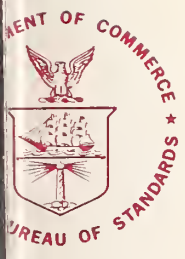

NBS SPECIAL PUBLICATION 363

SUPPLEMENT 2

U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

Bibliography on Atomic Energy Levels and Spectra

July 1975 through June 1979

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Programming Science and Technology — Computer Systems Engineering.

[1]Headquarters and Laboratories at Gaithersburg, MD, unless otherwise noted; mailing address Washington, DC 20234.
[2]Some divisions within the center are located at Boulder, CO 80303.

Bibliography on Atomic Energy Levels and Spectra

July 1975 through June 1979

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NATIONAL BUREAU OF STANDARDS, Ernest Ambler, Director

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Foreword

The National Standard Reference Data System was established in 1963 for the purpose of promoting the critical evaluation and dissemination of numerical data of the physical sciences. The program is coordinated by the Office of Standard Reference Data of the National Bureau of Standards but involves the efforts of many groups in universities, government laboratories, and private industry. The primary aim of the program is to provide compilations of critically evaluated physical and chemical property data. These tables are published in the *Journal of Physical and Chemical Reference Data*, in the NSRDS-NBS series of the National Bureau of Standards, and through other appropriate channels.

The task of critical evaluation is carried out in various data centers, each with a well-defined technical scope. A necessary preliminary step to the critical evaluation process is the retrieval from the world scientific literature of all papers falling within the scope of the center. Each center, therefore, builds up a comprehensive well-indexed bibliographical file which forms the base for the evaluation task. Bibliographies derived from these files are published when they appear to be of value to research workers and others interested in the particular technical area.

Further information on NSRDS and the publications which form the primary output of the program may be obtained by writing to the Office of Standard Reference Data, National Bureau of Standards, Washington, DC 20234.

David R. Lide, Jr., Chief
Office of Standard Reference Data

Contents

Bibliography on Atomic Energy Levels and Spectra July 1975 through June 1979

Romuald Zalubas and Arlene Albright

This is the second supplement to NBS Special Publication 363, *Bibliography on Atomic Energy Levels and Spectra, July 1968 through June 1971*. Supplement 1 covered the period from July 1971 through June 1975, and this bibliography covers the literature from July 1975 through June 1979. It contains approximately 1200 references classified by subject for individual atoms and atomic ions. A number index identifies the references. An author index is included. References included contain data on energy levels, classified lines, wavelengths, Zeeman effect, Stark effect, hyperfine structure, isotope shift, ionization potentials, or theory which gives results for specific atoms or atomic ions.

Key words: Atomic energy levels; atomic spectra; bibliography; energy levels, atomic; spectra, atomic; wavelengths, atoms and ions.

1. Introduction

This is Supplement 2 for the publication, *Bibliography on Atomic Energy Levels and Spectra* [1][1] by the Atomic Energy Levels Data Center. We list references to new papers which have a journal publication date up to June 30, 1979 and were available to us as reprints or in journals in our library. The format is the same as in previously published bibliographies.

1.1. Reference Classification Scheme and Scope of Bibliography

The references pertain to atomic structure and spectra that arise from interactions or excitations involving electrons in the outer shells of free atoms and atomic ions, or from inner shell excitations corresponding to frequencies up to the soft x-ray range. A paper was included if it gave results for a particular ion or spectrum falling into one of the following categories:

EL Energy Levels. Experimental energy differences, except Hfs or IS. Includes references that suggest the rejection of previously reported levels.

ND New Designations. New or changed designations or J values for known energy levels.

CL Classified Lines. Indicates the assignment of observed lines to transitions between energy levels that are specified by theoretical designations and/or by their positions in a known level scheme.

TA Transition Array. Lines or groups of lines assigned to transition array(s) (but not to particular levels or terms).

W Wavelengths (or wavenumbers). New measurements, or wavelengths newly assigned to a particular spectrum. References that list measurements of other entities corresponding to energy differences between levels may also be included.

ZE Zeeman Effect data or interpretation.

SE Stark Effect data or interpretation.

Hfs Hyperfine Structure. Observations and theory.

IS Isotopic or Isomeric (Nuclear) Shifts.

QF Quantum Field effects. Lamb shifts, experimental and theoretical results.

IP Ionization Potential.

SF Series Formulae. Evaluated series constants.

TE Theoretical Energies. Restricted to a few references that give calculated energy levels with accuracies about equal to or exceeding those now obtainable by observation.

[1] Figures in brackets refer to the literature references in section 1.3

PT Parametric Theory. Evaluations of the usual energy parameters of Slater-Condon theory, or extensions thereof, based on fitting the theory to experimental levels, *g*-factors and/or other observed quantities.

AT Ab initio Theory. These references are mostly to Hartree-Fock type calculations of energy parameters or levels.

In section 2.2. the above categories are arranged alphabetically.

References to atomic energy levels and spectra determined from solution or crystal data have category symbols enclosed in parentheses.

It is worth noting that this bibliography does not contain references to atomic transition probabilities, line intensities, or broadening. The NBS Data Center on Atomic Transition Probabilities and Atomic Line Shapes and Shifts publishes bibliographies on these subjects [2].

This bibliography is further restricted, with few exceptions, to original research papers or monographs. Textbooks, extensive compilations of special interest, and other selected publications that are not included in the classified references are given at the end of this introduction in section 1.4.

1.2. Arrangement of Bibliography and Handling of Special Types of References

Each reference has been assigned a number. In section 2.2 the appropriate reference numbers are given under headings for individual spectra (element and ionization stage). The reference numbers under each spectrum heading are listed separately for each of the content categories explained above. Reference numbers for papers reporting wavelengths of unknown ionization stage are given as the first group for the element.

The full references are given in order of the assigned numbers in section 3. Each such reference is followed by the spectra and category symbols appropriate to the content. Except for Russian titles, which are given in English, the titles of articles are given in the language in which they were published. References to articles from Russian journals that also appear in English translations are to the translation journals.

Section 2.1 is an index to the spectra for which there are references; an author index (sec. 4) follows the listing of the complete references.

The main exception from the arrangement described above is for the references 4750T through 4810T. Each of these papers give theoretical results for a rather large number of elements and/or ionization stages and their numbers are followed by a "T" to indicate that the papers give theoretical results only. These references are included in section 3, along with the usual information on their content, and in the author index. However, they were omitted from the reference numbers for the individual spectra (sec. 2.2).

Most of the reference numbers followed by an "A" indicate abstracts of theses in Dissertation Abstracts. Some of the other references are to theses for which the AEL Data Center has obtained copies. The assigned content categories for these abstracts are those thought to be applicable to the paper itself, as indicated by the abstract; the indicated results are not necessarily included in the abstracts. These abstracts frequently provide information about work in progress.

References to lanthanide and actinide atomic energy levels and spectra determined from solution or crystal data are included for atoms and atomic ions for which these data have not been determined for the free gaseous atom or ion. For these references, the reference classification categories which apply are enclosed in parentheses to differentiate them from articles to atomic energy levels and spectra of free gaseous atoms and atomic ions.

The abbreviations of periodical titles generally follow the style given in *Bibliographic Guide for Editors and Authors* [3].

We are grateful to Dr. W. C. Martin for many valuable consultations and Dr. J. Sugar for his advice during the preparation of this bibliography. We thank Dr. L. Hagan for a smooth transfer of the bibliographic work to us, and we also thank Deirdre Thompson for performing bibliographic searches of references and proofreading the bibliography. We are grateful to Carla Messina, Robert Thompson, Connie Seymour, and Bettijoyce Molino for skills involved with creating the author and individual spectra indexes directly from each separate bibliographic entry and for placing these indexes and individual references into a computer-readable form for automatic typesetting.

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2.1. Index to Spectra—Continued

2.1. Index to Spectra—Continued

2.1. Index to Spectra—Continued

2.1. Index to Spectra—Continued

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2.1. Index to Spectra—Continued

Hydrogen

H^-	AT	3669, 3759, 3832, 4091
	EL	3814, 3995
	PT	4071
H I	EL	3562, 4214, 4354, 4554, 4702
	Hfs	3562, 3796
	IS	3707
	QF	3796, 3854, 3981, 4147, 4227, 4260, 4273, 4276, 4353, 4386, 4496, 4512, 4587, 4707
	SE	3963, 4181

Helium

He^-	AT	4023
	EL	3938, 3939, 4002, 4023, 4029, 4070, 4129
	PT	4166
He I	AT	3669, 3712, 3844, 3852, 4015, 4073, 4091, 4175, 4255, 4334, 4490, 4507, 4616, 4700
	CL	3814, 3877, 3909, 4125, 4689
	EL	3558, 3676, 3686, 3741, 3814, 3817, 3845, 3848, 3853, 3877, 3909, 3939, 3959, 3980, 4013, 4078, 4238, 4325, 4364, 4401, 4446, 4621, 4670, 4689
	Hfs	4631
	IS	4349
	PT	3688, 3876, 3879, 4524
	QF	3860, 4690
	SE	3845, 3897, 3918, 4125
	TA	4589
	TE	4011, 4156
	W	3814, 3877, 3909, 4013, 4034
	ZE	3675, 3688, 4098, 4198, 4200, 4358A
He II	AT	4710
	EL	3557, 3594, 3595, 3826, 4155, 4209, 4614
	Hfs	3721, 4025
	PT	4710
	QF	3594, 3595, 3826, 3981, 4207
	SE	3971, 4207, 4513
	W	4034

Lithium

Li I	AT	3566, 3708, 3806, 3839, 3847, 4139, 4212, 4222, 4393, 4408, 4451, 4465, 4497, 4546, 4598, 4669
	CL	3806, 3814, 4080, 4101, 4191, 4192, 4379, 4617
	EL	3566, 3670, 3671, 3806, 3814, 4080, 4101, 4102, 4122, 4192, 4362, 4379, 4411, 4705
	Hfs	3576, 3708, 3725, 3746, 3750, 3839, 3900, 4103, 4263, 4362, 4393, 4669
	IP	4671
	IS	4362, 4441, 4488
Li I–Continued	ND	4191, 4222
	PT	3566, 3750, 4166, 4424, 4425
	SE	4194
	SF	4072
	TA	4438
	TE	4011
	W	3681, 3806, 3814, 4034, 4080, 4191, 4617
	ZE	4114
Li II	AT	3566, 4175, 4563
	CL	3698, 3814, 4046, 4191, 4250
	EL	3566, 3814, 4705
	Hfs	4420
	ND	4191
	PT	3566
	W	3698, 3814, 4034, 4046, 4191, 4283
Li III	QF	3795A, 3981
	W	4034, 4283

Beryllium

Be I	AT	3723, 3895, 4332, 4365, 4657
	EL	3567, 4102, 4516
	IP	3828, 4671
	PT	3830
	W	3797
Be II	AT	3901, 4465, 4598
	CL	4172, 4249, 4250
	EL	4102, 4172, 4516
	Hfs	3737, 3746, 3902, 4103
	IP	4671
	W	3797, 4172
Be III	CL	4172
	EL	4172
	Hfs	3722
	W	3797, 4172
	ZE	3722

Boron

B^{--}	TE	4012
B I	CL	3744
	EL	3744, 4517
	ND	4672
	W	3744
B II	AT	4365
	EL	4102, 4517
	IP	4671
	W	4106
B III	AT	4465, 4598
	CL	3987, 3989, 4036, 4172, 4250
	EL	3989, 4036, 4102, 4172, 4517
	Hfs	3746, 4103

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	IP	4671
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Carbon

C^{--}	TE	4012
C^{-}	AT	4186
C I	AT	3575, 3916, 4638, 4649
	CL	3731
	EL	3731
	ND	3731
	SE	3911, 4137
	TE	4011
	W	3731, 4059
C II	AT	4649
	CL	4142
	Hfs	4093
C III	AT	3629A, 4365, 4649
	CL	4142
	Hfs	4093, 4141
	IP	4671
	PT	4568
C IV	AT	4232, 4393, 4465, 4598, 4649
	CL	3987, 4172, 4250, 4368
	EL	4172, 4368
	Hfs	3746, 4103, 4393
	IP	4671
	PT	4574
	W	4034, 4172
C V	AT	4094
	CL	3987, 4172, 4250
	EL	4172
	Hfs	4094
	QF	3981
	W	3748, 3801, 4034, 4172
C VI	W	3748, 3801, 4034

Nitrogen

N^{--}	TE	4012
N I	AT	3783, 4186
	CL	3928
	EL	3928
	Hfs	4247
	IP	3928
N I–Continued		
	W	3928
	ZE	4247
N II	CL	3885, 3928, 4142, 4491
	EL	3928
	IP	3928
	TE	4011
	W	3928
N III	CL	3885, 3928, 4142, 4491
	EL	3928
	Hfs	3958
	IP	3928
	W	3928
N IV	AT	3629A, 4365
	CL	4142
	EL	4066
	Hfs	3697, 3762, 4103
	IP	4671
	ND	3614
	PT	4568
N V	AT	4598
	CL	3650, 3885, 3984, 3987, 3988, 4172, 4368
	EL	3650, 3984, 4172, 4368
	Hfs	3746
	IP	4671
	PT	4574
	W	3650, 3856, 3984, 3988, 4034, 4172
N VI	CL	3988, 4172
	EL	4172
	W	3988, 4034, 4172
N VII	W	4034

Oxygen

O^{--}	TE	4012
O I	AT	3716, 3916, 4113
	CL	3760, 4442, 4706A
	EL	3696, 3760, 4340
	IP	3760
	W	3760, 3835
	ZE	4432
O II	AT	4186
	CL	4142
O III	AT	4638
	CL	4706A
	W	3738
O IV	W	3829
O V	AT	3629A, 4365
	CL	3718, 4142, 4218

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	EL	4066
	IP	4671
	ND	4218
	PT	4568
	W	3829, 4218
O VI	AT	4598
	CL	3650, 3718, 3984, 3987, 4004, 4172, 4218, 4296, 4368, 4521A
	EL	3650, 3984, 4004, 4172, 4296, 4368, 4521A
	Hfs	3746
	IP	4671
	ND	4218
	W	3624, 3650, 3829, 3984, 4004, 4034, 4172, 4218
O VII	CL	3718, 3784, 3987, 4172, 4218, 4474
	EL	3784, 4172
	ND	4218
	W	3784, 3960, 4034, 4172, 4218
O VIII	CL	3784, 4218
	EL	3784
	ND	4218
	W	3784, 4034, 4218

Fluorine

F I	CL	4442
	EL	4442
	Hfs	4431
F II	AT	3716
F III	AT	4186
F V	CL	3987
	W	3748
F VI	CL	4581
	IP	4671
	W	3748, 3977
F VII	AT	4598
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	EL	4004
	Hfs	3746
	IP	4671
	W	3748, 3977, 4004
F VIII	CL	4581
	EL	3982
	Hfs	3982
	W	3748, 3977
F IX	CL	4520
	QF	3786
	W	3748, 3977

Neon

Ne^-	EL	3720, 3938
Ne I	AT	3612, 3951, 4510, 4659
	CL	3735, 4003, 4024, 4384, 4494, 4678, 4701
	EL	3804, 3940, 4003, 4177, 4183, 4384, 4614, 4678, 4701
	Hfs	3577, 3590, 3781, 4067, 4183, 4184, 4298
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Ne II	AT	3951, 4492
	CL	4370
	EL	3720, 3956, 4370, 4437
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	W	4509
	ZE	4492
Ne III	AT	3716
	CL	3684, 4400
	PT	4484
	W	3568, 3684, 3957
Ne IV	AT	4667
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	PT	4522
	W	3568, 3684
Ne V	AT	4667
	CL	3568, 4674
	EL	3568
	PT	4484, 4522
	W	3568
Ne VI	AT	4667
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	EL	4595
	PT	4522
	W	3568
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	EL	4066, 4595
	IP	4671
	PT	4522, 4568
	W	3554, 3568
Ne VIII	AT	4598, 4667
	CL	3554, 3650, 3784, 3984, 4392, 4595
	EL	3650, 3784, 3984, 4140, 4392, 4595
	Hfs	3746
	IP	4671
	PT	4522
	W	3554, 3554, 3650, 3784, 3984, 4034

Ne IX	AT	4667
	CL	3784, 3984, 4392, 4674
	EL	3784, 3984, 4392
	PT	4522
	W	3554, 3784, 3984, 4034
Ne X	CL	3784, 4392
	EL	3784, 4392
	W	3554, 3784, 4034

Sodium

Na I	AT	3666, 3806, 3847, 4302, 4373, 4590
	CL	3791, 3806, 3882, 4377, 4565, 4596, 4697
	EL	3717, 3791, 3806, 3823A, 3882, 3899, 3907, 3968, 3978, 4031, 4041, 4053, 4061, 4119, 4215, 4239, 4271, 4348, 4373, 4489, 4526, 4596, 4609, 4697
	Hfs	3592, 3661, 3808, 3820, 3875, 3908, 3964, 3976, 3994, 3997A, 4062, 4063, 4079, 4217, 4239, 4282, 4427, 4460, 4481, 4628
	IS	3592, 3954, 3974, 4289, 4352, 4628
	ND	4596
	PT	3789, 3908
	SE	3776, 3785, 3966, 3976, 3994, 4119, 4221, 4609
	SF	4072
	TA	4505, 4602
	W	3791, 3806, 3882, 4697
	ZE	4179A, 4208
Na II	AT	4590, 4633
	CL	4668
	EL	4526, 4633, 4668
	IP	4671
Na IV	CL	3834
	EL	3834
	ND	3834
	PT	3834
	W	3834
Na X	CL	3784
	EL	3784
	W	3784

Magnesium

Mg^-	EL	4044
Mg I	AT	4339, 4462
	CL	3561, 4057, 4355, 4462, 4561
	EL	3561, 4057, 4267, 4312, 4462, 4561, 4572
	IS	4068, 4244, 4686
	W	3561
Mg II	AT	3806, 4302, 4373
	CL	3806, 4467
Mg II–Continued		
	EL	3806, 4267, 4324, 4373, 4467, 4561
	ND	3910
	PT	3910
	W	3806
Mg III	AT	4480
	CL	4197
	EL	4197
	IP	4671
Mg V	AT	4113, 4567
	CL	4474, 4567
	EL	4567
	PT	4484, 4567
Mg VI	CL	4474
Mg VII	AT	4440, 4638
	CL	4474
	PT	4484
Mg VIII	CL	4472
Mg IX	AT	4330
	CL	4330
Mg X	AT	3604, 4466
	CL	3784, 4466
	EL	3784
	ND	3816
	TA	4650
	W	3604, 3784, 3816, 4466
Mg XI	AT	4533
	CL	3784, 4042, 4110, 4608
	EL	3784, 4110
	ND	3816
	SF	4608
	TA	4650, 4653
	W	3784, 3816, 4042
Mg XII	CL	3690, 4042, 4539, 4612
	ND	3816
	W	3816, 4042

Aluminum

Al	W	4576
Al^{--}	TE	4012
Al I	AT	3838
	CL	3597, 3736
	EL	3597
	IP	3597
	W	3597, 3736
Al II	AT	3810
	CL	4575
	EL	4575

Al II–Continued		
	IP	4575
	ND	4575
Al IV	CL	4197
	EL	4197
	IP	4671
	SF	4456
	W	3967
Al V	AT	3565
	CL	3565, 4111, 4607
	EL	3565
	IP	3565
	PT	3565
	W	3565
Al VI	AT	4567
	CL	3565, 4111, 4543, 4567
	EL	3565, 4567
	PT	4567
	W	3565
Al VII	CL	4111, 4674
Al X	AT	4330
	CL	4330
Al XI	AT	3604, 4466
	CL	4050, 4083, 4203, 4466, 4684
	EL	4083
	W	3604, 3801, 4050, 4466
Al XII	CL	4042, 4050, 4110, 4203, 4684
	EL	4110
	TA	4547, 4653
	W	4042, 4050, 4301
Al XIII	CL	4042, 4050, 4539
	SE	3975
	TA	4547
	W	4042, 4050, 4301

Silicon

Si	W	3986
Si^{--}	TE	4012
Si I	AT	4452, 4453
	W	4081
Si II	AT	3813
Si V	CL	3640, 3934
	EL	3640, 3934
	IP	4671
	PT	3934
	SF	4456
	W	3640, 3934
Si VI	CL	4206
	EL	4206
	PT	4206
Si VII	AT	4402, 4567
	CL	4567
	EL	4567
	PT	4484, 4567
Si VIII	CL	3888, 4470, 4474, 4549
	EL	3634
	PT	4484
	W	3634, 3888
Si IX	AT	4440
	CL	3888
	PT	4484
	W	3888, 3977
Si X	AT	3643
	CL	3888, 4472
	W	3888, 3977
Si XI	AT	4330
	CL	3888, 4600
	W	3888, 3977, 4600
Si XII	AT	3604, 4466
	CL	3888, 4004, 4466, 4539, 4600
	EL	4004
	W	3604, 3888, 3977, 4004, 4466, 4599, 4600
Si XIII	CL	3888, 4042, 4539, 4588, 4600
	EL	4588
	TA	4547, 4653
	W	3888, 3977, 4042, 4600
Si XIV	CL	3888, 4042, 4539, 4600, 4684
	TA	4547
	W	3888, 4042, 4600

Phosphorus

P^{--}	TE	4012
P^{-}	EL	4121
P I	AT	4336, 4646
	CL	4646
	EL	4646
P III	CL	4134
	EL	4134
	IP	4134
	ND	4134
P IV	CL	4144
	EL	4144
	ND	4144

P V	AT	4302
P VI	CL	4216
	EL	4216
	IP	4671
	PT	4216
	SF	4456
P IX	CL	4674
P X	EL	3920
	PT	3920
P XI	PT	4449
P XII	AT	4330
P XIII	AT	4466
	CL	4466
	W	4466
P XIV	CL	4042, 4110
	EL	4110
	TA	4652, 4653
	W	4042
P XV	CL	4042
	W	4042

Sulfur

S⁻ ⁻	TE	4012
S I	AT	4336
	CL	3890, 4347
	EL	3890, 4347
	PT	4584
	W	3579
S II	AT	4641
	CL	4293
	W	3579, 3947, 4182, 4293
S III	CL	3949, 4054, 4293
	EL	4054
	W	3949, 4054, 4293
S IV	CL	3633, 4054, 4293
	EL	3633, 4054
	W	3633, 4054, 4293, 4343
S V	CL	4054, 4293, 4343
	EL	4054
	W	4054, 4293
S VI	CL	4054, 4293, 4343
	EL	4054, 4343
	IP	4344
	SF	4344
	W	4054, 4293
S VII	CL	4054, 4293, 4294, 4683
	EL	4054, 4294, 4683
	IP	4671
	SF	4456
	W	4054, 4293
S VIII	CL	4054, 4472
	EL	4054
	W	4054
S IX	CL	4474
	PT	3922, 4484
S X	CL	4474
	EL	3634
	PT	4484
	W	3634
S XI	AT	4440
	CL	4474
	EL	3920
	PT	3920, 4484
S XII	CL	4326, 4472
S XIII	AT	4330
S XIV	AT	4466
	CL	3930, 4466, 4684
	EL	4086
	W	4466
S XV	CL	4042, 4110, 4684
	EL	4110
	TA	4653
	W	4042
S XVI	CL	4042, 4539
	W	4042

Chlorine

Cl I	EL	3803
Cl VII	IP	4344
	SF	4344
	W	4391
Cl VIII	CL	4399
	IP	4671
	SF	4456
Cl X	CL	4531
	PT	3922
Cl XII	CL	4531
Cl XIV	AT	4330
Cl XV	AT	4466
	CL	4466
	W	4466

Cl XVI	CL	4110, 4398
	EL	4110, 4398
	QF	4398, 4613
	TA	4653
Cl XVII	QF	4635

Argon

Ar^-	EL	3617, 3938
Ar I	CL	3979, 4385, 4678
	EL	3869, 3940, 4177, 4385, 4458, 4475, 4483, 4532, 4678
	IP	4671
	ND	3869
	PT	3724
	SF	4532
	W	3979, 4158
Ar II	AT	4492
	EL	3720, 3956, 4322
	IP	3824
	ZE	4492
Ar III	AT	4351
	CL	3684
	W	3684
Ar IV	CL	3684
	W	3684
Ar V	CL	4421
Ar VI	CL	4421
Ar VII	CL	3983, 4421, 4580
	W	3983
Ar VIII	AT	4302
	CL	3983, 4421, 4580
	IP	4344
	SF	4344
	W	3983
Ar IX	CL	4399, 4421, 4580
	EL	4421
	IP	4671
	SF	4456
Ar X	CL	4421, 4472
	W	4580
Ar XI	CL	4474
	PT	3922, 4484
	W	4580
Ar XII	PT	4484
	W	4580
Ar XIII	EL	3920
	PT	3920, 4484, 4623
Ar XIV	PT	4623
Ar XV	AT	4330
	CL	4518
Ar XVI	AT	3604, 4675
	CL	4292, 4681
	EL	3604, 4292, 4416
	W	3604
Ar XVII	AT	4533
	CL	3985, 4205, 4292, 4681
	EL	4292, 4416
	W	3985, 4193
Ar XVIII	QF	4426, 4626

Potassium

K I	AT	3599, 3602, 3847, 4582
	CL	3599, 3602, 4315
	EL	3599, 3602, 3775, 3925, 4251, 4315, 4478, 4695
	Hfs	3556, 3908, 4481
	IP	3602
	ND	4582
	PT	3908
	SE	3556
	SF	4072
	W	3599, 3602, 3868
	ZE	3556, 3944
K II	IP	4671
K IV	CL	3633
	EL	3633
	W	3633
K V	CL	3633
	EL	3633
	W	3633
K VI	CL	3633
	EL	3633
	W	3633
K VII	CL	3633
	EL	3633
	W	3633, 3851
K VIII	W	3851
K IX	CL	3851, 3896*
	EL	3851, 3896
	IP	4344
	ND	3851, 3896
	SF	4344
	W	3851, 3896
K X	CL	4564
	IP	4671
	SF	4456

K XII	PT	3922
K XIV	PT	3920
K XVI	AT	4330
K XVII	AT	4466
	CL	3840, 4466
	TA	4650
	W	3604, 4466
K XVIII	TA	4650, 4653

Calcium

Ca I	AT	3598, 3685, 4405
	CL	3685, 3880, 4084, 4135, 4169, 4499
	EL	3627, 3685, 3880, 3933, 3941, 4084, 4135, 4169, 4499, 4542
	Hfs	4579, 4627
	IS	3950, 4210, 4405, 4579
	ND	3880
	PT	3627, 3880
	QF	4692
	SE	4135
	SF	4157
	TA	4473
	W	3685, 3880, 3933, 3993, 4084, 4169, 4499
Ca II	AT	4582
	CL	4499, 4644
	EL	3933, 4499
	ND	4582
	W	3933, 4499
Ca III	CL	4197
	EL	3933, 4197
	IP	4671
	W	3933
Ca V	CL	3633
	EL	3633
	W	3633
Ca VI	CL	3633
	EL	3633
	W	3633
Ca VII	CL	3633
	EL	3633
	PT	4434
	W	3633
Ca VIII	CL	3633
	EL	3633
	W	3633
Ca IX	CL	3943, 4434
	EL	3943
	PT	4434
	W	3943
Ca X	CL	3551, 3851, 3896, 3943
	EL	3851, 3896, 3943
	IP	4344
	ND	3851, 3896
	SF	4344
	W	3551, 3851, 3896, 3943
Ca XI	CL	3705, 4564
	IP	4671
	SF	4456
	W	3705
Ca XII	CL	4472, 4538
	EL	3920
	PT	3920
Ca XIII	AT	4402
	CL	4538
	PT	3922, 4484
Ca XIV	CL	3551
	EL	3551
	PT	4484
	W	3551
Ca XV	AT	4403
	CL	3551, 4538
	EL	3551
	PT	3920, 4484, 4623
	W	3551
Ca XVI	CL	3628
	EL	3628
	PT	4449, 4623
	W	3551, 3628
Ca XVII	AT	4330, 4637
	CL	3628
	EL	3628
	W	3551, 3628
Ca XVIII	AT	3604
	CL	3840, 4518
	W	3604
Ca XIX	AT	4533
	TA	4653

Scandium

Sc I	AT	3807
	CL	4189
	EL	4189
	Hfs	3555, 3768, 3769
	ND	4189
	PT	3807, 4224
	W	4189
	ZE	4189
Sc IV	CL	4197
	EL	4197
	IP	4671

Sc VI	CL	3633
	EL	3633
	W	3633
Sc VII	CL	3633
	EL	3633
	W	3633
Sc VIII	CL	3633
	EL	3633
	W	3633
Sc IX	CL	3633
	EL	3633
	W	3633
Sc X	CL	4434
Sc XI	CL	3896, 3943
	EL	3896, 3943
	IP	4344
	ND	3896
	SF	4344
	W	3896, 3943
Sc XII	CL	3705, 4564
	SF	4456
	W	3705
Sc XIV	PT	3922
Sc XVI	PT	3920
Sc XVIII	AT	4330
Sc XIX	CL	3840
Sc XX	TA	4653

Titanium

Ti I	Hfs	3555
Ti II	W	4037
Ti III	CL	3593
	EL	3593
	IP	3593
	PT	3593, 3871, 4664
	SF	3593
	W	3593, 4037
Ti IV	W	4037
Ti V	AT	3693
	CL	3693, 4197
	EL	3693, 4197
	IP	3693, 4671
	PT	3693
	W	3693, 4037
Ti VI	W	4037
Ti VII	CL	3633
	EL	3633
	W	3633, 4037
Ti VIII	CL	3633
	EL	3633
	W	3633, 4037
Ti IX	CL	3633
	EL	3633
	W	3633, 4037
Ti X	CL	3633
	EL	3633
	W	3633, 4037
Ti XI	CL	3943, 4434
	EL	3943
	W	3748, 3943, 4037
Ti XII	CL	3623, 3896
	EL	3623, 3896
	IP	3623, 4344
	ND	3896
	PT	3623
	SF	3623, 4344
	W	3623, 3748, 3896, 4037
Ti XIII	CL	3705, 4564
	SF	4456
	W	3705, 3748, 4037
Ti XIV	W	3748, 4037
Ti XV	PT	3922, 4484
	W	3748
Ti XVI	CL	3591
	EL	3591
	PT	4484
	W	3591
Ti XVII	PT	3920, 4484
Ti XIX	AT	4043, 4330
	CL	4043, 4330, 4571
	W	4043
Ti XX	CL	3840, 4518, 4571
Ti XXI	TA	4547, 4653
	W	4136
Ti XXII	TA	4547

Vanadium

V I	AT	3657, 4551
	CL	4235, 4236

V I–Continued		
	EL	4236
	Hfs	4551
	W	4235, 4236
V II	CL	4482
	EL	4482
V III	PT	3871, 4664
V IV	CL	4270
	PT	3871
V V	CL	3632, 3917
	EL	3632, 3917
	IP	3917
	ND	3917
	W	3632, 3917
V VI	AT	3622
	CL	3622, 4197
	EL	3622, 4197
	IP	3622, 4671
	PT	3622
	W	3622
V VII	CL	3633
	EL	3633
	W	3633
V VIII	CL	3633
	EL	3633
	W	3633
V IX	CL	3633
	EL	3633
	W	3633
V X	CL	3633
	EL	3633
	W	3633
V XI	CL	3633
	EL	3633
	W	3633
V XIII	CL	3896
	EL	3896
	IP	4344
	ND	3896
	SF	4344
	W	3896
V XIV	CL	3705, 4564
	SF	4456
	W	3705
V XVI	PT	3922
V XVII	CL	3591
	EL	3591
	W	3591
V XVIII	PT	3920
V XX	AT	4043, 4230, 4330
	CL	4043, 4230, 4330
	EL	4230
	PT	4230
	W	4043
V XXI	CL	3840
V XXII	TA	4653
	W	4136

Chromium

Cr^-	EL	4121
Cr I	AT	3657
	CL	4170
	EL	4170
	Hfs	4397
	ND	4170
	PT	4170
	W	4170
Cr II	AT	4523
	W	4679
Cr III	AT	4523
	CL	3878
	EL	3878
	ND	3878
	PT	3878
	W	3878
Cr IV	AT	4523
	PT	4664
Cr V	AT	4523
Cr VI	AT	4523
Cr VII	AT	3618
	CL	3618, 4197
	EL	3618, 4197
	IP	3618, 4671
	PT	3618
	W	3618
Cr VIII	CL	3633
	EL	3633
	W	3633
Cr IX	CL	3633
	EL	3633
	W	3633

Cr X	CL	3633, 4474
	EL	3633
	W	3633
Cr XI	CL	3633, 4434
	EL	3633, 4434
	W	3633
Cr XIV	CL	3896
	EL	3896
	IP	4344
	ND	3896
	SF	4344
	W	3896
Cr XV	CL	3705, 4436, 4564
	W	3705
Cr XVII	CL	3591
	EL	3591
	PT	3922, 4484
	W	3591
Cr XVIII	CL	3591
	EL	3591
	PT	4484
	W	3591
Cr XIX	PT	3920, 4484
Cr XXI	AT	4043, 4330
	CL	4043, 4330, 4518, 4571
	W	4043
Cr XXII	AT	3604
	CL	3840, 4518, 4571
	EL	3604
	TA	4547
	W	3604
Cr XXIII	TA	4547
	W	4136

Manganese

Mn I	AT	3644, 4415
	CL	4406
	EL	4406
	Hfs	3893, 4680
	IP	4406
	W	3644, 4406
Mn III	AT	4523
	CL	4479
	EL	4479
Mn IV	AT	4523
Mn V	AT	4523
	CL	4167, 4381, 4515
	EL	4167, 4515
Mn V–Continued		
	ND	4167
	PT	3745, 4167, 4515
	W	4167
Mn VI	AT	4523
	CL	4164
	EL	4164
	ND	4164
Mn VIII	IP	4671
Mn IX	CL	3633
	EL	3633
	W	3633
Mn X	CL	3633
	EL	3633
	W	3633
Mn XI	CL	3633, 4474
	EL	3633
	W	3633
Mn XII	CL	4434
	EL	4434
Mn XV	CL	3896
	EL	3896
	IP	4344
	ND	3896
	SF	4344
	W	3896
Mn XVI	CL	3705, 4564
	W	3705
Mn XVIII	PT	3922
Mn XIX	CL	3591
	EL	3591
	W	3591
Mn XX	PT	3920
Mn XXI	PT	4449
Mn XXII	AT	4043, 4330
	CL	4043, 4518
	W	4043
Mn XXIII	AT	3604
	CL	3840, 4518
	EL	3604
	W	3604

Iron

Fe I	CL	3678, 3866, 3972, 4548
	EL	3866, 3972, 4548
	ND	3866, 3972

Fe I–Continued		
	PT	3866
	W	3678, 3866, 3972, 4548
Fe II	CL	4009, 4196, 4433
	EL	4009, 4433
	IP	4433
	W	4009, 4182, 4196, 4433, 4509
Fe III	AT	4523
	CL	4511
	W	4182
Fe IV	AT	4523
	CL	4346
	EL	4346
	ND	4346
Fe V	AT	3625, 4523
	CL	3625
	EL	3625
	PT	3625
	W	3625
Fe VI	AT	4523
	ND	3777
	PT	4664
	W	3777
Fe VIII	W	3748
Fe IX	CL	3619, 4014, 4197, 4463, 4474
	EL	3619, 4197, 4345, 4463
	IP	4671
	W	3619, 3748, 4014
Fe X	AT	4396
	CL	3633, 4014, 4032, 4190, 4463, 4470, 4474, 4538, 4674
	EL	3633, 4190, 4345, 4463
	PT	3651, 4190
	W	3633, 3748, 4014, 4032
Fe XI	AT	4396
	CL	3633, 4014, 4190, 4463, 4470, 4474, 4538, 4549, 4674
	EL	3633, 3634, 4190, 4463
	PT	4190
	W	3633, 3634, 4014
Fe XII	AT	4331, 4396
	CL	4014, 4331, 4463, 4470, 4474, 4549
	EL	3634, 4331, 4463
	PT	4331
	W	3634, 3891, 4014, 4059
Fe XIII	AT	4331, 4396
	CL	3634, 4014, 4331, 4434, 4463, 4474, 4538
	EL	3634, 4434, 4463
Fe XIII–Continued		
	PT	3772, 4331, 4434
	W	3634, 3778, 4014
Fe XIV	AT	4396
	CL	4014, 4463, 4538
	EL	4463
	W	3748, 3748, 4014
Fe XV	AT	4396
	CL	4014, 4434, 4463
	EL	4463
	PT	4434
	W	3748, 4014
Fe XVI	AT	4302, 4396
	CL	4014, 4185, 4463
	EL	4185, 4463
	IP	4344
	SF	4344
	W	3748, 4014
Fe XVII	CL	3630, 3705, 3764, 3784, 4014, 4211, 4436, 4564
	EL	3630, 3784
	IP	4008, 4485
	SF	4456
	W	3630, 3705, 3748, 3764, 3784, 4008, 4014, 4211, 4341
Fe XVIII	AT	4615
	CL	3784, 3921, 4014, 4211, 4404, 4409, 4615
	EL	3784, 4404
	W	3748, 3784, 4014, 4211
Fe XIX	AT	3843, 4402
	CL	3921, 4077, 4185, 4211, 4387, 4409, 4642
	EL	4185
	PT	3922, 4484
	W	4211
Fe XX	AT	4402
	CL	3591, 3635, 4211, 4387, 4450, 4642
	EL	3591, 3635, 4450
	PT	4484
	W	3591, 3635, 4211
Fe XXI	AT	4403, 4583
	CL	3635, 3865, 4211, 4387
	EL	3635
	PT	3920, 4484
	W	3635, 3865, 4059, 4211, 4341
Fe XXII	AT	4230
	CL	3635, 4230, 4409, 4518
	EL	3635, 4230
	PT	4230
	W	3635

Fe XXIII	AT	4043, 4230, 4330, 4637
	CL	4043, 4219, 4230, 4330, 4361, 4409, 4518, 4571
	EL	4230, 4361
	PT	4230
	W	4043, 4219
Fe XXIV	AT	3604, 3843, 4500
	CL	3840, 4014, 4219, 4361, 4518, 4571, 4651
	EL	3604, 4361, 4651
	TA	4547
	W	3604, 4014, 4219
Fe XXV	AT	4533
	CL	4361, 4409, 4651
	EL	4361, 4651
	TA	4547
	W	4136
Fe XXVI	CL	4014, 4361
	EL	4361
	TA	4547
	W	4014

Cobalt

Co I	CL	4288, 4548
	EL	4548
	Hfs	4165, 4288
	W	4548
Co II	CL	4687
	EL	4687
	W	4509
Co III	PT	4664
Co V	CL	4698
	EL	4698
	PT	4698
Co VI	CL	3631
	EL	3631
	ND	3631
	PT	3631
	W	3631
Co VII	TE	4074
Co X	CL	3619
	EL	3619
	W	3619
Co XIV	CL	4434
	EL	4434
Co XVI	CL	4434
Co XVII	CL	4518
	IP	4344
	SF	4344
Co XVIII	CL	3705
	W	3705
Co XIX	AT	4615
	CL	4404, 4615
	EL	4404
Co XX	CL	3591
	EL	3591
	W	3591
Co XXI	CL	3591
	EL	3591
	W	3591
Co XXIV	AT	4043, 4330
	CL	4043
	W	4043

Nickel

Ni^-	EL	4121
Ni I	CL	4548
	EL	4548
	Hfs	4174
	W	4548
Ni II	W	4182
Ni III	AT	4523
	PT	4664
Ni IV	AT	4523
	CL	3732
	EL	3732
	ND	3732
	PT	3732
	W	3732
Ni V	AT	4523
	CL	3739, 3912
	EL	3739, 3912
	IP	3912
	ND	3912
	PT	3739, 3912
	W	3739, 3912
Ni VI	AT	4523
Ni VII	CL	3621
	EL	3621
	ND	3621
	PT	3621
	W	3621
Ni VIII	PT	3926
	TE	4074
Ni X	W	3619

Ni XI	CL	3619, 4674
	EL	3619, 4345
	W	3619
Ni XII	CL	4032, 4674
	EL	4345
	PT	3651
	W	4032
Ni XIII	CL	4474
Ni XIV	CL	4474
Ni XV	CL	4434
	EL	4434
Ni XVI	CL	4699
Ni XVII	CL	4434
Ni XVIII	CL	4185
	EL	4185
	IP	4344
	SF	4344
Ni XIX	CL	3705, 3784, 4436, 4564
	EL	3784
	W	3705, 3784, 3905
Ni XX	AT	4615
	CL	4404, 4615
	EL	4404
Ni XXI	AT	3843
	CL	3591, 4077, 4185, 4387, 4640
	EL	3591, 4185
	W	3591
Ni XXIII	AT	4638
Ni XXV	AT	4043, 4330
	CL	4043, 4571, 4699
	W	4043
Ni XXVI	AT	3604, 3843, 4500
	CL	4518, 4571
	TE	3604
Ni XXVII	AT	4533
	CL	4699

Copper

Cu I	CL	4548
	EL	4548
	W	4548
Cu II	W	4195
Cu III	PT	3751
Cu IV	CL	3728
	EL	3728
	PT	3728
Cu V	CL	3881
	EL	3881
	ND	3881
	PT	3881
	W	3881
Cu IX	PT	3926
Cu X	W	3977
Cu XI	W	3977
Cu XII	CL	3619
	EL	3619
	W	3619, 3977
Cu XIII	W	3977
Cu XIV	W	3977
Cu XVI	CL	4434, 4486
	EL	4434
	W	4486
Cu XVII	CL	4486
	W	4486
Cu XVIII	CL	4434, 4486
	W	3748, 4486
Cu XIX	CL	4185, 4486, 4665
	EL	4185, 4665
	Hfs	4173
	IP	4344, 4665
	SF	4344
	W	3748, 4486
Cu XXI	AT	4615
	CL	4185, 4404, 4615
	EL	4185, 4404
	PT	3613
Cu XXII	CL	4077, 4185, 4640
	EL	4185
	PT	3613
Cu XXIII	CL	4185
	EL	4185
	PT	3613
Cu XXVI	AT	4043, 4330
	CL	4043
	W	4043
Cu XXVIII	TA	4000

Zinc

Zn^-	EL	4044
Zn I	AT	4256
	CL	3641, 4256
	EL	3641, 3867, 4256
	Hfs	3906
	IP	3641
	W	3641, 3798
Zn III	AT	4688
Zn X	PT	3926
Zn XVII	CL	4486
	PT	4434
	W	4486
Zn XVIII	CL	4486
	W	4486
Zn XIX	CL	4075, 4434, 4486
	PT	4434
	W	4486
Zn XX	CL	4075, 4185, 4486, 4665
	EL	4185, 4665
	IP	4344, 4665
	SF	4344
	W	4486
Zn XXII	AT	4615
	CL	3613, 4185, 4185, 4286, 4404, 4615
	EL	3613, 4185, 4185, 4286, 4404
	W	3613
Zn XXIII	AT	4113
	CL	3613, 4077, 4185
	EL	3613, 4185
	W	3613
Zn XXIV	CL	3613, 4185
	EL	3613, 4185
	W	3613
Zn XXVI	PT	4449
Zn XXVII	AT	4043, 4330
	CL	4043
	W	4043

Gallium

Ga^-	EL	4120
Ga I	AT	4413
	CL	4049
	EL	4049
	IP	4152
	ND	4049, 4413
	W	4049
Ga II	AT	4645
	CL	4560
	EL	4560
Ga IV	CL	3607
	EL	3607
	W	3607
Ga XXI	CL	4185, 4665
	EL	4185, 4665
	IP	4344, 4665
	SF	4344
Ga XXIII	CL	4185
	EL	4185
	PT	3613
Ga XXIV	PT	3613

Germanium

Ge^-	EL	4120
Ge I	CL	3935, 4118
	EL	3935, 4118
	IP	3935
	ND	3935, 4118
	PT	3935
	W	3935
Ge V	CL	3608
	EL	3608
	W	3608
Ge XIII	W	3913
Ge XIV	W	3913
Ge XIX	W	3913
Ge XXII	CL	4185, 4665
	EL	4185, 4665
	IP	4344, 4665
	SF	4344
Ge XXIV	AT	4615
	CL	3613, 4185, 4286, 4404, 4615
	EL	3613, 4185, 4286, 4404
	W	3613
Ge XXV	CL	3613
	EL	3613
	W	3613
Ge XXIX	AT	4043
	CL	4043
	W	4043

Arsenic

As^-	EL	4121

As XXIII	CL	4185, 4665
	EL	4185, 4665
	IP	4344, 4665
	SF	4344
As XXV	CL	4185
	EL	4185

Selenium

Se I	CL	4168
	W	4048, 4124, 4168
Se II	CL	4076, 4090
	EL	4076
	W	4076, 4090
Se III	W	3961
Se IV	W	3961
Se V	W	3961
Se VI	EL	4300
	IP	4300
	ND	4300
	W	3961, 4300
Se VII	CL	3961
	EL	3961
	ND	3961
	W	3771, 3961
Se VIII	CL	3771
	EL	3771
	ND	3771
	PT	3771
	W	3771
Se XXIII	W	4085
Se XXIV	CL	4665
	EL	4665
	IP	4344
	SF	4344
	W	4085
Se XXV	W	4085
Se XXVI	AT	4615
	CL	4286, 4404, 4615
	EL	4286, 4404
Se XXXI	AT	4043
	CL	4043
	W	4043

Bromine

Br IV	W	4258
Br V	ND	3955
Br VI	AT	4645
Br XXIV	CL	4185
	EL	4185
Br XXV	CL	4665
	EL	4665
	IP	4344, 4665
	SF	4344
Br XXXI	PT	4449

Krypton

Kr I	CL	3740, 3802, 3931, 3932, 3979, 4503, 4541, 4676, 4678
	EL	3740, 3788, 3802, 3931, 3932, 3940, 4177, 4503, 4676, 4678
	Hfs	4233
	IP	4676
	IS	3846, 4063, 4107, 4159, 4171, 4213, 4233, 4352, 4573
	ND	3802
	PT	4395
	W	3740, 3931, 3932, 3979, 4021
Kr II	EL	3956
	IP	3824
	ND	3945
	PT	4056
Kr III	ND	3945
	W	3684
Kr IV	CL	3874
	ND	3945
	W	3684, 4259
Kr V	CL	3874
	ND	3945
	W	4259
Kr VI	CL	3609, 3874
	EL	3609
Kr VII	CL	3609, 3874, 4204
	W	4204
Kr VIII	CL	3609, 4204
Kr IX	CL	4204
Kr X	CL	4204
Kr XI	CL	4204
Kr XII	CL	4204
Kr XIII	CL	4204
Kr XXV	CL	4219
	W	4219, 4566

Kr XXVI	AT	4302
	CL	4219, 4566
	W	4219
Kr XXVII	CL	4566
Kr XXXIII	AT	4637
	CL	4624
Kr XXXIV	CL	4624
Kr XXXV	CL	4065
	EL	4065

Rubidium

Rb I	AT	3583, 3836, 3861, 4493, 4527
	CL	3583, 4240, 4569, 4620, 4693
	EL	3583, 3714, 3790, 3857, 3952, 4058, 4069, 4240, 4266, 4350A, 4493
	Hfs	3747, 3753, 3773, 3787A, 3833, 3861, 3872, 3908, 3997A, 4001, 4017, 4018, 4035, 4328, 4481
	IS	3747, 3763, 4126, 4366
	ND	3583, 4493
	PT	3908, 4493
	SE	3668, 3861, 4005
	TA	4455
	W	3583, 3850, 4028, 4498
	ZE	3861, 4040, 4055, 4198, 4358A
Rb II	AT	3583
	Hfs	3990
Rb III	AT	3583
	CL	3713
	EL	3713
	W	3713
	ZE	3713
Rb VIII	CL	4088
	W	4088
Rb IX	CL	4088
	W	4088
Rb XXVI	W	4566
Rb XXVII	CL	4566
Rb XXVIII	CL	4566

Strontium

Sr I	AT	4163
	CL	3889, 3942, 4278, 4447, 4557, 4648
	EL	3889, 3933, 3941, 3942, 4278, 4447, 4469, 4542, 4557, 4603, 4648, 4654
	Hfs	3990, 4245
	IP	4447
Sr I–Continued		
	ND	3942
	PT	3601, 3942
	TA	4439, 4469, 4473
	W	3889, 3933, 3942, 4603
	ZE	3553, 4278
Sr II	CL	4648
	EL	3933, 4268, 4603, 4648, 4654
	W	3933, 4603
Sr IV	AT	3647
	CL	3647, 4311
	EL	3647, 4311
	IP	3647, 4311
	PT	3647, 4311
	W	3647
Sr IX	CL	4088
	W	4088
Sr X	CL	4088
	W	4088
Sr XXVII	W	4566
Sr XXVIII	CL	4566
Sr XXIX	CL	4566

Yttrium

Y I	CL	4443
	EL	4443
	IP	4592
	PT	4443
	W	4443
Y II	CL	3601
	EL	3601
	IP	3601
	PT	3601
	W	3601
Y III	CL	4586
	EL	4586
Y VI	AT	3611
	CL	3611, 4047, 4378
	EL	3611, 4047, 4378
	ND	3611
	W	3611
Y VII	CL	4087, 4378
	EL	4087, 4378
Y VIII	CL	4087, 4378
	EL	4087, 4378

Y X	CL	4088
	W	4088
Y XI	CL	4088
	W	4088
Y XXVIII	W	4566
Y XXIX	CL	4566
Y XXX	CL	4566
Y XXXI	CL	4329
	EL	4329

Zirconium

Zr I	Hfs	4285
	IP	4592
	PT	4285
	ZE	3887
Zr III	PT	3601
Zr IV	CL	4586
	EL	4586
Zr V	AT	4594
	CL	4594
	EL	4594
	IP	4594
Zr VII	AT	3652
	CL	3652, 4047, 4378
	EL	3652, 4047, 4378
	W	3652
Zr VIII	CL	4087, 4378
	EL	4087, 4378
Zr IX	CL	4087, 4378
	EL	4087, 4378
Zr XI	AT	4342
	CL	4088
	W	4088
Zr XIII	AT	4417
Zr XV	AT	4342
Zr XXIX	W	4566
Zr XXX	CL	4566
Zr XXXI	CL	4566
Zr XXXVI	PT	4449

Niobium

Nb I	Hfs	3569, 3570
	IP	4592
	PT	3570
	ZE	3569
Nb IV	PT	3601
Nb V	CL	4586
	EL	4586
Nb VIII	AT	3652
	CL	3652, 4047, 4378
	EL	3652, 4047, 4378
	W	3652
Nb IX	CL	4087, 4378
	EL	4087, 4378
Nb X	CL	4087, 4378
	EL	4087, 4378
Nb XII	CL	4088
	W	4088
Nb XXXII	CL	4566

Molybdenum

Mo I	AT	4133
	Hfs	4448, 4471
	IP	4592
	IS	4133, 4471
	ZE	4448
Mo II	AT	4133
	IS	4133
Mo VI	CL	4586
	EL	4586
Mo VIII	CL	3646
	EL	3646
	IP	3646
	W	3646
Mo IX	AT	3652
	CL	3652, 4047, 4378, 4577
	EL	3652, 4047, 4378, 4577
	IP	4577
	W	3652
Mo X	CL	4087, 4378
	EL	4087, 4378
Mo XI	CL	4087, 4378
	EL	4087, 4378
Mo XIII	AT	4342, 4645
	CL	4088, 4662
	W	4088

Mo XIV	AT	4593
	CL	4088, 4234, 4593, 4662
	EL	4234, 4593
	IP	4234, 4593
	W	4088
Mo XV	AT	4417
	CL	4176, 4257
	EL	4257
	ND	4360
	W	4257
Mo XVI	AT	4145
	CL	4176, 4257
	EL	4257
	W	4257
Mo XVII	AT	4145, 4342
	CL	4176, 4257
	EL	4257
	W	4257
Mo XVIII	AT	4145
	CL	4176
Mo XIX	AT	4145
	CL	4176
Mo XX	CL	4176
Mo XXI	CL	4176
Mo XXII	CL	4176
Mo XXIII	CL	4176
Mo XXIV	CL	4176
Mo XXV	CL	4176
Mo XXVI	CL	4176
Mo XXVII	CL	4176
Mo XXVIII	CL	4176
Mo XXIX	CL	4176
Mo XXX	CL	4109, 4176, 4257, 4257
	EL	4109, 4257, 4257
	ND	4109
	W	4257, 4257, 4566
Mo XXXI	CL	4109, 4176, 4219, 4257, 4566
	EL	4109, 4257
	ND	4109
	PT	4333
	W	4219, 4257, 4566
Mo XXXII	AT	4302
Mo XXXII–Continued		
	CL	4109, 4176, 4219, 4257, 4566
	EL	4109, 4257
	IP	4344
	ND	4109
	PT	4333
	SF	4344
	W	4219, 4257
Mo XXXIII	CL	3863, 4176, 4333, 4566
	EL	3863, 4333
	ND	3863
	W	3863
Mo XXXIV	CL	4329
	EL	4329
Mo XXXIX	AT	4637
Mo XL	CL	4281
	W	4281
Mo XLI	CL	4281

Technetium

Tc I	AT	4097
	Hfs	4097
	IP	4592

Ruthenium

Ru I	Hfs	4045
	IP	4592

Rhodium

Rh I	IP	4592
Rh XLI	PT	4449

Palladium

Pd I	Hfs	3855
	IP	4592
	IS	3855
Pd XVIII	EL	4290

Silver

Ag I	AT	4338, 4558
	CL	4105, 4338, 4558, 4677
	EL	4105, 4338, 4558, 4677
	IP	4105
	IS	4242
	ND	4105, 4338
	W	4338, 4677
Ag II	CL	4027, 4248, 4261, 4269
	W	4027, 4248, 4261

Ag IV	CL	3703
	EL	3703
	W	3703
Ag XIX	EL	4290
Ag XXXVIII	CL	3863
	EL	3863
	ND	3863
	TA	4000
	W	3863

Cadmium

Cd^-	EL	4044
Cd I	AT	4305
	CL	3641, 3757, 3758, 4305, 4376, 4620
	EL	3641, 3867, 4305, 4376
	Hfs	3559, 3894, 3948
	IP	3641
	IS	3653, 3679, 3894, 4383
	W	3641, 3757, 3758, 3864, 4376
Cd II	Hfs	3894
	IS	3563, 3653, 3894
	ZE	4429
Cd IV	CL	4099
	EL	4099
	ND	4099
	PT	4099
Cd XX	EL	4290

Indium

In^-	EL	4120
In I	AT	3765, 4413
	CL	3765, 4495
	EL	3765, 4495
	IS	4459
	ND	3765, 4413
	W	3765, 4495
In III	CL	4327
	EL	4327
	IP	4327
In V	CL	3770, 4201, 4316
	EL	3770, 4201, 4316
	IP	4316
	ND	3770, 4201, 4316
	PT	3770, 4201, 4316
	W	3770, 4201
In VI	CL	3755
	EL	3755
	W	3755
In XXI	EL	4290

Tin

Sn^-	EL	4120
Sn I	CL	3779, 3936, 4118
	EL	3936, 4118
	Hfs	4711
	IP	3936
	ND	3936, 4118
	W	3779, 3936
Sn II	CL	3779
	W	3779
Sn V	CL	4099
	EL	4099
	ND	4099
	PT	4099
Sn VI	CL	4099, 4199
	EL	4099, 4199, 4299
	ND	4099, 4199
	PT	4099, 4199
	W	4199
Sn XLVI	PT	4449

Antimony

Sb^-	EL	4121
Sb I	EL	3794
	Hfs	3794, 4407
	PT	3794
Sb VI	CL	4099, 4601
	EL	4099, 4601
	IP	4601
	ND	4099
	PT	4099
Sb VII	AT	4601
	CL	4099, 4601
	EL	4099, 4299, 4601
	ND	4099
	PT	4099, 4601

Tellurium

Te^-	EL	4121
Te I	CL	3680, 3682
	EL	3682
	PT	3682
	W	3682
	ZE	3680, 3682
Te II	CL	4089
	EL	4089
	IS	4303
	W	4089

Te VII	CL	4601
	EL	4601
	IP	4601
Te VIII	AT	4601
	CL	4601
	EL	4601
	PT	4601

Iodine

I I	CL	3674, 4625
	EL	3674
	Hfs	3674
	PT	3674
	W	3674
I II	CL	3680
	EL	3680
	ZE	3680
I VI	CL	4639
I XXIV	CL	3580
	EL	3580
	W	3580
I XXV	CL	3580
	EL	3580
	W	3580
I XXVI	CL	3580
	EL	3580
	W	3580

Xenon

Xe I	CL	3931, 3979, 4678
	EL	3582, 3931, 3940, 4154, 4177, 4678
	Hfs	3588, 3700, 4630
	IS	4022, 4039, 4297, 4454
	PT	4395
	W	3582, 3819, 3931, 3979, 4021
	ZE	4629
Xe II	CL	4318
	EL	3956, 4112, 4428
	Hfs	4380
	IP	3824
	ND	4006, 4419, 4428
	PT	4419, 4428
	ZE	4428
Xe III	AT	4660
	CL	3766, 4660
	EL	3766, 4660
	IP	4660
	ND	4660
	W	3684, 3766, 4225, 4254
Xe IV	W	3684, 4225, 4254
Xe XXV	CL	4219
	W	4219
Xe XXVI	CL	4219
	W	4219
Xe XLIV	AT	4302

Cesium

Cs I	AT	3825, 3859, 4265, 4528, 4544, 4559
	CL	3560, 3585, 3596, 4051, 4375, 4620
	EL	3585, 3733, 3953, 4051, 4241, 4271, 4308, 4310, 4375
	Hfs	3560, 3572, 3589, 3596, 3616, 3636, 3637, 3638, 3753, 3756, 3787A, 3833, 3842, 3859, 3872, 3997A, 4001, 4108, 4237, 4265, 4287, 4422, 4460, 4481, 4519, 4545, 4691
	IS	4356, 4422, 4519, 4545, 4606
	ND	4544
	PT	3789
	QF	3827
	SE	3668, 3799, 3815, 3859, 4005, 4375
	TA	4540
	W	3560, 3585, 3596, 3663, 3756, 4051
	ZE	3616, 3636, 3637, 3638, 3842, 3859, 4309, 4530, 4632
Cs II	AT	3649
	CL	3649
	EL	3649
	W	3649
	ZE	3649, 4309
Cs III	CL	3749
	EL	3749
	IP	3749
	PT	3749
	W	3749
Cs IX	CL	4178
	EL	4178
	ND	4178
Cs X	CL	4178
	EL	4178
	ND	4178

Barium

Ba I	AT	3822, 3886, 4313, 4559, 4610
	CL	3626, 3662, 3701, 4030, 4295, 4414, 4444, 4559, 4682
	EL	3626, 3701, 3873, 4030, 4132, 4295, 4394, 4414, 4444, 4461, 4542, 4559
	Hfs	4019, 4127, 4444, 4685
	IP	4542
	IS	4611
	ND	4030, 4610

Ba I–Continued		
	PT	4461, 4542
	SE	4279
	TA	4410, 4439, 4476, 4605
	W	3626, 3662, 3701, 4030, 4559
	ZE	3553, 3873
Ba II	AT	3584, 4274, 4556
	CL	3662, 3726, 3727
	EL	3564, 3726, 3727, 3821, 4394
	Hfs	3774, 3990, 4019, 4220, 4275, 4658
	IS	3965, 4220, 4274
	W	3662, 3726, 3727
	ZE	3841
Ba III	CL	3667
	EL	3667
	IP	3667
	ND	3667
	W	3892
Ba IV	CL	3749
	EL	3749
	IP	3749
	PT	3749
	W	3749
Ba X	CL	4178
	EL	4178
	ND	4178
Ba XI	CL	4178
	EL	4178
	ND	4178

Lanthanum

La I	AT	4591
	EL	3730, 3915
	Hfs	4116, 4337
	IP	4592
	ND	3730
	PT	3730
	ZE	3730
La IV	AT	4562
	CL	4562
	EL	4562
	W	4562
La V	CL	3749
	EL	3749
	IP	3749
	PT	3749
	W	3749
La XI	CL	4178
	EL	4178
	ND	4178
La XII	CL	4178
	EL	4178
	ND	4178

Cerium

Ce I	AT	3858
	EL	3915, 3991
	IP	4277, 4321, 4514
	IS	3656, 3858
Ce II	AT	3858, 4388
	CL	3923
	EL	3923
	IS	3858, 4388
	ND	3923
	W	3923
	ZE	3923
Ce XII	CL	4178
	EL	4178
	ND	4178
Ce XIII	CL	4178
	EL	4178
	ND	4178

Praseodymium

Pr I	Hfs	3639
	IP	4514
	ZE	3639
Pr III	AT	4536
	PT	4536
Pr IV	Hfs	3660, 3811
	ZE	3659, 3660
Pr V	IP	4095
Pr XIII	CL	4178
	EL	4178
	ND	4178
Pr XIV	CL	4178
	EL	4178
	ND	4178

Neodymium

Nd I	CL	4038
	EL	3809
	IP	4277, 4321, 4514
	IS	4038, 4323, 4382
	ZE	3809
Nd II	CL	4038
	IS	4038, 4323, 4382
	PT	4390

Nd III	CL	3973
	EL	3973
	W	3973
Nd IV	CL	3578
	EL	3578, 4502
	PT	3578, 4502
	SE	4502
	W	3578
Nd V	IP	4095
Nd XIV	CL	4178
	EL	4178
	ND	4178
Nd XV	CL	4178
	EL	4178
	ND	4178

Promethium

Pm I	IP	4277, 4514
Pm IV	AT	4096
	CL	3574
	EL	3574
	PT	3574
	W	3574
Pm V	IP	4095

Samarium

Sm I	CL	4187
	EL	4132
	Hfs	4229, 4552
	IP	4277, 4321, 4514
	IS	4180, 4229, 4253, 4552, 4570
	PT	4253
	W	4153
Sm V	IP	4095
Sm XVI	CL	4178
	EL	4178
	ND	4178

Europium

Eu I	AT	3792
	CL	3780, 3792, 3849, 4666
	EL	3780, 3792, 3849, 4132, 4666
	Hfs	3709, 4704
	IP	4277, 4321, 4514
	IS	3914, 4704
	ND	3780, 3792, 3849
	W	3780, 3792, 3849, 4666
	ZE	3780
Eu III	AT	3818
	CL	4115
Eu III–Continued		
	EL	4115
	PT	4115
Eu V	IP	4095

Gadolinium

Gd I	IP	4277, 4321, 4464, 4514
	IS	3870, 4138, 4382, 4708
	ND	4708
Gd II	Hfs	4555
	IS	3870, 4382, 4708
	ND	4708
Gd IV	AT	3818
	CL	4115
	EL	4115
	PT	4115
Gd V	IP	4095

Terbium

Tb I	CL	4656
	Hfs	4656
	IP	4277, 4321, 4514
	ND	4656
	PT	4150
Tb II	CL	4487
	EL	4487
	ZE	4487
Tb IV	CL	3689
	EL	3689
	IP	3689
	PT	3689
	W	3689
Tb V	IP	4095

Dysprosium

Dy I	Hfs	3998, 4151, 4252, 4412
	IP	4277, 4321, 4514
	IS	3550, 3782, 4252
Dy II	EL	3743
	IS	4280
	ND	3743
	PT	3743, 4280, 4390
	ZE	3743
Dy V	IP	4095
Dy XXXIX	CL	3863
	EL	3863
	ND	3863
	W	3863

Ho I	CL	4202
	EL	4202
	Hfs	4202
	IP	4277, 4321, 4514
	ND	4202
	PT	4228
	W	3800, 4202
Ho II	CL	3742
	EL	3742, 4390
	ND	3742
	PT	3742, 4390
	W	3742, 3800
Ho III	EL	3962
	ND	3962
	PT	3962
Ho IV	SE	3702
Ho V	IP	4095

Erbium

Er I	CL	3550
	IP	4277, 4321, 4514
	IS	3550
Er II	PT	4390
Er V	IP	4095

Thulium

Tm I	AT	4591, 4643
	Hfs	4148
	IP	4277
Tm II	AT	4591
	PT	4390
Tm IV	CL	3615
	EL	3615
	PT	3615
	W	3615
Tm V	IP	4095

Ytterbium

Yb I	AT	3672
	CL	3550, 3719, 4262, 4534
	EL	3946, 4132, 4262, 4534, 4535, 4585
	Hfs	3969, 3970
	IP	4262, 4277
	IS	3550, 4126
	ND	3550, 3946
	PT	4534
	W	3706, 3719, 4226, 4262, 4335, 4363
	ZE	4262
Yb II	EL	4443
	IP	3654
	W	3654, 3719, 4226, 4443
Yb III	CL	3654
	IP	3654
	W	3654
Yb IV	CL	3715, 4317
	EL	3715, 4317
	PT	4317
	W	3715, 4317
Yb V	IP	4095

Lutetium

Lu I	CL	4320
	EL	4320
	Hfs	4418, 4636
	IS	4636
	ND	4320
	PT	4389
	W	4320
Lu II	AT	3672
	PT	4504
Lu III	CL	3654, 4597
	EL	4597
	IP	3654
	W	3654
Lu IV	CL	3654
	IP	3654
	W	3654
Lu V	CL	4435
	EL	4435
	IP	4095
	PT	4435

Hafnium

Hf I	CL	3620
	EL	3620
	Hfs	4149
	IP	3620, 4592
	PT	4389
	W	3620
	ZE	3620
Hf II	PT	4504
Hf III	AT	3883
Hf IV	CL	3654, 4597
	EL	4597
	IP	3654
	W	3654

Hf V	CL	3654, 3694
	EL	3694
	IP	3654, 4095
	W	3654, 3694

Tantalum

Ta I	IP	4592
	PT	4389
Ta II	CL	4504
	EL	4504
	PT	4504
Ta IV	CL	4307
	EL	4307
	PT	4307
Ta V	CL	3654, 3695, 4597
	EL	3695, 4597
	Hfs	3695
	IP	3654, 3695, 4095
	W	3654, 3695
Ta VI	CL	3654
	IP	3654
	W	3654
Ta XLVI	CL	4146
	W	4146
Ta XLVII	CL	4146
	W	4146

Tungsten

W I	Hfs	4619
	IP	4592
	IS	4374, 4696
	ZE	4619
W II	PT	4504
W VI	CL	3654, 4597
	EL	4597
	IP	3654, 3694
	W	3654
W VII	CL	3654, 3694
	EL	3694
	IP	3654, 3694
	PT	3694
	W	3654, 3694
W XX	TA	4430
W XXI	TA	4430, 4663
W XXII	TA	4430
W XXIII	TA	4430
W XXIV	TA	4430
W XXV	TA	4430, 4663
W XXVI	TA	4430
W XXVII	TA	4430
W XXVIII	TA	4430
W XXIX	TA	4430, 4663
W XXX	TA	4430
W XXXI	TA	4131, 4430
W XXXII	TA	4131, 4430
W XXXIII	TA	4131, 4430
W XXXIV	TA	4131, 4430, 4663
W XXXV	TA	4131, 4430
W XLV	AT	4645
W XLVII	CL	3863
	EL	3863
	ND	3863
	W	3863
W LXIV	AT	4302

Rhenium

Re I	Hfs	4618
	IP	4592
	IS	4618
	ND	4618
	PT	4389
Re II	PT	4504
Re VII	CL	3654, 3683, 3704, 4597
	EL	3683, 3704, 4597
	Hfs	3704
	IP	3654, 3683, 3704
	W	3654, 3683, 3704
Re VIII	CL	3654
	IP	3654
	W	3654

Osmium

Os I	IP	4592
Os VIII	CL	3654, 4597
	EL	4597
	IP	3654
	W	3654

Os IX	CL	3654
	IP	3654
	W	3654

Iridium

Ir I	Hfs	4284
	IP	4592
	PT	4284
	ZE	4284
Ir II	CL	4457
	EL	4457
Ir IX	CL	3654
	IP	3654
	W	3654
Ir X	CL	3654
	IP	3654
	W	3654

Platinum

Pt I	Hfs	3677
	IP	4592
	IS	3677
	W	4082
Pt II	PT	4504
	W	4082
Pt X	CL	3654
	IP	3654
	W	3654
Pt XI	CL	3654
	IP	3654
	W	3654
Pt LI	CL	3863
	EL	3863
	ND	3863
	W	3863

Gold

Au I	CL	4231
	EL	4231
	IP	4231
	W	4231
Au II	PT	4504
Au XI	CL	3654
	IP	3654
	W	3654
Au XII	CL	3654
	IP	3654
	W	3654
Au XXVI	TA	4663
Au XXX	TA	4663
Au XXXIV	TA	4663
Au XXXIX	TA	4663
Au LII	CL	3863
	EL	3863
	ND	3863
	TA	4000
	W	3863
Au LXIX	AT	4302

Mercury

Hg^-	EL	4044
Hg I	CL	4160
	EL	4010, 4160
	Hfs	3581, 3687, 3734, 3752, 3904, 4160, 4161, 4655
	IS	3665, 3687, 3734, 4052, 4160, 4161, 4525, 4655
	PT	4161
	W	4160, 4162
	ZE	3664, 3710, 3903, 4143
Hg II	Hfs	4007, 4306, 4372
	IS	4007
Hg XII	CL	3654
	IP	3654
	W	3654
Hg XIII	CL	3654
	IP	3654
	W	3654

Thallium

Tl^-	EL	4120
Tl I	AT	4264, 4413
	CL	3645, 3884, 4123, 4413
	EL	3645, 3884, 4117, 4413
	Hfs	3655, 3898, 4064, 4264
	IS	3655, 3898
	ND	4413, 4622
	PT	4117
	W	3645, 3884, 3999
	ZE	4530
Tl II	CL	3692
Tl XIII	CL	3654
	IP	3654
	W	3654

Tl XIV	CL	3654
	IP	3654
	W	3654

Lead

Pb^-	EL	4120
Pb I	CL	3586, 3937, 4100, 4104, 4246
	EL	3586, 3937, 4100, 4104
	IP	4100, 4104
	ND	4100, 4104, 4622
	W	3586, 3937
Pb II	CL	3699, 4272
	EL	3699, 3805
	IP	3699
	W	3699, 4272
Pb III	CL	4272
	W	4272
Pb IV	CL	4272
	W	4272
Pb XIV	CL	3654
	IP	3654
	W	3654
Pb XV	CL	3654
	IP	3654
	W	3654

Bismuth

Bi^-	EL	4121
Bi I	AT	4128, 4445
	CL	4355, 4357
	EL	4357
	Hfs	3648, 3658, 3812, 4291, 4537
	IP	4357
	IS	4537
	ZE	3812
Bi II	CL	3711, 4357
	EL	3711, 4033
	W	3711
Bi III	CL	3992
	Hfs	3992
Bi XV	CL	3654
	IP	3654
	W	3654
Bi XVI	CL	3654
	IP	3654
	W	3654

Francium

Fr I	AT	4371
	CL	4304
	EL	4304

Thorium

Th I	CL	3552
	EL	3552
	W	3552
	ZE	3552
Th V	CL	4709
Th LXXX	AT	4302

Uranium

U I	AT	3691, 4026, 4369, 4550, 4553, 4578, 4673
	CL	3600, 3603, 3606, 4188
	EL	3600, 3603, 3606, 3642, 3691, 3729, 3929, 4020, 4092, 4634
	Hfs	3831, 4506, 4550, 4553, 4661
	IP	3603, 3691, 3929
	IS	3606, 3924, 4060, 4359, 4423, 4477, 4506, 4550, 4553, 4578
	ND	3642
	PT	3837
	W	3600, 3603, 3606, 4188
	ZE	3642
U II	AT	4673
	CL	3761
U III	AT	4673
U IV	AT	4508, 4673
	PT	4508
	W	3571
U V	AT	4508, 4673
	PT	4508
	W	3571
U VI	AT	3754, 4508, 4673
	CL	3754
	EL	3754
	PT	4508
	W	3754
U VII	AT	4673
U LXIII	AT	4645

Neptunium

Np I	CL	3793, 4604
	EL	3793, 3862, 4604
	Hfs	3793
	IP	4604

Np I–Continued		
	ND	3793, 3862
	PT	3862
	W	3793
	ZE	3793, 3862
Np IV	AT	4508
	PT	4508
	W	3571
Np V	AT	4508
	PT	4508
	W	3571
Np VI	AT	4508
	PT	4508
Np VII	AT	4508
	PT	4508

Plutonium

Pu	W	3587
Pu IV	AT	4508
	PT	4508
Pu V	AT	4508
	PT	4508
Pu VI	AT	4508
	PT	4508
Pu VII	AT	4508
	PT	4508

Americium

Am III	AT	4508
	PT	4508
Am IV	AT	4508
	PT	4508
Am V	AT	4508
	PT	4508
Am VI	AT	4508
	PT	4508
Am VII	AT	4508
	PT	4508
Am VIII	AT	4508
	PT	4508

Curium

Cm I	CL	3587, 3919, 3927
	EL	3587, 3927
	IS	3587, 3919, 3927
	ND	3927, 4223
Cm I–Continued		
	W	3587, 3919, 3927
	ZE	3919, 3927
Cm II	CL	3587, 3919
	EL	3587
	IS	3919
	W	3587, 3919
	ZE	3919
Cm IV	CL	3573
	EL	3573
	PT	3573
	W	3573

Berkelium

Bk I	CL	3610, 4703
	EL	3610, 4703
	Hfs	3610, 4703
	W	3610, 4703
	ZE	4703
Bk II	CL	3610, 4703
	EL	3610, 4703
	Hfs	3610, 4703
	W	3610, 4703
	ZE	4703

Californium

Cf I	CL	3605
	EL	3605
	Hfs	3605
	W	3605
Cf II	CL	3605
	EL	3605
	Hfs	3605
	W	3605

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Yb I: ND CL IS

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Ca X: CL W
Ca XVI, XVII: W

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Pu: W

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Ca VII, Zn XVII: PT
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