9). J **43**, 97 (1949) RP2010.

Reese, R. M., Mohler, F. L., Dibeler, V. H., Mass spectra of fluorocarbons. J **49**, 343 (1952) RP2370.

Reese, R. M., Wise, C. E., Dibeler, V. H., Mohler, F. L., Introduction of measured liquid samples into the mass spectrometer. J **44**, 215 (1950) RP2072.

Reggia, F., Beatty, R. W., An improved method of measuring efficiencies of ultra-high-frequency and microwave bolometer mounts. J **54**, 321 (1955) RP2594.

Reilly, M. L., Furukawa, G. T., Heat capacity of polyisobutylene from 0° to 380° K. J **56**, 285 (1956) RP2676.

Reilly, M. L., Furukawa, G. T., McCoskey, R. E., Heat capacity, heats of fusion and vaporization, and vapor pressure of tetrafluoroethylene. J **51**, 69 (1953) RP2432.

Heat capacity, heats of transitions, fusion, and vaporization, and vapor pressure of octafluorocyclobutane. J **52**, 11 (1954) RP2466.

Heat capacity of some butadiene-styrene copolymers from 0° to 330° K. J **55**, 127 (1955) RP2610.

Reilly, M. L., Furukawa, G. T., McCoskey, R. E., Harman, A. W., Heat capacity; heats of fusion, vaporization, and transition; and vapor pressure of N-dimethylaminodiborane, $(CH_3)_2NB_2H_5$. J **55,** 201 (1955) RP2620.

Reiney, M. J., Achhammer, B. G., Reinhart, F. W., Study of degradation of polystyrene, using infrared spectrophotometry. J **47,** 116 (1951) RP2235.

Reiney, M. J., Tryon, M., Achhammer, B. G., Study of degradation of polystyrene, using ultraviolet spectrophotometry. J **51,** 155 (1953) RP2445.

Reinhart, F. M., Digges, T. G., Influence of boron one some properties of experimental and commercial steels. J **39,** 67 (1947) RP1815.

Reinhart, F. W., Achhammer, B. G., Kline, G. M., Mechanism of the degradation of polyamides. J **46,** 391 (1951) RP2210.

Reinhart, F. W., Achhammer, B. G., Reiney, M. J., Study of degradation of polystyrene, using infrared spectrophotometry. J **47,** 116 (1951) RP2235.

Rich, E. H., Fookson, A., Pomerantz, P., Preparation and purification of hydrogen deuteride. J **47,** 31 (1951) RP2224.

Rich, E. H., Mears, T. W., Fookson, A., Pomerantz, P., Dussinger, C. S., Howard, F. L., Syntheses and properties of two olefins, six paraffins, and their intermediates. J **44,** 299 (1950) RP2079.

Richards, L. E., Strauss, S. W., Moore, D. G., Harrison, W. N., Fundamental factors controlling electrical resistivity in vitreous ternary lead silicates. J **56.** 135 (1956) RP2658.

Richey, G. G., McKenna, E. H., Hobbs, R. B., Methods and equipment for testing printed-enamel felt-base floor covering. (1952). BMS130.

Richmond, J. C., Francisco, A. C., The use of plastic replicas in evaluating surface texture of enamels. J **42,** 449 (1949) RP1985.

Riddell, G., Brenner, A., Deposition of nickel and cobalt by chemical reduction. J **39,** 385 (1947) RP1835.

Riddell, H. F., Newman, S. B., Hammond, H. K., III, Becker value of manila rope by photoelectric reflectometry. J **51,** 141 (1953) RP2443.

Riley, R., Weaver, E. R., Measurement of water in gases by electrical conduction in a film of hygroscopic materials and the use of pressure changes in calibration. J **40,** 169 (1948) RP1865.

Roberts, D. E., Heats of polymerization. A summary of published values and their relation to structure. J **44,** 221 (1950) RP2073.

Roberts, D. E., Armstrong, G. T., Goldstein, J. M., Liquid-vapor phase equilibrium in solutions of oxygen and nitrogen at pressures below one atmosphere. J **55,** 265 (1955) RP2629.

Roberts, D. E., Jessup, R. S., Heat of combustion of phenyl-beta-naphthylamine (N-phenyl-2-napthylamine). J **40,** 281 (1948) RP1873.
Heat of polymerization of alpha-methylstyrene from heats of combustion of monomer and four polymer fractions. J **46,** 11 (1951) RP2169.

Roberts, D. E., Mandelkern, L., Nature of stark rubber. J **54,** 167 (1955) RP2578.

Roberts, D. E., Nelson, R. A., Jessup, R. S., Heats of copolymerization of butadiene and styrene from measurements of heats of combustion. J **48,** 275 (1952) RP2313.

Roberts, D. E., Newton, C. J., Mandelkern, L., Preferred orientation in stark rubber. J **55,** 143 (1955) RP2613.

Roberts, H. S., Curtis, H. L., An instrument for the rapid production of a decimal series of potentials and its application to ballistic measurements. J **41,** 45 (1948) RP1902.

Rodney, W., Weir, C., Spinner, S., Malitson, I., Optical and volumetric relaxation effects in glass following removal of high hydrostatic pressures. J **58,** 189 (1957) RP2751.

Rodney, W. S., Spindler, R. J., Index of refraction of fused-quartz glass for ultraviolet, visible, and infrared wavelengths. J **53,** 185 (1954) RP2531.
Refractive index of cesium bromide for ultraviolet, visible, and infrared wavelengths. J **51,** 123 (1953) RP2440.
Refractivity of potassium bromide for visible wavelengths. J **49,** 253 (1952) RP2361.

Rodney, W. S., Stephens, R. E., Refractive indices of five selected optical glasses. J **52,** 303 (1954) RP2504.

Roeser, W. F., Mebs, R. W., Solders and soldering. (1950). C492.

Romanoff, M., Underground corrosion. (1957) C597.

Romanoff, M., Denison, I. A., Behavior of experimental zinc-steel couples underground. J **40,** 301 (1948) RP1876.
Corrosion of galvanized steel in soils. J **49,** 299 (1952) RP2366.
Corrosion of low-alloy irons and steels in soils. J **49,** 315 (1952) RP2367.
Corrosion of nickel cast irons in soils. J **51,** 313 (1953) RP2459.
Effect of exposure to soils on the properties of asbestos-cement pipe. J **47,** 367 (1951) RP2264.
Soil-corrosion studies, 1946 and 1948: Copper alloys, lead, and zinc. J **44,** 259 (1950) RP2077.
Soil-corrosion studies, 1946: Ferrous metals and alloys. J **44,** 47 (1950) RP0257.

Rosberry, F. W., Effect of object frequency on focal position of four photographic objectives. J **57,** 17 (1956) RP2688.

Rosberry, F. W., Tilton, L. W., Badger, F. T., Refractive uniformity of a borosilicate glass after different annealing treatments. J **49,** 21 (1952) RP2340.

Rosenberg, S. J., Temper brittleness of boron-treated steels. J **58,** 175 (1957) RP2750.

Rosenberg, S. J., Darr, J. H., Stabilization of austenitic stainless steel. J **40,** 321 (1948) RP1878.

Rosenberg, S. J., Digges, T. G., Heat treatment and properties of iron and steel. (1950) C495.

Rosenberg, S. J., Irish, C. R., Solubility of carbon in 18-percent-chromium–10-percent-nickel austenite. J **48,** 40 (1952) RP2281.

Rosenberg, S. J., Meyerson, M. R., A study of the final stages of the austenite to martensite transformation in SAE 1050 steel. J **55,** 177 (1955) RP2616.

Rosenwasser, H., DeJuren, J. A., Absolute calibration of NBS standard thermal neutron density. J **52,** 93 (1954) RP2477.
Diffusion length of thermal neutrons in water. J **51,** 203 (1953) RP2452.

Ross, G. S., Glasgow, A. R., Jr., Purification of substances by a process of freezing and fractional melting under equilibrium conditions. J **57,** 137 (1956) RP2703.

Rosser, J. B., A method of computing exact inverses of matrices with integer coefficients. J **49,** 349 (1952) RP2371.
Real roots of real dirichlet L-series. J **45,** 505 (1950) RP2165.
Transformations to speed the convergence of series. J **46,** 56 (1951) RP2175.

Rosser, J. B., Lanczos, C., Hestenes, M. R., Karush, W., Separation of close eigenvalues of a real symmetric matrix. J **47,** 291 (1951) RP2256.

Rossini, F. D., Epstein, M. B., Barrow, G. M., Pitzer, K. S., Heats, equilibrium constants, and free energies of formation of the dimethyl cyclopentanes. J **43,** 245 (1949) RP2026.

Rossini, F. D., Epstein, M. B., Mair, B. J., Willingham, C. B., Separation of the 177° to 200° C fraction of petroleum and the isolation of normal undecane. J **42,** 139 (1949) RP1957.

Rossini, F. D., Epstein, M. B., Pitzer, K. S., Heats, equilibrium constants, and free energies of formation of cyclopentene and cyclohexene. J **42,** 379 (1949) RP1976.

Rossini, F. D., Forziati, A. F., Alkylbenzenes in the C_9 fraction from seven representative crude petroleums. J **39,** 425 (1947) RP1839.
Physical properties of sixty API–NBS hydrocarbons. J **43,** 473 (1949) RP2038.

Rossini, F. D., Forziati, A. F., Camin, D. L., Density, refractive index, boiling point, and vapor pressure of eight monoolefin (1-alkene), six pentadiene, and two cyclomonoolefin hydrocarbons. J **45,** 406 (1950) RP2151.

Rossini, F. D., Forziati, A. F., Norris, W. R., Vapor pressures and boiling points of sixty API–NBS hydrocarbons. J **43,** 555 (1949) RP2049.

Rossini, F. D., Glasgow, A. R., Jr., Willingham, C. B., Hydrocarbons in the 108° to 116° C fraction of petroleum. J **44,** 141 (1950) RP2065.
Separation of 2,3-dimethylpentane, 1,*cis*-3-dimethylcyclopentane, and 3-ethylpentane from petroleum. J **44,** 411 (1950) RP2088.

Rossini, F. D., Johnson, W. H., Prosen, E. J., Heats of combustion and isomerization of the six C_7H_{14} alkylcyclopentanes. J **42,** 251 (1949) RP1966.

Rossini, F. D., Kilpatrick, J. E., Beckett, C. W., Prosen, E. J., Pitzer, K. S., Heats, equilibrium constants, and free energies of formation of the C_3 to C_5 diolefins, styrene, and the methylstyrenes. J **42,** 225 (1949) RP1964.

Rossini, F. D., Kilpatrick, J. E., Werner, H. G., Beckett, C. W., Pitzer, K. S., Heats, equilibrium constants, and free energies of formation of the alkylcyclopentanes and alkylcyclohexanes. J **39,** 523 (1947) RP1845.

Rossini, F. D., Knowlton, J. W., Heats of combustion and formation of cyclopropane. J **43,** 113 (1949) RP2012.

Rossini, F. D., Prosen, E. J., Johnson, W. H., Heats of combustion and isomerization of the eight C_8H_{16} alkylcyclohexanes. J **39,** 49 (1947) RP1812.

Heats of formation and isomerization of the eight C_8H_{12} alkylcyclohexanes in the liquid and gaseous states. J **39,** 173 (1947) RP1821.

Rossini, F. D., Prosen, E. J., Maron, F. W., Heat of isomerization of the two butadienes. J **42,** 269 (1949) RP1968.

Heats of combustion, formation, and isomerization of ten C_4 hydrocarbons. J **46,** 106 (1951) RP2181.

Rossini, F. D., Streiff, A. J., Alkylbenzenes in the C_8 fraction from five different catalytic petroleum refining processes. J **39,** 303 (1947) RP1830.

Rossini, F. D., Streiff, A. J., Murphy, E. T., Zimmerman, J. C., Soule, L. F., Sedlak, V. A., Willingham, C. B., Purification, purity, and freezing points of *n*-decane, 4 alkylcyclopentanes, 9 alkylcyclohexanes, 2 monoolefins, 1,2-butadiene, and 2-butyne of the API–Standard and API–NBS series. J **39,** 321 (1947) RP1833.

Rossini, F. D., Streiff, A. J., Soule, L. F., Kennedy, C. M., Janes, M. E., Sedlak, V. A., Willingham, C. B., Purification, purity, and freezing points of twenty-nine hydrocarbons of the API–Standard and API–NBS series. J **45,** 173 (1950) RP2122.

Rossini, F. D., Streiff, A. J., Zimmerman, J. C., Soule, L. F., Butt, M. T., Sedlak, V. A., Willingham, C. B., Purification, purity, and freezing points of 30 hydrocarbons of the API–Standard and API–NBS series. J **41,** 323 (1948) RP1929.

Rossini, F. D., Wagman, D. D., Evans, W. H., Levine, S., Jaffe, I., Selected values of chemical thermodynamic properties. (1952) C500.

Roth, F. L., Holt, W. L., Knox, E. O., Strain tester for rubber. J **41,** 95 (1948) RP1907.

Roth, F. L., Stiehler, R. D., Strain test for evaluation of rubber compounds. J **41,** 87 (1948) RP1906.

Roth, R. S., Classification of perovskite and other ABO_3-type compounds. J **58,** 75 (1957) RP2736.

Pyrochlore-type compounds containing double oxides of trivalent and tetravalent ions. J **56,** 17 (1956) RP2643.

Roth, R. S., Burdick, M. D., Parker, H. S., McGandy, E. L., An X-ray study of the system uranium monocarbide-uranium dicarbide-beryllium carbide. J **54,** 217 (1955) RP2584.

Roth, R. S., Coughanour, L. W., Phase equilibrium relations in the systems titania-niobia and zirconia-niobia. J **55,** 209 (1955) RP2621.

Roth, R. S., Coughanour, L. W., DeProsse, V. A., Phase equilibrium relations in the systems lime-titania and zirconia-titania. J **52,** 37 (1954) RP2470.

Roth, R. S., Coughanour, L. W., Marzullo, S., Sennett, F. E., Solid-state reactions and dielectric properties in the system magnesia-lime-tin oxide-titania. J **54,** 149 (1955) RP2576.

Solid-state reactions and dielectric properties in the systems magnesia-zirconia-titania and lime-zirconia-titania. J **54,** 191 (1955) RP2580.

Roth, R. S., Jaffe, B., Marzullo, S., Properties of piezoelectric ceramics in the solid-solution series lead titanate-lead zirconate-lead oxide: Tin oxide and lead titanate-lead hafnate. J **55,** 239 (1955) RP2626.

Roth, R. S., Lang, S. M., Fillmore, C. L., Some properties of porcelains and phase relations in the ternary systems of beryllia and zirconia with titania, ceria, and chromia. J **53,** 201 (1954) RP2534.

Roth, R. S., Lang, S. M., Knudsen, F. P., Fillmore, C. L., High-temperature reactions of uranium dioxide with various metal oxides. (1956) C568.

Rothberg, S., Fookson, A., Pomerantz, P., Some characteristics of Stedman packing in the distillation of hydrogen and its isotopes. J **47,** 449 (1951) RP2271.

Rothberg, S., Pomerantz, P., Fookson, A., Mears, T. W., Howard, F. L., Synthesis and physical properties of several acetylenic hydrocarbons. J **52,** 51 (1954) RP2472.

Synthesis and physical properties of several aliphatic and alicyclic hydrocarbons. J **52,** 59 (1954) RP2473.

Rothman, S., Weissberg, S. G., Simha, R., Viscosity of dilute and moderately concentrated polymer solutions. J **47,** 298 (1951) RP2257.

Rouse, G. F., Forman, R., Oxide cathode base metal studies. J **46,** 30 (1951) RP2171.

Rowen, J. W., Blaine, R. L., Sorption of nitrogen and water vapor on textile fibers. J **39,** 479 (1947) RP1842.

Rowen, J. W., Forziati, F. H., Effect of changes in crystalline structure on the infrared absorption spectrum of cellulose. J **46,** 38 (1951) RP2172.

Rowen, J. W., Forziati, F. H., Plyler, E. K., Spectrophotometric determination of carboxyl in cellulose. J **46,** 288 (1951) RP2197.

Rowen, J. W., Forziati, F. H., Stone, W. K., Appel, W. D., Cotton powder for infrared transmission measurements. J **45,** 109 (1950) RP2116.

Rowen, J. W., Hunt, C. M., Blaine, R. L., Submicroscopic structure of cellulose from nitrogen sorption measurements. J **43,** 547 (1949) RP2048.

Rowen, J. W., Hunt, C. M., Plyler, E. K., Absorption spectra in the detection of chemical changes in cellulose and cellulose derivatives. J **39,** 133 (1947) RP1816.

Rowen, J. W., Plyler, E. K., Effect of deuteration, oxidation, and hydrogen-bonding on the infrared spectrum of cellulose. J **44,** 313 (1950) RP-2080.

Ruegg, F. W., Halpern, C., Gravimetric analysis of exhaust gas from gas turbine combustion chambers. J **45,** 113 (1950) RP2117.

Ruegg, F. W., Klug, H. J., Analytical and experimental studies with idealized gas turbine combustors. J **49,** 279 (1952) RP2365.

Russell, H. N., Moore, C. E., Binding energies for electrons of different types. J **48,** 61 (1952) RP2285.

First spectrum of barium, Ba I. J **55,** 299 (1955) RP2633.

Ryan, J. V., Bender, E. W., Fire endurance of open-web steel-joist floors with concrete slabs and gypsum ceilings. (1954) BMS141.

Ryan, J. V., Cummings, J. W., Hutton, A. C., Fire effects and fire control in nitrocellulose photographic-film storage. (1956) BMS145.

Ryan, J. V., Mitchell, N. D., Fire tests of steel columns encased with gypsum lath and plaster. (1953) BMS135.

Ryan, J. V., Mitchell, N. D., Bender, E. D., Fire resistance of shutters for moving-stairway openings. (1952) BMS129.

Rynders, G. F., Faick, C. A., Williams, A. E., Effect of convection currents on the distribution of striae in pots of optical glass. J **42,** 153 (1949) RP1959.

Rynders, G. F., Grauer, O. H., Hubbard, D., Electrode function (pH response) of the soda-silica glasses. J **41,** 273 (1948) RP1923.

Rynders, G. F., Hubbard, D., Chemical durability, specular gloss, and transmittance of optical glasses. J **41,** 477 (1948) RP1933.

Effect of annealing and other heat treatments on the pH response of the glass electrode. J **40,** 105 (1948) RP1859.

Thickness of inhibiting films on glass electrode surfaces. J **41,** 163 (1948) RP1915.

Voltage anomalies of the glass electrode and the chemical durability of the glass. J **39,** 561 (1947) RP1848.

Rynders, G. F., Hubbard, D., Black, M. H., Electrode function (pH response), hygroscopicity, and chemical durability of soda-lead oxide-silica glasses. J **45,** 430 (1950) RP2154.

Rynders, G. F., Hubbard, D., Black, M. H., Holley, S. F. Electrode function (pH response), hygroscopicity, and chemical durability of soda-potash-silica glasses. J **46,** 168 (1951) RP2189.

Rynders, G. F., Hubbard, D., Cleek, G. W., Electrode function (pH response), hygroscopicity, and chemical durability of Na_2O–CaO–SiO_2 glasses. J **44,** 247 (1950) RP2076.

Rynders, G. F., Shermer, H. F., Cleek, G. W., Hubbard, D., Atypical pH response of some nonsilicate glasses. J **52,** 251 (1954) RP2497.

S

Sager, E. E., Byers, F. C., Spectral absorbance of some aqueous solutions in the range 10° to 40° C. J **58,** 33 (1957) RP2731.

Sager, E. E., Siewers, I. J., Dissociation constant of 4-aminobenzophenone calculated from ultraviolet spectra at several temperatures. J **45,** 489 (1950) RP2162.

Overlapping dissociation constants of 4,4′-diaminobenzophenone from spectral-absorbency measurements. J **49,** 7 (1952) RP2337.

Salzer, H. E., Checking and interpolation of functions tabulated at certain irregular logarithmic intervals. J **46,** 74 (1951) RP2177.

Formulas for inverse osculatory interpolation. J **56,** 51 (1956) RP2647.

New formulas for facilitating osculatory interpolation. J **52,** 211 (1954) RP2491.

On calculating the zeros of polynomials by the method of Lucas. J **49,** 133 (1952) RP2348.

Osculatory interpolation in the complex plane. J **54,** 263 (1955) RP2587.

Table of coefficients for obtaining the first derivative without differences. (1948) AMS2.

Table of powers of complex numbers. (1950) AMS8.

Tables of coefficients for the numerical calculation of Laplace transforms. (1953) AMS30.

Tables of n! and $\Gamma(n+1/2)$ for the first thousand values of n. (1951) AMS16.

Salzer, H. E., Zucker, R., Capuano, R., Table of the zeros and weight factors of the first twenty Hermite polynomials. J **48,** 111 (1952) RP2294.

Sanford, R. L., Winter, P. H., A permeameter for magnetic testing at magnetizing forces up to 300 oersteds. J **45,** 17 (1950) RP2109.

Sargent, C. J., Gautier, T. N., Jr., Prediction of the likelihood of interference at frequencies of 30 to 42 megacycles in Alaska. J **52,** 21 (1954) RP2468.

Sass, S., Marton, C., Swerdlow, M., VanBronkhorst, A., Meryman, H., Bibliography of electron miscroscopy. (1950) C502.

Saunders, J. B., Construction of a Kösters double-image prism, J **58,** 21 (1957) RP2729.

Image shifts caused by rotating a constant deviation prism in divergent light. J **41,** 287 (1948) RP1925.

Precise topography of optical surfaces. J **47,** 148 (1951) RP2239.

Refractivity measurements on Canada balsam by interferometry. J **53,** 373 (1954) RP2555.

Refractivity measurements on thick plates. J **53,** 165 (1954) RP2529.

Testing of large optical surfaces with small test plates. J **53,** 29 (1954) RP2514.

The Kösters interferometer. J **58,** 27 (1957) RP2730.

Saunders, J. B., Tool, A. Q., Expansion effects of annealing borosilicate thermometer glasses. J **42,** 171 (1949) RP1960.

Expansion effects shown by some Pyrex glasses. J **40,** 67 (1948) RP1856.

Saxon, D. S., Futterman, W., Osborne, E., A numerical solution of Schrödinger's equation in the continuum. J **52,** 259 (1954) RP2498.

Scal, R. K-F., Miniature intermediate-frequency amplifiers. (1954) C548.

Schaffer, R., Appel, W. D., Forziati, F. H., Reactions at wet-dry interfaces on fibrous materials. J **54,** 103 (1955) RP2570.

Schaffer, R., Isbell, H. S., Improved synthesis of sodium D-glucuronate-6-C^{14} and of D-glucose-6-C^{14}. J **56,** 191 (1956) RP2667.

Synthesis of β-gentiobiose-1-C^{14}. J **57,** 333 (1956) RP2722.

Schaffer, R., Isbell, H. S., Frush, H. L., Synthesis of α-D-glucose-2-C^{14}, α-D-mannose-2-C^{14}, and α-D-galactose-2-C^{14}. J **54,** 201 (1955) RP2581.

Schaum, J. H., Burnett, H. C., Magnesium-rich side of the magnesium-zirconium constitution diagram. J **49,** 155 (1952) RP2352.

Schiefer, H. F., Solution of problem of producing uniform abrasion and its application to the testing of textiles. J **39,** 1 (1947) RP1807.

Schiefer, H. F., Crean, L. E., Krasny, J. F., Improved single-unit Schiefer abrasion testing machine. J **42,** 481 (1949) RP1988.

Schiefer, H. F., Krasny, J. F., Note on the disintegration of wool in abrasion tests. J **44,** 9 (1950) RP2054.

Schiefer, H. F., McCrackin, F. L., Smith, J. C., Stone, W. K., Stress-strain relationships in yarns subjected to rapid impact loading: 2. Breaking velocities, strain energies, and theory neglecting wave propagation. J **54,** 277 (1955) RP2590.

Schiefer, H. F., Smith, J. C., McCrackin, F. L., Stress-strain relationships in yarns subjected to rapid impact loading: 3. Effect of wave propagation. J **55,** 19 (1955) RP2601.

Schiefer, H. F., Smith, J. C., McCrackin, F. L., Stone, W. K., Towne, K. M., Stress-strain relationships in yarns subjected to rapid impact loading: 4. Transverse impact tests. J **57,** 83 (1956) RP2695.

Schiefer, H. F., Stone, W. K., Fox, G., Stress-strain relationships in yarns subjected to rapid impact loading: 1. Equipment, testing procedure, and typical results. J **54,** 269 (1955) RP2589.

Schmidt, A. F., Birmingham, B. W., Brown, E. H., Class, C. R., Vessels for the storage and transport of liquid hydrogen. J **58,** 243 (1957) RP2757.

Schoonover, I. C., Brauer, G. M., Sweeney, W. T., Effect of water on the induction period of the polymerization of methyl methacrylate. J **49,** 359 (1952) RP2372.

Schoonover, I. C., Mitchell, J. A., Dickson, G., Vacher, H. C., Some factors affecting the dimensional stability of the silver-tin-(copper-zinc) amalgams. J **52,** 185 (1954) RP2487.

Schoonover, I. C., Souder, W., Research on dental materials at the National Bureau of Standards: A review and Bibliography. (1950) C497.

Schrack, R. A., Radio-frequency power measurements. (1953) C536.

Schriesheim, A., Method for the controlled burning of combustible materials and analyses of the combustion gases. J **57,** 245 (1956) RP2715.

Schubauer, G. B., Adams, G. H., Effect of support on the performance of vane anemometers. J **40,** 275 (1948) RP1872.

Schubert, D. C., Marton, L., Morgan, M. M., Shah, J. R., Simpson, J. A., Electron-optical bench. J **47,** 461 (1951) RP2273.

Schuette, K. E., Manov, G. G., Kirk, F. S., Ionization constant of 5-5′-diethylbarbituric acid from 0° to 60° C. J **48,** 84 (1952) RP2289.

Schuhmann, P. J., Davis, M. M., Acid-base reactions in benzene and other organic solvents: Behavior of bromphthalein magenta with different classes of organic basis. J **39,** 221 (1947) RP1825.

Schuhmann, P. J., Davis, M. M., Lovelace, M. E., Acid-base reactions in organic solvents. Behavior of some halogenated derivatives of phenolsulfonephthalein with different classes of organic bases in benzene. J **41,** 27 (1948) RP1900.

Schuhmann, S., Shepherd, M., Determination of hydrogen by slow combustion over platinum in excess oxygen. J **53,** 77 (1954) RP2518.

Schuhmann, S., Shepherd, M., Thomas, R., Dibeler, V. H., Experimental study of the Koppers-Hinckley-Podbielniak apparatus and method for the determination of conjugated dienes. J **39,** 435 (1947) RP1840.

Schwarz, K. M., Smith, R. W., Federal and State Weights and Measures Laws. (1951) C501.

Statutory net-content marking requirements for packages (undefined) and packages of foods, drugs, and cosmetics. (1950) C503.

Schwebel, A., Caswell, R. S., Brabant, J. M., Disintegration rate of carbon-14. J **53,** 27 (1954) RP2513.

Schwebel, A., Isbell, H. S., Karabinos, J. V., Frush, H. L., Holt, N. B., Galkowski, T. T., Synthesis of D-glucose-1-C^{14} and D-mannose-1-C^{14}. J **48,** 163 (1952) RP2301.

Schwebel, A., Isbell, H. S., Moyer, J. D., Determination of carbon-14 in solutions of C^{14}-labeled materials by means of a proportional counter. J **53,** 221 (1954) RP2537.

Schwerdtfeger, W. J., Electrical measurements in the selection of bolt materials for service underground. J **52,** 265 (1954) RP2499.

Laboratory measurement of the corrosion of ferrous metals in soils. J **50,** 329 (1953) RP2422.

Measurement of the corrosion rate of iron by polarization techniques. J **58,** 145 (1957) RP2746.

Schwerdtfeger, W. J., Denison, I. A., Geometric factors in electrical measurements relating to corrosion and its prevention. J **54,** 61 (1955) RP2566.

Schwerdtfeger, W. J., McDorman, O. N., Potential and current requirements for the cathodic protection of steel in soils. J **47,** 104 (1951) RP2233.

Scott, A. H., Directional effects in dielectric properties of molded rubber. J **43,** 355 (1949) RP2030.

Measurement of multimegohm resistors. J **50,** 147 (1953) RP2402.

Scott, L. W., Washer, F. E., Influence of the atmosphere upon the precision of telescope pointing. J **39,** 297 (1947) RP1829.

Scott, M. R., Way, K., Fano, L., Thew, K., Nuclear data (includes supplements 1, 2, and 3). (1950) C499.

Scott, R. B., Destruction of superconductivity by current. J **41,** 581 (1948) RP1940.

Thermal design of large storage vessels for liquid hydrogen and helium. J **58,** 317 (1957) RP2764.

Scott, R. B., Armstrong, G. T., Brickwedde, F. G., Vapor pressures of the methanes. J **55,** 39 (1955) RP2603.

Scott, R. B., Mikesell, R. P., Heat conduction through insulating supports in very low temperature equipment. J **57,** 371 (1956) RP2726.

Scott, R. B., Woolley, H. W., Brickwedde, F. G., Compilation of thermal properties of hydrogen in its various isotopic and ortho-para modifications. J **41,** 379 (1948) RP1932.

Scribner, B. F., Ballinger, J. C., Spectrochemical analysis of bronze by a porous electrode method J **47,** 221 (1951) RP2246.

Scribner, B. F., Meggers, W. F., Arc and spark spectra of technetium. J **45,** 476 (1950) RP2161.

Scribner, B. F., Meggers, W. F., Bozman, W. R., Absorption and emission spectra of promethium. J **46,** 85 (1951) RP2179.

Scribner, B. W., O'Leary, M. J., Missimer, J. K., Resin bonding of offset papers containing mineral fillers. J **47,** 357 (1951) RP2262.

Scribner, B. W., Shaw, M. B., O'Leary, M. J., Missimer, J. K., Resin bonding of hardwood fibers in offset papers. J **45,** 208 (1950) RP2126.

Scribner, B. W., Wilson, W. K., Development of standards for analytical filter papers. J **39,** 21 (1947) RP1809.

Sedlak, V. A., Madorsky, S. L., Hart, V. E., Straus, S., Thermal degradation of tetrafluoroethylene and hydrofluoroethylene polymers in a vacuum. J **51,** 327 (1953) RP2461.

Sedlak, V. A., Streiff, A. J., Murphy, E. T., Zimmerman, J. C., Soule, L. F., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of *n*-decane, 4 alkylcyclopentanes, 9 alkylcyclohexanes, 2 monoolefins, 1,2-butadiene, and 2-butyne of the API-Standard and API-NBS series. J **39,** 321 (1947) RP1833.

Sedlak, V. A., Streiff, A. J., Soule, L. F., Kennedy, C. M., Janes, M. E., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of twenty-nine hydrocarbons of the API-Standard and API-NBS series. J **45,** 173 (1950) RP2122.

Sedlak, V. A., Streiff, A. J., Zimmerman, J. C., Soule, L. F., Butt, M. T., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of 30 hydrocarbons of the API-Standard and API-NBS series. J **41,** 323 (1948) RP1929.

Sedlak, V. A., Willingham, C. B., Test mixtures for distillation at atmospheric and reduced pressure. J **45,** 315 (1950) RP2140.

Seegmiller, E., Brenner, A., Burkhead, J., Electrodeposition of tungsten alloys containing iron, nickel, and cobalt. J **39,** 351 (1947) RP1834.

Seeman, G. S., Swerdlow, M., A method for the electron microscopy of wool. J **41,** 231 (1948) RP1921.

Selby, M. C., High-frequency voltage measurement. (1949) C481.

Selby, M. C., Behrent, L. F., A bolometer bridge for standardizing radio-frequency voltmeters. J **44,** 15 (1950) RP2055.

Selby, M. C., Wolzien, E. C., Jickling, R. M., Coaxial radio-frequency connectors and their electrical quality. J **52,** 121 (1954) RP2480.

Selgin, M., Broida, H. P., Morowitz, H. J., Optical spectroscopic determination of hydrogen isotopes in aqueous mixtures. J **52,** 293 (1954) RP2503.

Selgin, P. J., Harmonic output of the synchronous rectifier. J **47,** 427 (1951) RP2267.

Proposed revision of the conventional method of wave-filter design. J **47,** 479 (1951) RP2276.

Seliger, H. H., A new method of radioactive standard calibration. J **45,** 496 (1950) RP2163.

Seliger, H. H., Cavallo, L., The absolute standardization of radioisotopes by 4 π counting. J **47,** 41 (1951) RP2226.

Seliger, H. H., Mann, W. B., Efficiency of 4π-crystal-scintillation counting: 2. Dead-time and coincidence corrections. J **57,** 257 (1956) RP2717.

Refinements in radioactive standardization by 4π beta counting. J **50,** 197 (1953) RP2409.

Seliger, H. H., Smith, C. C., Steyn, J., Efficiency of 4π-crystal-scintillation counting. 1. Experimental technique and results. J **57,** 251 (1956) RP2716.

Seliger, H. H., Ziegler, C. A., Thermal quenching in alpha- and gamma-excited fluorescent solutions. J **58,** 125 (1957) RP2743.

Selwood, P. W., Applications of magneto-chemistry to polymers and polymerization. J **41,** 151 (1948) RP1914.

Senderoff, S., Brenner, A., A spiral contractometer for measuring stress in electrodeposits. J **42,** 89 (1949) RP1953.

Calculation of stress in electrodeposits from the curvature of a plated strip. J **42,** 105 (1949) RP1954.

Sennett, F. E., Coughanour, L. W., Roth, R. S., Marzullo, S., Solid-state reactions and dielectric properties in the system magnesia-lime-tin oxide-titania. J **54,** 149 (1955) RP2576.

Solid-state reactions and dielectric properties in the systems magnesia-zirconia-titania and lime-zirconia-titania. J **54,** 191 (1955) RP2580.

Setchkin, N. P., A method and apparatus for determining the ignition characteristics of plastics. J **43,** 591 (1949) RP2052.

Self-ignition temperatures of combustible liquids. J **53,** 49 (1954) RP2516.

Shack, R. V., Characteristics of an image-forming system. J **56,** 245 (1956) RP2672.

Shafer, M. R., Bovey, H. L., Applications of dimensional analysis to spray-nozzle performance data. J **52,** 141 (1954) RP2482.

Laboratory flow tests of fixed spray nozzles with hydrocarbons and with air. J **43,** 449 (1949) RP2035.

Shafer, M. R., Fiock, E. F., Bovey, H. L., Van Lone, R. B., Correcting for density and viscosity of incompressible fluids in float-type flowmeters. J **47,** 227 (1951) RP2247.

Shah, J. R., Marton, L., Morgan, M. M., Schubert, D. C., Simpson, J. A., Electron-optical bench. J **47,** 461 (1951) RP2273.

Shapiro, G., Subminiaturization techniques for low-frequency receivers. (1954) C545.

Shartsis, L., Canga, R., Surface tension of molten zinc borates. J **43,** 221 (1949) RP2023.

Shartsis, L., Newman, E. S., Some energy relations in the systems PbO-B_2O_3 and PbO-SiO_2. J **40,** 471 (1948) RP1893.

Shartsis, L., Spinner, S., Surface tension on molten alkali silicates. J **46,** 385 (1951) RP2209.

Viscosity and density of molten optical glasses. J **46,** 176 (1951) RP2190.

Shartsis, L., Spinner, S., Smock, A. W., Surface tension of compositions in the systems PbO-B_2O_3 and PbO-SiO_2. J **40,** 61 (1948) RP1855.

Shaw, J. H., Benedict, W. S., Claassen, H. H., Absorption spectrum of water vapor between 4.5 and 13 microns. J **49,** 91 (1952) RP2347.

Shaw, M. B., Scribner, B. W., O'Leary, M. J., Missimer, J. K., Resin bonding of hardwood fibers in offset papers. J **45,** 208 (1950) RP2126.

Shaw, M. B., Weber, C. G., O'Leary, M. J., Missimer, J. K., Resin bonding and strength development in offset papers. J **40,** 427 (1948) RP1887.

Shelton, G. R., Bunting, E. N., Creamer, A. S., Properties of calcium-barium titanate dielectrics. J **43,** 237 (1949) RP2025.

Shelton, G. R., Bunting, E. N., Creamer, A. S., Jaffe, B., Properties of beryllium-barium titanate dielectrics. J **47,** 15 (1951) RP2222.

Shelton, G. R., Creamer, A. S., Bunting, E. N., Properties of barium-magnesium titanate dielectrics. J **41,** 17 (1948) RP1899.

Shenker, H., Corruccini, R. J., Modified 1913 reference tables for iron-constantan thermocouples. J **50,** 229 (1953) RP2415.

Shenker, H., Lauritzen, J. I., Jr., Corruccini, R. J., Reference tables for thermocouples. (1951) C508.

Shenker, H., Lauritzen, J. I., Jr., Corruccini, R. J., Lonberger, S. T., Reference tables for thermocouples. (1955) C561.

Shenstone, A. G., Meggers, W. F., Moore, C. E., First spectrum of arsenic. J **45,** 346 (1950) RP2144.

Shepherd, M., Apparatus for the determination of minor components of a gas mixture. J **52,** 1 (1954) RP2464.

Mass spectrometric analysis of a standard sample of carburetted water-gas by laboratories cooperating with the American Society for Testing Materials. J **44,** 509 (1950) RP2098.

Shepherd, M., Schuhmann, S., Determination of hydrogen by slow combustion over platinum in excess oxygen. J **53,** 77 (1954) RP2518.

Shepherd, M., Thomas, R., Schuhmann, S., Dibeler, V. H., Experimental study of the Koppers-Hinckley-Podbielniak apparatus and method for the determination of conjugated dienes. J **39,** 435 (1947) RP1840.

Sherfey, J. M., Apparatus for the preparation of anhydrous titanium (III) chloride and titanium (III) bromide. J **46,** 299 (1951) RP2199.

Sherman, M. A., Axilrod, B. M., Strength of heat-resistant laminated plastics up to 300° C. J. **45,** 65 (1950) RP2114.

Sherman, M. A., Axilrod, B. M., Cohen, V., Wolock, I., Effects of moderate biaxial stretch-forming on tensile and crazing properties of acrylic plastic glazing. J **49,** 331 (1952) RP2369.

Shermer, H. F., Surface tension of molten glasses in the system barium oxide-boric oxide-silica. J **56,** 155 (1956) RP2661.

Thermal expansion of binary alkali silicate glasses. J **57,** 97 (1956) RP2698.

Thermal expansion of binary alkaline-earth borate glasses. J **56,** 73 (1956) RP2650.

Shermer, H. F., Rynders, G. F., Cleek, G. W., Hubbard, D., Atypical pH response of some nonsilicate glasses. J **52,** 251 (1954) RP2497.

Sherrard, E. S., Perls, T. A., Frequency response of second-order systems with combined coulomb and viscous damping. J **57,** 45 (1956) RP2693.

Shortley, G., Kiess, C. C., Zeeman effect and g-values for neutral nitrogen and oxygen. J **42,** 183 (1949) RP1961.

Shoub, H., Lee, T. G., Cameron, J. M., Methods of testing small fire extinguishers. (1957) BMS150.

Siegel, R., Blanch, G., Table of modified Bernoulli polynomials. J **44,** 103 (1950) RP2060.

Siewers, I. J., Sager, E. E., Dissociation constants of 4-aminobenzophenone, calculated from ultraviolet spectra at several temperatures. J **45,** 489 (1950) RP2162.

Overlapping dissociation constants of 4,4′-diaminobenzophenone from spectral-absorbency measurements. J **49,** 7 (1952) RP2337.

Sigler, P. A., Geib, M. N., Boone, T. H., Measurement of the slipperiness of walkway surfaces. J **40,** 339 (1948) RP1879.

Silberstein, R., Hartsfield, W. L., Ostrow, S. M., Back-scatter observations by the Central Radio Propagation Laboratory—August 1947 to March 1948. J **44,** 199 (1950) RP2071.

Silsbee, F. B., Establishment and maintenance of the electrical units. (1949) C475.

Extension and dissemination of the electrical and magnetic units by the National Bureau of Standards. (1952) C531.

Suggested practices for electrical standardizing laboratories. (1956) C578.

Simha, R., Effect of concentration on the viscosity of dilute solutions. J **42,** 409 (1949) RP1981.

Note on volume effect in coiling molecules. J **40,** 21 (1948) RP1852.

Simha, R., Callomon, I. G., Gaughan, M. B., Jeppson, H. H., Bibliography of recent research in the field of high polymers. (1950) C498.

Simha, R., Wall, L. A., Copolymerization. J **41,** 521 (1948) RP1937.

Simha, R., Weissberg, S. G., Rothman, S., Viscosity of dilute and moderately concentrated polymer solutions. J **47,** 298 (1951) RP2257.

Simpson, D., Plyler, E. K., Infrared spectra of pentachlorofluoroethane, 1,2-dichlorotetrafluoroethane, and 1-bromo-2-fluoroethane. J **50,** 223 (1953) RP2414.

Simpson, J. A., Marton, L., Lachenbruch, S. H., Electron-optical shadow method of magnetic-field mapping. J **52,** 97 (1954) RP2478.

Simpson, J. A., Marton, L., Morgan, M. M., Schubert, D. C., Shah, J. R., Electron-optical bench. J **47,** 461 (1951) RP2273.

Simpson, P. A., Sogn, L. T., Loading of quartz oscillator plates. J **49,** 325 (1952) RP2368.

Skramstad, H. K., Wright, J. H., Taback, L., A high-speed computer for predicting radioactive fallout. J **58,** 101 (1957) RP2740.

Smith, C. C., Davenport, T. I., Mann, W. B., McCraven, C. C., Comparison of four national radium standards. Part 1. Experimental procedures and results. [Part 2. Statistical procedures and survey, by W. S. Connor and W. J. Youden.] J **53,** 267 (1954) RP2544.

Smith, C. C., Seliger, H. H., Steyn, J., Efficiency of 4π-crystal-scintillation counting: 1. Experimental technique and results. J **57,** 251 (1956) RP2716.

Smith, D. F., Crichlow, W. Q., Morton, R. N., Corliss, W. R., Worldwide radio noise levels expected in the frequency band 10 kilocycles to 100 megacycles. (1955) C557.

Smith, E. K., Jr., Worldwide occurrence of sporadic E. (1957) C582.

Smith, E. K., Jr., Weintraub, S., The constants in the equation for atmospheric refractive index at radio frequencies. J **50,** 39 (1953) RP2385.

Smith, E. R., Bates, R. G., Bower, V. E., Calcium hydroxide as a highly alkaline pH standard. J **56,** 305 (1956) RP2680.

Smith, E. R., Bates, R. G., Bower, V. E., Miller, R. G., pH of solutions of potassium hydrogen *d*-tartrate from 0° to 60° C. J **47,** 433 (1951) RP2268.

Smith, E. R., Bates, R. G., Pinching, G. D., pH standards of high acidity and high alkalinity and the practical scale of pH. J **45,** 418 (1950) RP2153.

Smith, E. R., Bower, V. E., Bates, R. G., pH of solutions of potassium tetroxalate from 0° to 60° C. J **51,** 189 (1953) RP2450.

Smith, E. R., Maryott, A. A., Table of dielectric constants of pure liquids. (1951) C514.

Smith, E. R., Torgesen, J. L., Bower, V. E., Boiling points of aqueous solutions of dextrose within the pressure range of 200 to 1,500 millimeters. J **45,** 458 (1950) RP2158.

Smith, F. A., Creitz, E. C., Infrared absorption spectra of the liquid butenes and 1,3-butadienes. J **43,** 365 (1949) RP2031.

Infrared studies of association in eleven alcohols. J **46,** 145 (1951) RP2187.

Smith, F. A., Isbell, H. S., Stewart, J. E., Frush, H. L., Moyer, J. D., Infrared spectra of D-talose monobenzoate and related substances. J **57,** 179 (1956) RP2708.

Smith, F. C., Levy, S., Stress distribution near reinforced circular hole, loaded by pin. J **42,** 397 (1949) RP1979.

Smith, J. C., McCrackin, F. L., Schiefer, H. F., Stress-strain relationships in yarns subjected to rapid impact loading: 3. Effect of wave propagation. J **55,** 19 (1955) RP2601.

Smith, J. C., McCrackin, F. L., Schiefer, H. F., Stone, W. K., Stress-strain relationships in yarns subjected to rapid impact loading: 2. Breaking velocities, strain energies, and theory neglecting wave propagation. J **54,** 277 (1955) RP2590.

Smith, J. C., McCrackin, F. L., Schiefer, H. F., Stone, W. K., Towne, K. M., Stress-strain relationships in yarns subjected to rapid impact loading: 4. Transverse impact tests. J **57,** 83 (1956) RP2695.

Smith, J. F., Brombacher, W. G., Van der Pyl, L. M., Guide to instrumentation literature. (1955) C567.

Smith, R. E., Taylor, J. K., Effect of maxima suppressors on polarographic diffusion currents. J **48,** 172 (1952) RP2302.

Smith, R. E., Taylor, J. K., Cooter, I. L., Polarographic limiting currents. J **42,** 387 (1949) RP1978.

Smith, R. W., Testing of measuring equipment (a manual for weights and measures officials). (1951) H45.

Smith, R. W., Schwarz, K. M., Federal and State Weights and Measures Laws. (1951) C501.

Statutory net-content marking requirements for packages (undefined) and packages of foods, drugs, and cosmetics. (1950) C503.

Smith, S. J., Branscomb, L. M., Atomic negative-ion-photodetachment cross-section and affinity measurements. J **55,** 165 (1955) RP2615.

Smith, S. W., Taylor, J. K., Polarographic determination of lead and cadmium in zinc-base alloys, using electrolytic separations at controlled potential. J **56,** 301 (1956) RP2679.

Some factors affecting the precision of polarographic half-wave potential measurements. J **56,** 143 (1956) RP2659.

Smith, W. H., Karabinos, J. V., Paulson, R. A., Thiophosphation of 2-methyl-2-nitro-1-propanol and the preparation of monothiophosphoric acid. J **48,** 322 (1952) RP2318.

Smith, W. H., Plyler, E. K., Acquista, N., Infrared spectra of bromochloromethane, dibromomethane, tribromochloromethane, and tetrabromomethane. J **44,** 503 (1950) RP2097.

Smith, W. H., Walton, W. W., McCulloch, F. W., Determination of small amounts of oxygen in organic compounds. J **40,** 443 (1948) RP1889.

Smock, A. W., Shartsis, L., Spinner, S., Surface tension of compositions in the systems PbO-B$_2$O$_3$ and PbO-SiO$_2$. J **40,** 61 (1948) RP1855.

Snow, C., A standard of small capacitance. J **42,** 287 (1949) RP1970.

Formulas for computing capacitance and inductance. (1954) C544.

Hypergeometric and Legendre functions, with applications to integral equations of potential theory. (1952) AMS19.

Magnetic fields of cylindrical coils and annular coils. (1953) AMS38.

Potential problems and capacitance for a conductor bounded by two intersecting spheres. J **43,** 377 (1949) RP2032.

Snyder, C. F., Isbell, H. S., Dryden, M. R., Holt, N. B., Optical rotations, refractive indices, and densities of dextran solutions. J **53,** 131 (1954) RP2525.

Snyder, C. F., Isbell, H. S., Holt, N. B., Dryden, M. R., Determination of molecular weights of dextrans by means of alkaline copper reagents. J **50,** 81 (1953) RP2393.

Snyder, W. A., Kennedy, R. J., Wyckoff, H. O., Concrete as a protective barrier for gamma rays from cobalt-60. J **44,** 157 (1950) RP2066.

Sogn, L. T., Barclay, C., Fundamental techniques in the frequency adjustment of quartz crystals. (1949) C480.

Reference data for orienting quartz plates by X-ray diffraction. (1953) C543.

Sogn, L. T., Howard, W. J., Mechanical production of very thin oscillator plates. J **43,** 459 (1949) RP2036.

Sogn, L. T., Simpson, P. A., Loading of quartz oscillator plates. J **49,** 325 (1952) RP2368.

Solow, M., Greene, F. M., Development of very-high-frequency field-intensity standards. J **44,** 527 (1950) RP2100.

Sorrows, H. E., Ellenwood, R. C., Cathode heater compensation as applied to degenerative voltage-stabilized direct-current power supplies. J **43,** 251 (1949) RP2027.

Souder, W., Hidnert, P., Thermal expansion of solids. (1950) C486.

Souder, W., Newman, S. B., Measurement of the thickness of capacitor paper. (1952) C352.

Souder, W., Schoonover, I. C., Research on dental materials at the National Bureau of Standards: A review and bibliography. (1950) C497.

Soule, L. F., Streiff, A. J., Kennedy, C. M., Janes, M. E., Sedlak., V. A., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of twenty-nine hydrocarbons of the API-Standard and API–NBS series. J **45,** 173 (1950) RP2122.

Soule, L. F., Streiff, A. J., Murphy, E. T., Zimmerman, J. C., Sedlak, V. A., Willingham, C. B., Rossini, F. D., Purification, purity and freezing points of *n*-decane, 4 alkylcyclopentanes, 9 alkylcyclohexanes, 2 monoolefins, 1,2-butadiene, and 2-butyne of the API-Standard and API-NBS series. J **39,** 321 (1947) RP1833.

Soule, L. F., Streiff, A. J., Zimmerman, J. C., Butt, M. T., Sedlak, V. A., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of 30 hydrocarbons of the API-Standard and API-NBS series. J **41,** 323 (1948) RP1929.

Sparks, C. M., Moon, C., Standards for low values of direct capacitance. J **41,** 497 (1948) RP1935.

Spencer, L. V., Fano, U., Penetration and diffusion of X-rays. Calculation of spatial distributions by polynomial expansion. J **46,** 446 (1951) RP2213.

Spindler, R. J., Rodney, W. S., Index of refraction of fuzed-quartz glass for ultraviolet, visible, and infrared wavelengths. J **53,** 185 (1954) RP2531.

Refractive index of cesium bromide for ultraviolet, visible, and infrared wavelengths. J **51,** 123 (1953) RP2440.

Refractivity of potassium bromide for visible wavelengths. J **49,** 253 (1952) RP2361.

Spinks, A. W., Zapf, T. L., Precise comparison method of testing alternating-current watthour meters. J **53,** 95 (1954) RP2521.

Spinner, S., Shartsis, L., Surface tension of molten alkali silicates. J **46,** 385 (1951) RP2209.

Viscosity and density of molten optical glasses. J **46,** 176 (1951) RP2190.

Spinner, S., Shartsis, L., Smock, A. W., Surface tension of compositions in the systems PbO-B$_2$O$_3$ and PbO-SiO$_2$. J **40,** 61 (1948) RP1855.

Spinner, S., Weir, C., Malitson, I., Rodney, W., Optical and volumetric relaxation effects in glass following removal of high hydrostatic pressures. J **58,** 189 (1957) RP2751.

Stair, R., Measurement of ozone over the Organ Mountains, New Mexico. J **40,** 9 (1948) RP1851.

Photoelectric spectroradiometry and its application to the measurement of fluorescent lamps. J **46,** 437 (1951) RP2212.

Seasonal variation of ozone at Washington, D.C. J **43,** 209 (1949) RP 2022.

Spectral-transmissive properties and use of eye-protective glasses. (1948) C471.

The ultraviolet spectral distribution of radiant energy from the sun. J **46,** 353 (1951) RP2206.

Ultraviolet absorption spectra of seven substituted benzenes. J **42,** 587 (1949) RP1996.

Ultraviolet radiant energy from the sun observed at 11,190 feet. J **49,** 227 (1952) RP2357.

Winter measurements of ozone over the Organ Mountains, New Mexico. J **42,** 145 (1949) RP1958.

Stair, R., Bagg, T. C., Johnston, R. G., Continuous measurement of atmospheric ozone by an automatic photoelectric method. J **52,** 133 (1954) RP2481.

Stair, R., Florence, J. M., Glaze, F. W., Hahner, C. H., Transmittance of near infrared energy by binary glasses. J **41,** 623 (1948) RP1945.

Stair, R., Johnston, R., Ultraviolet spectral radiant energy reflected from the moon. J **51,** 81 (1953) RP2434.

Stair, R., Johnston, R. G., Effects of recent knowledge of atomic constants and of humidity on the calibrations of the National Bureau of Standards thermal-radiation standards. J **53,** 211 (1954) RP2535.

Preliminary spectroradiometric measurements of the solar constant. J **57,** 205 (1956) RP2710.

Stair, R., Johnston, R. G., Bagg, T. C., Spectral distribution of energy from the sun. J **53,** 113 (1954) RP2523.

Stang, A. H., Greenspan, M., Perforated cover plates for steel columns: Summary of compressive properties. J **40,** 347 (1948) RP1880.

Stang, A. H., Jaffe, B. S., Bending tests of large welded-steel box girders at different temperatures. J **41,** 483 (1948) RP1934.

Perforated cover plates for steel columns; compressive properties of plates having ovaloid, elliptical, and "square" perforations. J **40,** 121 (1948) RP1861.

Stanley, R. W., Meggers, W. F., Wavelengths from iron-halide lamps. J **58,** 41 (1957) RP2733.

Stein, M. L., Gradient methods in the solution of systems of linear equations. J **48,** 407 (1952) RP2330.

On methods for obtaining solutions of fixed end-point problems in the calculus of variations. J **50,** 277 (1953) RP2418.

Stein, P., A note on bounds of multiple characteristic roots of a matrix. J **48,** 59 (1952) RP2284.

A note on the bounds of the real parts of the characteristic roots of a matrix. J **48,** 106 (1952) RP2292.

Some general theorems on iterants. J **48,** 82 (1952) RP2288.

Steiner, E. T., Hosterman, E. R., Aging of Karakul and seal fur skins. J **45,** 317 (1950) RP2141.

Steiner, T., Hobbs, R. B., Hosterman, E. R., Laboratory and service tests of hand luggage. (1949) M193.

Stephens, R. E., Computation of achromatic objectives. (1954) C549.

Reduction of sphero-chromatic aberration in catadioptric systems. J **40,** 467 (1948) RP1892.

Stephens, R. E., Malitson, I. H., Index of refraction of magnesium oxide. J **49,** 249 (1952) RP2360.

Stephens, R. E., Rodney, W. S., Refractive indices of five selected optical glasses. J **52,** 303 (1954) RP2504.

Stephens, R. E., Tilton, L. W., Plyler, E. K., Refractive indices of thallium bromide-iodide crystals for visible and infrared radiant energy. J **43,** 81 (1949) RP2008.

Stern, H., Krynitsky, A. I., Effect of boron on the structure and some physical properties of plain cast irons. J **42,** 465 (1949) RP1987.

Stewart, J. E., Absorption of radiant energy by solid particles in suspension. J **54,** 41 (1955) RP2563.

Infrared absorption spectrum of trimethylborane. J **56,** 337 (1956) RP2684.

Infrared spectra of chromatographically fractionated asphalts. J **58,** 265 (1957) RP2759.

Stewart, J. E., Harvey, M. R., Achhammer, B. G., Index of refraction and particle size as factors in the infrared spectrophotometry of polyvinyl chloride. J **56,** 225 (1956) RP2670.

Stewart, J. E., Isbell, H. S., Frush, H. L., Moyer, J. D., Smith, F. A., Infrared spectra of D-talose monobenzoate and related substances. J **57,** 179 (1956) RP2708.

Stewart, J. E., Johannesen, R. B., Gordon, C. L., Gilchrist, R., Application of infrared spectroscopy to the determination of impurities in titanium tetrachloride. J **53,** 197 (1954) RP2533.

Steyn, J., Smith, C. C., Seliger, H. H., Efficiency of 4π-crystal-scintillation counting: 1. Experimental technique and results. J **57,** 251 (1956) RP2716.

Stiefel, E., On Cauchy-Riemann equations in higher dimensions. J **48,** 395 (1952) RP2328.

Two applications of group characters to the solution of boundary-value problems. J **48,** 424 (1952) RP2332.

Stiefel, E., Hestenes, M. R., Methods of conjugate gradients for solving linear systems. J **49,** 409 (1952) RP2379.

Stiehler, R. D., Mendel, J., Sensitivity—a criterion for the comparison of methods of test. J **53,** 155 (1954) RP2527.

Stiehler, R. D., Martin, G. M., Mandel, J., Aerological sounding balloons. J **53,** 383 (1954) RP2557.

Stiehler, R. D., Roth, F. L., Strain test for evaluation of rubber compounds. J **41,** 87 (1948) RP1906.

Stimson, H. F., The international temperature scale of 1948. J **42,** 209 (1949) RP1962.

Stockmann, L. L., Loftus, T. P., Mann, W. B., Paolella, L. F., Youden, W. J., Comparison of national radium standards. J **58,** 169 (1957) RP2749.

Stone, W. K., Forziati, F. H., Rowen, J. W., Appel, W. D., Cotton powder for infrared transmission measurements. J **45,** 109 (1950) RP2116.

Stone, W. K., McCrackin, F. L., Schiefer, H. F. Smith, J. C., Stress-strain relationships in yarns subjected to rapid impact loading: 2. Breaking velocities, strain energies, and theory neglecting wave propagation. J **54,** 277 (1955) RP2590.

Stone, W. K., Schiefer, H. F., Fox, G., Stress-strain relationships in yarns subjected to rapid impact loading: 1. Equipment, testing procedure, and typical results. J **54,** 269 (1955) RP2589.

Stone, W. K., Smith, J. C., McCrackin, F. L., Schiefer, H. F., Towne, K. M., Stress-strain relationships in yarns subjected to rapid impact loading: 4. Transverse impact tests. J **57,** 83 (1956) RP2695

Strang, A. G., Haven, C. E., Assembled polygon for the calibration of angle blocks. J **50,** 45 (1953) RP2387.

Straus, S., Madorsky, S. L., Concentration of copper 63 by the countercurrent electromigration method. J **41,** 41 (1948) RP1901.

Pyrolysis of styrene, acrylate, and isoprene polymers in a vacuum. J **50,** 165 (1953) RP2405.

Pyrolytic fractionation of polystyrene in a high vacuum and mass spectrometer analysis of some of the fractions. J **40,** 417 (1948) RP1886.

Thermal degradation of polychlorotrifluoroethylene, poly-α,β,β-trifluorostyrene, and poly-p-xylylene in a vacuum. J **55,** 223 (1955) RP2624.

Thermal degradation of polymers as a function of a molecular structure. J **53,** 361 (1954) RP2553.

Straus, S., Madorsky, S. L., Bradt, P., Concentration of isotopes of mercury in countercurrent molecular stills. J **41,** 205 (1948) RP1918.

Straus, S., Madorsky, S. L., Hart, V. E., Pyrolysis of cellulose in a vacuum. J **56,** 343 (1956) RP2685.

Straus, S., Madorsky, S. L., Hart, V. E., Sedlak, V. A., Thermal degradation of tetrafluoroethylene and hydrofluoroethylene polymers in a vacuum. J **51,** 327 (1953) RP2461.

Straus, S., Madorsky, S. L., Thompson, D., Williamson, L., Pyrolysis of polyisobutene (vistanex), polyisoprene, polybutadiene, GR-S, and polyethylene in a high vacuum. J **42,** 499 (1949) RP1989.

Strauss, S. W., Electrical resistivity of vitreous ternary lithium-sodium silicates. J **56,** 183 (1956) RP2665.

Strauss, S. W., Moore, D. G., Harrison, W. N., Richards, L. E., Fundamental factors controlling electrical resistivity in vitreous ternary lead silicates. J **56,** 135 (1956) RP2658.

Streets, R. E., Cold-starting abilities of various substitute motor fuels. J **39,** 39 (1947) RP1811.

Streets, R. E., Brooks, D. B., Automotive antifreezes. (1948) C474.

Streets, R. E., Howard, F. L., Brooks, D. B., Automotive antifreeze. (1956) C576.

Streiff, A. J., Murphy, E. T., Zimmerman, J. C., Soule, L. F., Sedlak, V. A., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of n-decane, 4 alkylcyclopentanes, 9 alkylcyclohexanes, 2 monoolefins, 1,2-butadiene, and 2-butyne of the API-Standard and API-NBS series. J **39,** 321 (1947) RP1833.

Streiff, A. J., Rossini, F. D., Alkylbenzens in the C_8 fraction from five different catalytic petroleum refining processes. J **39,** 303 (1947) RP1830.

Streiff, A. J., Soule, L. F., Kennedy, C. M., Janes, M. E., Sedlak, V. A., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of twenty-nine hydrocarbons of the API-Standard and API-NBS series. J **45,** 173 (1950) RP2122.

Streiff, A. J., Zimmerman, J. C. Soule, L. F., Butt, M. T., Sedlak, V. A., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of 30 hydrocarbons of the API-Standard and API-NBS series. J **41,** 323 (1948) RP1929.

Stromberg, R. R., Pore-size distribution in collagen and leather by the porosimeter method. J **54,** 73 (1955) RP2567.

Stromberg, R. R., Swerdlow, M., Collagen pores determined by electron microscopy. J **54,** 83 (1955) RP2568.

Stromberg, R. R., Swerdlow, M., Mandel, J., Electron microscopy of synthetic elastomer latices. J **50,** 299 (1953) RP2419.

Sullivan, B. M., McMurdie, H. F., Crystal forms of chromium orthophosphate. J **48,** 159 (1952) RP2300.

Sullivan, B. M., McMurdie, H. F., Mauer, F. A., High-temperature X-ray study of the system Fe_3O_4-Mn_3O_4. J **45,** 35 (1950) RP2111.

Sulzer, P. G., Wales, M., Williams, L. C., Pulsed light system for multiple-cell ultracentrifuge rotor. J **50,** 69 (1953) RP2390.

Swanson, H. E., Fuyat, R. K., Standard X-ray diffraction powder patterns. (1953) C539, Vol. II.

Swanson, H. E., Fuyat, R. K., Ugrinic, G. M., Standard X-ray diffraction powder patterns. (1954) C539, Vol. III.
Standard X-ray diffraction powder patterns. (1955) C539, Vol. IV.
Swanson, H. E., Gilfrich, N. T., Cook, M. I., Standard X-ray diffraction powder patterns. (1956) C539, Vol. 6.
Swanson, H. E., Gilfrich, N. T., Ugrinic, G. M., Standard X-ray diffraction powder patterns. (1955) C539, Vol. V.
Swanson, H. E., Tatge, E., Standard X-ray diffraction patterns. J **46,** 318 (1951) RP2202.
Standard X-ray diffraction powder patterns. (1953) C539, Vol. I.
Sweeney, W. T., Copeland, H. I., Jr., Brauer, G. M., Forziati, A. F., Setting reaction of zinc oxide and eugenol. J **55,** 133 (1955) RP2611.
Sweeney, W. T., Schoonover, I. C., Brauer, G. M., Effect of water on the induction period of the polymerization of methyl methacrylate. J **49,** 359 (1952) RP2372.
Swerdlow, M., Hattiangdi, G. S., Characterization of alkali soaps by electron microscopy. J **42,** 343 (1949) RP1973.
Swerdlow, M., Marton, C., Sass, S., VanBronkhorst, A., Meryman, H., Bibliography of electron microscopy. (1950) C502.
Swerdlow, M., Newman, S. B., Borysko, E., Ultramicrotomy by a new method. J **43,** 183 (1949) RP2020.
Swerdlow, M., Seeman, G. S., A method for the electron microscopy of wool. J **41,** 231 (1948) RP1921.
Swerdlow, M., Stromberg, R. R., Collagen pores determined by electron microscopy. J **54,** 83 (1955) RP2568.
Swerdlow, M., Stromberg, R. R., Mandel, J., Electron microscopy of synthetic elastomer latices. J **50,** 299 (1953) RP2419.
Swiggard, E. M., Clabaugh, W. S., Gilchrist, R., Preparation of barium titanyl oxalate tetrahydrate for conversion to barium titanate of high purity. J **56,** 289 (1956) RP2677.
Swindells, J. F., Coe, J. R., Jr., Godfrey, T. B., Absolute viscosity of water at 20° C. J **48,** 1 (1952) RP2279.
Swindells, J. F., Hardy, R. C., Cottington, R. L., Precise measurements with Bingham viscometers and Cannon master viscometers. J **52,** 105 (1954) RP2479.
Swindells, J. F., McKee, S. A., White, H. S., Mountjoy, W., Laboratory wear tests with automotive gear lubricants. J **42,** 125 (1949) RP1955.
Szasz, O., Generalization of S. Bernstein's polynomials to the infinite interval. J **45,** 239 (1950) RP2131.
Szasz, O., Lukacs, E., Nonnegative trigonometric polynomials and certain rational characteristic functions. J **52,** 153 (1954) RP2484.
Some nonnegative trigonometric polynomials connected with a problem in probability. J **48,** 139 (1952) RP2297.
Szasz, O., Todd, J., Convergence of Cauchy-Riemann sums to Cauchy-Riemann integrals. J **47,** 191 (1951) RP2243.

T

Taback, L., Wright, J. H., Skramstad, H. K., A high-speed computer for predicting radioactive fallout. J **58,** 101 (1957) RP2740.
Tatge, E., Swanson, H. E., Standard X-ray diffraction patterns. J **46,** 318 (1951) RP2202.
Standard X-ray diffraction powder patterns. (1953) C539, Vol. I.
Taussky, O., Bounds for characteristic roots of matrices II. J **46,** 124 (1951) RP2184.
Contributions to the solution of systems of linear equations and the determination of eigenvalues. (1954) AMS39.
Taussky, O., Hoffman, A. J., A characterization of normal matrices. J **52,** 17 (1954) RP2467.
Taussky, O., Paige, L. J., Simultaneous linear equations and the determination of eigenvalues. (1954) AMS29.
Taylor, E. W., Absorption of radio waves reflected at vertical incidence as a function of the sun's zenith angle. J **41,** 575 (1948) RP1939.
Taylor, J. K., Smith, R. E., Effect of maxima suppressors on polarographic diffusion currents. J **48,** 172 (1952) RP2302.
Taylor, J. K., Smith, R. E., Cooter, I. L., Polarographic limiting currents. J **42,** 387 (1949) RP1978.
Taylor, J. K., Smith, S. W., Polarographic determination of lead and cadmium in zinc-base alloys, using electrolytic separations at controlled potential. J **56,** 301 (1956) RP2679.
Some factors affecting the precision of polarographic half-wave potential measurements. J **56,** 143 (1956) RP2659.
Taylor, L. S., Day, F. H., Absorption of X-rays in air. J **40,** 393 (1948) RP1883.
Taylor, L. S., Wyckoff, H. O., X-ray protection design. (1952) H50.
Taylor, W. C., Bogue, R. H., A sulfate susceptibility test for portland cements. J **45,** 223 (1950) RP2128.
Tchen, C. M., On the spectrum of energy in turbulent shear flow. J **50,** 51 (1953) RP2388.
Stochastic processes and dispersion of configurations of linked events. J **46,** 480 (1951) RP2217.
Temperley, H. N. V., Residual entropy of linear polymers. J **56,** 55 (1956) RP2648.
Thew, K., Way, K., Fano, L., Scott, M. R., Nuclear data (includes supplements 1, 2, and 3). (1950) C499.
Thomas, C., Herschman, H. K., Fatigue characteristics of electroformed sheets with and without iron backing. J **43,** 477 (1949) RP2039.
Thomas, H. A., Driscoll, R. L., Hipple, J. A., Measurement of the proton moment in absolute units. J **44,** 569 (1950) RP2104.
Thomas, J. L., Precision resistors and their measurement. (1948) C470.
Thomas, J. L., Peterson, C., Cooter, I. L., Kotter, F. R., An absolute measurement of resistance by the Wenner method. J **43,** 291 (1949) RP2029.
Thomas, R., Shepherd, M., Shuhmann, S., Dibeler, V. H., Experimental study of the Koppers-Hinckley-Podbielniak apparatus and method for the determination of conjugated dienes. J **39,** 435 (1947) RP1840.
Thompson, D., Madorsky, S. L., Straus, S., Williamson, L., Pyrolysis of polyisobutene (vistanex), polyisoprene, polybutadiene, GR-S, and polyethylene in a high vacuum. J **42,** 499 (1949) RP1989.
Thompson, G. N., Preparation and revision of building codes. (1949) BMS116.
Thompson, G. N., Dunham, J. W., Brekke, G. N., Live loads on floors in buildings. (1952) BMS133.
Thompson, J. P., Ingberg, S. H., Dunham, J. W., Combustible contents in buildings. (1957) BMS149.
Tidwell, E. D., Allen, H. C., Jr., Plyler, E. K., Infrared spectrum of acetylene. J **57,** 213 (1956) RP2711.
Tidwell, E. D., Plyler, E. K., Allen, H. C., Jr., Infrared spectra of polychlorobenzenes. J **58,** 255 (1957) RP2758.
Tidwell, E. D., Plyler, E. K., Blaine, L. R., Infrared absorption and emission spectra of carbon monoxide in the region from 4 to 6 microns. J **55,** 183 (1955) RP2617.
Precise measurement of wavelengths in infrared spectra. J **55,** 279 (1955) RP2630.
Tierney, E. M., Achenbach, P. R., A study of a baseboard convector heating system in a test bungalow. (1949) BMS115.
Tighe, N. J., Fused-quartz fibers. A survey of properties, applications, and production methods. (1956) C569.
Tikson, M., Tabulation of an integral arising in the theory of cooperative phenomena. J **50,** 177 (1953) RP2406.
Tilton, L. W., Optical glass of interferometer and schlieren quality for wind-tunnel optics. J **42,** 279 (1949) RP1969.
Tilton, L. W., Plyler, E. K., Refractivity of lithium fluoride with application to the calibration of infrared spectrometers. J **47,** 25 (1951) RP2223.
Tilton, L. W., Plyler, E. K., Stephens, R. E., Refractive indices of thallium bromide-iodide cyrstals for visible and infrared radiant energy. J **43,** 81 (1949) RP2008.
Tilton, L. W., Rosberry, F. W., Badger, F. T., Refractive uniformity of a borosilicate glass after different annealing treatments. J **49,** 21 (1952) RP2340.
Tilton, L. W., Wood, L. A., Refractive index of natural rubber for different wavelengths. J **43,** 57 (1949) RP2004.

Todd, J., Evaluation of the exponential integral for large complex arguments. J **52,** 313 (1954) RP2508.
Experiments in the computation of conformal maps. (1955) AMS42.
Table of arctangents of rational numbers. (1951) AMS11.

Todd, J., Szasz, O., Convergence of Cauchy-Riemann sums to Cauchy-Riemann integrals. J **47,** 191 (1951) RP2243.

Tomkins, F. S., Meggers, W. F., Fred, M., Emission spectra of actinium. J **58,** 297 (1957) RP2763.

Tool, A. Q., Saunders, J. B., Expansion effects of annealing borosilicate thermometer glasses. J **42,** 171 (1949) RP1960.
Expansion effects shown by some Pyrex glasses. J **40,** 67 (1948) RP1856.

Torgesen, J. L., Bower, V. E., Smith, E. R., Boiling points of aqueous solutions of dextrose within the pressure range of 200 to 1,500 millimeters. J **45,** 458 (1950) RP2158.

Touloukian, Y. S., Hilsenrath, J., Beckett, C. W., Benedict, W. S., Fano, L., Hoge, H. J., Masi, J. F., Nuttall, R. L., Woolley, H. W., Tables of thermal properties of gases. (1955) C564.

Towne, K. M., Smith, J. C., McCrackin, F. L., Schiefer, H. F., Stone, W. K., Stress-strain relationships in yarns subjected to rapid impact loading: 4. Transverse impact tests. J **57,** 83 (1956) RP2695.

Townes, C. H., Kisliuk, P., Molecular microwave spectra tables. J **44,** 611 (1950) RP2107 and (1952) C518.

Trees, R. E., Bacher and Goudsmit theory of complex spectra. J **53,** 35 (1954) RP2515.

Trees, R. E., Bozman, W. R., Matrices of spin-orbit interaction of the electron configuration d^4s. J **58,** 95 (1957) RP2739.

Trees, R. E., Bozman, W. R., Corliss, C. H., Meggers, W. F., An intersystem transition in the first spectrum of beryllium. J **50,** 131 (1953) RP2399.

Trees, R. E., Cahill, W. F., Rabinowitz, P., Computation of atomic energy levels: Spectrum of singly ionized tantalum (Ta II). J **55,** 335 (1955) RP2639.

Trees, R. E., Harvey, M. M., Low even configurations of the first spectrum of molybdenum (Mo I). J **49,** 397 (1952) RP2378.

Trimble, T. F., Ku, P. M., Scavenging characteristics of a two-stroke-cycle engine as determined by skip-cycle operation. J **57,** 325 (1956) RP2721.

Tryon, M., An improved apparatus for determining moisture in rubber by distillation with toluene. J **45,** 362 (1950) RP2146.

Tryon, M., Horowitz, E., Mandel, J., Determination of natural rubber in GR–S—natural rubber vulcanizates by infrared spectroscopy. J **55,** 219 (1955) RP2623.

Tryon, M., Reiney, M. J., Achhammer, B. G., Study of degradation of polystyrene, using ultraviolet spectrophotometry. J **51,** 155 (1953) RP2445.

Turcotte, A. L., McDonald, E. J., Density and refractive indices of lactose solution. J **41,** 63 (1948) RP1904.

U

Ugrinic, G. M., Levin, E. M., The system barium oxide-boric oxide-silica. J **51,** 37 (1953) RP2430.

Ugrinic, G. M., Swanson, H. E., Fuyat, R. K., Standard X-ray diffraction powder patterns. (1954) C539, Vol. III.
Standard X-ray diffraction powder patterns. (1955) C539, Vol. IV.

Ugrinic, G. M., Swanson, H. E., Gilfrich, N. T., Standard X-ray diffraction powder patterns. (1955) C539, Vol. V.

V

Vacher, H. C., A correlation of polarized light extinctions with crystal orientation in 70 nickel-30 copper alloy. J **49,** 149 (1952) RP2351.

Vacher, H. C., Bechtoldt, C. J., Delta ferrite-austenite reactions and the formation of carbide, sigma, and chi phases in 18 chromium-8 nickel-3.5 molybdenum steels. J **53,** 67 (1954) RP2517.
Phase-diagram study of alloys in the iron-chromium-molybdenum-nickel system. J **58,** 7 (1957) RP2728.

Vacher, H. C., Bennett, J. A., Calibration of X-ray measurement of strain. J **40,** 285 (1948) RP1874.

Vacher, H. C., Burnett, H. C., Jr., A note on the formation and structure of iron dendrites in a magnesium alloy. J **44,** 443 (1950) RP2090.

Vacher, H. C., Mitchell, J. A., Schoonover, I. C., Dickson, G., Some factors affecting the dimensional stability of the silver-tin-(copper-zinc) amalgams. J **52,** 185 (1954) RP2487.

Vacher, H. C., Newton, C. J., Correlation of polarized light phenomena with the orientation of some metal crystals. J **53,** 1 (1954) RP2510.

Valis, H. J., Blaine, R., Studies of the Mattson shot classifier. J **41,** 371 (1948) RP1931.
Surface available to nitrogen in hydrated portland cements. J **42,** 257 (1949) RP1967.

Valore, R. C., Volume changes observed in small concrete cylinders during freezing and thawing with a mercury displacement dilatometer. J **43,** 1 (1949) RP2000.

VanBronkhorst, A., Marton, C., Sass, S., Swerdlow, M., Meryman, H., Bibliography of electron microscopy. (1950) C502.

Van der Pyl, L. M., Brombacher, W. G., Smith, J. F., Guide to instrumentation literature. (1955) C567.

VanDusen, M. S., Dahl, A. I., Freezing points of cobalt and nickel. J **39,** 291 (1947) RP1828.
Resistance-temperature relation and thermoelectric properties of uranium. J **39,** 53 (1947) RP1813.

Van Lone, R. B., Shafer, M. R., Fiock, E. F., Bovey, H. L., Correcting for density and viscosity of incompressible fluids in float-type flowmeters. J **47,** 227 (1951) RP2247.

Van Valkenburg, A., Pike, R. G., Synthesis of mica. J **48,** 360 (1952) RP2323.

Van Valkenburg, A., Jr., Synthesis of a fluoro talc and attempted synthesis of fluoro chrysotile and fluoro anthophyllite. J **55,** 215 (1955) RP2622.

Vier, D. T., Ginnings, D. C., Ball, A. F., Calorimetric determination of the half-life of polonium. J **50,** 75 (1953) RP2392.

Vickers, R. A., III, Kanagy, J. R., Factors affecting the water-vapor permeability of leather. J **44,** 347 (1950) RP2082.

Vinal, G. W., Morehouse, C. K., Hamer, W. J., Effect of inhibitors on the corrosion of zinc in dry-cell electrolytes. J **40,** 151 (1948) RP1863.

W

Wacker, P. F., Cheney, R. K., Specific heat, enthalpy, and entropy of uranyl fluoride. J **39,** 317 (1947) RP1832.

Wagman, D. D., Evans, W. H., Thermodynamics of some simple sulfur-containing molecules. J **49,** 141 (1952) RP2350.

Wagman, D. D., Evans, W. H., Jacobson, R., Munson, T. R., Thermodynamic properties of the alkali metals. J **55,** 83 (1955) RP2608.

Wagman, D. D., Evans, W. H., Munson, T. R., Thermodynamic properties of some gaseous halogen compounds. J **55,** 147 (1955) RP2614

Wagman, D. D., Rossini, F. D., Evans, W. H., Levine, S., Jaffe, I., Selected values of chemical thermodynamic properties. (1952) C500.

Wait, J. R., Amplitude and phase of the low-frequency ground wave near a coastline. J **58,** 237 (1957) RP2756.
Mixed path ground wave propagation: 1. Short distances. J **57,** 1 (1956) RP2687.
Radiation from a vertical antenna over a curved stratified ground. J **56,** 237 (1956) RP2671.

Wait, J. R., Howe, H. H., Amplitude and phase curves for ground-wave propagation in the band 200 cycles per second to 500 kilocycles. (1956) C574.

Wait, J. R., Mientka, W., Slotted-cylinder antenna with a dielectric coating. J **58,** 287 (1957) RP2762.

Wait, J. R., Murphy, A., Influence of a ridge on the low-frequency ground wave. J **58,** 1 (1957) RP2727.

Wales, M., Sulzer, P. G., Williams, L. C., Pulsed light system for multiple-cell ultracentrifuge rotor. J **50,** 69 (1953) RP2390.

Wall, L. A., Mass spectrometric investigation of the thermal decomposition of polymers. J **41,** 315 (1948) RP1928.

Wall, L. A., Brown, D. W., Chemical activity of gamma-irradiated polymethyl methacrylate. J **57,** 131 (1956) RP2702.

Wall, L. A., Florin, R. E., Brown, D. W., Hymo, L. A., Michaelsen, J. D., Factors affecting the thermal stability of polytetrafluoroethylene. J **53,** 121 (1954) RP2524.

Wall, L. A., Michaelsen, J. D., Further studies on the pyrolysis of polytetrafluoroethylene in the presence of various gases. J **58,** 327 (1957) RP2765.

Thermal decomposition of polytetrafluoroethylene in various gaseous atmospheres. J **56,** 27 (1956) RP2644.

Wall, L. A., Simha, R., Copolymerization. J **41,** 521 (1948) RP1937.

Wallace, E. L., Leather research and technology at the National Bureau of Standards: A review and bibliography. (1955) C560.

Walsh, J. L., Young, D., On the accuracy of the numerical solution of the Dirichlet problem by finite differences. J **51,** 343 (1953) RP2463.

Walters, L. C., Johler, J. R., Kellar, W. J., Phase of the low radiofrequency ground wave. (1956) C573.

Walton, W. W., Hattiangdi, G. S., Hoffman, J. I., Some physical chemical properties of aqueous solutions of soaps and soapless detergents. J **42,** 361 (1949) RP1974.

Walton, W. W., Isbell, H. S., Barium 2-keto-lactobionate and the corresponding barium bromide double salts. J **41,** 119 (1948) RP1910.

The preparation of calcium melibionate. J **42,** 383 (1949) RP1977.

Walton, W. W., McCulloch, F. W., Smith, W. H., Determination of small amounts of oxygen in organic compounds. J **40,** 443 (1948) RP1889.

Washer, F. E., A simplified method of measuring the marginal powers of spectacle lenses. J **55,** 79 (1955) RP2607.

An instrument for measuring longitudinal spherical aberration of lenses. J **43,** 137 (1949) RP2015.

Axial performance of spectacle lenses. J **57,** 355 (1956) RP2724.

Effect of camera tipping on the location of the principal point. J **57,** 31 (1956) RP2691.

Effect of magnification on the precision of indoor telescope pointing. J **39,** 163 (1947) RP1820.

Sources of error in and calibration of the *f*-number of photographic lenses. J **41,** 301 (1948) RP1927.

Washer, F. E., Case, F. A., Calibration of precision airplane mapping cameras. J **45,** 1 (1950) RP2108.

Washer, F. E., Gardner, I. C., Lenses of extremely wide angle for airplane mapping. J **40,** 93 (1948) RP1858.

Method for determining the resolving power of photographic lenses. (1953) C533.

Washer, F. E., Scott, L. W., Influence of the atmosphere upon the precision of telescope pointing. J **39,** 297 (1947) RP1829.

Wasow, W., On small disturbances of plane Couette flow. J **51,** 195 (1953) RP2451.

On the mean duration of random walks. J **46,** 462 (1951) RP2215.

On the truncation error in the solution of Laplace's equation by finite differences. J **48,** 345 (1952) RP2321.

Random walks and the eigenvalues of elliptic difference equations. J **46,** 65 (1951) RP2176.

Waterhouse, R. V., Sound insulation of wall, floor, and door constructions. (1956) BMS144 Supplement.

Watts, J. M., Cones, H. N., Cottony, H. V., A 600-ohm multiple-wire delta antenna for ionosphere studies. J **44,** 475 (1950) RP2094.

Way, K., Fano, L., Scott, M. R., Thew, K., Nuclear data (includes supplements 1, 2, and 3). (1950) C499.

Weaver, E. R., Control of odors. (1950) C491.

Formulas and graphs for representing the interchangeability of fuel gases. J **46,** 213 (1951) RP2193.

Weaver, E. R., Diniak, A. W., A new computer for calculating the water content of gases. J **56,** 269 (1956) RP2674.

Weaver, E. R., Jessup, R. S., Gas calorimeter tables. (1948) C464.

Weaver, E. R., Riley, R., Measurement of water in gases by electrical conduction in a film of hygroscopic materials and the use of pressure changes in calibration. J **40,** 169 (1948) RP1865.

Weber, C. G., Shaw, M. B., O'Leary, M. J., Missimer, J. K., Resin bonding and strength development in offset papers. J **40,** 427 (1948) RP1887.

Wechsler, M. T., Jessup, R. S., Brickwedde, F. G., Heat of fluorination of cobaltous fluoride, and the heats of reaction of cobaltic fluoride with hydrogen and with bis(trifluoromethyl)benzene (*a,a,a,a',a',a'*-hexafluoroxylene). J **44,** 457 (1950) RP2092.

Weinberg, J. G., Bennett, J. A., Fatigue notch sensitivity of some aluminum alloys. J **52,** 235 (1954) RP2495.

Weinstein, W., Astigmatism of skew pencils in optical systems containing toric surfaces. J **54,** 251 (1955) RP2586.

Weintraub, S., Smith, E. K., Jr., The constants in the equation for atmospheric refractive index at radio frequencies. J **50,** 39 (1953) RP2385.

Weir, C., Spinner, S., Malitson, I., Rodney, W., Optical and volumetric relaxation effects in glass following removal of high hydrostatic pressures. J **58,** 189 (1957) RP2751.

Weir, C. E., Compressibilities of crystalline and glassy modifications of selenium and glucose. J **52,** 247 (1954) RP2496.

Compressibility of natural and synthetic high polymers at high pressures. J **46,** 207 (1951) RP2192.

Effect of moisture on compressibility of natural high polymers. J **49,** 135 (1952) RP2349.

Effect of temperature on the volume of leather and collagen in water. J **41,** 279 (1948) RP1924.

High-pressure apparatus for compressibility studies and its application to measurements on leather and collagen. J **45,** 468 (1950) RP2160.

Influence of temperature and moisture on the electrical properties of leather. J **48,** 349 (1952) RP2322.

Isothermal compressibilities of alkaline earth oxides at 21° C. J **56,** 187 (1956) RP2666.

Rate of shrinkage of tendon collagen: Heat, entropy, and free energy of activation of the shrinkage of untreated tendon; effect of acid, salt, pickle, and tannage on the activation of tendon collagen. J **42,** 17 (1949) RP1947.

Second-order transitions of rubbers at high pressures. J **50,** 311 (1953) RP2420.

Temperature dependence of compression of linear high polymers at high pressures. J **53,** 245 (1954) RP2540.

Temperature dependence of compression of natural rubber-sulfur vulcanizates of high sulfur content. J **50,** 153 (1953) RP2403.

The system lime-water at 21° C and high pressures. J **54,** 37 (1955) RP2562.

Thermodynamics of the rubber-sulfur system at high pressures. J **50,** 321 (1953) RP2421.

Transitions and phases of polytetrafluoroethylene (Teflon). J **50,** 95 (1953) RP2395.

Weir, C. E., Carter, J., Rate of shrinkage of tendon collagen: Further effects of tannage and liquid environment on the activation constants of shrinkage. J **44,** 599 (1950) RP2106.

Weir, C. E., Hoffman, J. D., Compressibilities of long-chain normal hydrocarbons. J **55,** 307 (1955) RP2634.

Weir, C. E., Hunt, C. M., Blaine, R. L., Behavior of cements and related materials under hydrostatic pressures up to 10,000 atmospheres. J **56,** 39 (1956) RP2646.

Weir, C. E., Leser, W. H., Wood, L. A., Crystallization and second-order transitions in silicone rubbers. J **44,** 367 (1950) RP2084.

Weissberg, S. G., Hanks, G. A., A convenient small osmometer. J **49,** 393 (1952) RP2377.

Weissberg, S. G., Simha, R., Rothman, S., Viscosity of dilute and moderately concentrated polymer solutions. J **47,** 298 (1951) RP2257.

Wells, E. J., Bloom, E. G., Mohler, F. L., Wise, C. E., Metastable transitions in mass spectra of hydrocarbons. J **43,** 65 (1949) RP2005.

Wells, E. J., Jr., Dibeler, V. H., Mohler, F. L., Reese, R. M., Mass spectra of some simple isotopic molecules. J **45,** 288 (1950) RP2135.

Wells, E. J., Jr., Mohler, F. L., Bloom, E. G., Lengel, J. H., Wise, C. E., Doubly changed ion spectra in mass spectra of hydrocarbons. J **42,** 369 (1949) RP1975.

Wells, E. J., Mohler, F. L., Bloom, E. G., Williamson, L., Wise, C. E., Mass spectra of C_5H_8 isomers. J **43,** 533 (1949) RP2045.

Wells, E. J., Mohler, F. L., Williamson, L., Wise, C. E., Dean, H. M., Bloom, E. G., Mass spectra of nonanes. J **44,** 291 (1950) RP2078.

Wells, L. S., Carlson, E. T., Barium aluminate hydrates. J **41,** 103 (1948) RP1908.

Hydration of aluminous cements and its relation to the phase equilibria in the system lime-alumina-water. J **57,** 335 (1956) RP2723.

Hydrothermal preparation of some strontium silicates. J **51,** 73 (1953) RP2433.

Wells, L. S., Carlson, E. T., Chaconas, T. J., Study of the system barium oxide-aluminum oxide-water at 30° C. J **45,** 381 (1950) RP2149.

Wells, L. S., Carlson, E. T., Peppler, R. B., Studies in the system magnesia-silica-water at elevated temperatures and pressures. J **51,** 179 (1953) RP2448.

Wells, L. S., Clark, W. F., Levin, E. M., Effect of aging on the soundness of regularly hydrated dolomitic lime putties. (1952) BMS127.

Expansive characteristics of hydrated limes and the development of an autoclave test for soundness. J **41,** 179 (1948) RP1917.

Wells, L. S., Clarke, W. F., Newman, E. S., Bishop, D. L., Investigation of failures of white-coat plaster. (1951) BMS121.

Wells, L. S., Levin, E. M., Clarke, W. F., Plasticity and water retentivity of hydrated limes for structural purposes. (1956). BMS146.

Wells, L. S., Newman, E. S., Heats of hydration and pozzolan content of portland-pozzolan cements. J **49,** 55 (1952) RP2342.

Wells, L. S., Newman, E. S., Gilfrich, J. B., Heat generation in the setting of magnesium oxychloride cements. J **49,** 377 (1952) RP2375.

Wells, L. S., Peppler, R. B., The system of lime, alumina, and water from 50° to 250° C. J **52,** 75 (1954) RP2476.

Werner, H. G., Kilpatrick, J. E., Beckett, C. W., Pitzer, K. S., Rossini, F. D., Heats, equilibrium constants, and free energies of formation of the alkylcyclopentanes and alkylcyclohexanes. J **39,** 523 (1947) RP1845.

Westfall, F. O., Meggers, W. F., Lamps and wavelengths of mercury 198. J **44,** 447 (1950) RP2091.

Wexler, A., Divided flow, low-temperature humidity test apparatus. J **40,** 479 (1948) RP1894.

Low-temperature performance of radiosonde electric hygrometer elements. J **43,** 49 (1949) RP2003.

Recirculating apparatus for testing hygrometers. J **45,** 357 (1950) RP2145.

Wexler, A., Brombacher, W. G., Methods of measuring humidity and testing hygrometers. (1951) C512.

Wexler, A., Daniels, R. D., Jr., Pressure-humidity apparatus. J **48,** 269 (1952) RP2312.

Wexler, A., Garfinkel, S. B., Jones, F. E., Hasegawa, S., Krinsky, A., A fast responding electric hygrometer. J **55,** 71 (1955) RP2606.

Wexler, A., Hasegawa, S., Relative humidity-temperature relationships of some saturated salt solutions in the temperature range 0° to 50° C. J **53,** 19 (1954) RP2512.

White, H. S., Small oil-free bearings. J **57,** 185 (1956) RP2709.

White, H. S., Bestul, A. B., Decker, G. E., Comparison of viscosities of rubbers from the McKee worker-consistometer and from the Mooney viscometer. J **46,** 283 (1951) RP2196.

White, H. S., McKee, S. A., The McKee worker-consistometer with constant-speed drives. J **46,** 18 (1951) RP2170.

White, H. S., McKee, S. A., Swindells, J. F., Mountjoy, W., Laboratory wear tests with automotive gear lubricants. J **42,** 125 (1949) RP1955.

White, H. S., Zei, D., Statistic friction tests with various metal combinations and special lubricants. J **46,** 292 (1951) RP2198.

Wicklund, J. S., Flieger, H. W., Jr., Masi, J. F., Heat capacity of gaseous hexafluoroethane. J **51,** 91 (1953) RP2437.

Wicklund, J. S., Masi, J. F., Flieger, H. W., Jr., Heat capacity of gaseous perfluoropropane. J **52,** 275 (1954) RP2500.

Wielandt, H., Pairs of normal matrices with property L. J **51,** 89 (1953) RP2436.

Wiener, M., Energy and angle distribution of the photoprotons from deuterium. (1951) C515.

Wiggins, T. A., Plyler, E. K., Gailar, N. M., Some accurately measured infrared wavelengths for calibration of grating spectrometers. J **48,** 221 (1952) RP2309.

Williams, A. E., Faick, C. A., Rynders, G. F., Effect of convection currents on the distribution of striae in pots of optical glass. J **42,** 153 (1949) RP1959.

Williams, E. K., Brenner, A., Couch, D. E., Electrodeposition of alloys of phosphorus with nickel or cobalt. J **44,** 109 (1950) RP2061.

Williams, E. S., Hermach, F. L., Multirange, audiofrequency thermocouple instruments of high accuracy. J **52,** 227 (1954) RP2494.

Williams, L. C., Wales, M., Sulzer, P. G., Pulsed light system for multiple-cell ultracentrifuge rotor. J **50,** 69 (1953) RP2390.

Williams, W. E., Greenough, M. L., An electron circuit for measuring the displacement of pressure-sensitive diaphragms. J **46,** 5 (1951) RP2168.

Williams, W. E., Jr., Sensitive mercury-level detecting unit for manometers. J **48,** 54 (1952) RP2283.

Williamson, L., Dibeler, V. H., Mohler, F. L., Mass spectra of diborane-d_6 and ethane-d_6. J **44,** 489 (1950) RP2095.

Williamson, L., Dibeler, V. H., Mohler, F. L., Reese, R. M., Mass spectrum of pentaborane (B_5H_9). J **43,** 97 (1949) RP2010.

Williamson, L., Madorsky, S. L., Straus, S., Thompson, D., Pyrolysis of polyisobutene (vistanex), polyisoprene, polybutadiene, GR–S, and polyethylene in a high vacuum. J **42,** 499 (1949) RP1989.

Williamson, L., Mohler, F. L., Bloom, E. G., Wise, C. E., Wells, E. J., Mass spectra of C_5H_8 isomers. J **43,** 533 (1949) RP2045.

Williamson, L., Mohler, F. L., Dean, H. M., Total ionization of hydrocarbons from mass spectral data. J **45,** 235 (1950) RP2130.

Williamson, L., Mohler, F. L., Dibeler, V. H., Dean, H., Mass spectra of deuteroacetylenes, monodeuterobenzene, and deuteronaphthalenes. J **48,** 188 (1952) RP2304.

Williamson, L., Mohler, F. L., Wise, C. E., Wells, E. J., Dean, H. M., Bloom, E. G., Mass spectra of nonanes. J **44,** 291 (1950) RP2078.

Willingham, C. B., Epstein, M. B., Mair, B. J., Rossini, F. D., Separation of the 177° to 200° C fraction of petroleum and the isolation of normal undecane. J **42,** 139 (1949) RP1957.

Willingham, C. B., Glasgow, A. R., Jr., Rossini, F. D., Hydrocarbons in the 108° to 116° fraction of petroleum. J **44,** 141 (1950) RP2065.

Separation of 2,3-dimethylpentane, 1,*cis*-3-dimethylcyclopentane, and 3-ethylpentane from petroleum. J **44,** 411 (1950) RP2088.

Willingham, C. B., Sedlak, V. A., Test mixtures for distillation at atmospheric and reduced pressure. J **45,** 315 (1950) RP2140.

Willingham, C. B., Streiff, A. J., Murphy, E. T., Zimmerman, J. C., Soule, L. F., Sedlak, V. A., Rossini, F. D., Purification, purity, and freezing points of *n*-decane, 4 alkylcyclopentanes, 9 alkylcyclohexanes, 2 monoolefins, 1,2-butadiene, and 2-butyne of the API-Standard and API–NBS series. J **39,** 321 (1947) RP1833.

Willingham, C. B., Streiff, A. J., Soule, L. F., Kennedy, C. M., Janes, M. E., Sedlak, V. A., Rossini, F. D., Purification, purity, and freezing points of twenty-nine hydrocarbons of the API–Standard and API–NBS series. J **45,** 173 (1950) RP2122.

Willingham, C. B., Streiff, A. J., Zimmerman, J. C., Soule, L. F., Butt, M. T., Sedlak, V. A., Rossini, F. D., Purification, purity, and freezing points of 30 hydrocarbons of the API–Standard and API–NBS series. J **41,** 323 (1948) RP1929.

Wilson, S. W., Nimeroff, I., A colorimeter for pyrotechnic smokes. J **52,** 195 (1954) RP2488.

Wilson, W. K., Launer, H. F., Flynn, J. H., Determination of glucose by means of sodium chlorite. J **51,** 237 (1953) RP2456.

Wilson, W. K., Scribner, B. W., Development of standards for analytical filter papers. J **39,** 21 (1947) RP1809.

Winter, P. H., Sanford, R. L., A permeameter for magnetic testing at magnetizing forces up to 300 oersteds. J **45,** 17 (1950) RP2109.

Wise, C. E., Bloom, E. G., Mohler, F. L., Lengel, J. H., Mass spectra of octanes. J **41,** 129 (1948) RP1912.

Metastable transitions in mass spectra of fifty-six hydrocarbons. J **40,** 437 (1948) RP1888.

Wise, C. E., Bloom, E. G., Mohler, F. L., Wells, E. J., Metastable transitions in mass spectra of hydrocarbons. J **43,** 65 (1949) RP2005.

Wise, C. E., Mohler, F. L., Bloom, E. G., Wells, E. J., Jr., Lengel, J. H., Doubly charged ion spectra in mass spectra of hydrocarbons. J **42,** 369 (1949) RP1975.

Wise, C. E., Mohler, F. L., Bloom, E. G., Williamson, L., Wells, E. J., Mass spectra of C_5H_8 isomers. J **43,** 533 (1949) RP2045.

Wise, C. E., Mohler, F. L., Williamson, L., Wells, E. J., Dean, H. M., Bloom, E. G., Mass spectra of nonanes. J **44,** 291 (1950) RP2078.

Wise, C. E., Reese, R. M., Dibeler, V. H., Mohler, F. L., Introduction of measured liquid samples into the mass spectrometer. J **44,** 215 (1950) RP2072.

Wolock, I., Axilrod, B. M., Sherman, M. A., Cohen, V., Effects of moderate biaxial stretch-forming on tensile and crazing properties of acrylic plastic glazing. J **49,** 331 (1952) RP2369.

Wolock, I., Newman, S. B., Optical studies of crazed plastic surfaces. J **58,** 339 (1957) RP2767.

Wolzien, E. C., Selby, M. C., Jickling, R. M., Coaxial radio-frequency connectors and their electrical quality. J **52,** 121 (1954) RP2480.

Wood, L. A., Tilton, L. W., Refractive index of natural rubber for different wavelengths. J **43,** 57 (1949) RP2004.

Wood, L. A., Weir, C. E., Leser, W. H., Crystallization and second-order transitions in silicone rubbers. J **44,** 367 (1950) RP2084.

Woolley, H. W., Calculation of thermodynamic functions for polyatomic molecules. J **56,** 105 (1956) RP2655.

Effect of Darling-Dennison and Fermi resonance on the thermodynamic functions. J **54,** 299 (1955) RP2592.

Thermodynamic functions for carbon dioxide in the ideal gas state. J **52,** 289 (1954) RP2502.

Thermodynamic functions for molecular oxygen in the ideal gas state. J **40,** 163 (1948) RP1864.

Woolley, H. W., Hilsenrath, J., Beckett, C. W., Benedict, W. S., Fano, L., Hoge, H. J., Masi, J. F., Nuttall, R. L., Touloukian, Y. S., Tables of thermal properties of gases. (1955) C564.

Woolley, H. W., Scott, R. B., Brickwedde, F. G., Compilation of thermal properties of hydrogen in its various isotopic and ortho-para modifications. J **41,** 379 (1948) RP1932.

Woolley, R. M., Levy, S., Kroll, W. D., Instability of simply supported square plate with reinforced circular hole in edge compression. J **39,** 571 (1947) RP1849.

Work, R. N., A photoelectric recording interferometer for measurement of dimensional changes. J **47,** 80 (1951) RP2230.

Worthington, V., Carson, F. T., Stiffness of paper. J **49,** 385 (1952) RP2376.

Wright, J. H., Taback, L., Skramstad, H. K., A high-speed computer for predicting radioactive fallout. J **58,** 101 (1957) RP2740.

Wyckoff, H. O., Kennedy, R. J., Concrete as a protective barrier for gamma rays from radium. J **42,** 431 (1949) RP1983.

Wyckoff, H. O., Kennedy, R. J., Bradford, W. R., Broad- and narrow-beam attenuation of 500- to 1,400-kilovolt X-rays in lead concrete. J **41,** 223 (1948) RP1920.

Wyckoff, H. O., Kennedy, R. J., Snyder, W. A., Concrete as a protective barrier for gamma rays from cobalt-60. J **44,** 157 (1950) RP2066.

Wyckoff, H. O., Kirn, F. S., Standard ionization-chamber requirements for 250- to 500-kilovolt X-rays. J **58,** 111 (1957) RP2741.

Wyckoff, H. O., Taylor, L. S., X-ray protection design. (1952) H50.

Wyckoff, J. M., Koch, H. W., Response of a sodium-iodide scintillation spectrometer to 10- to 20-million-electron-volt electrons and X-rays. J **56,** 319 (1956) RP2682.

Wyly, R. S., Eaton, H. N., Capacities of plumbing stacks in buildings. (1952) BMS132.

Frost closure of roof vents in plumbing systems. (1954) BMS142.

Wyly, R. S., French, J. L., Eaton, H. N., Wet venting of plumbing fixtures. (1950) BMS119.

Wyman, G. M., Brode, W. R., Absorption spectra of thioindigo dyes in benzene and chloroform. J **47,** 170 (1951) RP2241.

Y

Youden, W. J., Connor, W. S., Comparison of four national radium standards. Part 2. Statistical procedures and survey. [Part 1. Experimental procedures and results, by T. I. Davenport, W. B., Mann, C. C. McCraven, and C. C. Smith.] J **53,** 267 (1954) RP2544.

New experimental designs for paired observations. J **53,** 191 (1954) RP2532.

Youden, W. J., Loftus, T. P., Mann, W. B., Paolella, L. E., Stockmann, L. L., Comparisons of national radium standards. J **58,** 169. (1957) RP2749.

Young, D., Walsh, J. L., On the accuracy of the numerical solution of the Dirichlet problem by finite differences. J **51,** 343 (1953) RP2463.

Z

Zabawsky, Z., Hamilton, E. H., Grauer, O. H., Hahner, C. H., Changes in the indices of refraction and liquidus of a barium crown glass produced by the partial substitution of some oxides. J **40,** 361 (1948) RP1881.

Zapf, T. L., Spinks, A. W., Precise comparison method of testing alternating-current watthour meters. J **53,** 95 (1954) RP2521.

Zei, D., White, H. S., Static friction tests with various metal combinations and special lubricants. J **46,** 292 (1951) RP2198.

Zelen, M., Bounds on a distribution function that are functions of moments to order four. J **53,** 377 (1954) RP2556.

Zelen, M., Lieblein, J., Statistical investigation of the fatigue life of deep-groove ball bearings. J **57,** 273 (1956) RP2719.

Zendle, B., McElhinney, J., Domen, S., A calorimeter for measuring the power in a high-energy X-ray beam. J **56,** 9 (1956) RP2642.

Ziegler, C. A., Seliger, H. H., Thermal quenching in alpha- and gamma-excited fluorescent solutions. J **58,** 125 (1957) RP2743.

Zimmerman, E. W., Bekkedahl, N., Quinn, F. A., Jr., Vulcanization of synthetic rubbers by the Peachey process. J **40,** 1 (1948) RP1850.

Zimmerman, J. C., Streiff, A. J., Murphy, E. T., Soule, L. F., Sedlak, V. A., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of *n*-decane, 4 alkylcyclopentanes, 9 alkylcyclohexanes, 2 monoolefins, 1,2-butadiene, and 2-butyne of the API-Standard and API-NBS series. J **39,** 321 (1947) RP1833.

Zimmerman, J. C., Streiff, A. J., Soule, L. F., Butt, M. T., Sedlak, V. A., Willingham, C. B., Rossini, F. D., Purification, purity, and freezing points of 30 hydrocarbons of the API-Standard and API–NBS series. J **41,** 323 (1948) RP1929.

Zucker, R., Salzer, H. E., Capuano, R., Table of the zeros and weight factors of the first twenty Hermite polynomials. J **48,** 111 (1952) RP2294.

Zweig, B., Burdick, M. D., Moreland, R. E., Linear thermal expansion of artificial graphites to 1,370° C. J **47,** 35 (1951) RP2225.

6. SUBJECT INDEX, JUNE 1, 1947, TO JUNE 30, 1957

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