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Thermal Properties
Of Aqueous Uni-univalent
Electrolytes

U.S. DEPARTMENT OF COMMERCE

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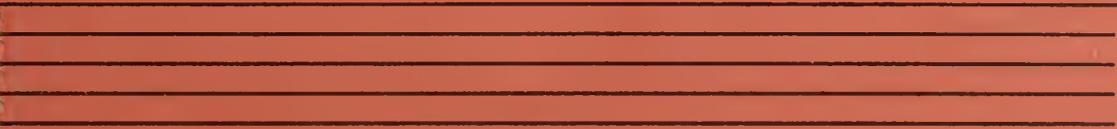
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Vivian Barfield Parker

Foreword

In 1963 the President's Office of Science and Technology established the National Standard Reference Data System to ensure that the technical community of the United States has maximum access to compilations of critically evaluated data in the physical sciences. The National Bureau of Standards was assigned administrative responsibility for this Government-wide activity.

The National Bureau of Standards, as well as other groups both in this country and abroad, has been active in the compilation of standard reference data for many years. However, in view of the great accumulation of unevaluated data, the accelerated production of new data, the known time lag in incorporating these data into critically evaluated compilations, and the urgent needs of the scientific and technical community, it was decided by the Federal Council for Science and Technology that a substantially greater effort, planned and coordinated on a national basis, was needed. The National Standard Reference Data System (NSRDS) is the outgrowth of that decision.

The NSRDS is conducted as a decentralized operation across the country, with central coordination by the NBS. It comprises a complex of data centers and other activities, carried on in government agencies, academic institutions, and non-government laboratories. The independent operational status of existing critical data projects is maintained and encouraged. The activities of data centers which are components of the NSRDS include the preparation of compilations of critically evaluated data, the preparation of critical reviews of the quantitative state of knowledge in a specialized area, and computations of useful functions derived from standard reference data.

The present publication is considered to be a product of the National Standard Reference Data System activities at the NBS. It consists of a compilation of critically evaluated data on the thermodynamic properties of aqueous uni-univalent electrolytes, prepared as one of the continuing projects of the NBS Thermochemistry Section.

A. V. Astin, *Director.*

Preface

Since 1940 the National Bureau of Standards has maintained in its Thermochemistry Section a program on the collection, analysis, and evaluation of chemical thermodynamic data on chemical substances. One of the important areas of consideration has been the thermochemistry of aqueous electrolyte solutions. Because of the comparatively regular behavior of dilute univalent electrolyte solutions in water, as predicted by classical theoretical considerations, one can establish consistent values for the heats and free energies of formation and entropies of the hypothetical single-ion species, once a value for one particular ion is assigned.

As part of the planned total review of the available chemical thermodynamic data, a systematic review of the heat-capacity, heat-of-solution, and heat-of-dilution data on simple 1–1 electrolytes has been made. From the analysis of these data, tables of selected "best" values of "apparent" heat capacities, and heats of dilution are given, as well as selected values of the heats of solution to infinite dilution. Also included is a review of data on the heats of neutralization of monobasic acids which has led to a selected "best" value for the heat of ionization of water.

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The available specific heat, heat of dilution, and heat of solution data for aqueous solutions of uni-univalent electrolytes have been critically reviewed and tables of selected "best" values at 25 °C prepared. In addition, the neutralization data have been critically reviewed in order to obtain the "best" value, 13,345 cal/mole, for the heat of ionization of water at 25 °C.

The electrolytes reviewed include the hydroxides, halides and oxyhalides, nitrates and nitrites, formates and acetates, cyanides, cyanates and thiocyanates, and permanganates of hydrogen, ammonium and the methyl ammonium derivatives, silver, and the alkali metals.

I. Introduction

The data on the thermal properties of aqueous uni-univalent electrolytes have been critically reviewed by Rossini [1, 2, 3, 4, 5],[1] Bichowsky and Rossini [6], Rossini et al. [7], Harned and Owen [8, 9], Pitzer and Brewer [10], Britske et al. [11], Lange and Robinson [12], and Lange and Monheim [13]. In view of the current program of the Thermochemistry Section on the revision of the tables of Selected Values of Chemical Thermodynamic Properties of chemical substances, it was felt advisable to re-examine all the available data on the thermal properties of the aqueous uni-univalent electrolytes and select systematically the most consistent set of values. It is hoped that this review, in addition to making available the experimental data, will serve to indicate areas where the data are inadequate or completely nonexistent.

The terminology and conventions used are those of Lewis and Randall [14], Lewis, Randall, Pitzer, and Brewer [10], Rossini [2, 3, 4], Harned and Owen [9], and Glasstone [15]. A summary of the terms used and their definitions follows:

Φ_C is the apparent molal heat capacity of the solute, equal to $[(1000 + mM_2)C - 1000\,C°]/m$ where C and $C°$ are the specific heats (per unit mass) of the solution and pure solvent, respectively, m is the molality, and M_2 is the molecular weight of the solute.

ΔH_{diln}, the integral heat of dilution, is the change in enthalpy, per mole of solute, when a solution of concentration m_1 is diluted to a final finite concentration m_2.

If the dilution is carried out by the addition of an infinite amount of solvent, so that the final solution is infinitely dilute, the enthalpy change is the integral heat of dilution to infinite dilution. Since Φ_L, the relative apparent molal enthalpy, is equal to and of opposite sign to this, only Φ_L is referred to here when discussing dilution to infinite dilution.

$\bar{L}_2$ is the relative partial molal enthalpy of the solute in the given solution, equal to $\Phi_L + \frac{1}{2}m^{1/2}(d\Phi_L/dm^{1/2})$.

$\bar{L}_1$ is the relative partial molal enthalpy of the solvent in the given solution, equal to $-(M_1m^{3/2}/2000)(d\Phi_L/dm^{1/2})$, where M_1 is the molecular weight of the solvent. It is also the partial or differential heat of dilution and may be defined as the change

in enthalpy per mole of solvent when it is added to a large volume of the solution at the given concentration.

$\bar{J}_2$ is the relative partial molal heat capacity of the solute, equal to $\bar{C}_2 - \bar{C}_2°$, which is equal to $(\partial \bar{L}_2/\partial T)_p$, where $\bar{C}_2$ is equal to $\Phi_C + \frac{1}{2}m^{1/2}(d\Phi_C/dm^{1/2})$ and $\bar{C}_2°$ is equal to $\Phi_C°$.

$\Phi_C°$ is the value of the apparent molal heat capacity of the solute at infinite dilution. It is not to be confused with the heat capacity of the pure solvent.

The limiting slopes of the apparent molal properties were taken as two thirds the limiting slopes for the partial molal properties given by Harned and Owen [9].

ΔH_{soln} is the total or integral heat of solution of one mole of solute to form a solution of concentration m. It is equal to $(H_m - 55.506H_1 - mH_2)/m$, where H_m is the enthalpy of the solution, and H_1 and H_2 are the molar enthalpies of the pure solvent and solute, respectively.

The partial or differential heat of solution is the increase in enthalpy per mole of solute when it is dissolved in a large volume of solution at a concentration m, so that there is no appreciable change in the latter. It is equal to $\bar{L}_2 - L_2$ where L_2 is the relative partial molal enthalpy of the pure solute.

$\Delta H_\infty°$ is the heat of solution at infinite dilution, equal to $\Delta H_{\text{soln}}(m) - \Phi_L(m)$.

$\Delta H_N°$ is the heat of neutralization at infinite dilution. In a reaction between a strong acid and a strong base at finite and equal concentrations, given by $HX \cdot nH_2O + MOH \cdot nH_2O = MX \cdot (2n+1)H_2O$, $\Delta H_N°$ is equal to $\Delta H_N - [\Phi_L MX \cdot (2n+1)H_2O - \Phi_L MOH \cdot nH_2O - \Phi_L HX \cdot nH_2O]$.

ΔH_i is the heat of ionization or dissociation of a weak acid or base into its ionic species, such as, $HA + H_2O = H_3O^+ + A^-$ and $RNH_2 + H_2O = RNH_3^+ + OH^-$.

K_i refers to the equilibrium constant of the above type reactions, with K_a and K_b referring specifically to the equilibrium constants of the acid and base reactions, respectively.

The properties were calculated, wherever possible, over the entire range from infinite dilution to approximate saturation or to a 1:1 mole ratio. Use was made of Seidell's and Linke's compilations [615, 616, 617] to obtain the saturation concentrations. Values for Φ_L and Φ_C were estimated for some electrolytes when there was enough information available on the other members of the family.

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II. Units of Energy and Constants

The unit of energy used is the thermochemical calorie, defined by the relation 1 thermochemical calorie = 4.1840 J. The 1961 atomic weights are used [16]. The values for the specific heat of water are those recommended by the International Committee of Weights and Measures as given by Stimson [17]. The conversion factors for correction to the thermochemical calorie are taken from [18] and [618]. Unless otherwise mentioned the specific heats of the pure solutes used to correct ΔH_{soln} to 25 °C have been obtained from Kelley [19] and Kelley and King [20]. The values of the limiting slopes appearing in the Debye-Hückel theory of strong electrolytes are taken from Harned and Owen [9]. The emf data, on the whole, were used as summarized by Harned and Owen. The heats of vaporization of H_2O used in the calculations on the dissociation pressures of the hydrates were obtained from Osborne, Stimson, and Ginnings [649]. Whenever sufficient data appeared in the original article, the results were completely recalculated, making appropriate corrections for the specific heat of water, atomic weights, calorie used, etc. When the details given were insufficient to make exact corrections, the experimental results were corrected on the basis of reasonable estimates of the quantities employed by the authors.

III. Uncertainties

The uncertainties assigned to the various values have been based on many factors—the experimental technique used, the details given, the number of measurements, the standard deviation, the magnitude of the corrections to 25 °C (and to infinite dilution, for $\Delta H_{\infty}^{\circ}$), the inherent error in the methods used, the reliability of previous work of the investigators, etc. A strictly mathematical evaluation can therefore not be made. The personal appraisal is an important part of the overall evaluation. For example, the standard deviation of Wüst and Lange's [21] work on KCl is ±1 cal, but the assigned uncertainty is larger; the value selected as the "best" value is 40 cal lower than theirs. As in the above case, the standard deviation and also the assigned uncertainty can be misleading. In other cases it is not possible to assign an uncertainty because of the lack of information.

IV. The Apparent Molal Heat Capacity

A great many investigators have measured the specific heats of aqueous electrolyte solutions although only a few have done so with sufficient precision to give reliable results for the apparent molal heat capacity of the solute. Harned and Owen [8] have pointed out the difficulty in obtaining satisfactory results in very dilute solutions. They show, for example, that at a concentration of 0.01 molal an error of 0.01 percent in the specific heat measurements results in an error of about 10 cal/deg mole in the apparent molal heat capacity of the solute, whereas an error of 1 percent in the determination of the concentration results in an error of only 0.5 cal/deg mole. For this reason a great deal of reliance has been placed on the Debye-Hückel theory in the very dilute region.

The measurements of specific heat were converted to Φ_C. The values for Φ_C were plotted against $m^{1/2}$ on large scale graphs. The first three systems treated were NaCl, HCl, and NaOH, at the various experimental temperatures. This was done to determine the temperature coefficients, which in general were applied to other systems when necessary to correct to 25 °C. In general the curve was drawn down to $m^{1/2} = 0.4$ following the data available as closely as possible. The curve was continued so that as $m^{1/2} \rightarrow 0$, the slope, $d\Phi_C/dm^{1/2}$, approached the limiting value (6.13 at 25 °C).

Preliminary values for Φ_C° at 25 °C for the hydroxides, chlorides, bromides, iodides, and nitrates of H, Li, Na, and K were obtained. It was assumed that the heat capacities of the individual ionic species are additive at infinite dilution. Equations of the following sort were set up:

$$\Phi_C^{\circ}(H^+) + \Phi_C^{\circ}(Cl^-) = \Phi_C^{\circ}(HCl)$$
$$\Phi_C^{\circ}(Na^+) + \Phi_C^{\circ}(Cl^-) = \Phi_C^{\circ}(NaCl)$$
$$\Phi_C^{\circ}(K^+) + \Phi_C^{\circ}(Cl^-) = \Phi_C^{\circ}(KCl)$$
$$\Phi_C^{\circ}(H^+) + \Phi_C^{\circ}(Br^-) = \Phi_C^{\circ}(HBr)$$
$$\Phi_C^{\circ}(Na^+) + \Phi_C^{\circ}(Br^-) = \Phi_C^{\circ}(NaBr)$$
$$\Phi_C^{\circ}(K^+) + \Phi_C^{\circ}(Br^-) = \Phi_C^{\circ}(KBr)$$
$$\Phi_C^{\circ}(H^+) + \Phi_C^{\circ}(NO_3^-) = \Phi_C^{\circ}(HNO_3)$$
$$\Phi_C^{\circ}(Na^+) + \Phi_C^{\circ}(NO_3^-) = \Phi_C^{\circ}(NaNO_3)$$
$$\Phi_C^{\circ}(K^+) + \Phi_C^{\circ}(NO_3^-) = \Phi_C^{\circ}(KNO_3).$$
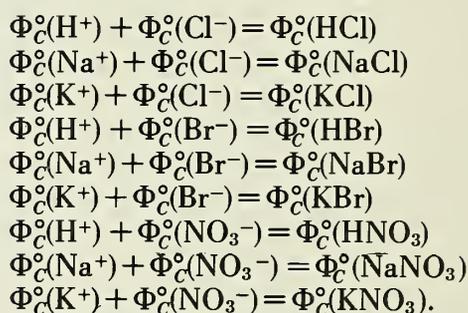
$\Phi_C^{\circ}(H^+)$ was set equal to 0. The values of Φ_C° for each electrolyte were weighted proportionally to their estimated reliability. By cross substituting values, values for the individual ions were obtained. The various values for each ion were weighted, depending on the source, and averaged. The Φ_C° values of the electrolytes were then adjusted to be self-consistent.

The values obtained were checked by the method of Guggenheim and Prue [22] as adapted by Pitzer and Brewer [10]. The results agreed well within the uncertainties. Thus, Pitzer and Brewer's values of Φ_C° for NaCl (-22.1 cal/deg mole) and KCl (-27.7) compare favorably with -21.5 and -27.4, respectively, obtained here by the above simple approach. If their method is used with the experimental data used here, values of -21.9 and -27.8 are obtained. The difference between $\Phi_C^{\circ}(Na^+)$ and $\Phi_C^{\circ}(K^+)$ in this work is 5.9 as compared to 5.6; for Cl^- and Br^-, 1.3 as compared to 1.2. It was therefore felt that there was no appreciable difference in results due to the method of extrapolation, but rather that it was which data were used and how the experimental data were treated that was more important. It was also felt advantageous

to treat each system individually. Very few adjustments were found to be necessary to make the results consistent, not only for Φ_C°, but also for Φ_L, ΔH_∞°, and ΔH_N°, at 25 °C.

Once the values for the above mentioned ions were determined, they were subtracted from the Φ_C° values obtained later for other compounds to obtain the values for the other ions in table I.

The values of Φ_C° of HCl, NaOH, and NaCl (table II) at temperatures other than 25 °C were not adjusted, since there were insufficient data available on the other systems to give an adequate number of values of Φ_C° for smoothing.

The values of Φ_C° for all compounds considered are given in tables III to IX. Graphic representation of the various families of curves, as well as a detailed curve for KCl, are given in figures I through VIII.

The available data for each compound are summarized in the following section. For each substance are listed the various investigations, with the temperature and range of concentrations measured. The investigations given the greatest weight in the evaluation of Φ_C are marked with an asterisk. The substances are discussed in the order: acids, ammonium and amine salts, silver salts, and salts of the alkali metals.

HF

The specific heat has been measured by Baud [23] (15 °C, $m=11.72$), Pranschke and Schwiete [24]* (18 °C, $m=34.30$ to 5.44), Kolesov, Skuratov, and Uvarov [25]* (25 °C, $m=2.01$ to 0.01), Thorvaldson and Bailey [26]* (19 °C, $m=46.37$ to 0.28), Roth and Chall [27] (50 °C, and between 20 and 50 °C, $m=13.26$), Roth, Pahlke, Bertram, and Börger [28]* (20 °C, $m=2.22$ to 0.11), and Mulert [29] (17–18 °C, $m=17.5$ to 2.63).

HCl

The specific heat has been measured by Thomsen [30]* (18 °C, $m=5.55$ to 0.56), Marignac [31, 32]* (22 °C, $m=2.22$ to 0.56), Richards and Rowe [33, 34] (18 °C, $m=0.28$), [35, 36] (18 °C, $m=0.56$ and 0.28), and [37]* (18 °C, $m=5.55$ and 2.77), Richards, Rowe, and Burgess [38] (20 °C, $m=6.30$ and 2.78), Roth and Chall [27] (50 °C, and between 22.5 and 50 °C, $m=2.25$), Ackermann [39]* (10, 20, 40 to 120 °C, $m=2.00$ to 0.50), Vrevskiĭ and Kaĭgorodov [40, 41]* (3.3, 20.5, 40.4, and 60.5 °C, $m=16.60$ to 0.17), Tucker [42] (10 °C, $m=12.67$ to 2.57), Richards, Mair, and Hall [43]* (16, 18, and 20 °C, $m=2.22$ to 0.56), Thorvaldson, Brown, and Peaker [44]* (18 and 19 °C, $m=2.78$), Drucker [45]* (18 °C, $m=2.65$ and 1.25), Radulescu and Jula [46]* (15 °C, $m=2.08$), Wicke, Eigen, and Ackermann [47]* (20, 40, 60 to 130 °C, $m=1.91$ to 0.59), Randall and Ramage [48]* (25 °C, $m=1.05$ to 0.08), Gucker and Schminke [49]* (25 °C, $m=2.01$ to 0.01), and Sturtevant [50]* (25 °C, $m=0.87$ to 0.02). The $\bar{J}_2$ values obtained here agree well with Bates and Bower's [51] values of $\bar{J}_2$ from emf measurements below $m=0.1$ and

Harned and Owen's [9] tabulation of $\bar{J}_2$ obtained from the extended Debye-Hückel equation. For $0.1 \leqslant m \leqslant 4.0$ the $\bar{J}_2$ values are below and within 2 cal/deg mole of the values tabulated by Harned and Owen from Harned and Ehlers' emf data. As $m \to 4.0$ the difference becomes 1 cal/deg mole.

Other emf measurements since 1955 have been reported by Hayes and Lietzke [52] (25 to 50 °C, $m=0.1$ to 0.001), Greeley [53] (25 to 200 °C, $m=1.0$ to 0.005), Covington and Prue [54] (25 °C, $m=0.07$ to 0.005) and [55] (25 °C, $m=0.1$ to 0.005), Oiwa [56] (25 °C, $m=0.1$ to 0.001), Taylor and Smith [57] (10 to 45 °C, $m=1.5$ to 0.9) and Aston and Gittler [58] (25 °C, $m=4.0$ to 1.2).

HClO₄

The specific heat has been measured by Berthelot [59, 60] (between 15 and 40 °C, $m=9.0$ to 0.05), and Richards and Rowe [36] (18 °C, $m=0.56$).

The data were not considered reliable for a Φ_C curve.

HBr

The specific heat has been measured by Tolloczko and Meyer [61] (13.25 °C, $m=4.1$), Richards and Rowe [35, 36]* (18 °C, $m=0.56$), Roozeboom [62]* (between 12 and 30 °C, $m=30.17$ to 0.28), and Johnson, Gilliland, and Prosen [63]* (25 °C, $m=11.10$).

$\bar{J}_2$ values were compared with Harned and Owen's [9], and Biermann and Yamasaki's [64] emf data. The agreement is good.

HI

The specific heat has been measured by Richards and Rowe [36]* (18 °C, $m=0.56$), and Johnson, Gilliland, and Prosen [63]* (25 °C, $m=7.60$).

HIO₃

The specific heat has been measured by Randall and Taylor [65]* (25 °C, $m=3.60$ to 0.07).

HNO₃

The specific heat has been measured by Thomsen [30]* (18 °C, $m=5.55$ to 0.23), Marignac [66]* (between 21 and 52 °C, $m=1.10$ to 0.56), Mishchenko and Ponomareva [67]* (21 °C, extremely concentrated solutions to 1.24), Forsythe and Giauque [68]* (25 °C, $m=35.55$ and 18.50), Roth [69]* (20 °C, $m=0.27$ to 0.03), Drucker [45]* (18 °C, $m=2.41$ to 1.06), Richards and Rowe [36] (18 °C, $m=0.56$) and [70]* (18 °C, $m=5.55$ to 0.14), Lloyd and Wyatt [71] (0 °C, extremely concentrated solutions), Bump et al. [72] (0 to 26.7 °C, extremely concentrated solutions), and Booman, Elverum, and Mason [73] (0 °C, extremely concentrated solutions).

CH₂O₂

The specific heat of aqueous formic acid has been measured by Bury and Davies [74]* (15 °C, $m=10.06$ to 1.33), Ackermann and Schreiner [75]* (0, 10, 20, 30 to 130 °C, $m=2.84$ to 0.49), and Glagoleva and Cherbov [76]* (25, 60, and 80 °C, 100% to $m=4.185$).

The specific heat of $CH_2O_2(1)$ has been measured by von Reis [77], Radulescu and Jula [46], Berthelot and Ogier [78], Pettersson [79], Glagoleva and Cherbov [76], Gibson, Latimer, and Parks [80]*, and Stout and Fisher [81]*.

$C_2H_4O_2$

The specific heat of aqueous acetic acid has been measured by Marignac [32, 66]* (between 21 and 52 °C, $m = 22.2$ to 2.22), Neĭman [82, 83]* (23.9, 42.0, 59.5, and 80.5 °C, 100% to $m = 0.96$), Richards and Gucker [84]* (16, 18, and 20 °C, $m = 2.22$), von Reis [85]* (18 °C, $m = 2.22$), Bury and Davies [74]* (15 °C, $m = 8.66$ to 0.91), and Ackermann and Schreiner [75]* (10, 20, 30 to 130 °C, $m = 3.00$ to 0.50).

Richards and Gucker [84]* calculated the specific heat (18 °C, $m = 1.11$ to 0.07) from ΔH_{diln} and the value of the specific heat at $m = 2.22$.

The specific heat of $C_2H_4O_2(1)$ has been measured by Radulescu and Jula [46]*, von Reis [77], Parks and Kelley [86]*, Swietoslawski and Zielenkiewicz [87], Neĭman [82, 83]*, Marignac [32], and Berthelot [88].

$C_3H_6O_2$

The specific heat of aqueous propionic acid has been measured by Bury and Davies [74]* (15 °C, $m = 5.84$ to $m = 0.49$) and Ackermann and Schreiner [75]* (0, 10, 20, 30 to 130 °C, $m = 2.00$ to 0.50).

NH_3

The specific heat has been measured by Rühlemann [89] (between 22 and 99 °C, $m = 1.35$), Vrevskiĭ and Kaĭgorodov [40, 41]* (2.4, 20.6, 41, and 60.9 °C, $m = 28.01$ to 0.84), and Hildenbrand and Giauque [90]* (25 °C, $m = 55.51$, and −73 to −18 °C, more concentrated solutions).

NH_4F

The specific heat has been measured by Labowitz and Westrum [91]* (25 °C, $m = 0.50$ to 0.005).

NH_4Cl

The specific heat has been measured by Thomsen [30]* (18 °C, $m = 7.40$ to 0.28), Marignac [32]* (between 20 and 52 °C, $m = 4.44$ to 0.56), Drucker [45]* (18 °C, $m = 4.73$ to 1.10), Mishchenko and Ponomareva [67, 92]* (25 °C, $m = 7.03$ to 0.31), D'Ans and Tollert [93]* (21, 41, 70, and 86 °C, $m = 3.28$ and 1.67), Winkelmann [94]* (15 to 28.6 °C, $m = 6.23$ to 0.58), Faasch [95]* (18 °C, $m = 3.96$ to 0.47), and Urban [96]* (20, 25, 30, 35, and 40 °C, $m = 2.00$).

The value for $\Phi_C^\circ NH_4^+$ was obtained by subtracting $\Phi_C^\circ Cl^-$ from $\Phi_C^\circ NH_4Cl$.

NH_4Br

The specific heat has been measured by Thomsen [30] (19 °C, $m = 0.28$) and Faasch [95] (18 °C, $m = 4.02$ to 0.50). The Φ_C line, however, was estimated.

$\Phi_C^\circ NH_4Br$ was obtained from $\Phi_C^\circ NH_4^+$ and $\Phi_C^\circ Br^-$

NH_4I

Thomsen [30] measured the specific heat (18 °C,

$m = 0.28$). The Φ_C curve was essentially estimated, using $\Phi_C^\circ NH_4I$ from the ions.

NH_4NO_3

The specific heat has been measured by Thomsen [30]* (18 °C, $m = 11.10$ to 0. 56), Marignac [32, 66]* (between 20 and 50 °C, $m = 11.10$ to 0.56), Tollinger [97]* (23.5 °C, $m = 0.56$), Zwicky [98] (20 °C, $m = 28.61$ to 1.39), Lerner-Steinberg [99]* (21.6 °C, $m = 0.60$ and 0.44), Chauvenet [100] (15 °C, $m = 1.33$), Drucker [45]* (20 °C, $m = 4.99$ and 1.05), Rutskov [101, 102]* (25, 50, and 75 °C, $m = 18.50$ to 0.56), Winkelmann [94]* (16 to 38 °C, $m = 8.33$ to 0.39), Cohen, Helderman, and Moesveld [103, 104] (32.3 °C, $m = 28.41$ to 1.39), and Gucker, Ayres, and Rubin [105, 106]* (25 °C, $m = 24.00$ to 0.10).

CH_3NH_3Cl

The specific heat has been measured by Whitlow and Felsing [107]* (25 °C, $m = 0.96$ to 0.09). Φ_C is tabulated only in the range from $m = 1.11$ to 0.09 since the data available are not considered reliable for extrapolation to infinite dilution. A rough extrapolation leads to a value for Φ_C° of −1 cal/deg mole.

$(CH_3)_2NH_2Cl$

The specific heat has been measured by Whitlow and Felsing [107]* (25 °C, $m = 0.98$ to 0.11). Φ_C is tabulated only in the range from $m = 1.11$ to 0.09 since the data available are not considered reliable for extrapolation to infinite dilution. A rough extrapolation leads to a value for Φ_C° of +2 cal/deg mole.

$(CH_3)_3NHCl$

The specific heat has been measured by Whitlow and Felsing [107]* (25 °C, $m = 1.0$ to 0.09). Φ_C is tabulated only in the range from $m = 1.11$ to 0.09 since the data available are not considered reliable for extrapolation to infinite dilution. A rough extrapolation leads to a value for Φ_C° of +4 cal/deg -mole.

AgF

The specific heat has been measured by Jahn-Held and Jellinek [110]* (25 °C, $m = 14$ to 1). Values for Φ_C are given at infinite dilution and above $m = 2$.

$AgNO_3$

The specific heat has been measured by Marignac [66]* (between 25 and 52 °C, $m = 2.22$ to 0.56) and Kapustinskiĭ, Yakushevskiĭ, and Drakin [111]* (25 °C, $m = 1.80$ to 0.28). Roth [69]* gives an equation for the range $m = 0.22$ to 0.08 at 18.5 °C.

$LiOH$

The specific heat has been measured by Richards and Rowe [70]* (18 °C, $m = 2.22$), and [36] (18 °C, $m = 0.56$), and Gucker and Schminke [112]* (25 °C, $m = 2.27$ to 0.04).

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Richards and Rowe [70]* calculated the specific heat (18 °C, $m = 1.11$ to 0.14) from ΔH_{diln} at 16 and 20 °C and the specific heat at $m = 2.22$.

The Φ_C curve was based primarily upon Gucker and Schminke's measurements.

LiCl

The specific heat has been measured by Tucker [42] (14 to 22 °C, $m = 16.34$ to 2.52), Chernyak [113] (25 °C, $m = 1.0$), Bennewitz and Kratz [114]* (20 °C, $m = 1.0$ to 0.05), White [115]* (25 °C, $m = 0.05$), Jauch [116] (18 °C, $m = 4.06$ to 0.50) Hess [117]* (25 °C, $m = 0.15$), Drucker [45]* (18 °C, $m = 9.8$ to 1.3), Gucker and Schminke [49]* (25 °C, $m = 2.46$ to 0.04), Richards and Rowe [70]* (18 °C, $m = 2.22$), and Lange and Dürr [118]* (25 to 28 °C, $m = 19.89$ to 0.56).

Richards and Rowe [70]* calculated the specific heat (18 °C, $m = 1.11$ to 0.14) from ΔH_{diln} and the specific heat at $m = 2.22$.

The Φ_C lines of Gucker and Schminke, and Lange and Dürr are parallel to one another. There seems to be a systematic error in the latter's work. The final Φ_C line is based primarily on Gucker and Schminke's work.

LiBr

The specific heat has been measured by Jauch [116]* (18 °C, $m = 4.45$ to 0.51), Lange and Schwartz [119]* (26.5 °C, $m = 17.92$ to 0.04), and Eigen and Wicke [120]* (10, 20, 40, 60 to 120 °C, $m = 0.56$, 0.91, and 1.32).

Here as in LiCl, the Φ_C lines of Eigen and Wicke and Lange and Schwartz are parallel. Eigen and Wicke's line was essentially used, with Lange and Schwartz's Φ_C values lowered by a constant amount to coincide with Eigen and Wicke's.

LiI

The specific heat has been measured by Jauch [116]* (18 °C, $m = 3.17$ to 0.51).

LiNO₃

The specific heat has been measured by Chauvenet [100] (15 °C, $m = 2$), Drucker [45]* (18 °C, $m = 1.89$ to 0.91), and Richards and Rowe [70]* (18 °C, $m = 2.22$). The latter also used ΔH_{diln} at 16 and 20 °C to calculate the specific heat from $m = 1.11$ to 0.14 at 18 °C.

NaOH

The specific heat has been measured by Thomsen [30]* (19 °C, $m = 7.40$ to 0.28), Bertetti and McCabe [121]* (3.12 to 60 °C, $m = 22.81$ to 1.06), Richards and Rowe [36]* (18.1 °C, $m = 0.56$ and 0.28), Ackermann [39, 122]* (10, 20, 40, 60 to 130 °C, $m = 2.00$ to 0.50), Richards and Gucker [84]* (16, 18, and 20 °C, $m = 2.22$), Sturtevant [50]* (25 °C, $m = 0.087$ to 0.006), Tucker [42] (16 to 21 °C, $m = 22.54$ to 4.92), Richards and Hall [123]* (18 °C, $m = 2.22$ to 0.56), Roth, Wirths, and Berendt [124] (19.8 °C, $m = 10.11$), Wilson and McCabe [125]* (29.8 to 122 °C, $m = 26.76$ to 25.20), and Gucker and Schminke [112]* (25 °C, $m = 2.55$ to 0.04).

The values of $\bar{J}_2$ obtained here agree well with those given by Harned and Owen [9] and Akerlöf and Kegeles [126] below $m = 2$.

NaCl

The specific heat has been measured by Thomsen [30] (19 °C, $m = 5.55$ to 0.28), Marignac [32] (18 °C and between 22 and 52 °C, $m = 2.22$ to 0.56), Stakhanova and Vasilev [127]* (25 °C, $m = 4.37$ to 0.20), Biron [128] (19 °C, $m = 0.28$ to 0.07), Blaszkowska [129]* (21.4 °C, $m = 2.22$ to 0.28), Zdanovskii [130]* (25 °C, $m = 2.33$), Zdanovskii and Suslina [131]* (25 °C, $m = 1.89$), Zdanovskii and Matsenok [132]* (25 °C, $m = 6.11$ to 1.75), Eigen and Wicke [120]* (10, 20, 40 to 130 °C, $m = 1.12$ to 0.41), D'Ans and Tollert [93] (21 and 41 °C, $m = 5.75$ to 1.66), Drucker [45]* (20 °C, $m = 4.36$ to 1.02), Chipman, Johnson, and Maass [133]* (18.8 and 25.4 °C, $m = 2.54$ to 0.43), Nikolaev, Kogan, and Ogorodnikov [134]* (25 °C, $m = 6.15$ to 0.34), Winkelmann [94] (17 to 46 °C, $m = 5.48$ to 0.53), Leitner [135] (25.7 to 95.7 °C, $m = 5.97$), Hess [117]* (25 °C, $m = 0.15$ to 0.003), White [136]* (35 to 45 °C, $m = 0.20$ to 0.01), Hess and Gramkee [137]* (15, 25, 35, 45 °C, $m = 1.03$ to 0.01), Voskresenskaya and Yankovskaya [138] (50 °C, $m = 57.6$ to 3.45), Lipsett, Johnson, and Maass [139]* (25 °C, $m = 6.01$ to 0.17), Bousefield and Bousefield [140]* (7, 20, and 33 °C, $m = 5.70$ to 0.25), Rutskov [101, 102]* (25, 50, and 75 °C, $m = 5.55$ to 0.20), Ackermann [39]* (10, 20, 40, 60 to 130 °C, $m = 2.00$ to 0.50), Randall and Ramage [48]* (25 °C, $m = 1.90$ to 0.07), Sandonnini and Gerosa [141] (18.5 °C, $m = 1.12$ to 0.20), Person [142] (0 to 13 °C, $m = 9.05$ to 1.88), Randall and Bisson [143]* (25 °C, $m = 6.20$ and 4.04), Randall and Rossini [144]* (25 °C, $m = 2.30$ to 0.04), and Richards and Gucker [84]* (18 °C, $m = 2.22$).

The $\bar{J}_2$ values were checked with those obtained from emf data as given by Harned and Owen [9]. The agreement is excellent below $m = 1$ and within 3 cal/deg mole between $m = 1$ and 4.

NaClO₃

The specific heat has been measured by Colomina and Nicolas [145]* (24 °C, $m = 15.39$ to 0.20) and Ferrer [146]* (25 °C, $m = 3.11$ to 0.19).

NaClO₄

The specific heat has been measured by Colomina and Nicolas [145]* (24.5 °C, $m = 12.22$ to 0.13), and Ferrer [146]* (25 °C, $m = 2.59$ to 0.24).

The values of Φ_C chosen were based on Ferrer's data up to $m = 2.6$ and above that on Colomina's.

NaBr

The specific heat of aqueous NaBr has been measured by Marignac [32, 66]* (between 20 and 52 °C, $m = 2.22$ to 0.56), Chipman, Johnson, and Maass [133] (25.4 and 18.8 °C, $m = 1.88$ to 0.24), Bender and Kaiser [147]* (25 and 30 °C, $m = 8.37$ to 0.97), Rossini [148]* (25 °C, $m = 0.43$ to 0.08), and Randall and Rossini [144]* (25 °C, smoothed values from $m = 1.00$ to 0.01).

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Below $m = 2.0$ the values obtained here for $\bar{J_2}$ were below but within 3 cal/deg mole of the emf values listed in Harned and Owen [9].

NaBrO₃

The specific heat has been measured by Ferrer [146]* (25 °C, $m = 2.34$ to 0.21).

NaI

The specific heat has been measured by Thomsen [30]* (18 °C, $m = 0.28$), Marignac [32, 66]* (between 20 and 51 °C, $m = 2.22$ to 0.56), Rossini [148]* (25 °C, $m = 0.85$ to 0.9), and Randall and Rossini [144]* (25 °C, smoothed values from $m = 1.00$ to 0.01).

NaNO₂

The specific heat has been measured by Ferrer [146]* (25 °C, $m = 2.25$ to 0.10) and Perreu [149] (15 °C, $m = 11.87$ to 1.45).

NaNO₃

The specific heat has been measured by Thomsen [30]* (18 °C, $m = 5.55$ to 0.28), Marignac [66]* (20.5 °C and between 22 and 52 °C, $m = 2.22$ to 0.56), Biron [128] (19 °C, $m = 0.28$ to 0.03), Person [142] (0 to 20 °C, $m = 7.7$ to 0.59), Magie [150] (room temperature, $m = 1.11$ to 0.19), D'Ans and Tollert [93]* (21 °C, $m = 5.0$), Winkelmann [94, 151] (2 to 60 °C, $m = 2.35$ to 0.37), Gerlach [152] (between 20 and 95 °C, $m = 10.2$), Richards and Gucker [84]* (18 °C, $m = 2.22$), Zdanovskiĭ [130]* (25 °C, $m = 2.58$), Rossini [148]* (25 °C, $m = 0.85$ to 0.08), Randall and Rossini [144]* (25 °C, smoothed values at $m = 1.00$ to 0.01), Richards and Rowe [70]* (18 °C, $m = 2.22$), Drucker [45]* (18 °C, $m = 4.59$ to 1.03), and Chauvenet [100] (15 °C, $m = 2.13$).

Richards and Rowe [70]* calculated the specific heat (18 °C, $m = 1.11$ to 0.14) from the dilution data at 16 and 20 °C and the specific heat at $m = 2.22$.

NaCHO₂

The specific heat of aqueous sodium formate has been measured by Ackermann and Schreiner [75]* (10, 20, 30 to 120 °C, $m = 2.85$ to 0.50).

NaC₂H₃O₂

The specific heat of aqueous sodium acetate has been measured by Thomsen [30]* (17 °C, $m = 2.78$ to 0.28), Marignac [32, 66]* (22.5 °C, and between 19 and 52 °C, $m = 2.22$ to 0.56), Richards and Gucker [84]* (16, 18, and 20 °C, $m = 2.22$), Perreu [153]* (19 °C, $m = 4.78$ to 1.36), Bindel [154] (21 °C, $m = 5.55$ to 1.11), Ferrer [146]* (25 °C, $m = 2.79$ to 0.23), Kapustinskiĭ and Stakhanova [155]* (25 °C, $m = 17.13$ to 3.14), Ackermann and Schreiner [75]* (10, 20, 30 to 120 °C, $m = 2.53$ to 0.60). Gnesotto and Fabris [156] measured the specific heat of the liquid trihydrate at 0 to 100 °C.

Richards and Gucker [157]* calculated the specific heat ($m = 1.09$ to 0.03) from dilution data and the specific heat at $m = 2.22$, obtained in [84].

NaC₃H₅O₂

The specific heat of aqueous sodium propionate

has been measured by Ackermann and Schreiner [75]* (10, 20, 30 to 120 °C, $m = 2.24$ to 0.50).

KOH

The specific heat has been measured by Thomsen [30]* (18 °C, $m = 1.85$ to 0.28), Jaquerod [158] (18 °C, $m = 4.92$ to 0.95), Gawlik [159]* (20 °C, $m = 0.33$ to 0.04), Voskresenskaya [160]* (20 °C, $m = 4.24$), Richards and Hall [123]* (18 °C, $m = 0.56$), Gucker and Schminke [49]* (25 °C, $m = 2.59$ to 0.04), Richards and Rowe [36]* (18 °C, $m = 0.56$) and [70]* (18 °C, $m = 13.38$ and 5.55), Sabatier [161] (temperature uncertain, $m = 13.37$).

Richards and Rowe [70]* calculated the specific heat (18 °C, $m = 2.22$ to 0.14) from the dilution data and specific heats of the more concentrated solutions.

The agreement of the calculated $\bar{J_2}$ values with those given by Harned and Owen [9] for the emf values is excellent.

KCl

The specific heat has been measured by Thomsen [30]* (18 to 20 °C, $m = 3.7$ to 0.28), Marignac [32, 66]* (19.5 °C and between 20 and 51 °C, $m = 1.11$ to 0.56), Andrews [162] (18 °C, $m = 0.25$), Stakhanova and Vasilev [127]* (25 °C, $m = 4.60$ to 0.20), Voskresenskaya and Rutskov [163]* (25 °C, $m = 1.40$), Biron [128] (19 °C, $m = 0.28$ to 0.03), Winkelmann [94] (0 to 55 °C, $m = 5.59$ to 0.42), and [151] (20 °C, $m = 0.71$), Chipman, Johnson, and Maass [133]* (18.8 and 25.4 °C, $m = 2.48$ to 0.33), Magie [150] (room temperature, $m = 1.11$ to 0.14), Sandonnini and Gerosa [141] (18.5 °C, $m = 0.75$ to 0.17), Jaquerod [158] (18 °C, $m = 3.8$ to 0.95), Cobb and Gilbert [164]* (25 °C, $m = 1.00$ and 0.50), D'Ans and Tollert [93]* (21 and 41 °C, $m = 4.40$ to 1.7), Nikolaev, Kogan, and Ogorodnikov [134]* (25 °C, $m = 4.80$ to 0.07), Zdanovskiĭ [130]* (25 °C, $m = 2.56$), Rutskov [101, 102]* (25 °C, $m = 4.63$ to 0.10), Popov, Bundel, and Choller [165]* (20 °C, $m = 0.56$ to 0.14), Popov, Khomyakov, Feodos'ev, and Schirokich [166]* (same data as [165]), Urban [96]* (10 to 40 °C, $m = 2.00$ to 0.10), Ferrer [146]* (25 °C, $m = 2.98$ to 0.05), Hess and Gramkee [137]* (15, 25, 35, 45 °C, $m = 1.03$ to 0.01), Clews [167]* (15.6 to 43.2 °C, $m = 2.50$ to 0.10), Gucker [168]* (20 °C, $m = 2.22$), Kapustinskiĭ, Yakushevskiĭ, and Drakin [111]* (25 °C, $m = 1.71$ to 0.52), Varasova, Mishchenko, and Frost [169]* (25 °C, $m = 4.85$ and 2.73), Randall and Bisson [143] (25 °C, $m = 4.85$ and 2.73), Bousefield and Bousefield [140]* (20 and 33 °C, $m = 3.40$ to 0.25), Randall and Rossini [144]* (25 °C, $m = 2.50$ to 0.05), Rossini [148]* (25 °C, $m = 2.25$ to 0.04), Cohen and Moesveld [170]* (19 °C, $m = 3.39$ and 1.03), Parshikov [171]* (25 °C, $m = 0.41$), and Richards and Rowe [70]* (18 °C, $m = 2.22$).

Richards and Rowe [70]* calculated the specific heat (18 °C, $m = 1.11$ to 0.14) from the directly determined specific heat at $m = 2.22$ and their dilution data. The ΔH_{soln} and ΔH_{diln} experiments of Wüst and Lange [21]* were sufficiently detailed

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to permit the computation of the heat capacity of the solutions. The ΔH_{soln} measurements of KCl at various temperatures were also used to compute Φ_C at the mean temperature.

The calculated J_2 values were compared with those obtained from the emf measurements as given by Harned and Owen [9]. The agreement was good, within 1 cal/deg mole below $m = 2$.

KBr

The specific heat has been measured by Thomsen [30]* (18 °C, $m = 0.28$), Marignac [32, 66]* (between 20 and 51 °C, $m = 2.22$ to 0.56), Popov, Bundel, and Choller [165]* (20 °C, $m = 0.19$), Bender and Kaiser [147]* (25 and 35 °C, $m = 5.52$ to 1.00), Rossini [148]* (25 °C, $m = 0.97$ to 0.04), Randall and Rossini [144]* (25 °C, smoothed values from $m = 1.00$ to 0.01), Chipman, Johnson, and Maass [133]* (25.4 and 18.4 °C, $m = 1.57$ to 0.21), Urban [96]* (10, 15, 20, 25, 30, 35, and 40 °C, $m = 2.00$), Popov, Skuratov, and Strel'tsova [172]* (20.2 °C, $m = 0.32$).

KI

The specific heat has been measured by Thomsen [30]* (18 °C, $m = 0.28$), Marignac [32] (between 20 and 51 °C, $m = 2.22$ to 0.56), Drucker [45]* (18 °C, $m = 3.24$ to 0.68), Popov, Skuratov, and Strel'tsova [172]* (20.2 °C, $m = 1.63$), Rossini [148]* (25 °C, $m = 0.85$ to 0.04), and Randall and Rossini [144] (25 °C, smoothed values from $m = 1.00$ to 0.01).

KIO₃

The specific heat has been measured by Randall and Taylor [65]* (25 °C, $m = 0.38$ to 0.04).

KNO₃

The specific heat has been measured by Thomsen [30]* (18 °C, $m = 2.22$ to 0.23), Marignac [32, 66]* (20.5 °C and between 22 and 52 °C, $m = 2.22$ to 0.56), Person [142] (0.6 to 20.6 °C, $m = 2.00$ to 0.50), Drucker [45]* (19 °C, $m = 2.18$ and 1.05), Voskresenskaya [160]* (30 °C, $m = 2.10$), Rutskov [101, 102]* (25, 50, and 75 °C, $m = 0.50$ to 6.94), Zdanovskiĭ [130]* (25 °C, $m = 3.12$), Magie [150] (room temperature, $m = 2.22$ to 0.14), Biron [128] (19 °C, $m = 0.28$ and 0.14), D'Ans and Tollert [93] (41 °C, $m = 2.78$), Winkelmann [94, 151] (4 to 60 °C, $m = 2.44$ to 0.30), Chauvenet [100] (15 °C, $m = 2.18$), Richards and Gucker [84]* (18 °C, $m = 2.22$), Andrews [162] (16.6 °C, $m = 0.26$), Gucker [168]* (20, 50, and 80 °C, $m = 2.22$), Richards and Rowe [70]* (18 °C, $m = 2.22$), Rossini [148]* (25 °C, $m = 1.05$ to 0.05), Randall and Rossini [144]* (25 °C, smoothed values at $m = 1.00$ to 0.01).

Lange and Monheim [173]* calculated the specific heat at 18.75 °C from the solution and dilution experiments at 12.5 and 25.0 °C at $m = 0.146$ to 0.0004. Richards and Rowe [70]* calculated the specific heat (18 °C, $m = 1.11$ to 0.14) from dilution data and the measured specific heat at $m = 2.22$.

KCNS

Urban [96]* has measured the specific heat (10, 15, 20, 25, 30, 35, and 40 °C, $m = 2.63$ to 0.50).

KC₂H₃O₂

The specific heat of aqueous potassium acetate has been measured by Marignac [32, 66]* (between 20 and 51 °C, $m = 11.11$ to 2.22), Drucker [45]* (18.6 °C, $m = 5.62$ to 1.05), Urban [96]* (10, 15, 20, 25, 30, 35, and 40 °C, $m = 2.36$ to 0.25), and Andrews [162] (18 °C, $m = 0.25$).

KMnO₄

The specific heat has been measured by Perreu [174]* (19 °C, $m = 0.40$ to 0.063) and Kapustinskiĭ and Klokman [175]* (25 °C, $m = 0.32$ to 0.03).

KClO₃

The specific heat has been measured by Bindel [154] (20 °C, $m = 2.78$ to 0.56). The data were not considered reliable for a Φ_C line.

Cs and Rb Compounds

The scarcity of concordant information on the Cs compounds makes the selection of $\Phi_C^\circ Cs^+$ difficult. The selection depends on whether the data of Richards and Rowe [70] at 18 °C on CsCl or CsNO₃, or the data of Kapustinskiĭ and coworkers [176, 177, 178, 179] on CsI at 25 °C are utilized. It was felt that the more recent measurements on CsI are the more reliable. This choice necessitated estimating the other Φ_C lines, which were drawn to be consistent with the CsI and the K compounds.

Since there was no reliable information available on the Rb compounds to determine $\Phi_C^\circ Rb^+$, the value was estimated on the basis of values of Φ_C° of Cs⁺, K⁺, and Na⁺.

The data available for each compound follow:

RbI

Jauch [116] has measured the specific heat (18 °C, $m = 3.14$ to 0.05).

RbNO₃

Chauvenet [100] has measured the specific heat (15 °C, $m = 1.45$).

CsCl

The specific heat has been measured by Bennewitz and Kratz [114]* (20 °C, $m = 0.41$ to 0.01) and Richards and Rowe [70]* (18 °C, $m = 1.11$ to 0.14).

CsI

The specific heat has been measured by Kapustinskiĭ, Yakushevskiĭ, and Drakin [176]* (25 °C, $m = 0.73$ to 0.15), and Kapustinskiĭ, Lipilina, and Samoĭlov [177, 178]* (25 °C, $m = 1.06$ to 0.22). Kapustinskiĭ [179]* reported the same values.

CsNO₃

The specific heat has been measured by Chauvenet [100] (15 °C, $m = 0.61$) and Richards and Rowe [70]* (18 °C, $m = 0.93$ to 0.14).
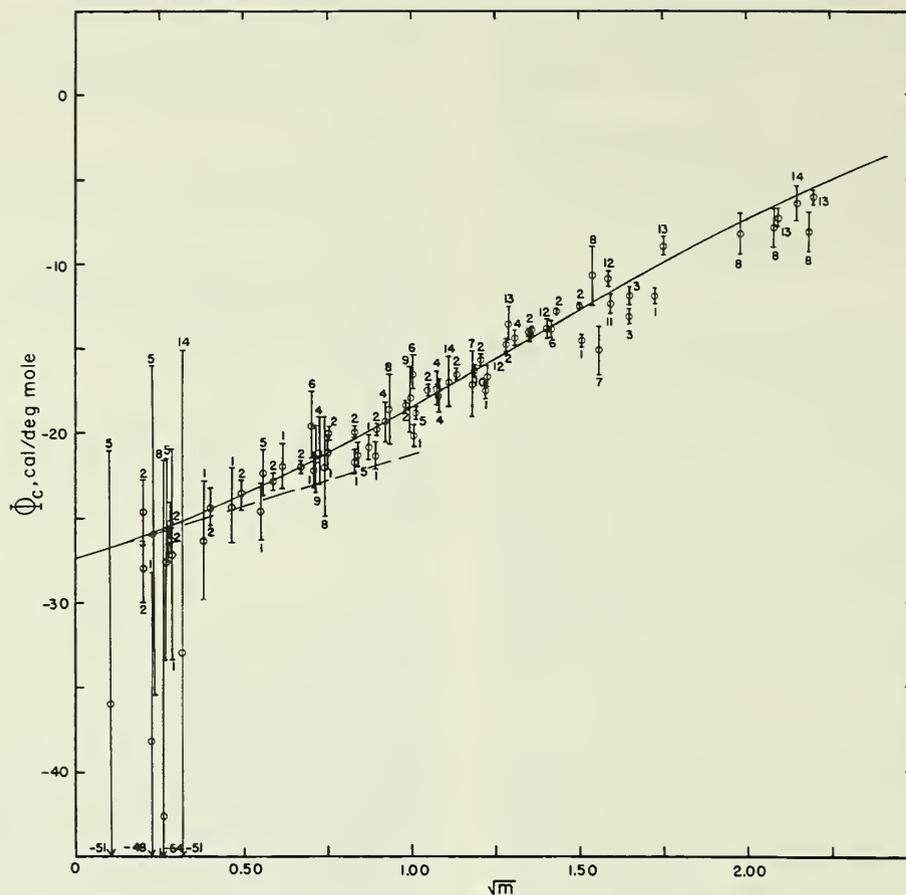
FIGURE I. *The apparent molal heat capacity, Φ_C, of KCl in cal/deg mole, at 25 °C as a function of $m^{1/2}$.*

The vertical line indicates the assigned uncertainty of the determination. The series of the determinations are:

(1) Ferrer [146]
(2) Rossini [148]
(3) Randall and Bisson [143]
(4) Kapustinskiĭ, Yakushevskiĭ, and Drakin [111]
(5) Hess and Gramkee [137]
(6) Urban [96]
(7) Varasova, Mischenko, and Frost [169]
(8) Nikolaev, Kogan, and Ogorodnikov [134]
(9) Cobb and Gilbert [164]
(10) Voskresenskaya and Rutskov [163]
(11) Zdanovskii [130]
(12) Clews [167]
(13) D'Ans and Tollert [93]
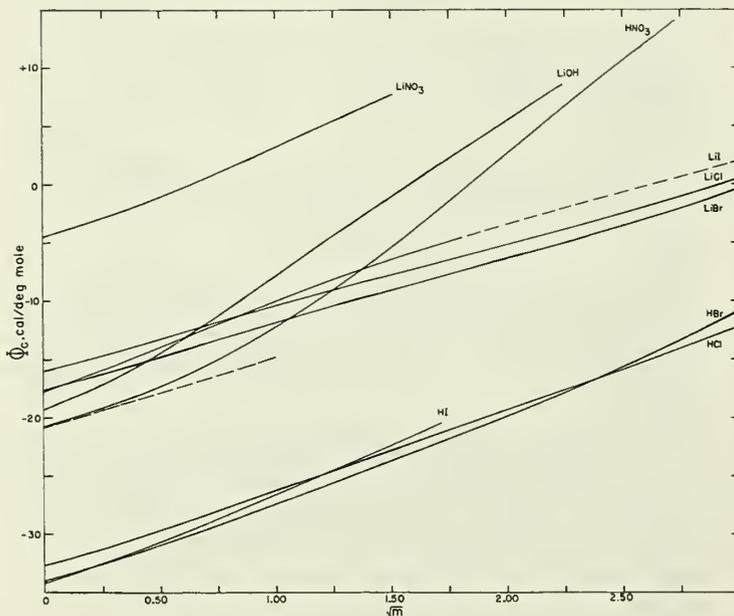
FIGURE II. *Φ_C as a function of $m^{1/2}$ in aqueous solutions of* HCl, HBr, HI, HNO$_3$, LiOH, LiCl, LiBr, LiI, *and* LiNO$_3$ *at 25 °C.*
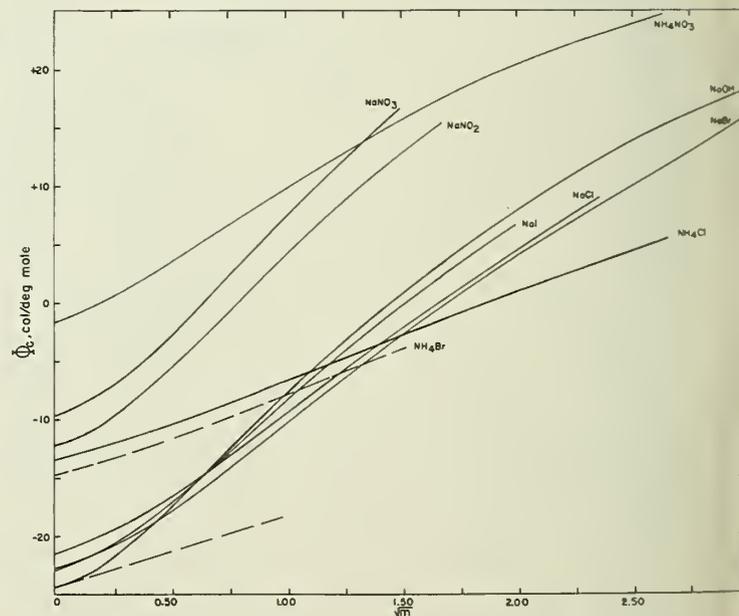
FIGURE III. *Φ_C as a function of $m^{1/2}$ in aqueous solutions of* NH$_4$Cl, NH$_4$Br, NH$_4$NO$_3$, NaOH, NaCl, NaBr, NaI, NaNO$_2$, *and* NaNO$_3$ *at 25 °C.*

NH$_4$Br is estimated.

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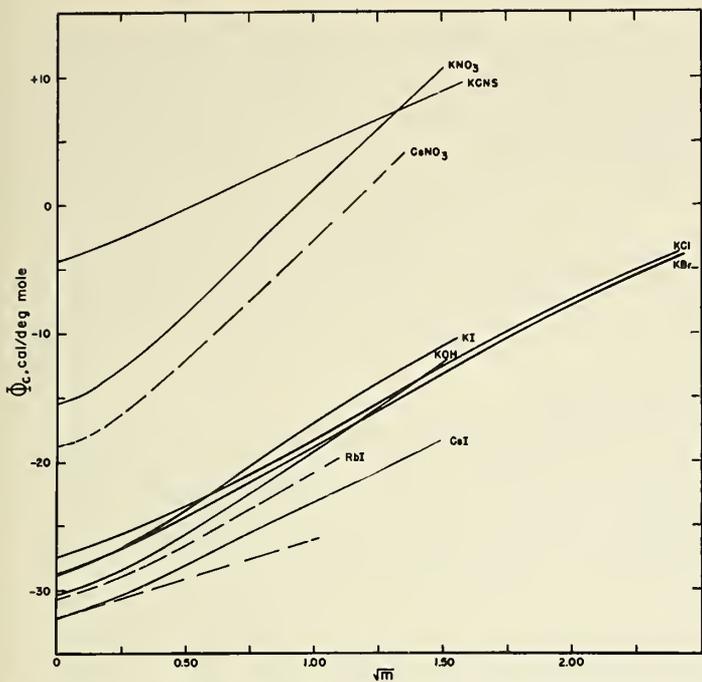
FIGURE IV. Φ_c as a function of $m^{1/2}$ in aqueous solutions of KOH, KCl, KBr, KI, KNO$_3$, KCNS, RbI, CsI, and CsNO$_3$ at 25 °C. CsNO$_3$ and RbI are estimated.

FIGURE VI. Φ_c as a function of $m^{1/2}$ in aqueous solutions of HCl, NH$_4$Cl, NaCl, KCl, RbCl, and CsCl at 25 °C. RbCl and CsCl are estimated.
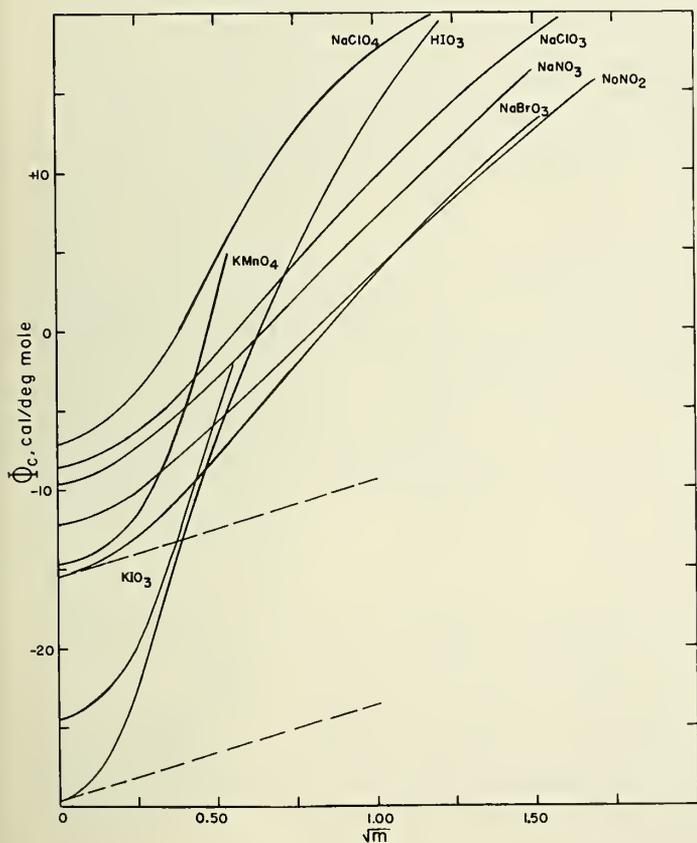
FIGURE V. Φ_c as a function of $m^{1/2}$ in aqueous solutions of HIO$_3$, NaClO$_3$, NaClO$_4$, NaBrO$_3$, NaNO$_2$, NaNO$_3$, KIO$_3$, and KMnO$_4$ at 25 °C.
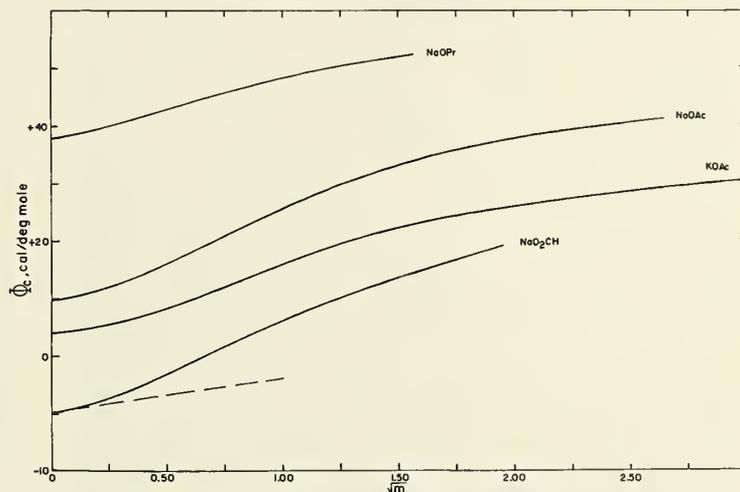
FIGURE VII. Φ_c as a function of $m^{1/2}$ in aqueous solutions of Na formate, Na acetate, Na propionate, and K acetate at 25 °C.
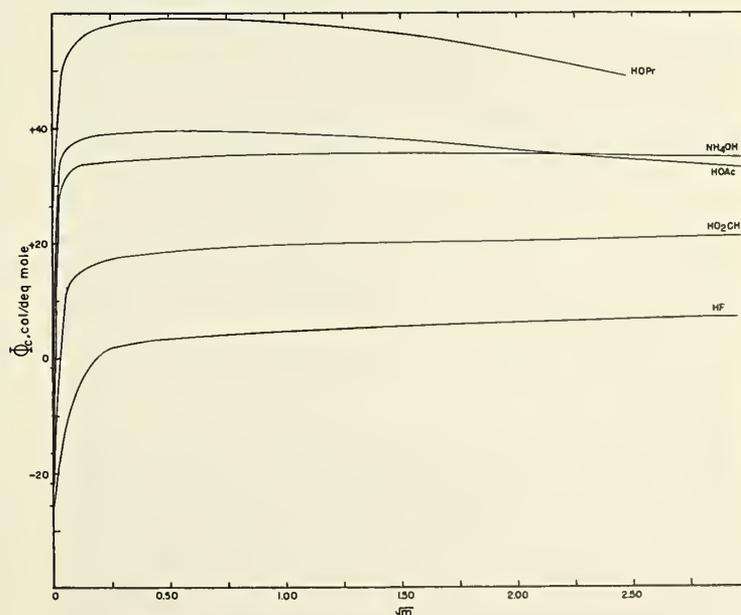
FIGURE VIII. Φ_c as a function of $m^{1/2}$ in aqueous solutions of HF, formic acid, acetic acid, propionic acid, and NH$_4$OH at 25 °C.

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V. Heats of Dilution

A great deal of the data from which Φ_L is obtained appears in the literature in the form of measurements of ΔH_{soln} as a function of concentration. By taking the difference between two measured ΔH_{soln} at concentrations m_1 and m_2, the ΔH_{diln} between the two concentrations is obtained. The ΔH_{soln} data treated in this way can be combined with the directly measured ΔH_{diln} data.

As in the case of the specific heat measurements, the original data were corrected as completely as possible to conform with the present best values of atomic weights, energy units, etc. The more important sets of measurements were completely recalculated from the experimental data whenever the necessary information was available. When necessary, the data were corrected to 25 °C using the values of Φ_C selected earlier.

The method used to obtain the values of Φ_L is the chord-area method developed by Young and coworkers [180, 181, 182, 183]. (An alternative method is that of Guggenheim and Prue [184] which leads to essentially the same results.) The chords $\Delta\Phi_L/\Delta(m^{1/2})$ were plotted against $m^{1/2}$ on large scale graphs. The extrapolation to infinite dilution was made using 472 cal/mole$^{3/2}$ for the limiting value of $d\Phi_L/dm^{1/2}$. A smooth curve was drawn through all the data, giving greater weight to the more reliable data. The $d\Phi_L/dm^{1/2}$ curves for NaCl and KCl resulting from the graphical method were compared with the curves obtained from least squares treatments of the same data. The results agreed well; it was therefore felt unnecessary to apply the least squares treatment to the less extensive data for the other systems. The resultant $d\Phi_L/dm^{1/2}$ curve was integrated to obtain Φ_L. In areas where Φ_L was not well defined by the chord area plot, and long chords were available, Φ_L values were obtained directly by using the experimental ΔH_{diln} and Φ_L for the defined area. In other cases where reliable ΔH_N data were available, Φ_L was obtained directly. All Φ_L values so obtained were consistent with the Φ_L values obtained by the chord-area method. There was very little necessity for adjusting values, lending support to the methods used and to the corrections applied. A detailed plot of the chord area treatment of NaCl is shown in figure IX. The values of $d\Phi_L/dm^{1/2}$, Φ_L, and $\bar{L}_2$ for NaCl are given in table X. Representative graphs of Φ_L for the various families are given in figures X–XIV. The detailed results are tabulated in tables XI–XVI.

The data available for each compound follow:

HF

ΔH_{diln} has been measured by Petersen [185] (21.5 °C, one dilution from $m = 0.20$ to 0.10), Roth [186] (20 °C, $m = 0.37$ to 0.11), Guntz [187] (17 °C, $m = 111.012$ to 0.14), Schäfer and Kahlenberg [188]* (25 °C, one dilution from $m = 34.43$ to 2.82) and [189]* (25 °C, one dilution from $m = 0.33$ to 0.03), and Roth, Pahlke, Bertram, and Börger [28]* (20 °C, $m = 24.0$ to 0.04).

The values of ΔH_i were obtained from the variation of K_i with temperature for the reactions: (1) HF = H$^+$ + F$^-$ and (2) HF + F$^-$ = HF$_2^-$, using the data of Roth [186], Broene and DeVries [190]*, and Wooster [191]*.

Other information on the ionization of HF can be obtained from the ΔH_N data of Thomsen [30] (with NaOH), von Steinwehr [192] (unspecified), Petersen [193] (with LiOH), Arrhenius [194] (with NaOH), Guntz [187] (with KOH and NH$_3$), Mulert [29] (with NaOH and KOH), Roth and Becker [195] (with NaOH), and Berthelot and Guntz [196] (HCl with KF).

The greatest weight was given to Wooster's data. The selected values at 25 °C are: $\Delta H(1) = -3,000$ cal/mole and $\Delta H(2) = +662$ cal/mole.

Elmore, Hatfield, Mason, and Jones [197] reviewed the thermal properties of aqueous HF and, using Wooster's K_i's, calculated the percentage of each ion in solution at various concentrations of HF. These percentages were used with the above determined ΔH_i's for reactions (1) and (2) to determine their contribution to ΔH_{soln} and ΔH_{diln}. These heats were combined with the dilution data to obtain Φ_L for the complete range. The Φ_L values as tabulated are to be used only with the ΔH_∞° for complete dissociation into the ions H$^+$ and F$^-$.

HCl

ΔH_{diln} has been measured by Thomsen [30]* (16.5 °C, $m = 21.2$ to 1.11), Berthelot [198]* (15 °C, $m = 25.58$ to 0.25), Naude [199]* (12 and 18 °C, $m = 1.0$ to 0.0001), Tucker [42]* (15 to 20 °C, $m = 13.0$ to 1.34), Becker and Roth [200]* (20 °C, $m = 5.38$ to 0.28), Richards, Mair, and Hall [43] (18 °C, $m = 2.22$ to 0.07), Richards and Rowe [37]* (18 and 20 °C, $m = 5.55$ to 0.14), von Steinwehr [192] (16 °C, $m = 4.7$ to 0.005), Muller [201] (16, 26, and 38 °C, $m = 1.0$ to 0.01), Thorvaldson, Brown, and Peaker [44]* (20 °C, $m = 2.78$ to 0.28), Petersen [185] (21.5 °C, $m = 0.56$ to 0.19), Richards, Rowe, and Burgess [38] (25 °C, $m = 6.30$ to 0.28), Roth [69]* (20 °C, $m = 1.11$ to 0.02), Vrevskiĭ and Zavaritskiĭ [202]* (15 °C, $m = 15.59$ to 1.10), Myers [203]* and Vanderzee and Myers [204]* (25 °C, $m = 4.49$ to 0.07), Sacconi, Paoletti, and Ciampolini [205]* (25 °C, one dilution from $m = 1.70$ to 0.03), Pitzer [206]* (25 °C, one dilution from $m = 1.19$ to 0.05), Sturtevant [50, 207, 208]* (25 °C, $m = 3.34$ to 0.005). Ellis [209] has calculated the heat of dilution from emf measurements (25 °C, $m = 4.484$ to 0.10).

L_1 has been measured by Roth and Wienert [210] (20.7 °C, $m = 17.28$), Schäfer, Wittig, and Jori [211]* (25 °C, $m = 16.9$), and Payn and Perman [212]* (20 and 30 °C, $m = 16.38$ to 1.60).

Bender and Biermann [213]* measured ΔH_N of HCl with NaOH (25 °C, $m_{HCl} = 16.39$ to 3.01).

Vrevskiĭ and Zavaritskiĭ [202, 214] measured ΔH_{soln} as a function of concentration (3.6, 21.5, 42, and 62.3 °C, $m = 16.37$ to 0.18).

The chord area plot was used to define the curve; chords were obtained from ΔH_{diln} and ΔH_{soln}. The Φ_L curve which was obtained was adjusted in

the region from $m=16.4$ to 4.9 to include the Φ_L obtained from the neutralization measurements. The greatest weight below $m=5$ was given to Sturtevant's corrected data, and above to Bender and Biermann's. Thomsen's and Berthelot's data were used between $m=16$ and 27. The last two values are extrapolated ones.

The calculated values of $\bar{L}_2$ agree within 10 cal/mole through $m=2.56$ with those given by Harned and Owen [9] from emf measurements.

HClO$_4$

ΔH_{diln} has been measured by Berthelot [59, 215, 216, 220] (19 and 21 °C, $m=55.5$ to 0.28), Krivtsov, Rosolovskiĭ, and Zinov'ev [217]* (25 °C, extremely concentrated solutions to $m=0.07$), Wood [218] (25 °C, one dilution from $m=0.52$ to 0.49), Austin and Mair [219] (25 °C, one dilution from $m=0.52$ to 0.02), and Vanderzee and Swanson [221]* (25 °C, $m=10.76$ to 0.004).

Φ_L was based primarily upon Vanderzee and Swanson's measurements. Above $m=11$, the results of Krivtsov et al., were. used.

HBr

ΔH_{diln} has been measured by Thomsen [30]* (19 °C, $m=25.12$ to 0.28), Berthelot [198]* (15.5 °C, $m=27.14$ to 0.10), Petersen [185] (21.5 °C, $m=0.56$ to 0.28), Roozeboom [62] (0 and 8.2 °C, $m=27.8$ to 0.25), and Louguinine and Schukareff [222] (18 °C, $m=6.49$ to dilute solutions).

Biermann and Weber [223]* measured ΔH_N of HBr with NaOH (25 °C, $m_{\mathrm{HBr}}=16$ to 3). Their results were used in this range to obtain Φ_L. Thomsen's data and Berthelot's data were used above and below this range and coordinated with the emf data, as given by Harned and Owen [9], below $m=0.4$ to complete the Φ_L curve.

HI

Below $m=0.56$ values of Φ_L were estimated on the basis of a comparison of LiCl-LiBr, NaCl-NaBr-NaI, and HCl-HBr. Above $m=0.56$ the ΔH_{diln} measurements of Thomsen [30]* (18.5 °C, $m=19.41$ to 0.23) and Berthelot [198]* (14 °C, $m=18.82$ to 0.16) were used.

Richards and Rowe's [224]* ΔH_N (15.5 and 17 °C, $m_{\mathrm{HI}}=0.56$) with NaOH and KOH were used as corroborating evidence.

HNO$_3$

ΔH_{diln} has been measured by Thomsen [30]* (18.8 °C, extremely concentrated solutions to $m=0.28$), Berthelot [225] (9.7 and 26 °C, $m=2.72$ to 0.69) and [226, 227]* (9.7 °C, extremely concentrated solutions to 0.69), Petersen [185] (21 °C, $m=0.67$ to 0.17), Richards and Rowe [70]* (20 °C, $m=5.55$ to 0.14), Naude [199]* (18 °C, $m=1.03$ to 0.0003), Becker and Roth [228]* (19.8 °C, $m=12.36$ to 0.01), and Good, Scott, Lacina, and McCullough [229] (25 °C, $m=1.50$ to 1.29).

$\bar{L}_1$ has been measured by Wilson and Miles [230] (20 °C, extremely concentrated solutions), Roth

[231] (20 °C, $m=1.52$), and Chedin and Dhers [232] (25 °C, $m=151.0$ to 6.64).

Forsythe and Giauque [68]* measured ΔH_{soln} of the liquid monohydrate and trihydrate to final molalities of 0.13 and 0.14 at 25 °C.

The chord area plot was used up to $m=5$. The resultant Φ_L curve was accepted as such. In the more concentrated region, another chord area plot was made using Thomsen's, Berthelot's, and Chedin and Dher's values. A preliminary curve of Φ_L was then made which was adjusted by using the long chords of Thomsen, Berthelot, and Forsythe and Giauque and the dilute Φ_L curve. The greatest weight was given to Forsythe and Giauque's measurements on the solution (dilution) of the liquid monohydrate and trihydrate to $m=0.13$.

CH$_2$O$_2$

ΔH_{diln} of aqueous formic acid has been measured by Thomsen [30]* (19 °C, $m=111.01$ to 0.28), Berthelot [233] (8.5 °C, $m=1.0$ to 0.25), and Faucon [234] (9 °C, $m=413$ to 1). ΔH_{soln} as a function of concentration has been measured by Glagoleva [235]* (25 °C, $m=677$ to 0.52).

ΔH_i of the reaction HCOOH(aq) $\rightarrow$ H$^+$ + HCOO$^-$, has been estimated from the K_a's given by Harned and Owen [9]* and Everett and Wynne-Jones [236]* and the ΔH_N experiments of von Steinwehr [192] and Canady, Papée, and Laidler [237]*.

The heat contribution due to ionization has been calculated by using the K_a listed in Harned and Owen [9] and incorporated into the Φ_L values. The Φ_L values are to be used only with $\Delta H^{\circ}_{\infty}$ (complete ionization).

C$_2$H$_4$O$_2$

ΔH_{diln} of aqueous acetic acid has been measured by Thomsen [30]* (19 °C, $m=111.01$ to 0.28), Berthelot [238] (23 and 24 °C, $m=2.78$ to 0.35), and [239] (8.5 °C, $m=1.0$ to 0.25), Faucon [234] (7.4 °C, extremely concentrated solution to $m=0.88$) and Richards and Gucker [157]* (16 and 20 °C, $m=2.22$ to 0.07).

$\bar{L}_1$ has been measured by Payn and Perman [212] (20, 30, 40 to 70 °C, extremely concentrated solutions to $m=1.72$).

ΔH_{soln} as a function of concentration has been measured by Klibanova and Neĭman [240]* (24 °C, $m=538$ to 0.77).

The ΔH_i of C$_2$H$_4$O$_2$ was estimated to be -60 cal/mole from the neutralization data of Thomsen [30]* (18 °C, with NaOH, $m_{\mathrm{C_2H_4O_2}}=0.28$), Canady, Papée, and Laidler [237]* (25 °C, with NaOH, $m_{\mathrm{C_2H_4O_2}}=0.005$), Richards and Mair [241]* (20 °C, with NaOH, $m_{\mathrm{C_2H_4O_2}}=0.56$), Berthelot [242] (9 °C, with NaOH, $m_{\mathrm{C_2H_4O_2}}=0.50$), Arrhenius [194] (21.5 °C, with NaOH), Lunden [243] (25 °C), Devoto [244], Jordan and Dumbaugh [245], Graham [246], Favre [247], and Andrews [248], and the K_a's and emf data as listed in Harned and Owen [9]*.

The heat contribution due to ionization has been calculated and incorporated into the Φ_L table, which is to be used only with the $\Delta H^{\circ}_{\infty}$ for complete ionization.

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NH₃ and NH₄OH

ΔH_{diln} has been measured by Thomsen [30]* (19 °C, $m = 17.34$ to 1.11), Berthelot [249] (14 °C, $m = 56.6$ to 0.28), Calvet [250] (17 °C, $m = 3.60$ to 0.28), Ramstetter and Hantke [251] (20 °C, $m = 2.56$ to 0.14), Baud and Gay [252] (12.5 °C, $m = 12.97$ to 2.22), and Vrevskiĭ and Zavaritskiĭ [202, 214]* (14 °C, $m = 18.50$ to 0.28).

Vrevskiĭ and Zavaritskiĭ [202, 214]* (3, 19.9, 41, and 61 °C, $m = 53.89$ to 0.44) measured ΔH_{soln} as a function of concentration.

ΔH_i is calculated as $+865$ cal/mole, by utilizing the data of Pitzer [206]* (25 °C, reaction of NaOH with NH₄Cl in dilute solution), the neutralization data of Thomsen [30]* (18 °C, with HCl and HNO₃, $m_{\text{NH}_4\text{OH}} = 0.28$), Berthelot [253] (20 °C with HCl, $m_{\text{NH}_4\text{OH}} = 0.50$), [215, 220] (18 °C, with HClO₄, $m_{\text{NH}_4\text{OH}} = 0.25$), and the K_B's at various temperatures and emf data as tabulated by Harned and Owen [9]*.

Other neutralization measurements are those of Bruni and Levi [254] (with HNO₃ and HClO₄), Berthelot [242, 255] (with acetic acid), [216] (with HClO₄), [256, 257] (with HNO₃ and HCl), Biltz and Messerknecht [258] (with HCl), Hess [259] (with HCl and HNO₃), Bouzat [260] (with HCl), Vorob'ev, Privalova, Monaenkova, and Skuratov [261] (with HClO₄), Favre and Silbermann [262] (with HCl and HNO₃), Favre [247] (with HNO₃, HCl and acetic acid), Andrews [263] (with unspecified acids), [248] (with HCl, HNO₃, and acetic acid), Lunden [243] (unspecified acids), Guntz [187] (with HF), and Delépine [264] (with HCl). Moore and Winmill [265] calculated the ΔH_i from conductivity measurements and partition coefficients at various temperatures.

The degree of ionization was calculated using the value given by Harned and Owen [9] for K_B for NH₄OH. The heat contribution of the ionization has been incorporated into the tabulated Φ_L values. For convenience, the values are given for NH₄OH·nH₂O and NH₃·nH₂O. The Φ_L values are to be used only with the value given for ΔH_∞° (complete ionization).

NH₄Cl

ΔH_{diln} has been measured by Thomsen [30]* (19 °C, $m = 5.55$ to 0.28), Pollok [266] (9 °C, one dilution of a saturated solution to $m = 4$), Mondain-Monval [267] (0.5 °C, one dilution from $m = 5.55$ to 0.19 and 18.1 °C, one dilution from $m = 6.89$ to 0.25) and [268] (0 and 19 °C, one dilution of a saturated solution to $m = 0.37$), Pratt [269]* (0 to 35.5 °C, $m = 2.22$ to 0.14), Magie [270]* (3.7 and 22.3 °C, $m = 2.22$ to 0.28), Fedorov and Sil'chenko [271]* (22 °C, $m = 7.12$ to 0.28), and Streeck [272]* (25 °C, $m = 1.07$ to 0.0002).

$\bar{L}_1$ has been measured by Dunnington and Hoggard [273] (20 to 25 °C, $m = 5.05$ to 2.31) and Rümelin [274] (13 °C, $m = 2.78$ and 2.22).

ΔH_{soln} as a function of concentration has been measured by Mishchenko and Ponomareva [92]* (25 °C, $m = 7.09$ to 0.03), Fedorov and Sil'chenko [271]* (22 °C, $m = 0.56$ to 0.14), and Winkelmann

[94] (17 to 28 °C, $m = 6.23$ to 0.58). von Stackelberg [275] measured the differential heat of solution (18 °C, $m = 5.88$ to 0.18).

The chord area plot was used. The greatest weight was placed upon Streeck's data in the dilute region. The resultant Φ_L curve was checked by using the long chords of Thomsen, Fedorov and Sil'chenko, Magie, Pratt, and Mishchenko and Ponomareva.

NH₄ClO₄

The Φ_L values given in the discussion of ΔH_∞° were estimated, by considering the behavior of related compounds and the ΔH_N data of Berthelot [216] (20 °C, $m = 0.10$) and Vorob'ev, Privalova, Monaenkova, and Skuratov [261]* (25 °C, $m_{\text{NH}_4\text{ClO}_4} = 0.14$).

NH₄Br

Only one measurement of the ΔH_{diln} has been reported, by Fedorov and Sil'chenko [271] (18 °C, one dilution from $m = 7.71$ to 0.28). The tabulated values of Φ_L have been estimated, by considering the behavior of NH₄Cl, HCl, HBr, NaCl, and NaBr.

NH₄I

The tabulated values of Φ_L have been estimated.

NH₄IO₃

The Φ_L values given for ΔH_∞° at 25 °C are estimated.

NH₄NO₃

ΔH_{diln} has been measured by Thomsen [30]* (18 °C, $m = 22.20$ to 0.28), Pratt [269]* (0 to 33.5 °C, $m = 2.22$ to 0.14), Mondain-Monval [276] (19 °C, one dilution of a saturated solution to $m = 0.37$) and [267] (0 °C, $m = 14.6$ to 0.39), Fedorov and Sil'chenko [271]* (21.5 °C, one dilution from $m = 24.13$ to 0.28), Tollinger [97]* (21 °C, $m = 18.50$ to 0.56), Wassermann [277]* (18.2 °C, $m = 22.21$ to 0.55–0.14), von Wartenberg and Lerner-Steinberg [278]* (18.2 °C, $m = 22.21$ to 0.56–0.24).

$\bar{L}_1$ has been measured by Dunnington and Hoggard [273] (22.5 °C, $m = 18.50$ to 2.22) and Rümelin [274] (11 °C, $m = 16.8$ and 12 °C, $m = 8.0$). Fricke and Havestadt [279] (0 °C, $m = 15.13$ to 1.63) measured the vapor pressure of aqueous NH₄NO₃ from which $\bar{L}_1$ may be calculated.

The ΔH_{soln} data of Fedorov and Sil'chenko [271]* (21.5 °C, $m = 0.56$ to 0.14) have also been used for the Φ_L determinations.

The chord area plot was used below $m = 1$. The long chords were then used with the Φ_L values obtained to obtain Φ_L for the more concentrated solutions.

NH₄C₂H₃O₂

ΔH_{diln} of aqueous ammonium acetate has been measured by Thomsen [30]* (20 °C, $m = 27.75$ to 0.28), and Dunnington and Hoggard [273] (22.5 °C, $m = 18.50$ to 2.28).

CH₃NH₂

ΔH_{diln} has been measured by Bonnefoi [280] (12 °C, one dilution from $m = 0.50$ to 0.10).

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ΔH_{soln} as a function of concentration has been measured by Felsing and Wohlford [281]* (35 °C, $m = 0.19$ to 0.05). The dilution values at 35 °C in this range are assumed to be relatively the same as at 25 °C. Values of Φ_L are given relative to $m = 0.056$.

$(CH_3)_2NH$

ΔH_{soln} as a function of concentration has been measured by Patterson and Felsing [282]* (30 °C, $m = 0.15$ to 0.04). The scatter of their values permits only approximate estimates of Φ_L, relative to $m = 0.056$.

$(CH_3)_3N$

ΔH_{soln} as a function of concentration has been measured by Patterson and Felsing [282]* (30 °C, $m = 0.15$ to 0.05). The scatter of their values permits only approximate estimates of Φ_L, relative to $m = 0.056$.

CH_3NH_3Cl

ΔH_{diln} has been measured by Streeck [272]* (25 °C, $m = 0.52$ to 0.0002) and Whitlow and Felsing [107]* (25 °C, $m = 1.02$ to 0.04). The chord area method was used to obtain preliminary values of Φ_L. These values were adjusted to fit Streeck's long chords.

$(CH_3)_2NH_2Cl$

ΔH_{diln} has been measured by Streeck [272]* (25 °C, $m = 0.52$ to 0.0002) and Whitlow and Felsing [107]* (25 °C, $m = 1.01$ to 0.05). The chord area method was used to obtain preliminary values of Φ_L. These values were adjusted to fit Streeck's long chords.

$(CH_3)_3NHCl$

ΔH_{diln} has been measured by Streeck [272]* (25 °C, $m = 0.53$ to 0.0002) and Whitlow and Felsing [107]* (25 °C, $m = 1.03$ to 0.05). The chord area method was used to obtain preliminary values of Φ_L. These values were adjusted to fit Streeck's long chords.

$N(CH_3)_4Cl$

ΔH_{diln} has been measured by Streeck [272]* (25 °C, $m = 0.53$ to 0.0004). The chord area method was used to obtain preliminary values of Φ_L. These values were adjusted to fit Streeck's long chords.

AgF

ΔH_{diln} has been measured by Jahn-Held and Jellinek [110]* (25 °C, $m = 13.96$ to 0.97). The tabulated values of Φ_L are referred to $m = 0.14$, since AgF is partially unionized and the association constants available are not sufficiently extensive to enable calculating the contribution of the ionization to Φ_L at greater dilutions. Equilibrium constants have been given by Connick and Paul [283], Paul [284], and Leden and Marthen [285].

$AgClO_4$

von Wartenberg [286] reported one measurement (temperature unknown, $m = 2.41$ to 1.0).

$AgNO_3$

Jackson, Smith, Gatty, and Wolfenden [287]* made one measurement (25 °C, $m = 0.37$ to 0.17) of ΔH_{diln}.

Terasaki [288] measured ΔH_{soln} as a function of concentration (25 °C, 20 measurements, $m = 1.09$ to 0.02). There is an error in the way the concentrations are expressed. The concentrations were corrected to the most reasonable form. The ΔH_{diln} were then used to determine Φ_L. Although there is still an error in the concentrations, it was felt that the values obtained were reasonable and in line with the Φ_L values of the other nitrates.

LiOH

ΔH_{diln} has been measured by Richards and Rowe [70]* (16 and 20 °C, $m = 2.22$ to 0.14) and Ueda [289, 290]* (25 °C, saturated solution to 0.14). Juza and Laurer [291] measured ΔH_N of LiOH with HCl (20 °C).

The chord area method was used to obtain Φ_L. These values were correlated with the emf data as given by Harned and Owen [9]*.

LiF

The Φ_L values were obtained from the ΔH_{diln} measurements of Leighton [292]* (25 °C, $m = 0.04$ to 0.01) and Lange and Leighton [293]* (25 °C, $m = 0.04$ to 0.01) by using the chord area plot.

LiCl

ΔH_{diln} has been measured by Tucker [42]* (15 °C, $m = 15.15$ to 1.82), Naude [199]* (17.5 to 26 °C, $m = 1.0$ to 0.0003), Nernst and Orthmann [294, 295]* (18 °C, $m = 0.10$ to 0.001), Lemoine [296] (10 and 20 °C, $m = 16.62$ to 0.49), Lange and Messner [297, 298]* (25 °C, one dilution from $m = 0.01$ to 0.0014), Richards and Rowe [70]* (16 and 20 °C, $m = 2.22$ to 0.14), Birnthaler and Lange [299] (25 °C, values on graph from $m = 18.32$ to 0), Lange and Dürr [118]* (25 °C, $m = 19.88$ to 0.63), and Monheim and Streeck [300]* (25 °C, $m = 0.28$ to 0.05).

$\bar{L}_1$ has been reported by Dunnington and Hoggard [273] (22.5 °C, $m = 13.88$ to 2.52) and Johnson and Molstad [301] (30, 50, and 70 °C, $m = 21.27$ to 0.77).

ΔH_{soln} as a function of concentration has been measured by Lange and Dürr [118]* (25 °C, $m = 18.31$ to 0.08).

$LiClO_4$

ΔH_{diln} has been measured by Jones [302]* (25 °C, $m = 3.98$ to 0.007) and Austin and Mair [219]* (25 °C, one dilution from $m = 1.0$ to 0.025). The chord area method was used.

LiBr

ΔH_{diln} has been measured by Lange and Schwartz [119]* (25 °C, $m = 17.92$ to 0.07), Lange and Messner [297, 298]* (25 °C, $m = 0.03$ to 0.001), Birnthaler and Lange [299]* (25 °C, $m = 16.65$ to 2.22), Mishchenko [303]* (25 °C, $m = 1.44$ to 0.12), Lange and

Mishchenko [304]* (25 °C, one dilution from $m = 1.44$ to 0.13) and Pennington [305] (25 °C, equation for the dilution of concentrated solutions from $m = 17.3$–11.5 to a dilute solution).

ΔH_{soln} as a function of concentration has been measured by Lange and Schwartz [119]* (25 °C, $m = 17.12$ to 0.22).

The chord area plot was used to obtain Φ_L.

LiI

The tabulated values of Φ_L were estimated.

LiNO₂

Dodé [306] measured ΔH_N of LiOH with HNO₂; however, the concentration and temperature are uncertain.

LiNO₃

Richards and Rowe [70]* measured ΔH_{diln} (20 °C, $m = 2.22$ to 0.14). Φ_L was obtained by the chord area method.

Richards and Rowe [224] measured ΔH_N of LiOH with HNO₃ (16 and 17 °C, $m_{LiNO_3} = 0.28$). This was used to check Φ_L obtained by the chord area method.

NaOH

ΔH_{diln} has been measured by Thomsen [30]* (19 °C, $m = 18.50$ to 0.56), Berthelot [307] (11 °C, $m = 21.6$ to 0.12), [225] (9.5 and 24 °C, one dilution from $m = 6.3$ to 0.66) and [233, 239] (8.5 °C, $m = 1$ to 0.13), Fricke [308]* (19 to 20 °C, $m = 26.42$ to 0.18), Calvet [250] (17 °C, $m = 2.58$ to 0.28), Sturtevant [50, 309]* (25 °C, $m = 4.18$ to 0.004), Pratt [269] (0 to 33.5 °C, $m = 4.11$ to 0.14), Sabatier [161, 310] (17 °C, $m = 11.10$ to 0.14), Richards and Gucker [157]* (16 and 20 °C, $m = 2.22$ to 0.02), Tucker [42]* (17 to 22 °C, $m = 20.91$ to 5.36), Bertetti and McCabe [311]* (20 °C, $m = 23.20$ to 3.92), Richards and Rowe [33]* (18 °C, one dilution from $m = 9.49$ to 1.28) and [70] (16 and 20 °C, $m = 9.64$ to 0.14), de Forcrand [312] (15 °C, one dilution of a saturated solution to $m = 10.8$) and [313] (20 °C, $m = 0.5$ to 0.13), and Wilson and McCabe [125] (93.3 °C, $m = 100$ to 21.3). Richards and Hall [314]* recalculated the dilution data of Richards and Gucker with new specific heat data.

$\bar{L}_1$, from vapor pressure measurements, has been calculated by Payn and Perman [212] (20 to 70 °C, $m = 10.30$ to 1.22) and Hayward and Perman [315] (20 and 30 °C, $m = 10.7$ to 6.25).

The chord area method was used. Greater weight was given in drawing the curves to Sturtevant's data below $m = 2$, and to Bertetti and McCabe's data above that.

The calculated values of $\bar{L}_2$ check reasonably well with Akerlöf and Kegeles' [126] emf values below $m = 12$. In the very dilute region, $m \lesssim 0.5$, the agreement with the emf results given by Harned and Owen [9] is only fair.

NaF

The tabulated Φ_L values are estimated on the basis of a comparison of LiF, LiOH, KF, KOH, and NaOH.

NaCl

ΔH_{diln} has been measured by Scholz [316] (0 °C, $m = 6.01$ to 0.25), Sandonnini and Gerosa [141] (18.5 °C, $m = 6.07$ to 0.44), Pollok [266] (9 °C, one dilution of a saturated solution to $m = 6$), Backlund [317] (17 °C, $m = 4.40$ to 0.37), Magie [270] (16.8 and 26.4 °C, $m = 2.22$ to 0.28), Pratt [269] (0 to 33.5 °C, $m = 2.22$ to 0.14), von Stackelberg [275] (0 and 18 °C, $m = 4.40$ to 0.56), Leitner [135] (20 °C, $m = 5.55$ to 0.56), van Deventer and van de Stadt [318] (one dilution from $m = 2.78$ to 0.28), Naude [199, 319]* (18 °C, $m = 1.0$ to 0.001), Richards and Rowe [70]* (20 °C, $m = 3.2$ to 0.19), Randall and Bisson [143]* (25 °C, $m = 6$ to 0.4), Malcolm, Parton, and Watson [320]* (25 °C, one dilution from $m = 2.70$ to 0.025), Young and Machin [181]* (25 °C, $m = 5.97$ to 0.19), Lange and Messner [297, 298]* (25 °C, one dilution from $m = 0.01$ to 0.001), Robinson [321]* (25 °C, $m = 0.10$ to 0.0008), Gulbransen and Robinson [322]* (25 °C, $m = 0.82$ to 0.005) in the form shown by Young and Groenier [180], Young and Vogel [183]* (25 °C, $m = 6.15$ to 0.05), and Monheim and Streeck [300]* (25 °C, $m = 0.32$ to 0.06).

$\bar{L}_1$ has been reported by Rümelin [274] (14 °C, $m = 2.78$ and 2.22) and Dunnington and Hoggard [273] (22.5 °C, $m = 6.17$ to 2.22).

The ΔH_{soln} data of Lipsett, Johnson, and Maass [323]* (20 and 25 °C, $m = 5.92$ to 0.04), Wüst and Lange [21]* (25 °C, $m = 5.62$ to 0.52), and Benson and Benson [324]* (25 °C, $m = 1.3$ to 0.05), were used in the chord area method, along with the measured ΔH_{diln}. The resultant Φ_L curve was checked with the other ΔH_{diln} and ΔH_{soln} data. The agreement was satisfactory.

The $\bar{L}_2$ values were checked with those given by Harned and Owen [9] for combined calorimetic, emf and boiling point data. The agreement is good below $m = 2$ and fair above.

NaClO₃

ΔH_{diln} has been measured by Colomina and Nicolas [145]* (25 °C, one dilution from $m = 9.05$ to 0.43) and Lange and Robinson [325]* (25 °C, $m = 0.10$ to 0.0004). Colomina and Nicolas [145]* (25 °C, $m = 8.54$ to 0.11) measured ΔH_{soln}.

NaClO₄

ΔH_{diln} has been measured by Jackson, Smith, Gatty, and Wolfenden [287]* (20 °C, one dilution from $m = 0.51$ to 0.23), Colomina and Nicolas [145]* (25 °C, $m = 15.39$ to 0.54), Austin and Mair [219]* (25 °C, one dilution from $m = 1.0$ to 0.025), and Vanderzee and Swanson [221]* (25 °C, $m = 11.80$ to 0.01).

ΔH_{soln} has been measured by Colomina and Nicolas [145]* (25 °C, $m = 12.22$ to 0.13).

The Φ_L values were based primarily upon Vanderzee and Swanson's measurements. Colomina and Nicolas' values above $m = 12$ were coordinated with them to complete the Φ_L curve.

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NaBr

ΔH_{diln} has been measured by Lange and Robinson [326, 327]* (25 °C, $m=0.16$ to 0.0025), van Deventer and van de Stadt [318] (16 °C, $m=8.20$ to 0.28), Hammerschmid and Robinson [329]* (25 °C, $m=0.10$ to 0.0003), Wüst and Lange [21]* (25 °C, $m=9.16$ to 1.10), and Wallace [328]* (25 °C, $m=9.00$ to 0.25). Dunnington and Hoggard [273] (24 °C, $m=4.27$ to 2.52) measured $\bar{L}_1$.

ΔH_{soln} has been measured by Wüst and Lange [21]* (25 °C, $m=8.63$ to 1.02).

NaBrO₃

The Φ_L values were obtained from Lange and Robinson's [325]* ΔH_{diln} measurements (25 °C, $m=0.10$ to 0.0004).

NaI

ΔH_{diln} has been measured by Thomsen [30]* (18 °C, $m=5.55$ to 0.56), Wüst and Lange [21]* (25 °C, $m=12.34$ to 9.85), and Lange and Robinson [326, 327]* (25 °C, $m \le 0.1$).

Wüst and Lange [21]* measured ΔH_{soln} (25 °C, $m=9.82$ to 0.63).

NaIO₃

The Φ_L values are based on Lange and Robinson's [325]* measurements of ΔH_{diln} (25 °C, $m=0.1$ to 0.0004).

NaNO₂

The Φ_L values given are based on Perreu's [149]* measurements of ΔH_{diln} (14 °C, $m=10.86$ to 0.19). Φ_L was assumed to be $+40$ at $m=0.19$, based on a comparison of the other Na⁺ electrolytes. The scale, however, is subject to adjustment.

NaNO₃

ΔH_{diln} has been measured by Thomsen [30]* (18 °C, $m=9.25$ to 0.28), Pollok [266, 330] (9 °C, one dilution of a saturated solution to $m=5$), von Stackelberg [275] (0 and 17 °C, $m=8.88$ to 0.28), Bishop [331]* (25 °C, $m=2.17$ to 1.50), Pratt [269]* (0 to 33 °C, $m=2.22$ to 0.14), Richards and Rowe [70]* (16 and 20 °C, $m=2.22$ to 0.14), van Deventer and van de Stadt [318] (17 °C, one dilution from $m=4.91$ to 0.28), Stahlberg [332]* (18 °C, $m=7.40$ to 0.19), Mondain-Monval [276]* (16 °C, $m=9.39$ to 0.54), and [267, 268] (0 and 16 °C, one dilution of a saturated solution to 0.37), Naude [199, 319]* (11 and 18 °C, $m=0.33$ to 0.001), and Lange and Robinson [325]* (25 °C, $m=0.10$ to 0.0002). $\bar{L}_1$ has been measured by Rümelin [274] (13 °C, $m=8.71$ to 0.55).

Below $m=0.1$ the greatest weight in the chord area plot was given to the measurements of Lange and Robinson. The Φ_L values obtained in this region were used in conjunction with the long chords of the other investigators to adjust the Φ_L values obtained from the integration of the complete $d\Phi_L/dm^{1/2}$ plot.

NaC₂H₃O₂

ΔH_{diln} has been measured by Thomsen [30]*

(19 °C, $m=5.55$ to 0.56), Berthelot [333] (temperature unknown, one dilution from $m=0.50$ to 0.25) and [233] (8.5 °C, $m=0.50$ to 0.25), Richards and Gucker [157]* (16 and 20 °C, $m=2.22$ to 0.03), Perreu [153] (18 °C, $m=4.78$ to 0.12), and Fricke [308]* (19.5 °C, $m=14.92$ to 0.28).

Fricke and Havestadt [279] (0 and 15 °C, $m=14.03$ to 5.24) and Perreu [153] (18 °C, saturated solution) measured $\bar{L}_1$.

NaCNS

ΔH_{diln} has been measured by Partington and Soper [334]* (25 °C, $m=15.17$ to 10.72). They [334]* also measured ΔH_{soln} (25 °C, $m=15.25$ to 0.28).

KF

ΔH_{diln} has been measured by de Forcrand [335] (15 °C, $m=14.23$ to 0.25), Guntz [187, 336] (temperature uncertain, $m=2.0$ to 0.50), Birnthaler and Lange [337]* (25 °C, $m=15.55$ to 0.06), Lange and Eichler [338]* (25 °C, $m=16.92$ to 1.52), Messner [339]* and Lange and Messner [340]* ($m=0.21$ to 0.004), and Monheim and Streeck [300] (25 °C, $m=0.30$ to 0.06).

ΔH_{soln} has been measured by Lange and Eichler [338]* (25 °C, $m=3.16$ to 0.21).

KOH

ΔH_{diln} has been measured by Thomsen [30]* (20 °C, $m=18.50$ to 0.56), Berthelot [307]* (11.5 °C, $m=18.14$ to 0.25) and [225] (11.5 and 24 °C, one dilution from $m=1$ to 0.5), Sabatier [310, 161]* (17 °C, $m=13.88$ to 0.21), de Forcrand [312] (15 °C, one dilution of a saturated solution to a dilute solution), Pratt [269] (0 to 33.5 °C, $m=3.65$ to 0.14), Richards and Rowe [70]* (16 and 20 °C, $m=5.55$ to 0.14), and Roth and Zeumer [341]* (20 °C, one measurement $m=0.83$ to 0.03).

Biermann [342]* measured ΔH_N of KOH with HCl (25 °C, $m_{KOH}=16$ to 3).

A chord area plot of the dilution data was made to obtain preliminary values of Φ_L. These values were adjusted to agree with the Φ_L values obtained from Biermann's neutralization data and with the emf data in the dilute region as summarized by Harned and Owen [8, 9]*.

KCl

ΔH_{diln} has been measured by Stearn and Smith [343] (25 °C, $m=3.16$ to 0.18), Nernst and Orthmann [294, 295, 344]* (18 °C, $m=0.33$ to 0.002), Naude [199]* (12.2 and 17.8 °C, $m=0.33$ to 0.007) and [319] (18 °C, $m=0.33$ to 0.004), Richards and Rowe [70]* (16 and 20 °C, $m=2.22$ to 0.14), Lange and Leighton [345]* (12.5 and 25 °C, $m=0.50$ to 0.002), Bishop [331] (25 °C, $m=4.49$ to 0.06), Mondain-Monval [268] (18 °C, one dilution of a saturated solution to $m=0.37$), Wüst and Lange [21]* (25 °C, $m=4.82$ to 0.57), Partington and Soper [334]* (25 °C, $m=4.82$ to 0.30), Pratt [269] (0 to 33.5 °C, $m=2.22$ to 0.14), Magie [270] (3 and 21 °C, $m=2.22$ to 0.28), van Deventer and van de Stadt

[318] (17 and 18 °C, $m = 4.24$ to 0.28), Pollok [266] (9 °C, saturated solution to $m = 3$), von Stackelberg [275] (0 and 18 °C, $m = 2.22$ to 0.28), Sandonnini and Gerosa [141] (18.5 °C, $m = 4.33$ to 0.28), Scholz [316] (0 °C, one dilution from $m = 3.62$ to 1.00), and Monheim and Streeck [300]* (25 °C, $m = 0.30$ to 0.06).

$\bar{L}_1$ has been measured by Dunnington and Hoggard [273] (22.5 °C, $m = 4.27$ to 2.0), Rümelin [274] (13.4 and 14.4 °C, $m = 2.78$ and 2.22), and Harrison and Perman [346] (40, 50 to 80 °C, $m = 4.29$ to 1.21).

ΔH_{soln} has been measured by Wüst and Lange [21]* (25 °C, $m = 4.47$ to 0.37) and Partington and Soper [334]* (25 °C, $m = 3.55$ to 0.31).

KClO₃

The Φ_L values are based on Andauer and Lange's [347]* measurements of ΔH_{diln} (15 and 25 °C, $m = 0.10$ to 0.0002).

Consideration was also given to von Stackelberg's [275] ΔH_{soln} measurements (16 °C, $m = 0.22$ and 0.11) and differential heats of solution (16 °C, $m = 0.50$ to 0.22).

KClO₄

The Φ_L values are based on Andauer and Lange's [347]* measurements of ΔH_{diln} (15 and 25 °C, $m = 0.10$ to 0.0002).

KBr

ΔH_{diln} has been measured by Berthelot [348] (11 °C, one dilution from $m = 0.50$ to 0.15), Scholz [316] (0 °C, $m = 4.0$ to 0.25), Hammerschmid and Robinson [329]* (25 °C, $m = 0.10$ to 0.0003), Wüst and Lange [21]* (25 °C, $m = 5.70$ to 0.42), and Monheim and Streeck [300]* (25 °C, $m = 0.32$ to 0.06).

$\bar{L}_1$ has been measured by Dunnington and Hoggard [273] (22.5 °C, $m = 5.55$ to 2.05) and Rümelin [274] (13.7 °C, $m = 2.78$ and 11.5 °C, $m = 2.2$).

ΔH_{soln} has been measured by Wüst and Lange [21]* (25 °C, $m = 5.25$ to 0.37).

KBrO₃

The tabulated Φ_L values have been estimated.

KI

ΔH_{diln} has been measured by Scholz [316] (0 °C, $m = 3.99$ to 0.15), Monheim and Streeck [300]* (25 °C, $m = 0.32$ to 0.06), and Wüst and Lange [21]* (25 °C, $m = 7.95$ to 0.28); Dunnington and Hoggard [273] measured $\bar{L}_1$ (22.5 °C, $m = 9.25$ to 1.85).

ΔH_{soln} has been measured by Wüst and Lange [21]* (25 °C, $m = 8.97$ to 7.34).

KIO₃

The tabulated Φ_L values were estimated considering the behavior of related compounds. The ΔH_{diln} measurements of Berthelot [216, 349] (13 °C, $m = 0.5$ to 0.13) and the differential heats of solution of von Stackelberg [275] (16 °C, $m = 0.28$ to 0.11) were considered.

KC₂H₃O₂

ΔH_{diln} has been measured by Thomsen [30]* (19 °C, $m = 11.10$ to 0.28).

KNO₃

ΔH_{diln} has been measured by Colson [350] (13.5 to 18 °C, $m = 0.25$ to 0.01 and from a saturated solution to $m = 0.13$), Naude [199]* (0, 12, 18, and 31 °C, $m = 0.33$ to 0.002) and [319]* (18 °C, $m = 0.33$ to 0.04), Lange and Messner [297, 298]* (25 °C, $m = 0.01$ to 0.009), Lange and Monheim [173]* (12.5 and 25 °C, $m = 0.13$ to 0.0006), Berenger-Calvet [351]* (16 °C, one dilution from $m = 0.78$ to 0.06), Mondain-Monval [268] (0 and 18 °C, one dilution of a saturated solution to $m = 0.37$), Nernst and Orthmann [294, 295, 344]* (18 °C, $m = 0.10$ to 0.0003), Richards and Rowe [70]* (20 °C, $m = 2.22$ to 0.14), Bishop [331]* (25 °C, $m = 2.38$ to 0.49), Pratt [269]* (0 to 33.5 °C, $m = 2.22$ to 0.14), Federov and Sil'chenko [271]* (22 °C, one dilution from $m = 3.38$ to 0.28), Scholz [316] (0 °C, $m = 1.0$ to 0.13), Pollok [266] (9 °C, one dilution of a saturated solution to $m = 2$), and Graham [352] (temperature unknown, $m = 1$ to 0.5).

$\bar{L}_1$ has been measured by Hunter and Bliss [353] (30 °C, $m = 2.55$ to 1.12), and Rümelin [274] (13 °C, $m = 2.29$ and 1.67).

ΔH_{soln} has been measured by Berenger-Calvet [351]* (16 °C, $m = 2.49$ to 0.09), von Stackelberg [275]* (15 °C, $m = 2.44$ to 0.22) and Winkelmann [94] (27.5 °C, $m = 2.41$ to 0.31).

Below $m = 0.1$ Lange and Monheim's data were given greater weight in the chord area plot. The Φ_L values obtained were adjusted above this molality by using the long chords.

KCNO

Myers [203]* and Vanderzee and Myers [204]* reported one dilution at 25 °C from $m = 0.26$ to 0.01. However, this was insufficient upon which to base a Φ_L curve.

KCNS

ΔH_{diln} has been measured by Partington and Soper [334]* (25 °C, $m = 23.96$ to 15.6 and one dilution from $m = 23.96$ to 0.65). Hunter and Bliss [353] measured $\bar{L}_1$ (30 °C, $m = 15.4$ to 2.57).

Partington and Soper [334]* measured ΔH_{soln} (25 °C, $m = 2.98$ to 0.25).

The chord area plot was used below $m = 3$. The long chord of Partington and Soper was used directly with the Φ_L at $m = 0.65$ to determine Φ_L at $m = 23.96$. This permitted the calculation of Φ_L from ΔH_{diln} down to $m = 15.6$.

The intermediate region was estimated with the aid of $\bar{L}_1$.

KMnO₄

The Φ_L values were obtained from Perreu's [174]* measurements of ΔH_{diln} (18 °C, $m = 0.40$ to 0.05).

RbF

The Φ_L values are based on Lange and Monheim's [173]* measurements of ΔH_{diln} (25 °C, $m = 0.21$ to 0.0003).

RbCl

Monheim and Streeck [300] reported two measure-

ments of ΔH_{diln} (25 °C, $m = 0.32$ to 0.08 and $m = 0.32$ to 0.06). However, their values on NaCl, KBr, KCl, KF, and KI exhibit systematic deviations. These measurements can therefore not be accepted. The tabulated Φ_L values were estimated on the basis of the behavior of CsCl, KCl, and KBr.

RbBr, RbI

The tabulated Φ_L values were estimated on the basis of the behavior of CsCl, KCl, KBr, and KI.

RbOH

de Forcrand [312] reported one measurement of ΔH_{diln} (15 °C, saturated solution to $m = 0.25$).

de Forcrand [354] reported one measurement of ΔH_N of RbOH with HCl at 15 °C. No concentrations were mentioned.

RbNO₃

The tabulated Φ_L values were estimated on the basis of the behavior of CsNO₃, KNO₃, and NaNO₃.

CsOH

de Forcrand [312]* reported one measurement of ΔH_{diln} (15 °C, saturated solution to $m = 0.25$).

Beketov [593] and de Forcrand [354] measured

ΔH_N of CsOH with HCl at 16 and 15 °C, respectively. No concentrations were given; therefore the data cannot be used for the Φ_L determinations.

CsF

The tabulated Φ_L values were estimated on the basis of the behavior of KF and RbF.

CsCl

ΔH_{diln} has been measured by Richards and Rowe [70]* (16 and 20 °C, $m = 1.11$ to 0.14), Lange and Kohler [355]* (25 °C, below $m = 0.25$), Messner [339]* (25 °C, below $m = 0.25$), and Monheim and Streeck [300] (25 °C, two dilutions from $m = 0.32$ to 0.08 and from $m = 0.32$ to 0.06). Monheim and Streeck's measurements appear to have a systematic error.

CsBr and CsI

The tabulated Φ_L values were estimated on the basis of the behavior of CsCl, KCl, KBr, and KI.

CsNO₃

The Φ_L values are based on Richards and Rowe's [70]* measurements of ΔH_{diln} (20 °C, $m = 0.93$ to 0.14).
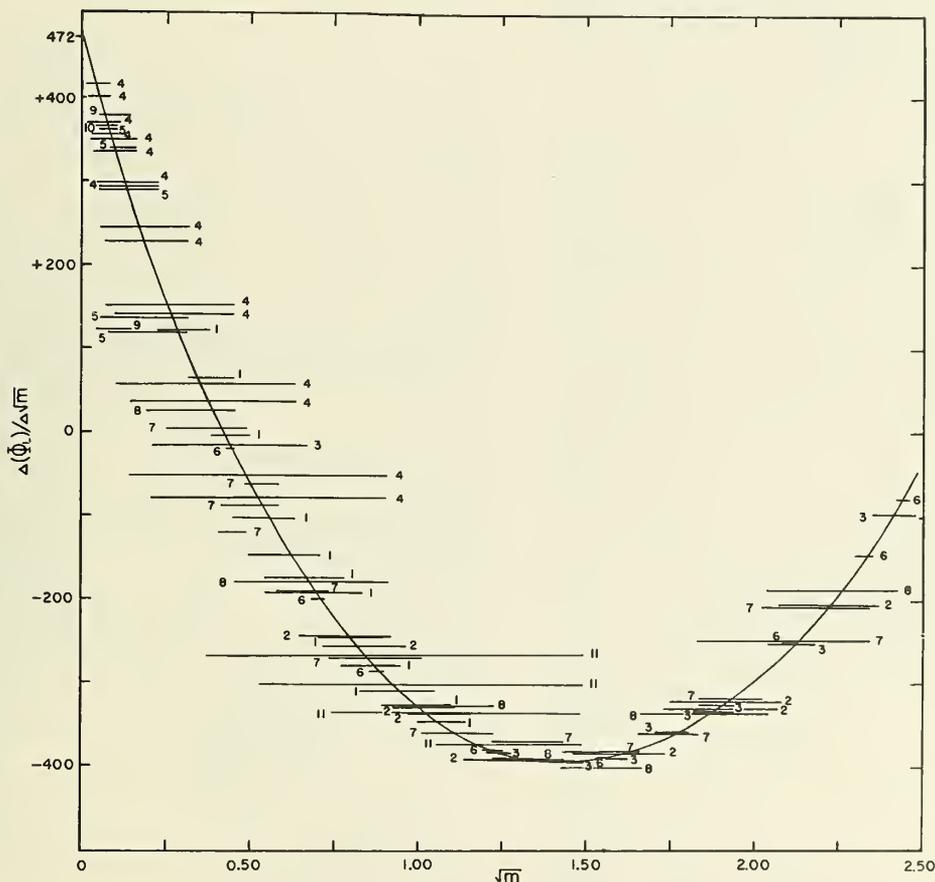
FIGURE IX. $\Delta(\Phi_L)/\Delta m^{1/2}$ *versus* $m^{1/2}$ *for NaCl at 25 °C.*

The series of determinations are:

1. Benson and Benson	25 °C ΔH_{soln} [324]	
2. Wüst and Lange	25 °C ΔH_{soln} [21]	
3. Young and Vogel	25 °C ΔH_{diln} [183]	
4. Gulbransen and Robinson	25 °C ΔH_{diln} [322]	
5. Robinson	25 °C ΔH_{diln} [321]	
6. Young and Machin	25 °C ΔH_{diln} [181]	
7. Lipsett, Johnson and Maass	25 °C ΔH_{soln} [323]	
8. Lipsett, Johnson and Maass	20 °C ΔH_{soln} [536]	
9. Criss and Cobble	25 °C ΔH_{soln} [541]	
10. Lange and Messner	20 °C ΔH_{diln} [297, 298]	
11. Richards and Rowe	20 °C ΔH_{diln} [70]	

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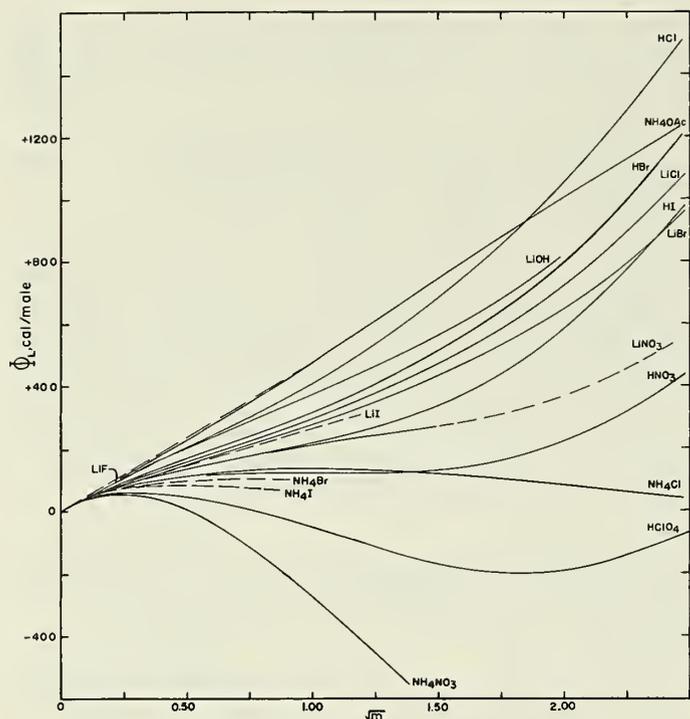
FIGURE X. *The relative apparent molal enthalpy,* Φ_L, *in cal/mole, as a function of* $m^{1/2}$ *at 25 °C in aqueous solutions of* HCl, HClO$_4$, HBr, HI, HNO$_3$, NH$_4$Cl, NH$_4$Br, NH$_4$I, NH$_4$NO$_3$, NH$_4$ *acetate,* LiOH, LiBr, LiI, *and* LiNO$_3$.

LiI, NH$_4$Br, and NH$_4$I are estimated. The broken portion of the lines for HClO$_4$ and LiNO$_3$ indicate the estimated values.
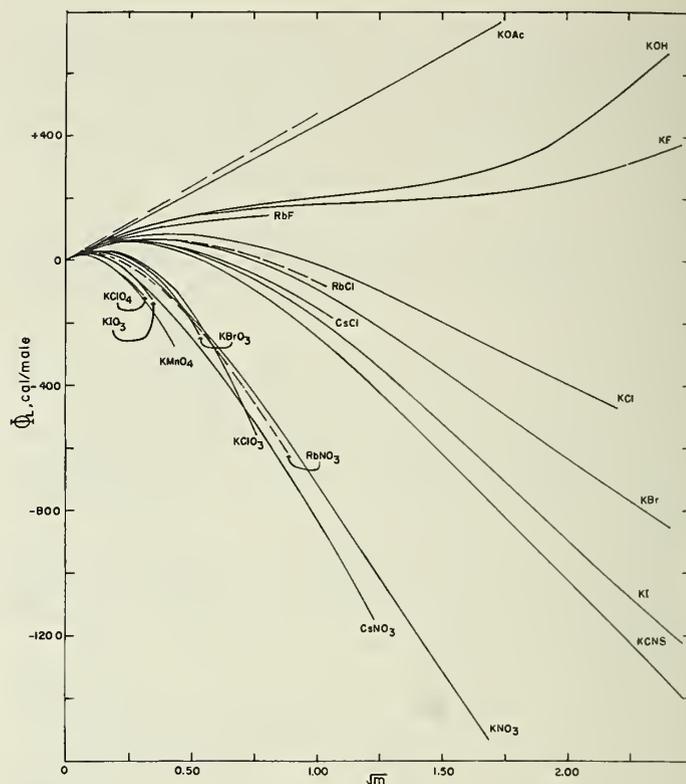
FIGURE XII. Φ_L *as a function of* $m^{1/2}$ *in aqueous solutions of* K, Rb, *and* Cs *compounds at 25 °C*.

The curves shown for RbNO$_3$ and RbCl are estimated.
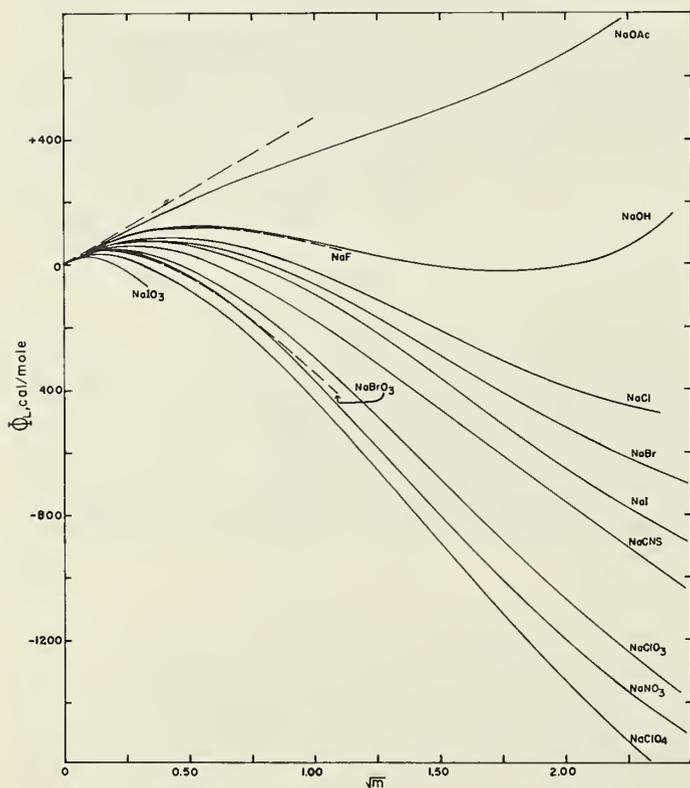
FIGURE XI. Φ_L *as a function of* $m^{1/2}$ *in aqueous solutions of* NaOH, NaF, NaCl, NaBr, NaI, NaClO$_3$, NaClO$_4$, NaBrO$_3$, NaIO$_3$, NaNO$_3$, NaCNS, *and* Na *acetate, at 25 °C*.

NaF and NaBrO$_3$ are estimated.
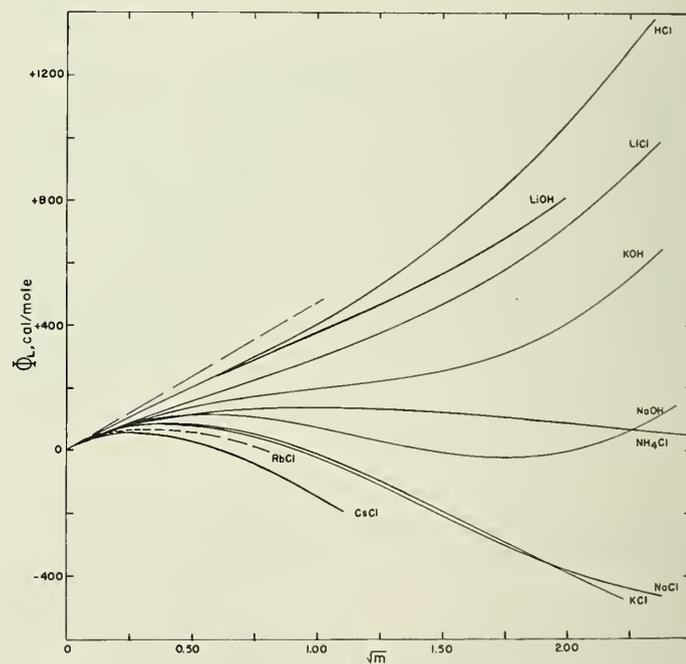
FIGURE XIII. Φ_L *as a function of* $m^{1/2}$ *in aqueous solutions of the hydroxides and chlorides of* H, NH$_4$, Li, Na, K, Rb, *and* Cs, *at 25 °C*.

The curve for RbCl is estimated.

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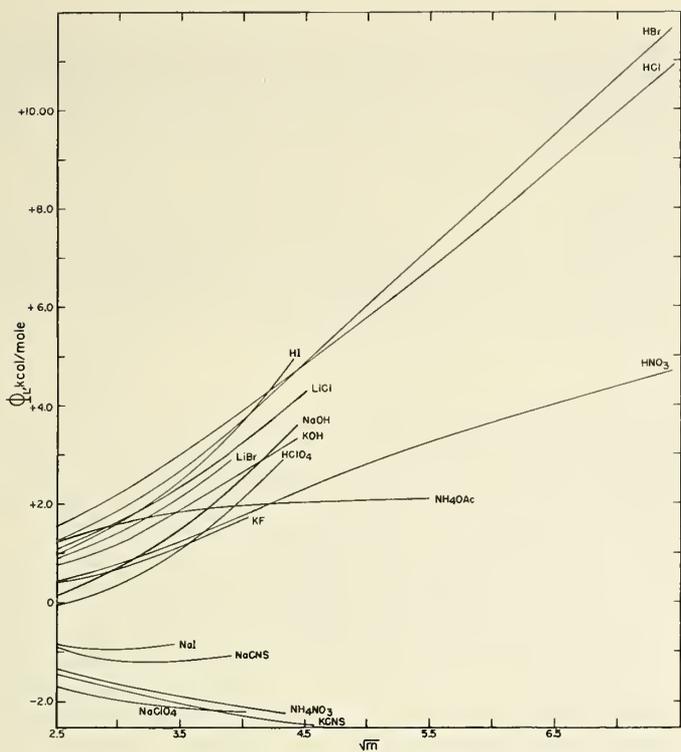
FIGURE XIV. Φ_L as a function of $m^{1/2} \geq 2.5$ in aqueous solutions at 25 °C.

VI. Heat of Neutralization

This discussion on ΔH_N is limited to the determination of ΔH_N°; citations are given only for systems considered in this determination. Wherever ΔH_N° was used to determine Φ_L or ΔH_i for a compound, reference is made to it in section V.

Rossini's [3] procedure was used. All the data utilized have been recalculated, using the newly evaluated Φ_L and Φ_C values for the key components. Only the most reliable data, for systems where Φ_L for all three components was well established, were used to determine ΔH_N°.

Table XVII lists the measurements (and their standard deviations) actually used for the final evaluation. This was limited to NaCl, KCl, NaNO$_3$, KNO$_3$, NaClO$_4$, and to the work of Richards and Rowe [224], Gillespie, Lambert, and Gibson [356], Bender and Biermann [213], Pitzer [206], and Vanderzee and Swanson [221, 357], despite the presence of reliable data, such as those of Richards and Rowe [224] on NaBr, NaI, KBr, KI, LiCl, LiBr, LiI, and LiNO$_3$, Biermann and Weber [223] on NaBr, and Biermann [342] on KCl, since the Φ_L values for HI, HBr, KOH, and LiOH were uncertain at the concentrations used in the neutralization experiments. Once ΔH_N° was established, their results were used to help define these uncertain regions. There are two recent series of measurements that require particular mention— those of Papée, Canady, and Laidler [358] and those of Bidinosti and Biermann [359]. Papée, Canady, and Laidler's measurements on the NaCl system in a microcalorimeter give a value of $-13,490 \pm 50$ cal/mole for ΔH_N°. The paper is not sufficiently detailed to determine whether precautions were taken to remove CO$_2$ from their dilute acid solutions, what ratio of NaOH to HCl was used, and how the extrapolation to infinite dilution was made. Bidinosti and Biermann's measurements on the NaClO$_4$ system give values for ΔH_N° that range from $-13,207$ to $-13,171$ cal/mole between 1 and 3 molal HClO$_4$ and from $-13,237$ to $-13,300$ cal/mole between 5 and 11 molal. There is no explanation for these discrepancies.

The tabulated values result in the following: Richards and Rowe, $-13,346 \pm 30$; Gillespie, Lambert, and Gibson, $-13,363 \pm 50$; Bender and Biermann, $-13,331 \pm 25$; Pitzer, $-13,366 \pm 25$; and Vanderzee and Swanson, $-13,336 \pm 20$ cal/mole. The "best" value for ΔH_N°, 25 °C, has been selected as $-13,345 \pm 25$ cal/mole.

Using the Φ_C° values for HCl, NaOH, and NaCl at the various temperatures, ΔH_N° may be expressed, in the range 15 to 30 °C, as $(\Delta H_N^\circ)_t = -13,345 + 53.5(t - 25°) - 0.46(t - 25°)^2$, or ΔH_i of H$_2$O as $(\Delta H_i^\circ)_t = 13,345 - 53.5(t - 25°) + 0.46(t - 25°)^2$.

This equation differs from those of Rossini [3] and Pitzer [206], primarily because of $d(\Delta C_P^\circ)/dT$ which is now calculated to be 0.9 cal/mole deg instead of 0.3. The recent work of Ackermann [39, 122] indicates a greater variation of Φ_C° of NaOH with temperature than previously accepted.

The value for ΔH_i°, at 20 °C = 13,710 cal/mole, given by Harned and Owen [9] from emf data, is 85 cal higher than that obtained by the use of the above equation. The equation given by Harned and Owen for the variation of ΔH_i° with temperature indicates a value of 13,510 cal/mole at 25 °C. The use of emf data for the heat of ionization involves the first and second derivatives with respect to T. The value obtained this way is generally not as reliable as that obtained calorimetrically.

Other measurements on the NaCl, NaNO$_3$, KCl, KNO$_3$, and NaClO$_4$ systems are as follows:

NaCl

ΔH_N has been measured by Thomsen [30], Berthelot [255, 257], Berthelot and Louguinine [360], Hess [361], von Steinwehr [192], Mathews [362], Mathews and Germann [363], Ellingson [364], Favre [247], Favre and Silbermann [262], Andrews [162, 248, 365], Roth [186], Könnecke, Steinert, and Leibnitz [366], Eley and Watts [367], Davies, Singer, and Stavely [368], Schultz [369], Keyes, Gillespie, and Mitsukuri [370], Douglas [371], Pitzer [206], Sacconi, Paoletti, and Ciampolini [205], Myers [203], Muller [372], Arrhenius [194], Lindner [373], Speakman and Stott [374], Gillespie, Lambert, and Gibson [356], Bender and Biermann [213], Olcott [375], Richards and Rowe [224], and Papée, Canady, and Laidler [358].

NaClO$_4$

ΔH_N has been measured by Thomsen [30], Berthelot [215, 216, 220], Vorob'ev, Privalova, Monaenkova, and Skuratov [261], and Bidinosti and Biermann [359].

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NaNO₃

The ΔH_N has been measured by Thomsen [30], Berthelot [257], Arrhenius [194], Hess [259], Andrews [248], Favre [247], Mathews and Germann [363], Richards and Rowe [224], and Favre and Silbermann [262].

KCl

ΔH_N has been measured by Thomsen [30], Muller [372, 376], Berthelot [257, 377, 378, 379], Hess [361, 380], Andrews [162, 248, 365], Favre and Silbermann [262], Favre [247], Gillespie, Lambert, and Gibson [356], Richards and Rowe [224], and Biermann [342].

KNO₃

ΔH_N has been measured by Thomsen [30], Berthelot [257], Graham [246], Hess [259], Andrews [162, 248, 365], Favre and Silbermann [262], Favre [247], and Richards and Rowe [224].

VII. Heat of Solution at Infinite Dilution

The experimental data on ΔH_{soln} were corrected to 25 °C, as explained earlier. The value of ΔH_∞° is obtained by using the relationship, $\Delta H_\infty^\circ = \Delta H_{soln,\, m} - \Phi_{L_m}$. A summary of the "best" values of ΔH_∞° for all the compounds can be found in table XXI.

The discussion below lists the experimental data (year reported, temperature of measurement, number of measurements, and concentration range), the values of ΔH_∞° obtained and the "best" value for each compound. Wherever information is not reported by the investigator, it is designated by ?.

KCl(c)

ΔH_{soln} has been reported by a great many investigators. As KCl has been proposed as a standard for use in solution calorimetry and as, in many cases, the older literature must be relied upon for the values of ΔH_{soln} of other compounds, all values between 15 and 30 °C reported for KCl have been tabulated, together with the estimated uncertainties, (table XVIII). The values may be separated into two distinct groups, $\Delta H_\infty^\circ = 4,150$ cal/mole as shown by Wüst and Lange [21] and $\Delta H_\infty^\circ = 4,115$ cal/mole.

The only apparent explanation at present, other than systematic errors in measurements, is that of variations in the treatment of the KCl sample. The "best" value of ΔH_∞° has been selected as $4,115 \pm 10$ cal/mole, as indicated by the preponderance of data in this region in the past 20 years.

Other measurements on KCl besides those tabulated have been reported by Berthelot [225], Lange and Monheim [173, 613], Yatsimirskiĭ and Grafova [437], Gire [438], Kaganovich and Mishchenko [439], Favre and Silbermann [262], Lehtonen [440], Zemczuzny and Rambach [441], Varali-Thevenet [442], Ostwald [443], Scholz [316], Samoïlov and Buslaeva [444], Kessler and Gorbanev [445], Agostini [446], Richardson and Wells [447], Austin and Mair [219], and Vrzhesnevskiĭ [448].

HF(g)

ΔH_{soln} has been measured by von Wartenberg and Fitzner [449] (1926; 32 °C, 10 measurements, $m = 0.14$) and Roth [69] (1944; 20 °C, five measurements, $m = 33.32$ to 5.55). The values of ΔH_∞° at 25 °C (complete ionization to H⁺ and F⁻) are $-14,700$ and $-14,720$ cal/mole, respectively. Khaĭdukov,

Linetskaya, and Bognovarov [450] have calculated ΔH_{soln} at $m = 0.14$ from vapor pressure measurements. Their value corrects to $-14,817$ cal/mole. Guntz [187] has also measured ΔH_{soln}.

von Wartenberg and Fitzner corrected their experimental values at $m = 0.14$ on the basis of the presence of only the hexamer and monomer of HF in the gaseous state. The more recent data and calculations of Franck and Meyer [451], Smith [452, 453], Spalthoff and Franck [454], Long, Hildebrand, and Morrell [455], Hu, White, and Johnston [456], and Jarry and Davis [457] indicate the presence of other polymer species. These more recent data were used to recalculate the association factors for the conditions of von Wartenberg and Fitzner's experiments. A value of $-11,600$ cal/mole was obtained at $m = 0.14$, $t = 25$ °C, which leads to the above value of $-14,700$ cal/mole. This is in excellent agreement with a value independent of the polymerization of 14,690 cal/mole for the difference, ΔH_f HF(g) $- \Delta H_f$ F⁻ (aqueous), obtained from the work of Hood and Woyski [634] on the reaction of NaCl(c) and HF(g) to form NaF(c) and HCl(g). It was not possible to recalculate Roth's value.

By using the value for ΔH_i selected in section V, we obtain for ΔH_∞° (no dissociation) $-11,700$ cal/mole, and ΔH_∞° (compete ionization) $= -14,700 \pm 200$ cal/mole. The latter value is to be used with the values of Φ_L given in table XV, which include the effects of the partial ionization and association.

HCl(g)

ΔH_{soln} has been measured by Berthelot and Louguinine [458] (1875; 20 °C, four measurements, $m = 0.40$ to 0.28), Thomsen [30] (1882; 19 °C, three measurements, $m = 0.20$ to 0.14), Vrevskiĭ and Zavaritskiĭ [202, 214] (1923; 21.5 and 42 °C, 15 measurements, $m = 4.83$ to 0.19), Roth and Richter [459] (1934; 21 °C, nine measurements, $m = 0.09$ to 0.006), Roth and Bertram [460] (1937; 19 °C, seven measurements, $m = 0.006$ to 0.0002), Roth, Börger, and Siemonsen [461] (1938; 20 °C, graph), Slansky [399] (1940; 25 °C, ?, ?), Gunn and Green [462] (1962; 25 °C, five measurements, $m = 0.02$), and Vanderzee and Nutter [652] (1963; 25 °C, 12 measurements, $m = 0.02$). The values of ΔH_∞° are: Berthelot and Louguinine, $-17,780 \pm 250$; Thomsen, $-17,760 \pm 100$; Vrevskiĭ and Zavaritskiĭ, $-17,837 \pm 50$; Roth and Richter, $-17,940 \pm 100$; Roth and Bertram, $-17,810 \pm 70$; Gunn and Green, $-17,888 \pm 15$; Van-

derzee and Nutter, $-17,875 \pm 12$ cal/mole. Roth, Börger, and Siemonsen's extrapolated value corrects to $-17,950$ cal/mole at 25 °C. Slansky gives a value of $-17,820$ cal/mole from his extrapolation. Vanderzee and Nutter's value, received after the value selected for ΔH°_∞ was incorporated into the revision of Circular 500, confirms the selection.

Measurements have also been made by Favre and Silbermann [262], Abria [463], and Favre [464].

"Best" value, $\Delta H^\circ_\infty = -17,888 \pm 15$ cal/mole.

HClO₄(l)

ΔH_{soln} has been measured by Krivtsov, Rosolovskiĭ, and Zinov'ev [217] (1960; 25 °C, one measurement, $m = 0.07$), Rosolovskiĭ, Krivtsov, and Zinov'ev [465] (same measurement as first) and Berthelot [215, 216] (1882; 19 °C, one measurement, $m = 0.10$).

The values of ΔH°_∞ are: Krivtsov et al., $-21,215 \pm 40$; Berthelot, $-20,570$ cal/mole.

"Best" value, $\Delta H^\circ_\infty = -21,215 \pm 40$ cal/mole.

HClO₄·H₂O(c)

ΔH_{soln} has been measured by Krivtsov, Rosolovskiĭ, and Zinov'ev [217] (1960; 25 °C, one measurement, $m = 0.07$); Arlman [466] (1939; one measurement, ?, ?), and Berthelot [215, 216, 220] (1882; 19 °C, one measurement, ?).

Krivtsov's value corrects to $-7,875 \pm 40$ cal/mole for ΔH°_∞. Arlman and Berthelot both report $-7,700$ cal/mole for ΔH_{soln}.

"Best" value, $\Delta H^\circ_\infty = -7,875 \pm 40$ cal/mole.

HBr(g)

ΔH_{soln} has been measured by Thomsen [30] (1883; 19 °C, three measurements, $m = 0.15$ to 0.11), Roth and Bertram [460] (1935; 20.5 °C, 17 measurements, $m = 0.22$ to 0.0005), Roth, Börger, and Siemonsen [461] (1938; 20.5 °C, results given in graph), and Vanderzee and Nutter [652] (1963; 25 °C, eight measurements, $m = 0.02$).

The values of ΔH°_∞ are: Thomsen, $-20,290 \pm 150$; Roth and coworkers, $-20,260 \pm 100$; Vanderzee and Nutter, $-20,350 \pm 12$ cal/mole.

Measurements have also been reported by Favre and Silbermann [262], Ruff and Menzel [467], and Berthelot [198].

"Best" value, $\Delta H^\circ_\infty = -20,350 \pm 12$ cal/mole.

HI(g)

ΔH_{soln} has been measured by Berthelot and Louguinine [458] (1875; 20 °C, three measurements, $m = 0.12$ to 0.06), Thomsen [30] (1883; 18 °C, three measurements, $m = 0.11$), Roth, Börger, and Siemonsen [461] (1938; 20 °C, results given in graph, $m = 0.006$ to 0.0004), and Roth [69] (1944; seven measurements, $m = 1.11$ to 0.02). The values of ΔH°_∞ are: Berthelot and Louguinine, $-19,850 \pm 300$; Thomsen, $-19,390 \pm 150$; Roth, Börger, and Siemonsen, $-19,680$; Roth, $-19,520 \pm 50$ cal/mole.

Measurements have also been made by Favre and Silbermann [262] and Cottrell [468] (of HI(l)).

"Best" value, $\Delta H^\circ_\infty = -19,520 \pm 50$ cal/mole.

HIO₃(c)

ΔH_{soln} has been measured by Berthelot [216] (1883; 12 °C, one measurement, $m = 0.13$), Thomsen [30] (1883; 18 °C, two measurements, $m = 0.28$), and Moles and Perez-Vitoria [394] (1932; 20.5 °C, four measurements, $m = 0.08$). The values of ΔH_{soln} at 25 °C are: Berthelot, 2,060; Thomsen, $1,850 \pm 50$; Moles and Perez-Vitoria, $2,380 \pm 50$ cal/mole. Ditte [469] also measured ΔH_{soln}.

The specific heat of the solid used to correct to 25 °C was estimated. Since Φ_L is unknown, the extrapolation to infinite dilution cannot be made.

"Best" value, $\Delta \bar{H}_{\mathrm{soln}} = 2,100 \pm 300$ cal/mole.

HNO₃(l)

ΔH_{soln} has been measured by Thomsen [30] (1882; 19 °C, ?, $m = 0.19$), Forsythe and Giauque [68] (1942; 25 °C, four measurements, $m = 0.13$), Karve [470], and Hess [471]. The differential heat of solution has been measured by Leclerc and Chédin [472] and Chédin and Dhers [232].

The values of ΔH°_∞ from the first two are: Thomsen, $-7,850 \pm 100$; Forsythe and Giauque, $-7,954 \pm 20$ cal/mole.

"Best" value, $\Delta H^\circ_\infty = -7,954 \pm 20$ cal/mole.

CH₂O₂(l)

ΔH_{soln} has been measured by Thomsen [30] (1883; 19 °C, one measurement, $m = 1.11$), Glagoleva [235] (1936; 25 °C, 24 measurements, $m = 677$ to 0.52), Berthelot [233, 239], and André [473]. The values of ΔH°_∞ (complete ionization) from the first two are -204 ± 20 cal/mole and -205 ± 10 cal/mole, respectively.

By using the value for ΔH_i selected in section V we obtain for the best value, ΔH°_∞ (no ionization) -175 ± 10 cal/mole.

"Best" value, ΔH°_∞ (complete ionization) $= \underline{-205} \pm 20$ cal/mole.

The latter value is to be used with the values of Φ_L tabulated.

C₂H₄O₂(l)

ΔH_{soln} has been measured by Berthelot [238] (1875; 7 to 23 °C, three measurements, $m = 2.78$ to 0.35), Berthelot and Louguinine [458] (1875; 20 °C, three measurements, $m = 0.44$ to 0.19), Thomsen [30] (1883; 19 °C, two measurements, $m = 2.78$ and 1.11), Pickering [474] (1895; 13.6 to 18.5 °C, five measurements, $m = 0.28$ to 0.14), Klibanova and Neĭman [240] (1933; 24 °C, 16 measurements, $m = 115$ to 0.77), and Pritchard and Skinner [475] (1950; 21 °C, one measurement, $m = 0.08$). The values of ΔH°_∞ (complete ionization) are: Berthelot, -350; Berthelot and Louguinine, -446; Thomsen, -364; Pickering, -326; Klibanova and Neĭman, -347; Pritchard and Skinner, -361 cal/mole.

By using the value for ΔH_i of C₂H₄O₂ determined in section V we obtain:

"Best" value, ΔH_∞° (no ionization) = −300 cal/mole.

"Best" value, ΔH_∞° (complete ionization) = −360 cal/mole.

The latter value is to be used with the Φ_L values which include the ionization contribution.

NH₃(g)

ΔH_{soln} has been measured by Thomsen [30] (1883; 19 °C, three measurements, $m = 0.43$ to 0.24), Vrevskiĭ and Zavaritskiĭ [202, 214] (1924; 19.9 and 41 °C, 29 measurements, $m = 34.05$ to 0.61), and Ramstetter and Hantke [251] (1931; 20 °C, five measurements, $m = 2.57$ to 0.80). The values, recomputed to ΔH_∞° (complete ionization) are: Thomsen, −7,587 ± 100; Vrevskiĭ and Zavaritskiĭ, −7,443 ± 40; Ramstetter and Hantke, −7,290 ± 150 cal/mole.

Other measurements of ΔH_{soln} are those of Vrevskiĭ and Zavaritskiĭ [202, 214] (3 °C and 61 °C), Berthelot [249], Favre and Silbermann [262], Baud and Gay [252], and Bouzat [260].

Vrevskiĭ and Zavaritskiĭ's value is preferred; however, as will be evident in the revision of Circular 500, Ramstetter and Hantke's value is more consistent with values obtained from other systems.

By using the value for ΔH_i NH₄OH (ΔH_i = +865 ± 30 cal/mole) determined in section V we obtain:

"Best" value, ΔH_∞° (no ionization) = −8,160 cal/mole.

"Best" value, ΔH_∞° (complete ionization) = −7,290 ± 150 cal/mole.

The values of Φ_L given for NH₄OH and NH₃ are to be used only with ΔH_∞° (complete ionization).

NH₄F(c)

Guntz [187] quotes a value of 1.5 kcal/mole from Favre for the ΔH_{soln} at 13 °C. The concentration is not mentioned. The reference cannot be located.

$\Delta H_{soln} = 1,500$ cal/mole.

NH₄Cl(c)

ΔH_{soln} has been measured by Winkelmann [94] (1873; 17.2 to 28 °C, 10 measurements, $m = 6.23$ to 0.58), Berthelot [377, 476] (1873; 10 °C, one measurement, $m = 0.46$), Thomsen [30] (1883; 18 °C, two measurements, $m = 0.28$), von Stackelberg [275] (1898; 18 °C, three measurements, $m = 0.74$ to 0.37), Colson [350] (1915; 14.9 and 22.3 °C, two measurements, $m = 0.23$), Mondain-Monval [268] (1923; 18 °C, one measurement, $m = 0.37$), Nacken [477] (1930; 20 °C, two measurements, $m = 0.27$), Drucker [45] (1934; 18.1 °C, one measurement, $m = 0.24$), Federov and Sil'chenko [271] (1937; 22 °C, three measurements, $m = 0.56$ to 0.14), and Mishchenko and Ponomareva [92] (1956; 25°C, 21 measurements, $m = 7.09$ to 0.03). The values of ΔH_∞° are: Winkelmann, 3,560 ± 50; Berthelot, 3,400; Thomsen, 3,530 ± 50; von Stackelberg, 3,586 ± 50; Colson, 3,615 ± 100; Mondain-Monval, 3,498; Nacken, 3,623 ± 75; Drucker, 3,528; Federov and Sil'chenko, 3,691 ± 100; Mishchenko and Ponomareva, 3,533

± 15 cal/mole. Measurements have also been reported by Favre and Silbermann [262], Anderson and Noyes [478], van Deventer and van de Stadt [318], Lehtonen [440], Varet [479], and André [480].

"Best" value, $\Delta H_\infty^\circ = 3,533 \pm 15$ cal/mole.

NH₄ClO₄(c)

ΔH_{soln} has been measured by Birky and Hepler [481] (1960; 25 °C, six measurements, $m = 0.009$ to 0.001) and Vorob'ev, Privalova, Monaenkova, and Skuratov [261] (1960; 25 °C, one measurement, $m = 0.14$). Φ_L has been estimated as 10 and 0 cal/mole, respectively, at the concentrations mentioned above. The values of ΔH_∞° are 8,020 ± 70 and 7,984 ± 20 cal/mole, respectively.

Berthelot [216, 220] has also measured ΔH_{soln}.

"Best" value, $\Delta H_\infty^\circ = 8,000 \pm 40$ cal/mole.

NH₄Br(c)

ΔH_{soln} has been measured by Thomsen [30, 482] (1877; 18 °C, four measurements, $m = 0.28$) and Federov and Sil'chenko [271] (1937; 18°C, three measurements, $m = 0.56$ to 0.14). The values of ΔH_∞° are 4,064 ± 50 and 3,920 ± 50 cal/mole, respectively.

Measurements have also been reported by Varet [479] and André [480].

"Best" value, $\Delta H_\infty^\circ = 4,010 \pm 100$ cal/mole.

NH₄I(c)

ΔH_{soln} has been measured by Thomsen [30] (1883; 19 °C, four measurements, $m = 0.28$) and Varet [479] (1896; 18 °C, one measurement, ?). The specific heat of the crystal used to correct to 25 °C was estimated. From Thomsen's measurements, ΔH_∞° is 3,280 ± 60 cal/mole.

"Best" value, $\Delta H_\infty^\circ = 3,280 \pm 60$ cal/mole.

NH₄IO₃(c)

ΔH_{soln} has been measured by Kapustinskiĭ, Shidlovskiĭ, and Shidlovskaya [483] (1958; 25 °C, three measurements, $m = 0.07$) and Spencer and Hepler [484] (1960; 25 °C, four measurements, $m = 0.014$ to 0.007). Φ_L was assumed to be −20 and +20 cal/mole, respectively. The values of ΔH_∞° are 7,590 ± 100 and 7,610 ± 100 cal/mole, respectively.

"Best" value, $\Delta H_\infty^\circ = 7,600 \pm 70$ cal/mole.

NH₄NO₂(c)

ΔH_{soln} has been measured by Berthelot [485, 486] (1874; 12.5 °C, one measurement, $m = 0.13$) and Bureau [487] (1937; 20 °C, one measurement, $m = 0.14$). The specific heat of the solid and Φ_C used to correct to 25 °C were estimated. Φ_L has been estimated as 60 cal/mole at the above concentrations. The values of ΔH_∞° are 4,300 and 4,610 cal/mole, respectively. Favre and Silbermann [262] also report a measurement.

"Best" value, $\Delta H_\infty^\circ = 4,600 \pm 200$ cal/mole.

NH₄NO₃(IV)

ΔH_{soln} has been measured by Winklemann [94] (1873; 16 to 22 °C, six measurements, $m = 3.12$ to 0.39), Tollinger [97] (1876; 19 to 25 °C, three measurements, $m = 0.56$), Thomsen [488] (1878; 18 °C, two measurements, $m = 0.28$), Mondain-Monval [267] (1925; 28 °C, one measurement, $m = 0.28$), Becker and Roth [489] (1934; 20 °C, seven measurements, $m = 0.05$), and Fedorov and Sil'chenko [271] (1937; 21.5 °C, three measurements, $m = 0.56$ to 0.14). The values of $\Delta H_{\infty}^{\circ}$ are: Winkelmann, $6{,}125 \pm 100$; Tollinger, $6{,}040 \pm 100$; Thomsen, $6{,}117 \pm 50$; Mondain-Monval, $5{,}990$; Becker and Roth, $6{,}093 \pm 40$; Fedorov and Sil'chenko, $6{,}216 \pm 50$ cal/mole.

Other measurements of ΔH_{soln} are those of Berthelot [377], van Deventer and de Stadt [318], Favre and Silbermann [262], Cohen and Helderman [490, 491], Cohen, Moesveld, and Helderman [492], and Mondain-Monval [268, 493].

"Best" value, $\Delta H_{\infty}^{\circ} = 6{,}140 \pm 50$ cal/mole.

NH₄C₂H₃O₂(c)

ΔH_{soln} has been measured by Berthelot [494] (1873; 24 °C, one measurement, $m = 0.28$). His value, recomputed to 25 °C, infinite dilution, and no hydrolysis, is -570 ± 200 cal/mole.

Φ_L as tabulated includes the hydrolysis effect.

NH₄CN(c)

ΔH_{soln} has been measured by Berthelot [377] (1875; 18 °C, one measurement, $m = 0.06$) and [216, 495] (1871; ?, one measurement, $m = 0.13$). The ΔC_p for correction to 25 °C has been estimated. Φ_L has been estimated as -15 cal/mole at $m = 0.06$. $\Delta H_{\infty}^{\circ}$ from Berthelot's first value is $4{,}200 \pm 250$ cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = 4{,}200 \pm 250$ cal/mole.

NH₄CNS(c)

ΔH_{soln} has been measured by Joannis [496] (1882; 12 °C, four measurements, ?). We have assumed the concentration to be $m = 0.56$, and Φ_L to be 30 cal/mole. $\Delta H_{\infty}^{\circ}$ is $5{,}400 \pm 200$ cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = 5{,}400 \pm 200$ cal/mole.

CH₃NH₂(g)

ΔH_{soln} has been measured by Aston and Ziemer [108] (1946; 25 °C, five determinations, $m = 0.104$), Felsing and Thomas [497] (1929; 25 or 30 °C, seven determinations, $m = 0.16$ to 0.06), Felsing and Wohlford [281] (1932; 35 °C, 12 determinations, $m = 0.19$ to 0.05), and Bonnefoi [280] (1901; 12 °C, two measurements, $m = 0.09$).

Aston and Ziemer's measurements on $CH_2NH_2(l)$ were corrected to $CH_3NH_2(g)$. Their corrected value for $\Delta H_{soln, m=0.104}$, $-11{,}167 \pm 57$ cal/mole, has been corrected to $\Delta H_{soln, m=0.0555}$. There appears to be a systematic error in Felsing's measurements.

The data are insufficient to warrant extrapolation to infinite dilution.

"Best" value, $\Delta H_{soln, m=0.0555} = -11{,}290 \pm 75$ cal/mole.

(CH₃)₂NH(g)

ΔH_{soln} has been measured by Patterson and Felsing [282] (1938; 30 °C, 15 measurements, $m = 0.15$ to 0.04). Their values were corrected to 25 °C; however, the random scatter of the values permits only an approximate value of $\Delta H_{soln, m=0.056} = -12{,}900 \pm 200$ cal/mole. Extrapolation to infinite dilution is not possible.

(CH₃)₃N(g)

ΔH_{soln} has been measured by Berthelot [498] (1880; 20 °C, one determination, $m = 0.21$) and Patterson and Felsing [282] (1938; 30 °C, 15 measurements, $m = 0.15$ to 0.05). The values were corrected to 25 °C; however, the random scatter of the values permits only an approximate value of $\Delta H_{soln, m=0.056} = -12{,}800 \pm 200$ cal/mole.

CH₃NH₃Cl(c)

ΔH_{soln} has been measured by Aston and Ziemer [108] (1946; 25 °C, four determinations, $m = 0.12$ to 0.10). The value of $\Delta H_{\infty}^{\circ}$ is $1{,}378 \pm 15$ cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = 1{,}378 \pm 15$ cal/mole.

(CH₃)₃NHCl(c)

ΔH_{soln} has been measured by Berthelot [498] (1880; 18 °C, one determination, $m = 0.21$). The specific heat of the crystal used to correct to 25 °C has been estimated. $\Delta H_{\infty}^{\circ} = 340 \pm 200$ cal/mole.

Tentative "Best" value, $\Delta H_{\infty}^{\circ} = 350 \pm 200$ cal/mole.

N(CH₃)₄Cl(c)

ΔH_{soln} has been measured by Askew et al., [499] (1934; 20 °C, two determinations, $m = 0.01$). The ΔC_P used to correct to 25 °C was estimated. $\Delta H_{\infty}^{\circ} = 975 \pm 75$ cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = 975 \pm 75$ cal/mole.

N(CH₃)₄Br(c)

ΔH_{soln} has been measured by Samoïlov [407, 408] (1951; 25 °C, one measurement, $m = 0.06$) and Askew et al., [499] (1934; 20 °C, three measurements, $m = 0.01$ to 0.006). The ΔC_P used to correct to 25 °C was estimated. Φ_L has been estimated as 10 and 25 cal/mole, respectively. The values, recomputed to infinite dilution and 25 °C, are 5,430 and $5{,}800 \pm 100$ cal/mole, respectively.

"Best" value, $\Delta H_{\infty}^{\circ} = 5{,}800 \pm 100$ cal/mole.

N(CH₃)₄I(c)

ΔH_{soln} has been measured by Walden [500] (1907; 19 to 20 °C, two determinations, $m = 0.22$ and 0.13) and Coulter, Pitzer, and Latimer [109] (1940; 25 °C, five determinations, $m = 0.06$ to 0.04). The latter investigators also measured the specific heat of the crystal; Φ_C was estimated. Φ_L has been estimated as -120 and 10 cal/mole, respectively. The values of $\Delta H_{\infty}^{\circ}$ are $10{,}080 \pm 100$ and $10{,}055 \pm 20$ cal/mole, respectively.

"Best" value, $\Delta H_{\infty}^{\circ} = 10{,}055 \pm 20$ cal/mole.

AgF · nH$_2$O(c)

Guntz [187, 501] has measured ΔH_{soln} of AgF (1884; 10 °C, $\Delta H_{\text{dilute solution}} = -3{,}400$ cal/mole) and AgF · 2H$_2$O, (10 °C, $\Delta H_{\text{dilute solution}} = 1{,}500$ cal/mole).

Guntz and Guntz [502, 503] measured ΔH_{soln} of AgF (1913; 16 °C, $\Delta H_{\text{dilute solution}} = -4{,}300$ cal/mole), AgF · H$_2$O (10 °C, $\Delta H_{\text{dilute solution}} = -850$ cal/mole), AgF · 2H$_2$O (10 °C, $\Delta H_{\text{dilute solution}} = 1{,}500$ cal/mole), and AgF · 4H$_2$O (13 °C, $\Delta H_{\text{dilute solution}} = 4{,}930$ cal/mole).

"Best" values cannot be given at the present time since there is insufficient information available.

AgClO$_4$(c)

ΔH_{soln} has been measured by Bruni and Levi [254] (1917; 12 °C, one measurement, $m = 0.06$). The ΔC_p used to correct to 25 °C was estimated. Φ_L has been assumed to be -100 cal/mole. The value of ΔH_∞° is $1{,}760 \pm 150$ cal/mole.

"Best" value, $\Delta H_\infty^\circ = 1{,}760 \pm 150$ cal/mole.

AgNO$_2$(c)

ΔH_{soln} has been measured by Berthelot [216] (1883; ?, one measurement, ?) and Bureau [487] (1937; 20 °C, one measurement, $m = 0.14$). Φ_L has been estimated as -20 cal/mole at $m = 0.14$. Berthelot reports $\Delta H_{\text{soln}} = 8{,}740$ cal/mole. Bureau's value, recomputed to infinite dilution and 25 °C, is 8,830 cal/mole.

"Best" value, $\Delta H_\infty^\circ = 8{,}830 \pm 200$ cal/mole.

AgNO$_3$(c)

ΔH_{soln} has been measured by Thomsen [30] (1883; 18 °C, two measurements, $m = 0.28$), Lange and Martin [397] (1937; 25 °C, one measurement, $m = 0.12$), Smith, Brown, and Pitzer [504] (1937; 25 °C, one measurement, $m = 0.009$), Roth [69] (1944; 17.4 to 19 °C, four measurements, $m = 0.08$ to 0.03), Graham and Hepler [505, 506] (1955; 25 °C, six measurements, $m = 0.06$ to 0.004), and Terasaki [288] (1957; 25 °C, 20 measurements, $m = 1.09$ to 0.02). The values of ΔH_∞° are: Thomsen, $5{,}377 \pm 50$; Lange and Martin, 5,475; Smith, Brown, and Pitzer, $5{,}365 \pm 50$; Roth, $5{,}428 \pm 50$; Graham and Hepler, $5{,}440 \pm 50$; Terasaki, $5{,}485 \pm 100$. Although the concentrations in Terasaki's paper were corrected to the most reasonable form, it was not possible to completely eliminate the errors.

Measurements have also been made by Berthelot [377], Favre and Silbermann [262], and Bruni and Levi [254].

"Best" value, $\Delta H_\infty^\circ = 5{,}400 \pm 50$ cal/mole.

LiOH(c)

ΔH_{soln} has been measured by de Forcrand [507, 508] (1907; 15 °C, one measurement, $m = 0.50$), Ueda [289, 290] (1933; 25 °C, four measurements, $m = 0.14$), and Reshetnikov [429] (1961; 25 °C, seven measurements, $m = 0.14$). The values of ΔH_∞° are: de Forcrand, $-4{,}990$; Ueda, $-5{,}040$; Reshetnikov, $-5{,}632 \pm 15$ cal/mole.

Truchot [509] has also reported a measurement.

"Best" value, $\Delta H_\infty^\circ = -5{,}632 \pm 15$ cal/mole.

LiOH·H$_2$O(c)

ΔH_{soln} has been measured by de Forcrand [510] (1906; 18 °C, one measurement, $m = 0.50$) and [508] (1908; 15 °C, one measurement, $m = 0.50$), and Ueda [289, 290] (1933; 25 °C, three measurements, $m = 0.14$). The values of ΔH_∞° are: de Forcrand, $-1{,}100$ and -950; Ueda, $-1{,}020 \pm 200$ cal/mole.

The dissociation pressure measurements of Ueda [290] lead to a value of ΔH for LiOH(c) $+$ H$_2$O(1) $=$ LiOH · H$_2$O(c) in poor agreement with that calculated from the ΔH_∞° values of the two solids, if $\Delta H_\infty^\circ = -1{,}020$ cal/mole is used. The value is in excellent agreement, though, with that calculated using de Forcrand's measurements on LiOH(c) and LiOH·H$_2$O(c). We have combined this difference with the value for LiOH(c) to obtain the "best" value.

"Best" value, $\Delta H_\infty^\circ = -1{,}600 \pm 400$ cal/mole.

LiF(c)

ΔH_{soln} has been measured by Kapustinskiĭ and Stakhanova [511] (1956; 25 °C, ?, ?) and Kolesov and Skuratov [512] (1961; 21.5 °C, 15 measurements, $m = 0.01$). de Forcrand [513] thought he measured ΔH_{soln} of LiF(c); solubility measurements indicate this was not possible, since his compound was much more soluble. Kapustinskiĭ and Stakhanova give a value at infinite dilution of $-1{,}330$ cal/mole. Kolesov and Skuratov's measurements correct to $1{,}130 \pm 25$ cal/mole. The solubility measurements of Payne [514] indicate that the differential heat of solution at saturation is positive.

"Best" value, $\Delta H_\infty^\circ = 1{,}130 \pm 25$ cal/mole.

LiCl(c)

ΔH_{soln} has been measured by Thomsen [30] (1883; 18.5 °C, three measurements, $m = 0.28$ to 0.19), Pickering [515] (1888; 18 °C, one measurement, $m = 0.28$), Bonnefoi [280, 516] (1897; 15 °C, one measurement, $m = 0.25$), Haigh [388] (1912; 21 °C, three measurements, $m = 0.14$), Lange and Dürr [118] (1926; 25 °C, 78 measurements, $m = 18.34$ to 0.04), Maier [517] (1927; 19.5 °C, one measurement, $m = 0.24$), Wassermann [277] (1930; 18.3 °C, four measurements, $m = 0.12$ to 0.08), Askew et al., [499] (1934; 20 °C, one measurement, $m = 0.04$), Lange and Martin [397] (1937; 25 °C, one measurement, $m = 0.20$), Samoĭlov [407, 408] (1951; 25 °C, one measurement, $m = 0.06$), and Samoĭlov and Buslaeva [444] (1960; 25 and 35 °C, three measurements, $m = 0.06$). The values of ΔH_∞° are: Thomsen, $-8{,}704 \pm 50$; Pickering, $-8{,}500 \pm 100$; Bonnefoi, $-8{,}847$; Haigh, $-8{,}700 \pm 50$; Lange and Dürr, $-8{,}813 \pm 40$; Maier, $-8{,}670$; Wassermann, $-8{,}884 \pm 30$; Askew et al., $-8{,}690$; Lange and Martin, $-8{,}963$; Samoĭlov, $-8{,}780$; Samoĭlov and Buslaeva, $-8{,}790 \pm 100$. The precision of Lange and Dürr's values is excellent. The overall uncertainty should be ± 10; however, there appears to be a systematic error in the measurements as shown by their specific heat measurements. In considering this, the "best" value has been estimated as $\Delta H_\infty^\circ = -8{,}850 \pm 50$ cal/mole.

"Best" value, $\Delta H^{\circ}_{\infty} = -8,850 \pm 50$ cal/mole.

LiCl·H$_2$O(c)

ΔH_{soln} has been measured by Bogorodskiĭ [518] (1911; 18 to 23 °C, four measurements, $m = 0.40$ to 0.28) and Maier [517] (1927; 19.5 °C, one measurement, $m = 0.17$). These values correct to $-4,540 \pm 100$ and $-4,590$ cal/mole, respectively.

The measurements of Ueda [290], Maier [517], Appleby and Crawford [636], and Hüttig and Reuscher [637] on the dissociation pressure of LiCl·H$_2$O(c) lead to a value of ΔH for the reaction, LiCl(c) + H$_2$O(1) = LiCl·H$_2$O(c), in good agreement with the difference, $\Delta H^{\circ}_{\infty}$ LiCl(c) $- \Delta H^{\circ}_{\infty}$ LiCl·H$_2$O(c).

"Best" value, $\Delta H^{\circ^*}_{\infty} = -4,560 \pm 100$ cal/mole.

LiCl·2H$_2$O(c)

ΔH_{soln} has been measured by Bogorodskiĭ [518] (1911; 18 to 23 °C, four measurements, $m = 0.39$ to 0.34). However, Campbell and Griffiths [638] reported the transition, LiCl·2H$_2$O(c) = LiCl·H$_2$O(c) occurred at 12.5 °C.

Hüttig and Reuscher's [637] measurements of the dissociation pressure lead to a value of ΔH for the reaction, LiCl·H$_2$O(c) + H$_2$O(1) = LiCl·2H$_2$O(c), in excellent agreement with the difference $\Delta H^{\circ}_{\infty}$ LiCl·H$_2$O(c) $- \Delta H^{\circ}_{\infty}$ LiCl·2H$_2$O(c).

Assuming that the compound exists at 25 °C, we have, as "best" value, $\Delta H^{\circ}_{\infty} = -1,120 \pm 40$ cal/mole.

LiClO$_4$(c)

ΔH_{soln} has been measured by Smeets [395] (1933; 18 °C, two measurements, $m = 0.24$), Markowitz, Harris, and Stewart [519] (1959; 25 °C, one measurement, $m = 0.12$), Birky and Hepler [481] (1960; 25 °C, nine measurements, $m = 0.02$ to 0.005), and Vorob'ev, Privalova, Monaenkova, and Skuratov [261] (1960; 25 °C, one measurement, $m = 0.13$). The ΔC_p used to correct to 25 °C has been estimated. The values correct to: Smeets, $-6,511 \pm 75$; Markowitz et al., $-6,364 \pm 50$; Birky and Hepler, $-6,325 \pm 50$; Vorob'ev et al., $-6,414 \pm 60$ cal/mole.

"Best" value, $\Delta H^{\circ}_{\infty} = -6,345 \pm 50$ cal/mole.

LiClO$_4$·3H$_2$O(c)

ΔH_{soln} has been measured by Smeets [395] (1933; 18 °C, two measurements, $m = 0.17$) and Markowitz, Harris, and Stewart [519] (1959; 25 °C, one measurement, $m = 0.12$). The ΔC_p used to correct to 25 °C has been estimated. Their values correct to 7,896 ± 75 and 7,795 ± 50 cal/mole.

"Best" value, $\Delta H^{\circ}_{\infty} = 7,795 \pm 50$ cal/mole.

LiBr(c)

ΔH_{soln} has been measured by Bodisko [520] (1889; 17 °C, one measurement, $m = 0.34$), Bonnefoi [521] (1900; 14 °C, one measurement, $m = 0.34$), Maier [517] (1927; 17 °C, one measurement, $m = 0.12$), and Lange and Schwartz [119] (1928; 25 °C, 44 measurements, $m = 17.12$ to 0.22). Their values of $\Delta H^{\circ}_{\infty}$ are: Bodisko, $-11,645 \pm 75$; Bonnefoi, $-11,830$

± 100; Maier, $-11,850$; Lange and Schwartz, $-11,668 \pm 50$. The precision of Lange and Schwartz' measurements is excellent; the standard deviation is ± 3. In view of the apparent systematic error in their specific heat measurements, the uncertainty in their solution measurements has been increased to ± 50 cal/mole.

"Best" value, $\Delta H^{\circ}_{\infty} = -11,670 \pm 50$ cal/mole.

LiBr·H$_2$O(c)

ΔH_{soln} has been measured by Maier [517] (1927; 17 °C, one measurement, $m = 0.10$). His value corrects to $-5,555$ cal/mole.

Maier's measurements of the dissociation pressure of LiBr·H$_2$O(c) lead to a ΔH for the reaction, LiBr(c) + H$_2$O(1) = LiBr·H$_2$O(c) in good agreement with the difference, $\Delta H^{\circ}_{\infty}$ LiBr(c) $- \Delta H^{\circ}_{\infty}$ LiBr·H$_2$O(c).

"Best" value, $\Delta H^{\circ}_{\infty} = -5,560 \pm 100$ cal/mole.

LiBr·2H$_2$O(c)

ΔH_{soln} has been measured by Maier [517] (1927; 17 °C, one measurement, $m = 0.08$). The value of $\Delta H^{\circ}_{\infty}$ is $-2,250$ cal/mole.

Maier's measurements of the dissociation pressure are discordant and cannot be used. Hüttig and Reuscher's [637] measurements lead to a ΔH for the reaction, LiBr·H$_2$O(c) + H$_2$O(1) = LiBr·2H$_2$O(c), which is in poor agreement with the difference $\Delta H^{\circ}_{\infty}$ LiBr·H$_2$O(c) $- \Delta H^{\circ}_{\infty}$ LiBr·2H$_2$O(c).

"Best" value, $\Delta H^{\circ}_{\infty} = -2,250 \pm 200$ cal/mole.

LiBrO$_3$(c)

ΔH_{soln} has been measured by Boyd and Vaslow [522] (1962; 25 °C, three measurements, $m = 0.007$). Φ_L has been estimated to be 30 cal/mole at this concentration. $\Delta H^{\circ}_{\infty}$ is 338 ± 40 cal/mole.

"Best" value, $\Delta H^{\circ}_{\infty} = 340 \pm 40$ cal/mole.

LiI(c)

ΔH_{soln} has been measured by Bodisko [523, 524, 525] (1888; 17 °C, one measurement, $m = 0.18$), Mosnier [526] (1897; 15 °C, one measurement, $m = 0.07$), Beketov and Beketov [527] (1902; 18 °C, two measurements, $m = 0.24$), and Maier [517] (1927; 17 °C, one measurement, $m = 0.07$). Beketov's measurements were on a mechanical mixture of LiI with NaCl and KCl. The values of $\Delta H^{\circ}_{\infty}$ are Bodisko, $-15,100 \pm 100$; Mosnier, $-15,280 \pm 150$; Beketov, $-15,030 \pm 150$; Maier, $-15,130 \pm 100$.

"Best" value, $\Delta H^{\circ}_{\infty} = -15,130 \pm 75$ cal/mole.

LiI·H$_2$O(c)

ΔH_{soln} has been measured by Maier [517] (1927; 17 °C, one measurement, $m = 0.07$). The value corrects to $-7,090 \pm 100$ cal/mole.

The dissociation pressure measurements of Maier [517] and Hüttig and Pohle [639] lead to a ΔH for the reaction, LiI(c) + H$_2$O(1) = LiI·H$_2$O(c), in fair agreement with the difference $\Delta H^{\circ}_{\infty}$ LiI(c) $- \Delta H^{\circ}_{\infty}$ LiI·H$_2$O(c).

"Best" value, $\Delta H^{\circ}_{\infty} = -7,090 \pm 200$ cal/mole.

LiI · 2H₂O(c)

ΔH_{soln} has been measured by Maier [517] (1927; 17 °C, one measurement, $m = 0.06$). His value corrects to $-3,530 \pm 100$ cal/mole.

Maier's dissociation pressure measurements lead to a ΔH for the reaction LiI · H₂O(c) + H₂O(l) = LiI · 2H₂O(c), in good agreement with the difference, ΔH_∞° LiI · H₂O $- \Delta H_\infty^\circ$ LiI · 2H₂O.

"Best" value, $\Delta H_\infty^\circ = -3,530 \pm 100$ cal/mole.

LiI · 3H₂O(c)

Maier [517] (1927; 17 °C, one measurement, $m = 0.05$) measured ΔH_{soln}. The value corrects to 140 cal/mole.

Maier's dissociation pressure measurements lead to a ΔH for the reaction, LiI · 2H₂O(c) + H₂O(l) = LiI · 3H₂O(c) that is impossible. We have therefore based ΔH_∞° on the calorimetric value.

"Best" value, $\Delta H_\infty^\circ = 140 \pm 100$ cal/mole.

LiNO₂(c)

ΔH_{soln} has been measured by Dodé [306, 528] (1936; 12 °C, three measurements, $m = 0.13$) and Bureau [487] (1937; 20 °C, one measurement, $m = 0.14$). The ΔC_p used to correct to 25 °C has been estimated. Φ_L has been estimated to be 130 cal/mole at the above concentrations. The values of ΔH_∞° are $-2,636$ and $-2,625$ cal/mole, respectively.

"Best" value, $\Delta H_\infty^\circ = -2,630 \pm 100$ cal/mole.

LiNO₂ · H₂O(c)

Bureau [487] (1937; 20 °C, one measurement, $m = 0.14$) has measured ΔH_{soln}. The ΔC_p used to correct to 25 °C has been estimated. Φ_L has been estimated as 130 cal/mole at this concentration. The value corrects to 1,680 cal/mole.

Ray and Ogg [640] reported one measurement of the dissociation pressure at 25 °C. This information is insufficient to use as corroborating evidence for the difference, ΔH_∞° LiNO₂(c) $- \Delta H_\infty^\circ$ LiNO₂ · H₂O(c). The "best" value has been based solely on Bureau's measurement.

"Best" value, $\Delta H_\infty^\circ = 1,680 \pm 200$ cal/mole.

LiNO₃(c)

ΔH_{soln} has been measured by Thomsen [30] (1883; 20 °C, two measurements, $m = 0.56$), Pickering [515] (1888; 18 °C, one measurement, $m = 0.27$), and Haigh [388] (1912; 21 °C, three measurements, $m = 0.12$). The values of ΔH_∞° are: Thomsen, -574 ± 50; Pickering, -626; and Haigh, -630 ± 50 cal/mole.

"Best" value, $\Delta H_\infty^\circ = -600 \pm 40$ cal/mole.

NaOH(c)

ΔH_{soln} has been measured by Thomsen [30] (1883; 17 °C, four measurements, $m = 0.34$ to 0.29), Berthelot [307] (1875; 10.5 °C, two measurements, $m = 0.36$), de Forcrand [529] (1902; 21.5 °C, one measurement, $m = 0.35$), Roth, Wirths, and Berendt [124] (1942; 20 °C, two measurements, $m = 10.11$ and 0.13), Bobtelsky and Lairsch [530] (1950; 23 °C, one

measurement, $m = 0.25$), Reshetnikov [429] (1961; 25 °C, five measurements, $m = 0.14$), and Murch and Giauque [531] (1962; 25 °C, five measurements, $m = 0.30$). The values of ΔH_∞° are: Thomsen, $-10,320$; Berthelot, $-10,410$; de Forcrand, $-10,540$; Roth and coworkers, $-10,400$; Bobtelsky and Lairsch, $-10,190$; Reshetnikov, $-10,555 \pm 20$ cal/mole. Murch and Giauque's value of $-10,637 \pm 10$ cal/mole was obtained from the extrapolation of their measurement on solid NaOH · nH₂O where n varied from 0.97 to 0.12. We have accepted their value.

"Best" value, $\Delta H_\infty^\circ = -10,637 \pm 10$ cal/mole.

NaOH · H₂O(c)

ΔH_{soln} has been measured by Pickering [532] (1895; 19 °C, two measurements, $m = 0.30$ and 0.19), de Forcrand [529] (1902; 21.5 °C, one measurement, $m = 0.35$), and Murch and Giauque [531] (1962; 25 °C, five measurements, $m = 0.30$). The corrected values are $-5,380 \pm 200$, $-5,400$, and $-5,118 \pm 10$ cal/mole, respectively. Murch and Giauque's value was obtained as for the anhydrous NaOH. We have selected their value.

"Best" value, $\Delta H_\infty^\circ = -5,118 \pm 10$ cal/mole.

NaF(c)

ΔH_{soln} has been measured by Guntz [187] (1884; 12 °C, one measurement, $m = 0.14$), Hepler, Jolly, and Latimer [533] (1953; 25 °C, one measurement, $m = 0.04$), and Latimer and Jolly [534] (1953; 25 °C, two measurements, $m = 0.04$ and 0.02). The values of ΔH_∞° are: Guntz, 130; Hepler, Jolly, and Latimer, 210; and Latimer and Jolly, 220 cal/mole.

de Forcrand [335] quotes a value which may have been taken from Guntz.

"Best" value, $\Delta H_\infty^\circ = 218 \pm 10$ cal/mole

NaCl(c)

The values of ΔH_∞° are shown in table XIX. Other measurements of the heat of solution have been reported by: Lehtonen [440], Scholz [316], Staub [542, 543], Berthelot [544], Berthelot and Ilosvay [383], Kessler and Gorbanev [445], Ostwald [443], Richardson and Wells [447], Brönsted [385], Sandonnini and Gerosa [141], Mishchenko and Yakovlev [545], Favre and Silbermann [262], Graham [246], Varali-Thevenet [442], von Stackelberg [275, 614], Zemczuzny and Rambach [441], Varet [479], Jones, Burgess, and Amis [546], Chipman, Johnson, and Maass [133], Allmand and Polack [547], and Koehler [612].

"Best" value, $\Delta H_\infty^\circ = 928 \pm 5$ cal/mole.

NaClO₂(c)

ΔH_{soln} has been measured by Fontana and Latimer [548] (1949; 25 °C, two measurements, $m = 0.005$), Levi and Bisi [549] (1956; 25 °C, three measurements, dilute solution), and Ishi [550] (1961; 18 °C, two measurements, $m = 0.06$). The ΔC_p used to correct to 25 °C has been estimated. Φ_L has been estimated as 25 cal/mole at $m = 0.005$ and 50 cal/mole at $m = 0.06$. Fontana and Latimer's value

corrects to 80 ± 10 cal/mole at infinite dilution. Ishi's value corrects to -20 ± 100 cal/mole at infinite dilution. Levi and Bisi give a value of 370 cal/mole for their "dilute solution."

"Best" value, $\Delta H_\infty^\circ = 80 \pm 10$ cal/mole.

$NaClO_2 \cdot 3H_2O(c)$

ΔH_{soln} has been measured by Levi and Bisi [549] (1956; 25 °C, three measurements, dilute solution) and Ishi [550] (1961; 18 °C, three measurements, $m = 0.06$). The ΔC_p used to correct to 25 °C was estimated. Levi and Bisi report a value of 7,020 cal/mole for their dilute solution. Ishi's value corrects to $6,780 \pm 100$ cal/mole at 25 °C and infinite dilution.

The dissociation pressure measurements of Riganti [641] lead to ambiguous results and cannot be used as corroborating evidence for the difference, $\Delta H_\infty^\circ \, NaClO_2(c) - \Delta H_\infty^\circ \, NaClO_2 \cdot 3H_2O(c)$.

"Best" value, $\Delta H_\infty^\circ = 6,830 \pm 100$ cal/mole.

$NaClO_3(c)$

ΔH_{soln} has been measured by Colomina and Nicolas [145] (1949; 25 °C, 14 measurements, $m = 8.54$ to 0.11), Nelson, Moss, and Hepler [551] (1960; 25 °C, six measurements, $m = 0.02$ to 0.01), and Ishi [550] (1961; 18 °C, one measurement, $m = 0.06$). The values of ΔH_∞° are $5,191 \pm 10$, $5,191 \pm 60$, and $5,056 \pm 100$ cal/mole, respectively.

Measurements have also been reported by Foote and Saxton [552], Brönsted [553], and Berthelot [377].

"Best" value, $\Delta H_\infty^\circ = 5,191 \pm 10$ cal/mole.

$NaClO_4(c)$

Measurements of ΔH_{soln} have been made by Smeets [395] (1933; 18 °C, two measurements, $m = 0.21$), Askew et al., [499] (1934; 20 °C, two measurements, $m = 0.005$), Lange and Martin [397] (1937; 25 °C, one measurement, $m = 0.12$), Colomina and Nicolas [145] (1949; 25 °C, 19 measurements, $m = 12.22$ to 0.13), and Vorob'ev et al., [261] (1960; 25 °C, ?, $m = 0.12$). The ΔC_p used to correct to 25 °C was estimated. Their values correct to: Smeets, $3,318 \pm 30$; Askew et al., $3,340 \pm 20$; Lange and Martin, 3,429; Colomina and Nicolas, $3,317 \pm 8$; Vorob'ev et al., $3,329 \pm 20$ cal/mole.

Other measurements have been reported by Berthelot [216, 377].

"Best" value, $\Delta H_\infty^\circ = 3,317 \pm 8$ cal/mole.

$NaClO_4 \cdot H_2O(c)$

ΔH_{soln} has been measured by Smeets [395] (1933; 18 °C, two measurements, $m = 0.20$). The ΔC_p used to correct to 25 °C has been estimated. This value corrects to $5,384 \pm 50$ cal/mole.

The dissociation pressure measurements of Markowitz and Boryta [642] lead to a ΔH for the reaction, $NaClO_4(c) + H_2O(l) = NaClO_4 \cdot H_2O(c)$, in fair agreement with the difference, $\Delta H_\infty^\circ \, NaClO_4(c) - \Delta H_\infty^\circ \, NaClO_4 \cdot H_2O(c)$.

"Best" value, $\Delta H_\infty^\circ = 5,380 \pm 50$ cal/mole.

$NaBr(c)$

ΔH_{soln} has been measured by Thomsen [30] (1883; 17 and 20 °C, ?, $m = 0.28$), Chipman, Johnson, and Maass [133] (1929; 25.4 °C, 15 measurements, $m = 1.42$ to 0.11), Askew et al., [499] (1934; 20 °C, one measurement, $m = 0.01$), Wüst and Lange [21] (1925; 25 °C, 15 measurements, $m = 8.63$ to 1.02), Lange and Dürr [389] (1926; 25 °C, four measurements, $m = 0.56$), Slansky [399] (1940; 25 °C, own extrapolation to infinite dilution), and Wallace [328] (1949; 25 °C, six measurements, $m = 0.06$ to 0.03). The values of ΔH_∞° are: Thomsen, -87; Chipman et al., -45 ± 200; Askew et al., -180; Wüst and Lange, -149 ± 15; Lange and Dürr, -248; Slansky, -40; Wallace, -144 ± 15.

Other measurements have been reported by Berthelot [377], Favre and Valson [554], and Varet [479].

"Best" value, $\Delta H_\infty^\circ = -144 \pm 15$ cal/mole.

$NaBr \cdot 2H_2O(c)$

ΔH_{soln} has been measured by Berthelot [377] (1875; 11 °C, one measurement, $m = 0.12$), Thomsen [30] (1883; 19 °C, two measurements, $m = 0.19$), and Samoĭlov [408] (1952; 25 °C, one measurement, $m = 0.06$). The values of ΔH_∞° are: Berthelot, 4,150; Thomsen, $4,454 \pm 50$; Samoĭlov, 4,572 cal/mole. Favre and Valson [554] also report a measurement.

The dissociation pressure measurements of Dingemans [643] and Bell [644] lead to a ΔH for the reaction, $NaBr(c) + 2H_2O(l) = NaBr \cdot 2H_2O(c)$, in good agreement with the difference, $\Delta H_\infty^\circ \, NaBr(c) - \Delta H_\infty^\circ \, NaBr \cdot 2H_2O(c)$.

"Best" value, $\Delta H_\infty^\circ = 4,454 \pm 50$ cal/mole.

$NaBrO_3(c)$

ΔH_{soln} has been measured by Spencer and Hepler [484] (1960; 25 °C, six measurements, $m = 0.02$ to 0.01) and Boyd and Vaslow [522] (1962; 25 °C, three measurements, $m = 0.007$ to 0.01). The values of ΔH_∞° are: $6,430 \pm 60$ and $6,350 \pm 100$ cal/mole, respectively.

"Best" value, $\Delta H_\infty^\circ = 6,430 \pm 60$ cal/mole.

$NaI(c)$

ΔH_{soln} has been measured by Berthelot [377] (1875; 11 °C, one measurement, $m = 0.11$), Thomsen [30] (1882; 20.1 °C, two measurements, $m = 0.28$), Pickering [515] (1888; 18 °C, one measurement, $m = 0.28$), Varet [479] (1896; 16 °C, one measurement, $m = 0.50$), Mosnier [526] (1897; 15 °C, one measurement, $m = 0.07$), Wüst and Lange [21] (1925; 25 °C, 14 measurements, $m = 9.82$ to 0.63), Askew et al., [499] (1934; 20 °C, two measurements, $m = 0.02$), and Mishchenko and Sukhotin [555] (1954; 25 °C, five measurements, $m = 0.10$ to 0.02). The values of ΔH_∞° are: Berthelot, $-1,800 \pm 200$; Thomsen, $-1,406 \pm 100$; Pickering, $-1,652$; Varet, $-1,565$; Mosnier, $-1,721$; Wüst and Lange, $-1,808 \pm 20$; Askew et al., $-1,781 \pm 30$; Mishchenko and Sukhotin, $-1,788 \pm 25$ cal/mole.

"Best" value, $\Delta H_\infty^\circ = -1,800 \pm 20$ cal/mole.

NaI · 2H₂O(c)

ΔH_{soln} has been measured by Berthelot [377] (1875; 11 °C, one measurement, $m = 0.11$), Thomsen [30] (1882; 19 °C, two measurements, $m = 0.18$) and Samoïlov [408] (1952; 25 °C, one measurement, $m = 0.06$). The values of ΔH_∞° are: Berthelot, 3,680; Thomsen, $3,855 \pm 50$; Samoïlov, 4,184 cal/mole.

Favre and Valson [554] also report a measurement. The dissociation pressure measurements of Dingemans [645] lead to a ΔH for the reaction, NaI(c) $+ 2H_2O(l) = $ NaI · 2H₂O(c), in excellent agreement with the difference, ΔH_∞°NaI(c) $- \Delta H_\infty^\circ$NaI · 2H₂O(c).

"Best" value, $\Delta H_\infty^\circ = 3,855 \pm 50$ cal/mole.

NaIO₃(c)

ΔH_{soln} has been measured by Spencer and Hepler [484] (1960; 25 °C, four measurements, $m = 0.01$ to 0.004) and Shidlovskiĭ and Valkina [556] (1961; 25 °C, three measurements, $m = 0.06$). The values of ΔH_∞° are $4,820 \pm 60$ and $4,890 \pm 60$ cal/mole, respectively.

"Best" value, $\Delta H_\infty^\circ = 4,850 \pm 60$ cal/mole.

NaIO₄(c)

Kapustinskiĭ and Yatsimirskiĭ [557] (1949; 25 °C, one measurement, ?) report a value of 8,910 cal/mole for ΔH_{soln}. Correction to infinite dilution is not possible.

"Best" value, $\Delta H_{\text{soln}} = 8,910$ cal/mole.

NaNO₂(c)

ΔH_{soln} has been measured by Swietoslawski [558] (1910; 18 °C, one measurement, $m = 0.16$), Matignon and Marchal [559] (1920; 20 °C, three measurements, $m = 0.16$), Dodé [306, 528] (1936; 12 °C, two measurements, $m = 0.13$), Bureau [487] (1937; 20 °C, one measurement, $m = 0.14$), Perreu [149] (1941; 14 °C, four measurements, $m = 0.14$), and Reshetnikov [429] (1961; 25 °C, five measurements, $m = 0.17$). The specific heat of the crystal used to correct to 25 °C was obtained from Voskresenskaya, Yankovskaya, and Anosov [621]. Φ_L has been assumed to be 50 cal/mole at these concentrations. The values of ΔH_∞° are: Swietoslawski, 3,300; Matignon and Marchal, 3,300; Dodé, 3,110; Bureau, 3,370; Perreu, 3,300; Reshetnikov, $3,320 \pm 70$ cal/mole. Reshetnikov's value is obtained from the ΔH_{soln} of a mechanical mixture of NaNO₂ with NaOH.

"Best" value, $\Delta H_\infty^\circ = 3,320 \pm 40$ cal/mole.

NaNO₃(c)

ΔH_{soln} has been measured by Winkelmann [94] (1873; 20 to 28 °C, 16 measurements, $m = 2.79$ to 0.37), Berthelot [377] (1875; 13 °C, one measurement, $m = 0.74$), Tilden [560] (1884; 16 °C, three measurements, $m = 0.56$), Thomsen [30] (1883; 18 °C, three measurements, $m = 0.28$), von Stackelberg [275] (1898; 17 °C, two measurements, $m = 0.28$ and 0.14), Haigh [388] (1912; 21 °C, three measurements, $m = 0.14$), Mondain-Monval [268] (1923; 16 °C, one measurement, $m = 0.37$), Voskresenskaya and Ponomareva [400] (1946; 25 °C, one measurement, $m = 0.18$), Lange and Martin [397] (1937; 25 °C, one

measurement, $m = 0.12$), and Van Tassel and Wendlandt [561] (1959; 25 °C, five measurements, $m = 0.28$). The values of ΔH_∞° are: Winkelmann, $4,840 \pm 150$; Berthelot, 4,700; Tilden, 4,772; Thomsen, $4,904 \pm 50$; von Stackelberg, $4,965 \pm 100$; Haigh, 4,790; Mondain-Monval, 4,640; Voskresenskaya and Ponomareva, 4,825; Lange and Martin, 4,892; Van Tassel and Wendlandt, $4,980 \pm 100$ cal/mole. Measurements have also been reported by Scholz [316], Varali-Thevenet [442], Mondain-Monval [276], and Zawidzki and Schagger [562].

"Best" value, $\Delta H_\infty^\circ = 4,900 \pm 50$ cal/mole.

NaC₂H₃O₂(c)

ΔH_{soln} has been measured by Thomsen [30] (1883; 19 °C, two measurements, $m = 0.28$), Pickering [384] (1887; 15 to 25 °C, 39 measurements, $m = 0.28$) and Jolly [563, 564] (1952; 25 °C, three measurements, $m = 0.008$ to 0.005). The specific heat of the crystal used to correct to 25 °C was obtained from Strelkov [622]. The values of ΔH_∞° are: Thomsen, $-4,136 \pm 50$; Pickering, $-4,200 \pm 50$; and Jolly, $-4,144 \pm 100$ cal/mole.

ΔH_{soln} has also been measured by Berthelot [377, 476].

"Best" value, $\Delta H_\infty^\circ = -4,140 \pm 50$ cal/mole.

NaC₂H₃O₂ · 3H₂O(c)

ΔH_{soln} has been measured by Thomsen [30] (1883; 19 °C, two measurements, $m = 0.14$), Pickering [384] (1887; 15 to 25 °C, 33 measurements $m, = 0.28$), Bindel [154] (1890; 21 °C, four measurements, $m = 5.55$ to 1.11), Calvet [250] (1933; 17 °C, three measurements, $m = 0.28$), and Perreu [153] (1940; 18 °C, one measurement, $m = 0.12$). The values of ΔH_∞° are: Thomsen, $4,800 \pm 50$; Pickering, $4,715 \pm 50$; Bindel, $4,534 \pm 75$; Calvet, $4,682 \pm 75$; Perreu, $4,663 \pm 100$ cal/mole.

Other measurements have been reported by Berthelot [476] and Gnesotto and Fabris [156].

The dissociation vapor pressure measurements of Baxter and Cooper [646] lead to a ΔH for the reaction, NaC₂H₃O₂(c) $+ 3H_2O(l) = $ NaC₂H₃O₂ · 3H₂O(c), in good agreement with the difference ΔH_∞° NaC₂H₃O₂(c) $- \Delta H_\infty^\circ$ NaC₂H₃O₂ · 3H₂O(c).

"Best" value, $\Delta H_\infty^\circ = 4,700 \pm 75$ cal/mole.

NaCN(c)

ΔH_{soln} has been measured by Joannis [496] (1882; 9 °C, three measurements, $m = 0.56$). The specific heat of the solid used to correct to 25 °C was obtained from Messer and Ziegler [623]. Φ_C was estimated. Φ_L has been estimated as -30 cal/mole at $m = 0.56$. The value of ΔH_∞° is 290 cal/mole.

"Best" value, $\Delta H_\infty^\circ = 290 \pm 200$ cal/mole.

NaCN · ½H₂O(c)

ΔH_{soln} has been measured by Joannis [496] (1882; 6 °C, one measurement, $m = 0.56$). Φ_L has been estimated as -30 cal/mole at $m = 0.56$. The value, recomputed to ΔH_∞°, is 790 cal/mole.

"Best" value, $\Delta H_\infty^\circ = 790 \pm 200$ cal/mole.

NaCN · 2H₂O(c)

ΔH_{soln} has been measured by Joannis [496] (1882; 9 °C, three measurements $m = 0.56$). Φ_L has been estimated as -30 cal/mole at $m = 0.56$. The value of ΔH_∞° is 4,440 cal/mole.

"Best" value, $\Delta H_\infty^\circ = 4,440 \pm 200$ cal/mole.

NaCNO(c)

ΔH_{soln} has been measured by Lord and Woolf [565] (1954; 25 °C, one measurement, $m = 0.03$) and Lemoult [566] (1899; 13 °C, four measurements, $m = 0.05$ to 0.02). Φ_L has been estimated as 50 cal/mole at these concentrations. The values of ΔH_∞° are: 4,590 $\pm$ 40 and 4,630 $\pm$ 100 cal/mole, respectively.

"Best" value, $\Delta H_\infty^\circ = 4,590 \pm 40$ cal/mole.

NaCNS(c)

ΔH_{soln} has been measured by Vrzhesnevskiĭ [448] (1912; 18 °C, one measurement, $m = 0.56$) and Partington and Soper [334] (1929; 25 °C, 19 measurements, $m = 1.23$ to 0.17). The ΔC_p used to correct to 25 °C was estimated. The values of ΔH_∞° are 1,670 and 1,632 $\pm$ 20 cal/mole, respectively.

"Best" value, $\Delta H_\infty^\circ = 1,632 \pm 20$ cal/mole.

KOH(c)

ΔH_{soln} has been measured by Berthelot [307, 377] (1875; 11.4 °C, one measurement, $m = 0.21$), Thomsen [30] (1883; 18 °C, one measurement, $m = 0.22$), de Forcrand [567] (1902; 21.5 °C, one measurement, $m = 0.33$), Voskresenskaya and Ponomareva [400] (1946; 25 °C, two measurements, $m = 0.18$), and Reshetnikov [429] (1961; 25 °C, six measurements, $m = 0.09$). The values of ΔH_∞° are: Berthelot, $-13,270$; Thomsen, $-13,750 \pm 100$; de Forcrand, $-13,257$; Voskresenskaya and Ponomareva, $-7,660$; Reshetnikov, $-13,769 \pm 20$ cal/mole.

"Best" value, $\Delta H_\infty^\circ = -13,769 \pm 20$ cal/mole.

KOH · nH₂O(c)

de Forcrand [567] (1902; 21.5 °C, one measurement for each composition, $m = 0.28$) measured ΔH_{soln} of various compositions of KOH · nH₂O(c), where $n = 0.25, 0.535, 0.91, 1.16,$ and 1.55. Berthelot's [307] measurements (1875; 11.4 °C, one measurement for each composition, $m = 0.33$) were on compositions where $n = 0.875$ and 2. The ΔH_∞° values obtained were plotted, together with the values of ΔH_∞° KOH(c) to obtain the ΔH_∞° values for the hydrates, KOH · H₂O(c) and KOH · 1.5H₂O(c). Berthelot's measurements on KOH · 2H₂O(c) appear to be seriously in error. No value for this is given.

The dissociation pressure measurements of Shibata, Oda, and Furukawa [650] and Bolte [651] are inconclusive.

KOH · H₂O(c). "Best" value, $\Delta H_\infty^\circ = -3,500 \pm 300$ cal/mole.

KOH · 1.5H₂O(c). "Best" value, $\Delta H_\infty^\circ = -2,500 \pm 300$ cal/mole.

KF(c)

ΔH_{soln} has been measured by Guntz [187] (1884; 18 °C, one measurement, $m = 0.28$), de Forcrand [335, 513] (1911; 15 °C, one measurement, $m = 0.50$), Lange and Eichler [338] (1927; 25 °C, eight measurements, $m = 3.16$ to 0.21), and Lange and Martin [397] (1937; 25 °C, one measurement, $m = 0.31$). The values, recomputed to ΔH_∞° are: Guntz, $-3,950$; de Forcrand, $-4,540$; Lange and Eichler, $-4,238 \pm 40$ (standard deviation is ± 4); Lange and Martin, $-4,007$ cal/mole.

"Best" value, $\Delta H_\infty^\circ = -4,238 \pm 40$ cal/mole.

KF·2H₂O(c)

ΔH_{soln} has been measured by Guntz [187] (1884; 20 °C, one measurement, $m = 0.28$), de Forcrand [335, 513] (1911; 15 °C, one measurement, $m = 0.50$), and Lange and Eichler [338] (1937; 25 °C, two measurements, $m = 0.47$ and 0.40). The values of ΔH_∞° are: Guntz, 830; de Forcrand, 1,890; Lange and Eichler, 1,666 $\pm$ 20 cal/mole.

The dissociation pressure measurements of Bell [647] lead to a ΔH for the reaction, KF(c) + 2H₂O(c) = KF·2H₂O(c), in excellent agreement with the difference ΔH_∞°KF(c) $- \Delta H_\infty^\circ$ KF·2H₂O(c).

"Best" value, $\Delta H_\infty^\circ = 1,666 \pm 20$ cal/mole.

KF · 4H₂O(c)

de Forcrand's reported value [335, 513] (1911; 15 °C, one measurement, $m = 0.51$) for ΔH_{soln} is 6,160 cal/mole. The melting point, reported by Yatlov and Polyakov [635] is 17.5 °C. A hypothetical ΔH_∞° at 25 °C would be 6,080 $\pm$ 200 cal/mole.

KClO₃(c)

ΔH_{soln} has been measured by Berthelot [377] (1875; 10 °C, one measurement, $m = 0.18$), Thomsen [30] (1882; 19 °C, two measurements, $m = 0.14$), von Stackelberg [275] (1898; 16 °C, five measurements, $m = 0.50$ to 0.11) and Nelson, Moss, and Hepler [551] (1960; 25 °C, six measurements, $m = 0.02$ to 0.005). The values of ΔH_∞° are: Berthelot, 9,610; Thomsen, 9,916 $\pm$ 50; von Stackelberg, 10,000 $\pm$ 100; Nelson, Moss, and Hepler, 9,870 $\pm$ 50 cal/mole.

Bindel [154] has also reported a measurement.

"Best" value, $\Delta H_\infty^\circ = 9,890 \pm 50$ cal/mole.

KClO₄(c)

ΔH_{soln} has been measured by von Stackelberg [275] (1898; 16 °C, four measurements, $m = 0.22$ to 0.06), Noyes and Sammet [568] (1903; 21 °C, seven measurements, $m = 0.12$), Latimer and Ahlberg [569] (1930; 25 °C, ?, $m = 0.03$), Birky and Hepler [481] (1960; 25 °C, seven measurements, $m = 0.009$ to 0.004) and Vorob'ev et al., [261] (1960; 25 °C, ?, $m = 0.01$). The values of ΔH_∞° are: von Stackelberg, 12,310 $\pm$ 100; Noyes and Sammet, 12,154 $\pm$ 30; Latimer and Ahlberg, 12,110 $\pm$ 50; Birky and Hepler, 12,300 $\pm$ 60; Vorob'ev et al., 12,127 $\pm$ 60 cal/mole.

Berthelot [215, 216] has also reported measurements.

"Best" value, $\Delta H_\infty^\circ = 12{,}200 \pm 60$ cal/mole.

KBr(c)

ΔH_{soln} has been measured by Thomsen [30] (1883; 19.6 °C, two measurements, $m = 0.28$), Brönsted [385] (1906; 20 °C, eight measurements, $m = 0.08$), Walden [500] (1907; 16.6 °C, two measurements, $m = 0.28$), Wüst and Lange [21] (1925; 25 °C, 31 measurements, $m = 5.25$ to 0.37), Popov, Bundel, and Choller [165] (1930; 20 °C, seven measurements, $m = 0.19$), Chipman, Johnson, and Maass [133] (1929; 15.8 to 27 °C, 30 measurements, $m = 0.43$ to 0.09), Fedorov and Sil'chenko [271] (1933; 23.5 °C, three measurements, $m = 0.56$ to 0.14), Lange and Martin [397] (1937; 25 °C, one measurement, $m = 0.13$), Popov, Skuratov, and Strel'tsova [172] (1940; 20.5 °C, $m = 0.12$), and Hietala [426] (1960; 25 °C, three measurements, $m = 0.28$). The values of ΔH_∞° are: Thomsen, $4{,}769 \pm 50$; Brönsted, $4{,}756 \pm 50$; Walden, $4{,}727 \pm 50$; Popov, Bundel, and Choller, $4{,}685 \pm 50$; Wüst and Lange, $4{,}777 \pm 40$; Chipman, Johnson, and Maass, $4{,}753 \pm 100$; Federov and Sil'chenko, $4{,}889 \pm 100$; Lange and Martin, $4{,}783$; Popov, Skuratov, and Strel'tsova, $4{,}542$; Hietala, $4{,}739 \pm 20$ cal/mole. Measurements have also been reported by Scholz [316], Berthelot [348, 377], Berthelot and Ilosvay [383], and Balarew and Kolarow [570]. Wüst and Lange's measurements appear to run high, as shown by their work on KCl. In view of this and Hietala's more recent measurements on KBr and KCl, a value of $4{,}750 \pm 20$ cal/mole has been chosen.

"Best" value, $\Delta H_\infty^\circ = 4{,}750 \pm 20$ cal/mole.

KBrO₃(c)

ΔH_{soln} has been measured by Berthelot [216, 571] (1878; 11 °C, one measurement, $m = 0.12$), Thomsen [30] (1883; 19 °C, two measurements, $m = 0.28$), von Stackelberg [275] (1898; 16 °C, three measurements, $m = 0.22$ and 0.11), Lange and Martin [397] (1937; 25 °C, one measurement, $m = 0.03$), Mel, Jolly, and Latimer [572, 573] (1953; 25 °C, three measurements, $m = 0.02$ to 0.009), and Boyd and Vaslow [522] (1962; 25 °C, one measurement, $m = 0.003$). The values of ΔH_∞° are: Thomsen, $9{,}832 \pm 50$; Berthelot, $9{,}300$; von Stackelberg, $9{,}710 \pm 100$; Lange and Martin, $9{,}888$; Mel, Jolly, and Latimer, $9{,}780 \pm 30$; Boyd and Vaslow, $9{,}700 \pm 100$ cal/mole.

"Best" value, $\Delta H_\infty^\circ = 9{,}830 \pm 50$ cal/mole.

KI(c)

ΔH_{soln} has been measured by Thomsen [30] (1882; 19 °C, two measurements, $m = 0.28$), Wüst and Lange [21] (1925; 25 °C, 24 measurements, $m = 7.95$ to 0.29), Lange and Martin [397] (1937; 25 °C, one measurement, $m = 0.11$), Popov, Skuratov, and Strel'tsova [172] (1940; 20.5 °C, one measurement, $m = 0.09$), Bobtelsky and Lairsch [530] (1950; 24.5 °C, one measurement, $m = 0.30$), and Kapustinskiĭ

and Drakin [411] (1952; 25 °C, one measurement, $m = 0.0008$). The values of ΔH_∞° are: Thomsen, $4{,}830 \pm 50$; Wüst and Lange, $4{,}897 \pm 40$ (standard deviation is ± 2); Lange and Martin, $4{,}873$; Popov, Skuratov, and Strel'tsova, $4{,}790 \pm 100$; Bobtelsky and Lairsch, $5{,}020$; Kapustinskiĭ and Drakin, $4{,}830 \pm 70$ cal/mole. Measurements have also been reported by Berthelot [377], Berthelot and Ilosvay [383], Scholz [316], Walden [500], Kantola [574], and Hieber and Mühlbauer [575].

Wüst and Lange's measurements tend to run slightly high. In view of this, a value of $4{,}860 \pm 30$ cal/mole has been selected.

"Best" value, $\Delta H_\infty^\circ = 4{,}860 \pm 30$ cal/mole.

KIO₃(c)

ΔH_{soln} has been measured by Berthelot [349] (1878; 12 °C, one measurement, $m = 0.12$), Thomsen [30] (1882; 19 °C, three measurements, $m = 0.13$ to 0.10), von Stackelberg [275] (1898; 16 °C, four measurements, $m = 0.22$ to 0.11), and Spencer and Hepler [484] (1960; 25 °C, five measurements, $m = 0.01$ to 0.006). The values of ΔH_∞° are; Berthelot, $5{,}600$; Thomsen, $6{,}640 \pm 50$; von Stackelberg, $6{,}610 \pm 100$; Spencer and Hepler, $6{,}630 \pm 50$ cal/mole.

"Best" value, $\Delta H_\infty^\circ = 6{,}630 \pm 50$ cal/mole.

KNO₂(c)

ΔH_{soln} has been measured by Dodé [306, 528] (1936; 12 °C, four measurements, $m = 0.14$), Bureau [487] (1937; 20 °C, one measurement, $m = 0.14$), and Reshetnikov [429] (1961; 25 °C, three measurements, $m = 0.17$). The ΔC_p used to correct to 25 °C was estimated. Φ_L has been estimated as -50 cal/mole at the above concentrations. The values of ΔH_∞° are: Dodé, $3{,}240 \pm 150$; Bureau, $3{,}270 \pm 150$; Reshetnikov, $3{,}190 \pm 70$ cal/mole. Reshetnikov's value is obtained from the ΔH_{soln} of a mechanical mixture of KOH with KNO₂.

"Best" value, $\Delta H_\infty^\circ = 3{,}190 \pm 70$ cal/mole.

KNO₃(c)

Values for ΔH_∞° are shown in table XX. Other measurements have been reported by Lloyd and Wyatt [71], Scholz [316], Person [584], Hieber and Mühlbauer [575], Varali-Thevenet [442], Staub [543], Berthelot [225, 377], Anderson and Noyes [478], Leval't-Ezerskiĭ [585], Graham [352], Colson [350], and Zawidzki and Schagger [562].

Part of the discrepancy in the tabulated values may be due to the presence of a few percent of the metastable form.

"Best" value, $\Delta H_\infty^\circ = 8{,}340 \pm 30$ cal/mole.

KC₂H₃O₂(c)

ΔH_{soln} has been measured by Thomsen [30] (1883; 19 °C, one measurement, $m = 0.28$). The specific heat of the crystal used to correct to 25°C was estimated. The value of ΔH_∞° is $-3{,}665 \pm 50$ cal/mole.

"Best" value, $\Delta H_\infty^\circ = -3{,}665 \pm 50$ cal/mole.

KCN(c)

Thomsen [30] (1883; 18 °C, two measurements, $m = 0.32$) and Lange and Martin [397] (1937; 25 °C, one measurement, $m = 0.32$) have measured ΔH_{soln}. Messer and Ziegler [623] measured the specific heat of the crystal. Φ_C was estimated. Φ_L has been estimated to be 10 and 60 cal/mole, respectively, at the measured concentrations. The values of $\Delta H_{\infty}^{\circ}$ are 2,860±75 and 2,745 cal/mole, respectively.

Berthelot has also measured ΔH_{soln} [216, 586].

"Best" value, $\Delta H_{\infty}^{\circ} = 2,800 \pm 100$ cal/mole.

KCNO(c)

ΔH_{soln} has been measured by Myers [203] (1958; 25 °C, four measurements, $m = 0.01$); Vanderzee and Myers [204] report the same measurements. Φ_L has been estimated as 40 cal/mole at $m = 0.01$. Their value of $\Delta H_{\infty}^{\circ}$ is 4,840±25 cal/mole.

Berthelot [495] also has measured ΔH_{soln}.

"Best" value, $\Delta H_{\infty}^{\circ} = 4,840 \pm 25$ cal/mole.

KCNS(c)

ΔH_{soln} has been measured by Joannis [496] (1882; 13 °C, three measurements, $m = 0.28$), Vrzhesnevskiĭ [448] (1912; 18 °C, one measurement, $m = 0.56$), and Partington and Soper [334] (1929; 25 °C, 14 measurements, $m = 2.98$ to 0.25). The specific heat of the crystal used to correct to 25 °C was estimated. The values of $\Delta H_{\infty}^{\circ}$ are: Joannis, 5,930; Vrzhesnevskiĭ, 6,090; Partington and Soper, 5,789±50 cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = 5,790 \pm 50$ cal/mole.

KMnO₄(c)

ΔH_{soln} has been measured by Thomsen [30] (1883; 18 °C, two measurements, $m = 0.11$), Roth and Becker [587] (1932; 16 to 21 °C, six measurements, $m = 0.08$ to 0.01), Perreu [174] (1940; 18 °C, one measurement, $m = 0.05$), and Nelson, Moss, and Hepler [551] (1960; 25 °C, six measurements, $m = 0.01$ to 0.005). The values of $\Delta H_{\infty}^{\circ}$ are: Thomsen, 10,260±150; Roth and Becker, 10,340±100; Perreu, 10,180; Nelson, Moss, and Hepler, 10,410 ±60 cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = 10,410 \pm 60$ cal/mole.

RbOH(c)

ΔH_{soln} has been measured by de Forcrand [510] (1906; 20 °C, one measurement, $m = 0.50$). The specific heat of the crystal used to correct to 25 °C was estimated. Φ_L has been estimated as 200 cal/mole at this concentration. The value of $\Delta H_{\infty}^{\circ}$ is −14,900 cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = -14,900 \pm 200$ cal/mole.

RbOH·H₂O(c)

ΔH_{soln} has been measured by de Forcrand [510] (1906; 20 °C, one measurement, $m = 0.50$). Φ_L has been estimated as 200 cal/mole at this concentration. The value of $\Delta H_{\infty}^{\circ}$ is −4,310 cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = -4,310 \pm 200$ cal/mole.

RbOH·2H₂O(c)

ΔH_{soln} has been measured by de Forcrand [510] (1909; 15 °C, one measurement, $m = 0.50$). Φ_L has been estimated as 200 cal/mole at this concentration. The value of $\Delta H_{\infty}^{\circ}$ is 210 cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = 210 \pm 200$ cal/mole.

RbF(c)

de Forcrand [513, 588] (1911; 15 °C, one measurement, $m = 0.50$), measured ΔH_{soln}. The value of $\Delta H_{\infty}^{\circ}$ is − 6,240 cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = -6,240 \pm 200$ cal/mole.

RbF·H₂O(c)

de Forcrand [589] (1911; 15 °C, one measurement, $m = 0.50$), measured ΔH_{soln} of the substance with the composition RbF·1/3H₂O. Lannung [648] showed the existence of RbF·H₂O. The $\Delta H_{\infty}^{\circ}$ RbF(c) and the $\Delta H_{\infty}^{\circ}$ for RbF·1/3H₂O were used to obtain $\Delta H_{\infty}^{\circ}$ RbF·H₂O(c) =− 100 cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = -100 \pm 300$ cal/mole.

RbF·1½H₂O(c)

de Forcrand [589] (1911; 15 °C, one measurement, $m = 0.50$), measured ΔH_{soln}. The value of $\Delta H_{\infty}^{\circ}$ is 320 cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = 320 \pm 200$ cal/mole.

RbCl(c)

ΔH_{soln} has been measured by de Forcrand [354] (1906; 19 °C, one measurement, $m = 0.25$) and [513, 588] (1911; 15 °C, one measurement, $m = 0.50$), Zemczuzny and Rambach [441] (1910; 18 °C, one measurement, $m = 0.56$), Haigh [388] (1912; 21 °C, three measurements, $m = 0.14$), Samoĭlov [590] (1956; 25 °C, one measurement, $m = 0.06$), and Samoĭlov and Buslaeva [444] (1960; 15 and 35 °C, two measurements, $m = 0.06$). The values of $\Delta H_{\infty}^{\circ}$ are: de Forcrand, 4,028 and 4,100; Zemczuzny and Rambach, 4,127; Haigh, 4,000±50; Samoĭlov, 4,112±50; Samoĭlov and Buslaeva, 4,151±75 cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = 4,130 \pm 75$ cal/mole.

RbClO₃(c)

ΔH_{soln} has been measured by Pitzer [591] (1938; 25 °C, two measurements, $m = 0.01$). Φ_L has been estimated as 25 cal/mole at this concentration. The value of $\Delta H_{\infty}^{\circ}$ is 11,410 ± 60 cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = 11,410 \pm 60$ cal/mole.

RbClO₄(c)

ΔH_{soln} has been measured by Pitzer [591] (1938; 25 °C, two measurements, $m = 0.01$). Φ_L has been estimated as 10 cal/mole at this concentration. The value of $\Delta H_{\infty}^{\circ}$ is 13,565±60 cal/mole.

"Best" value, $\Delta H_{\infty}^{\circ} = 13,560 \pm 60$ cal/mole.

RbBr(c)

ΔH_{soln} has been measured by de Forcrand [513, 588] (1911; 15 °C, one measurement, $m = 0.50$) and Lange and Martin [397] (1937; 25 °C, one measure-

ment, $m = 0.11$). The values of ΔH_∞° are 5,618 and 5,230 cal/mole, respectively.

"Best" value, $\Delta H_\infty^\circ = 5,230 \pm 100$ cal/mole.

RbBrO₃(c)

ΔH_{soln} has been measured by Boyd and Vaslow [522] (1962; 25 °C, three measurements, $m = 0.004$). Φ_L has been estimated to be 20 cal/mole at this concentration. The value of ΔH_∞° is 11,700 ± 100 cal/mole.

"Best" value, $\Delta H_\infty^\circ = 11,700 \pm 100$ cal/mole.

RbI(c)

ΔH_{soln} has been measured by Mosnier [526] (1897; 15 °C, one measurement, $m = 0.06$) and de Forcrand [513, 588] (1911; 15 °C, one measurement, $m = 0.50$). The values of ΔH_∞° are 5,675 and 6,225 cal/mole, respectively.

"Best" value, $\Delta H_\infty^\circ = 6,000 \pm 300$ cal/mole.

RbNO₃(c)

ΔH_{soln} has been measured by Haigh [388] (1912; 21 °C, three measurements, $m = 0.14$) and Vorobiev, Skuratov, and Ebragen [592] (1961; ?, ?, $m = 0.03$). The specific heat of the crystal used to correct to 25 °C was obtained from Mustajoki [624]. Haigh's value corrects to 8,716 ± 60 cal/mole at 25 °C and infinite dilution. Vorobiev's reported value of 8,910 for ΔH_{soln} is a preliminary one; hence it is given little weight in the selection of ΔH_∞°.

"Best" value, $\Delta H_\infty^\circ = 8,720 \pm 60$ cal mole.

CsOH(c)

ΔH_{soln} has been measured by Beketov [593] (1892; 16 °C, one measurement, $m = 0.17$) and de Forcrand [510] (1906; 15 °C, one measurement, $m = 0.50$). The specific heat of the solid used to correct to 25 °C was estimated. Φ_L has been estimated as 160 and 230 cal/mole, respectively, at the measured concentrations. The value of ΔH_∞° are $-16,470$ and $-17,090 \pm 200$ cal/mole, respectively.

"Best" value, $\Delta H_\infty^\circ = -17,100 \pm 200$ cal/mole.

CsOH · H₂O(c)

ΔH_{soln} has been measured by de Forcrand [510] (1906; 15 °C, one measurement, $m = 0.50$). Φ_L has been estimated as 230 cal/mole at this concentration. The value of ΔH_∞° is $-4,900 \pm 200$ cal/mole.

"Best" value, $\Delta H_\infty^\circ = -4,900 \pm 200$ cal/mole.

CsF(c)

ΔH_{soln} has been measured by de Forcrand [513, 588] (1911; 15 °C, one measurement, $m = 0.50$). The value of ΔH_∞° is $-8,810 \pm 200$ cal/mole.

"Best" value, $\Delta H_\infty^\circ = -8,810 \pm 200$ cal/mole.

CsF · H₂O(c)

de Forcrand [589] (1911; 15 °C, one measurement, $m = 0.50$) measured ΔH_{soln} of the substance with the composition CsF · 2/3H₂O. Lannung [648] showed the existence of CsF · H₂O(c). ΔH_∞° CsF

and ΔH_∞° for CsF · 2/3H₂O were used to obtain ΔH_∞° of CsF · H₂O $= -2,500$ cal/mole.

"Best" value, $\Delta H_\infty^\circ = -2,500 \pm 300$ cal/mole.

CsF·1½ H₂O(c)

de Forcrand [589] (1911; 15 °C, one measurement, $m = 0.50$) has measured ΔH_{soln}. The value of ΔH_∞° is $-1,300$ cal/mole.

"Best" value, $\Delta H_\infty^\circ = -1,300 \pm 200$ cal/mole.

CsCl(c)

ΔH_{soln} has been measured by de Forcrand [354] (1906; 19 °C, one measurement, $m = 0.25$) and [513, 588] (1911; 15 °C, one measurement, $m = 0.50$), Haigh [388] (1912; 21 °C, three measurements, $m = 0.14$), Samoĭlov [590] (1960; 25 °C, one measurement, $m = 0.05$), Rodnikova [594] (1958; 15 and 35 °C, six measurements, $m = 0.05$), and Samoĭlov and Buslaeva [444] (1960; 15 and 35 °C, three measurements, $m = 0.06$). The values of ΔH_∞° are: de Forcrand, 4,300 and 4,320; Haigh, 4,077 ± 50; Samoĭlov, 4,254; Rodnikova, 4,180 ± 100; Samoĭlov and Buslaeva, 4,180 ± 100 cal/mole.

Beketov and Beketov [527] also measured ΔH_{soln}, using mechanical mixtures of CsCl with LiI, NaI, and KI.

"Best" value, $\Delta H_\infty^\circ = 4,250 \pm 100$ cal/mole.

CsClO₄(c)

Pitzer [591] (1938; 25 °C, four measurements, $m = 0.002$ to 0.009) has measured ΔH_{soln}. Φ_L has been estimated as 15 cal/mole in this concentration range. The value of ΔH_∞° is 13,250 ± 100 cal/mole.

"Best" value, $\Delta H_\infty^\circ = 13,250 \pm 100$ cal/mole.

CsBr(c)

ΔH_{soln} has been measured by de Forcrand [513, 588] (1911; 15 °C, one measurement, $m = 0.50$) and Lange and Martin [397] (1937; 25 °C, one measurement, $m = 0.11$). The values of ΔH_∞° are 6,420 and 6,210 cal/mole, respectively.

"Best" value, $\Delta H_\infty^\circ = 6,210 \pm 100$ cal/mole.

CsBrO₃(c)

ΔH_{soln} has been measured by Boyd and Vaslow [522] (1962; 25 °C, five measurements, $m = 0.005$ to 0.001). Φ_L has been estimated as 20 cal/mole in this concentration range. The value of ΔH_∞° is 12,060 ± 100 cal/mole.

"Best" value, $\Delta H_\infty^\circ = 12,060 \pm 100$ cal/mole.

CsI(c)

ΔH_{soln} has been measured by Beketov and Beketov [527] (1904; 18 °C, three measurements, $m = 0.16$ to 0.12) and de Forcrand [513, 588] (1911; 15 °C, one measurement, $m = 0.50$). Beketov and Beketov's measurements were with mechanical mixtures of CsI with LiCl, NaCl, and KCl. The values of ΔH_∞° are 7,960 ± 150 cal/mole and 7,970 cal/mole, respectively.

"Best" value, $\Delta H_\infty^\circ = 7,970 \pm 100$ cal/mole.

CsNO₃(c)

ΔH_{soln} has been measured by Haigh [388] (1912; 21 °C, four measurements, $m = 0.14$). The value of ΔH_∞° is $9,560 \pm 50$ cal/mole.

"Best" value, $\Delta H_\infty^\circ = 9,560 \pm 50$ cal/mole.

VIII. Review Papers

Besides those mentioned in the introduction, there are numerous review and compilation papers on the thermal properties of the aqueous uni-univalent electrolytes. Among these are Eigen and Wicke [625], Latimer [626], Mishchenko [627], Gucker [628], Wüst and Lange [629], Vasil'ev et al. [630], Robinson and Frank [631], and Kapustinskiĭ, Drakin and Yakushevskiĭ [632]. Particular note should be made of Robinson and Stoke's [633] correlation of activity coefficients, conductivities, osmotic co-efficients, etc.

No attempt is made here to list all review papers on the thermal properties of specific aqueous uni-univalent electrolytes. The following lists some for the more important compounds.

HF

Elmore, Hatfield, Mason, and Jones [197] have calculated the thermal properties at 25 °C. They include the activity, free energy, enthalpy, entropy, and molal heat capacity. Franck and Spalthoff [611] correlate the specific heat at constant volume with the density and temperature.

HCl

Van Nuys [596] presents charts summarizing the enthalpy and heat of dilution data from 0 to 100 °C.

HNO₃

Chédin [597] reviews the properties of aqueous HNO₃, its hydrates, equilibrium equations, and ionization. McCurdy and McKinley [598] correlate the enthalpy-temperature data for the HNO₃-H₂SO₄-H₂O system. Kharbanda [619] provides a monogram which permits the calculation of the specific heat of aqueous solutions from −40 to 192 °C. Bump and Sibbitt [620] correlate the specific heat data of aqueous mixtures of HNO₃ and H₂SO₄.

C₂H₄O₂

Lemlich, Gottschlich, and Hoke [595] give an enthalpy-concentration chart for acetic acid-water mixtures.

NH₃

Rozenfel'd [599] gives a temperature-entropy diagram for the aqueous system.

NH₄NO₃

Othmer and Frohlich [600] construct an enthalpy-concentration diagram.

AgNO₃

Kangro and Groeneveld [601], using vapor pressure data at 20 and 25 °C, calculate values of $\bar{L}_1$ at 22.5 °C and the activity coefficients at 25 °C from $m = 15$ to 1.

LiOH

Kangro and Groeneveld [601], using vapor pressure data at 20 and 25 °C, calculate values of $\bar{L}_1$ at 22.5 °C and the activity coefficients at 25 °C from $m = 5$ to 1.

LiCl

Kangro and Groeneveld [601], using vapor pressure data at 20 and 25 °C, calculate values of $\bar{L}_1$ at 22.5 °C and the activity coefficients at 25 °C from $m = 18$ to 1.

LiBr

Löwer [602] and Rozenfel'd and Karnaukh [603] give isotherms for the enthalpy-concentration of aqueous solutions.

LiNO₃

Kangro and Groeneveld [601], using vapor pressure data at 20 and 25 °C, calculate values of $\bar{L}_1$ at 22.5 °C and the activity coefficients at 25 °C from $m = 20$ to 1.

NaOH

Rant [604, 605] gives diagrams for the enthalpy-entropy-concentration-temperature properties. Ginzburg [606, 610] gives the thermal properties of concentrated solutions. Haltenberger [607] gives an enthalpy-concentration chart. Kangro and Groeneveld [601], using vapor pressure data at 20 and 25 °C, calculate values of $\bar{L}_1$ at 22.5 °C and the activity coefficients at 25 °C from $m = 27$ to 2.

NaCl

Fábry [608] constructs a temperature-enthalpy-concentration chart. Shields [609] reviews the physical and thermal properties of brine solutions.

NaNO₃

Kangro and Groeneveld [601], using vapor pressure data at 20 and 25 °C, calculate values of $\bar{L}_1$ at 22.5 °C and the activity coefficients at 25 °C from $m = 9$ to 1.

KOH

Kangro and Groeneveld [601], using vapor pressure data at 20 and 25 °C, calculate values of $\bar{L}_1$ at 22.5 °C and the activity coefficients at 25 °C from $m = 21$ to 1.

KNO₃

Kangro and Groeneveld [601], using vapor pressure data at 20 and 25 °C, calculate values of $\bar{L}_1$ at 22.5 °C and the activity coefficients at 25 °C from $m = 3$ to 1.

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X. Tables

TABLE 1

Φ_C°, cal/deg mole, of the ions at 25 °C

Ion	Φ_C°
H^+	0
NH_4^+	19.1
Ag^+	5.2
Li^+	16.4
Na^+	11.1
K^+	5.2
Rb^+	*3.3
Cs^+	1.9
OH^-	−35.5
F^-	−25.5
Cl^-	−32.6
ClO_3^-	−19.7
ClO_4^-	−18.2
Br^-	−33.9
BrO_3^-	−26.5
I^-	−34.0
IO_3^-	−29.6
IO_4^-	*−28.2
NO_2^-	−23.3
NO_3^-	−20.7
CNS^-	−9.6
CHO_2^-	−21.0
$C_2H_3O_2^-$	−1.5
$C_3H_5O_2^-$	+26.7
MnO_4^-	−19.6

*Estimated.

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| | | Table II A. *Heat capacity: aqueous HCl* | | | | | | | Table II B. *Heat capacity: aqueous NaOH* | | | |

n	m	15°	20°	25°	30°		n	m	15°	20°	25°	30°
∞	0.00	−34.8	−33.8	−32.6	−31.9		∞	0.00	−34.4	−29.4	−24.4	−18.9
100,000	.000555	−34.6	−33.6	−32.4	−31.7		100,000	.000555	−34.3	−29.3	−24.3	−18.8
50,000	.00111	−34.6	−33.6	−32.4	−31.6		50,000	.00111	−34.3	−29.2	−24.2	−18.7
20,000	.00278	−34.5	−33.5	−32.3	−31.5		20,000	.00278	−34.2	−29.1	−24.1	−18.6
10,000	.00555	−34.4	−33.3	−32.2	−31.4		10,000	.00555	−34.1	−29.0	−23.9	−18.5
7,000	.00793	−34.3	−33.2	−32.1	−31.3		7,000	.00793	−34.0	−28.9	−23.8	−18.4
5,000	.01110	−34.2	−33.1	−32.0	−31.2		5,000	.01110	−33.8	−28.7	−23.7	−18.3
4,000	.01388	−34.2	−33.1	−31.9	−31.1		4,000	.01388	−33.7	−28.6	−23.6	−18.2
3,000	.01850	−34.1	−33.0	−31.8	−31.0		3,000	.01850	−33.5	−28.4	−23.4	−18.0
2,000	.02775	−33.9	−32.8	−31.6	−30.8		2,000	.02775	−33.2	−28.1	−23.1	−17.8
1,500	.03700	−33.7	−32.6	−31.4	−30.6		1,500	.03700	−32.8	−27.7	−22.8	−17.2
1,000	.05551	−33.4	−32.3	−31.2	−30.3		1,000	.05551	−32.1	−27.1	−22.2	−17.2
900	.0617	−33.3	−32.2	−31.2	−30.3		900	.0617	−31.9	−26.9	−22.0	−17.0
800	.0694	−33.2	−32.1	−31.1	−30.2		800	.0694	−31.6	−26.6	−21.8	−16.9
700	.0793	−33.1	−31.9	−30.9	−30.0		700	.0793	−31.3	−26.3	−21.5	−16.7
600	.0925	−32.9	−31.8	−30.8	−29.9		600	.0925	−30.8	−25.9	−21.2	−16.4
500	.1110	−32.7	−31.6	−30.6	−29.7		500	.1110	−30.2	−25.4	−20.7	−16.1
400	.1388	−32.4	−31.3	−30.3	−29.5		400	.1388	−29.4	−24.6	−20.0	−15.5
300	.1850	−31.9	−30.9	−30.0	−29.1		300	.1850	−28.1	−23.5	−18.9	−14.6
200	.2775	−31.1	−30.2	−29.3	−28.5		200	.2775	−25.8	−21.4	−17.1	−13.1
150	.3700	−30.4	−29.6	−28.8	−27.9		150	.3700	−23.8	−19.7	−15.5	−11.8
100	.5551	−29.3	−28.6	−27.8	−27.1		100	.5551	−20.4	−16.6	−12.9	−9.7
75	.7401	−28.4	−27.8	−27.0	−26.3		75	.7401	−17.3	−14.0	−10.7	−7.8
50	1.1101	−27.0	−26.4	−25.6	−25.1		50	1.1101	−12.5	−9.7	−7.1	−4.7
40	1.3877	−26.1	−25.5	−24.8	−24.3		40	1.3877	−9.8	−7.1	−4.8	−2.8
30	1.8502	−24.7	−24.2	−23.6	−23.2		30	1.8502	−6.0	−3.5	−1.7	−0.1
25	2.2202	−23.7	−23.2	−22.7	−22.3		25	2.2202	−3.5	−1.2	+0.4	+1.7
20	2.7753	−22.4	−21.9	−21.5	−21.2		20	2.7753	−0.3	+1.8	3.2	4.7
15	3.7004	−20.5	−20.2	−19.8	−19.6		15	3.7004	+4.1	5.7	6.8	7.7
12	4.6255	−18.8	−18.5	−18.2	−18.0		12	4.6255	7.5	8.8	9.8	10.5
10	5.5506	−17.3	−17.0	−16.8	−16.6		10	5.5506	10.3	11.3	12.2	12.9
9.5	5.8427	−16.8	−16.6	−16.4	−16.2		9.5	5.8427	11.0	12.0	12.8	13.6
9.0	6.1674	−16.4	−16.1	−15.8	−15.7		9.0	6.1674	11.8	12.7	13.5	14.3
8.5	6.5301	−15.8	−15.6	−15.4	−15.2		8.5	6.5301	12.6	13.5	14.3	15.1
8.0	6.9383	−15.3	−15.1	−14.8	−14.6		8.0	6.9383	13.4	14.3	15.1	15.8
7.5	7.4008	−14.7	−14.5	−14.2	−14.0		7.5	7.4008	14.2	15.1	15.8	16.6
7.0	7.9295	−14.0	−13.8	−13.5	−13.2		7.0	7.9295	15.1	16.0	16.6	17.4
6.5	8.5394	−13.2	−13.0	−12.7	−12.5		6.5	8.5394	15.9	16.9	17.5	18.2
6.0	9.2510	−12.3	−12.1	−11.8	−11.6		6.0	9.2510	16.8	17.7	18.4	19.0
5.5	10.0920	−11.3	−11.1	−10.8	−10.6		5.5	10.0920	17.6	18.4	19.1	19.7
5.0	11.1012	−10.1	−9.8	−9.6	−9.4		5.0	11.1012	18.4	19.2	19.8	20.4
4.5	12.3346	−8.2	−8.5	−8.7	−8.0		4.5	12.3346	19.4	20.0	20.6	21.1
4.0	13.8765	−7.1	−6.8	−6.6	−6.5		4.0	13.8765	20.3	20.9	21.3	21.8
3.5	15.8589	−5.1	−4.9	−4.7	−4.6		3.5	15.8589	21.4	21.7	22.0	22.3
							3.25	17.0788	21.8	22.0	22.2	22.5
							3.0	18.5020	22.0	22.2	22.3	22.5
							2.5	22.2024	22.0	22.1	22.2	22.3
							2.0	27.7530	21.2	21.2	21.2	21.2

TABLE II C. *Heat capacity: aqueous NaCl*

Φ_C, cal/deg mole

n	m	15°	20°	25°	30°
∞	0.00	− 25.2	− 23.3	− 21.5	− 20.1
100,000	.000555	− 25.1	− 23.2	− 21.4	− 20.0
50,000	.00111	− 25.0	− 23.1	− 21.3	− 19.9
20,000	.00278	− 24.9	− 23.0	− 21.2	− 19.8
10,000	.00555	− 24.8	− 22.9	− 21.1	− 19.6
7,000	.00793	− 24.7	− 22.8	− 21.0	− 19.5
5,000	.01110	− 24.6	− 22.7	− 20.9	− 19.4
4,000	.01388	− 24.5	− 22.6	− 20.8	− 19.3
3,000	.01850	− 24.4	− 22.5	− 20.7	− 19.2
2,000	.02775	− 24.2	− 22.3	− 20.4	− 19.0
1,500	.03700	− 23.9	− 22.0	− 20.2	− 18.8
1,000	.05551	− 23.4	− 21.6	− 19.8	− 18.4
900	.0617	− 23.3	− 21.4	− 19.6	− 18.2
800	.0694	− 23.1	− 21.3	− 19.5	− 18.1
700	.0793	− 22.8	− 21.0	− 19.3	− 17.9
600	.0925	− 22.5	− 20.8	− 19.0	− 17.6
500	.1110	− 22.0	− 20.3	− 18.6	− 17.3
400	.1388	− 21.4	− 19.8	− 18.2	− 16.9
300	.1850	− 20.5	− 19.0	− 17.5	− 16.2
200	.2775	− 19.0	− 17.5	− 16.3	− 15.1
150	.3700	− 17.7	− 16.4	− 15.2	− 14.1
100	.5551	− 15.5	− 14.8	− 13.4	− 12.5
75	.7401	− 13.6	− 12.6	− 11.7	− 10.9
50	1.1101	− 10.4	− 9.6	− 8.8	− 8.2
40	1.3877	− 8.3	− 7.6	− 7.0	− 6.4
30	1.8502	− 5.7	− 5.1	− 4.6	− 4.1
25	2.2202	− 3.5	− 2.9	− 2.4	− 2.0
20	2.7753	− 0.8	− 0.4	0.0	+ 0.2
15	3.7004	....	....	+ 3.3	3.5
12	4.6255	....	....	6.3	....
10	5.5506	....	....	9.0	....
9.5	5.8427	....	....	9.7	....
9.0	6.1674	....	....	10.5	....

TABLE III. *Heat capacity: acids*

Φ_C, cal/deg mole, at 25 °C

n	m	HF	HCl	HBr	HI	HIO_3	HNO_3	CH_2O_2	$C_2H_4O_2$	$C_3H_6O_2$
∞	0.00	−25.5	−32.6	−33.9	−34.0	−29.6	−20.7	−21.0	−1.5	+26.7
500,000	.000111	−23.0	....	....	....	....	....	−9.8	+25.8	38.0
100,000	.000555	−18.8	−32.4	−33.8	−33.9	−29.4	−20.6	−1.2	32.6	45.1
50,000	.00111	−16.6	−32.4	−33.7	−33.8	−29.3	−20.5	+3.1	34.0	48.3
20,000	.00278	−12.4	−32.3	−33.6	−33.7	−29.1	−20.4	10.2	35.7	52.2
10,000	.00555	−8.6	−32.2	−33.4	−33.5	−28.5	−20.3	12.7	36.9	54.1
7,000	.00793	−6.7	−32.1	−33.4	−33.4	−28.4	−20.2	13.7	37.4	54.8
5,000	.01110	−4.9	−32.0	−33.3	−33.3	−28.1	−20.1	14.3	37.8	55.3
4,000	.01388	−3.6	−31.9	−33.2	−33.2	−27.7	−20.1	14.7	37.9	55.6
3,000	.01850	−2.2	−31.8	−33.1	−33.1	−27.2	−20.0	15.1	38.1	56.1
2,000	.02775	−0.5	−31.6	−32.9	−32.9	−25.8	−19.8	15.8	38.5	56.7
1,500	.03700	+0.4	−31.4	−32.7	−32.7	−24.9	−19.6	16.4	38.7	57.1
1,000	.05551	1.6	−31.2	−32.5	−32.5	−23.0	−19.3	16.8	39.0	57.7
900	.0617	1.8	−31.2	−32.4	−32.4	−22.3	−19.2	17.0	39.0	57.8
800	.0694	2.0	−31.1	−32.3	−32.3	−21.5	−19.1	17.2	39.1	57.9
700	.0793	2.2	−30.9	−32.2	−32.1	−20.2	−19.0	17.3	39.2	58.0
600	.0925	2.4	−30.8	−32.1	−32.0	−18.7	−18.9	17.5	39.3	58.3
500	.1110	2.7	−30.6	−31.9	−31.7	−16.7	−18.7	17.7	39.4	58.4
400	.1388	2.8	−30.3	−31.6	−31.4	−13.9	−18.4	18.0	39.4	58.6
300	.1850	3.2	−30.0	−31.2	−30.9	−10.1	−17.9	18.3	39.4	58.8
200	.2775	3.3	−29.3	−30.6	−30.2	−4.7	−17.2	18.7	39.3	58.9
150	.3700	3.5	−28.8	−30.1	−29.6	−0.7	−16.4	18.9	39.2	58.8
100	.5551	3.8	−27.8	−29.1	−28.4	+4.8	−15.0	19.0	39.1	58.7
75	.7401	4.1	−27.0	−28.5	−27.5	9.2	−13.7	19.2	38.9	58.6
50	1.1101	4.5	−25.6	−26.8	−25.9	15.7	−11.5	19.8	38.6	58.3
40	1.3877	4.9	−24.8	−25.9	−24.8	19.0	−9.9	19.8	38.4	58.0
30	1.8502	5.3	−23.6	−24.5	−23.3	23.1	−7.3	20.0	38.0	57.1
25	2.2202	5.6	−22.7	−23.6	−22.2	25.7	−5.4	20.1	37.7	56.2
20	2.7753	5.7	−21.5	−22.2	−20.8	....	−2.7	20.2	37.1	55.0
15	3.7004	6.0	−19.8	−20.3	....	....	+1.4	20.4	36.3	53.1
12	4.6255	6.2	−18.2	−18.5	....	....	5.0	20.4	35.4	51.3
10	5.5506	6.3	−16.8	−16.8	....	....	8.5	20.6	34.8	49.7
9.5	5.8427	6.4	−16.4	−16.3	....	....	9.2	20.6	34.7	....
9.0	6.1674	6.4	−15.8	−15.7	....	....	10.3	20.6	34.5	....
8.5	6.5301	6.5	−15.4	−15.1	....	....	11.4	20.7	34.4	....
8.0	6.9383	6.6	−14.8	−14.4	....	....	12.5	20.7	34.2	....
7.5	7.4008	6.7	−14.2	−13.2	....	....	13.7	20.8	34.0	....
7.0	7.9295	6.9	−13.5	−12.7	....	....	14.9	20.8	33.8	....
6.5	8.5394	7.0	−12.7	−11.9	....	....	16.1	20.8	33.5	....
6.0	9.2510	7.1	−11.8	−10.8	....	....	17.1	20.9	33.3	....
5.5	10.0920	7.2	−10.8	−9.6	....	....	18.3	20.9	33.0	....
5.0	11.1012	7.3	−9.6	−8.2	....	....	19.3	21.0	32.8	....
4.5	12.3346	7.4	−8.7	−6.8	....	....	20.4	21.1	32.5	....
4.0	13.8765	7.5	−6.6	−5.5	....	....	21.3	21.2	32.2	....
3.5	15.8589	7.6	−4.7	−4.0	....	....	22.1	21.3	31.8	....
3.25	17.0788	7.6	....	−3.2	....	....	22.6	21.4	31.7	....
3.0	18.5020	7.7	....	−2.3	....	....	23.0	21.5	31.5	....
2.5	22.2024	7.8	....	−0.4	....	....	23.8	21.6	31.2	....
2.0	27.7530	7.9	....	....	....	....	24.6	21.7	30.8	....
1.5	37.0040	....	....	....	....	....	25.2	21.8	30.4	....
1.0	55.506	....	....	....	....	....	25.7	22.0	30.1	....

Table IV.

TABLE IV. *Heat capacity: ammonium and alkyl ammonium compounds*

Φ_C, cal/deg mole, at 25 °C

n	m	NH$_4$OH	NH$_4$F	NH$_4$Cl	NH$_4$Br*	NH$_4$I*	NH$_4$NO$_3$	CH$_3$NH$_3$Cl	(CH$_3$)$_2$NH$_2$Cl	(CH$_3$)$_3$NHCl
∞	0.00	− 16.4	− 6.4	− 13.5	− 14.8	− 14.9	− 1.6	.....	......	......
500,000	.000111	+ 19.4	....	....	....	....	....	.....	......	......
100,000	.000555	26.7	− 6.3	− 13.4	(− 14.7)	(− 14.8)	− 1.5	.....	......	......
50,000	.00111	29.3	− 6.2	− 13.3	(− 14.6)	(− 14.7)	− 1.4	.....	......	......
20,000	.00278	31.5	− 6.1	− 13.2	(− 14.5)	(− 14.6)	− 1.3	.....	......	......
10,000	.00555	32.7	− 6.0	− 13.1	(− 14.4)	(− 14.5)	− 1.1	.....	......	......
7,000	.00793	33.3	− 5.9	− 13.0	(− 14.3)	(− 14.4)	− 1.0	.....	......	......
5,000	.01110	33.6	− 5.8	− 12.9	(− 14.2)	(− 14.3)	− 0.9	.....	......	......
4,000	.01388	33.7	− 5.7	− 12.8	(− 14.1)	(− 14.2)	− 0.8	.....	......	......
3,000	.01850	33.7	− 5.6	− 12.7	(− 14.0)	(− 14.1)	− 0.7	.....	......	......
2,000	.02775	33.7	− 5.4	− 12.6	(− 13.9)	(− 14.0)	− 0.5	.....	......	......
1,500	.03700	33.8	− 5.2	− 12.4	(− 13.7)	(− 13.8)	− 0.2	.....	......	......
1,000	.05551	33.9	− 5.0	− 12.1	(− 13.4)	(− 13.5)	+ 0.2	.....	......	......
900	.0617	33.9	− 4.9	− 12.0	(− 13.3)	(− 13.4)	0.4	.....	......	......
800	.0694	34.0	− 4.8	− 11.9	(− 13.2)	(− 13.3)	0.5	.....	......	......
700	.0793	34.1	− 4.7	− 11.8	(− 13.2)	(− 13.2)	0.8	.....	......	......
600	.0925	34.1	− 4.5	− 11.7	(− 13.0)	(− 13.0)	1.0	4.5	8.7	10.3
500	.1110	34.2	− 4.4	− 11.6	(− 12.8)	(− 12.8)	1.3	5.1	9.6	11.2
400	.1388	34.4	− 4.1	− 11.3	(− 12.5)	(− 12.4)	1.8	5.8	10.9	12.5
300	.1850	34.6	− 3.6	− 11.0	(− 12.1)	(− 11.9)	2.5	6.7	12.7	14.3
200	.2775	34.8	− 2.9	− 10.3	(− 11.4)	(− 10.9)	3.7	7.8	15.4	17.1
150	.3700	34.9	− 2.3	− 9.7	(− 10.9)	(− 10.1)	4.8	8.2	17.2	19.3
100	.5551	35.2	− 1.4	− 8.7	(− 9.8)	(− 8.7)	6.6	8.1	18.8	22.4
75	.7401	35.4	− 0.6	− 7.8	(− 9.0)	(− 7.5)	8.0	7.5	19.4	24.5
50	1.1101	35.6	+ 0.7	− 6.2	(− 7.5)	(− 5.5)	10.4	5.6	19.4	26.8
40	1.3877	35.7	1.7	− 5.3	(− 6.5)	(− 4.3)	11.9	.....	......	......
30	1.8502	35.7	2.8	− 3.9	(− 5.0)	(− 2.5)	14.0	.....	......	......
25	2.2202	35.8	3.7	− 2.9	(− 4.0)	(− 1.2)	15.4	.....	......	......
20	2.7753	35.6	4.7	− 1.6	....	....	17.3	.....	......	......
15	3.7004	35.6	6.2	+ 0.3	....	....	19.7	.....	......	......
12	4.6255	35.4	7.5	1.9	....	....	21.6	.....	......	......
10	5.5506	35.3	8.3	3.4	....	....	22.9	.....	......	......
9.5	5.8427	35.3	8.5	3.8	....	....	23.3	.....	......	......
9.0	6.1674	35.2	8.8	4.3	....	....	23.7	.....	......	......
8.5	6.5301	35.1	9.1	4.8	....	....	24.2	.....	......	......
8.0	6.9383	35.1	9.5	5.3	....	....	24.7	.....	......	......
7.5	7.4008	35.1	9.9	6.0	....	....	25.1	.....	......	......
7.0	7.9295	35.0	10.2	....	....	....	25.6	.....	......	......
6.5	8.5394	34.9	10.6	....	....	....	26.1	.....	......	......
6.0	9.2510	34.8	11.2	....	....	....	26.6	.....	......	......
5.5	10.0920	34.7	11.8	....	....	....	27.2	.....	......	......
5.0	11.1012	34.6	12.5	....	....	....	27.8	.....	......	......
4.5	12.3346	34.5	13.3	....	....	....	28.5	.....	......	......
4.0	13.8765	34.5	14.1	....	....	....	29.1	.....	......	......
3.5	15.8589	34.6	14.9	....	....	....	29.8	.....	......	......
3.25	17.0788	34.7	15.3	....	....	....	30.2	.....	......	......
3.0	18.5020	34.8	15.7	....	....	....	30.7	.....	......	......
2.5	22.2024	35.1	16.1	....	....	....	31.6	.....	......	......
2.0	27.7530	35.1	17.4	....	....	....	....	.....	......	......
1.5	37.0040	35.3	18.3	....	....	....	....	.....	......	......
1.0	55.506	35.8	19.2	....	....	....	....	.....	......	......

*Estimated.

TABLE V. *Heat capacity: silver and lithium compounds*

Φ_c, cal/deg mole, at 25 °C

n	m	AgF	AgNO₃	LiOH	LiCl	LiBr	LiI	LiNO₃
∞	0.00	−20.3	−15.5	−19.1	−16.2	−17.5	−17.6	−4.3
100,000	.000555	....	−15.4	−19.9	−16.1	−17.4	−17.5	−4.2
50,000	.00111	....	−15.3	−18.8	−16.0	−17.3	−17.4	−4.1
20,000	.00278	....	−15.2	−18.7	−15.9	−17.2	−17.3	−4.0
10,000	.00555	....	−15.0	−18.6	−15.8	−17.1	−17.2	−3.8
7,000	.00793	....	−14.9	−18.5	−15.7	−17.0	−17.1	−3.7
5,000	.01110	....	−14.8	−18.3	−15.6	−16.9	−17.0	−3.6
4,000	.01388	....	−14.7	−18.2	−15.5	−16.8	−16.9	−3.5
3,000	.01850	....	−14.5	−18.1	−15.4	−16.7	−16.8	−3.4
2,000	.02775	....	−14.2	−17.9	−15.2	−16.5	−16.5	−3.2
1,500	.03700	....	−13.9	−17.7	−15.0	−16.3	−16.3	−3.0
1,000	.05551	....	−13.2	−17.3	−14.8	−16.1	−16.0	−2.8
900	.0617	....	−13.0	−17.2	−14.7	−16.0	−15.9	−2.7
800	.0694	....	−12.8	−17.0	−14.6	−15.9	−15.7	−2.6
700	.0793	....	−12.5	−16.8	−14.5	−15.8	−15.6	−2.5
600	.0925	....	−12.1	−16.6	−14.3	−15.7	−15.4	−2.4
500	.1110	....	−11.6	−16.2	−14.2	−15.6	−15.2	−2.2
400	.1388	....	−10.8	−15.8	−13.9	−15.4	−14.9	−1.9
300	.1850	....	−9.7	−15.1	−13.6	−15.0	−14.4	−1.5
200	.2775	....	−7.8	−13.9	−13.0	−14.5	−13.6	−0.8
150	.3700	....	−6.1	−12.8	−12.6	−14.0	−13.0	−0.1
100	.5551	....	−3.3	−11.0	−11.7	−13.2	−11.8	+1.1
75	.7401	....	−1.0	−9.5	−11.1	−12.5	−10.8	2.1
50	1.1101	....	+2.9	−6.9	−10.0	−11.5	−9.3	3.8
40	1.3877	....	5.5	−5.3	−9.4	−10.8	−8.4	4.9
30	1.8502	−2.2	9.2	−2.9	−8.5	−9.7	−7.2	6.5
25	2.2202	−2.1	11.8	−1.2	−7.8	−9.0	−6.4	7.7
20	2.7753	−1.8	....	+1.0	−6.9	−8.0	−5.3	....
15	3.7004	−1.5	....	4.6	−5.6	−6.8	*(−3.9)	....
12	4.6255	−1.4	....	7.5	−4.5	−5.5	(−2.6)	....
10	5.5506	−1.2	....	....	−3.3	−4.4	(−1.5)	....
9.5	5.8427	−1.2	....	....	−2.9	−4.0	(−1.2)	....
9.0	6.1674	−1.2	....	....	−2.6	−3.6	(−0.9)	....
8.5	6.5301	−1.2	....	....	−2.2	−3.2	(−0.5)	....
8.0	6.9383	−1.1	....	....	−1.8	−2.8	(−0.1)	....
7.5	7.4008	−1.1	....	....	−1.2	−2.2	(+0.5)	....
7.0	7.9295	−1.1	....	....	−0.6	−1.6	(1.1)	....
6.5	8.5394	−1.1	....	....	+0.1	−0.8	(1.8)	....
6.0	9.2510	−1.2	....	....	0.9	−0.1	(2.6)	....
5.5	10.0920	−1.3	....	....	1.7	+0.8	(3.4)	....
5.0	11.1012	−1.5	....	....	2.5	1.7	(4.4)	....
4.5	12.3346	−1.6	....	....	3.5	2.8	(5.2)	....
4.0	13.8765	−1.8	....	....	4.5	4.0	(6.2)	....
3.5	15.8589	....	....	....	5.8	5.3	(7.4)	....
3.25	17.0788	....	....	....	6.4	6.1	....	....
3.0	18.5020	....	....	....	6.9	6.8	....	....

*Estimated.

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n	m	NaOH	NaCl	NaClO$_3$	NaClO$_4$	NaBr	NaBrO$_3$	NaI	NaNO$_2$	NaNO$_3$	NaCHO$_2$	Na-C$_2$H$_3$O$_2$	Na-C$_3$H$_5$O$_2$
∞	0.00	−24.4	−21.5	−8.6	−7.1	−22.8	−15.4	−22.9	−12.2	−9.6	−9.9	+9.6	+37.8
100,000	.000555	−24.3	−21.4	−8.5	−7.0	−22.7	−15.3	−22.8	−12.1	−9.5	−9.8	9.7	37.9
50,000	.00111	−24.2	−21.3	−8.4	−6.9	−22.6	−15.2	−22.7	−12.0	−9.4	−9.7	9.8	38.0
20,000	.00278	−24.1	−21.2	−8.3	−6.8	−22.5	−15.1	−22.6	−11.9	−9.3	−9.6	9.9	38.1
10,000	.00555	−23.9	−21.1	−8.2	−6.6	−22.4	−15.0	−22.5	−11.8	−9.1	−9.5	10.0	38.3
7,000	.00793	−23.8	−21.0	−8.1	−6.5	−22.3	−14.8	−22.4	−11.7	−9.0	−9.3	10.1	38.4
5,000	.01110	−23.7	−20.9	−7.9	−6.3	−22.2	−14.7	−22.3	−11.5	−8.9	−9.2	10.3	38.5
4,000	.01388	−23.6	−20.8	−7.8	−6.2	−22.1	−14.6	−22.2	−11.4	−8.8	−9.1	10.4	38.6
3,000	.01850	−23.4	−20.7	−7.7	−5.9	−22.0	−14.4	−22.1	−11.3	−8.6	−8.9	10.5	38.7
2,000	.02775	−23.1	−20.4	−7.4	−5.5	−21.8	−14.1	−21.9	−11.0	−8.3	−8.6	10.8	39.0
1,500	.03700	−22.8	−20.2	−7.1	−5.0	−21.6	−13.7	−21.7	−10.7	−8.0	−8.3	11.1	39.2
1,000	.05551	−22.2	−19.8	−6.5	−4.1	−21.2	−13.1	−21.2	−10.2	−7.4	−7.7	11.7	39.7
900	.0617	−22.0	−19.6	−6.3	−3.9	−21.0	−12.9	−21.1	−10.0	−7.2	−7.6	11.8	39.8
800	.0694	−21.8	−19.5	−6.1	−3.5	−20.9	−12.6	−20.8	−9.8	−7.0	−7.3	12.0	39.9
700	.0793	−21.5	−19.3	−5.7	−3.0	−20.7	−12.3	−20.6	−9.5	−6.7	−7.0	12.3	40.2
600	.0925	−21.2	−19.0	−5.4	−2.4	−20.4	−11.8	−20.3	−9.2	−6.4	−6.7	12.6	40.4
500	.1110	−20.7	−18.6	−4.9	−1.5	−20.0	−11.3	−19.9	−8.7	−5.9	−6.2	13.1	40.8
400	.1388	−20.0	−18.2	−4.1	−0.1	−19.6	−10.4	−19.2	−7.9	−5.2	−5.5	13.8	41.2
300	.1850	−18.9	−17.5	−2.8	+1.9	−18.8	−9.2	−18.3	−6.9	−4.1	−4.4	14.6	42.0
200	.2775	−17.1	−16.3	−0.7	5.5	−17.5	−7.1	−16.7	−5.1	−2.1	−2.5	16.4	43.2
150	.3700	−15.5	−15.2	+1.1	8.4	−16.5	−5.2	−15.3	−3.6	−0.5	−1.0	17.9	44.2
100	.5551	−12.9	−13.4	4.2	12.7	−14.4	−2.1	−12.9	−0.9	+2.2	+1.6	20.5	45.8
75	.7401	−10.7	−11.7	6.6	15.3	−12.7	+0.5	−11.0	+1.4	4.5	3.6	22.7	46.9
50	1.1101	−7.1	−8.8	10.7	18.4	−9.7	4.9	−7.6	5.1	8.3	6.8	26.4	48.6
40	1.3877	−4.8	−7.0	13.1	20.0	−7.7	7.4	−5.4	7.3	10.7	8.7	28.5	49.6
30	1.8502	−1.7	−4.6	16.4	22.3	−4.9	10.8	−2.4	10.4	14.2	11.6	31.1	50.8
25	2.2202	+0.4	−2.4	18.4	23.8	−3.0	13.1	−0.4	12.6	16.4	13.6	32.7	51.7
20	2.7753	3.2	0.0	20.7	25.9	−0.4	....	+2.1	15.3	....	15.8	34.6	......
15	3.7004	6.8	+3.3	23.4	28.4	+2.9	....	5.6	19.1	....	18.6	36.9	......
12	4.6255	9.8	6.3	25.3	30.1	5.8	....	....	....	....	....	38.4	
10	5.5506	12.2	9.0	26.5	31.2	8.2	....	....	....	....	....	39.5	......
9.5	5.8427	12.8	9.7	26.9	31.4	9.0	....	....	....	....	....	39.9	......
9.0	6.1674	13.5	10.5	27.2	31.7	9.8	....	....	....	....	....	40.2	......
8.5	6.5301	14.3	....	27.5	32.0	10.7	....	....	....	....	....	40.6	......
8.0	6.9383	15.1	....	27.8	32.3	11.6	....	....	....	....	....	40.9	......
7.5	7.4008	15.8	....	28.2	32.6	12.7	....	....	....	....	....	41.4	......
7.0	7.9295	16.6	....	28.6	32.9	13.8	....	....	....	....	....	....	......
6.5	8.5394	17.5	....	29.0	33.3	15.0	....	....	....	....	....	....	......
6.0	9.2510	18.4	....	29.4	33.6	16.3	....	....	....	....	....	....	......
5.5	10.0920	19.1	....	....	34.0	....	....	....	....	....	....	....	......
5.0	11.1012	19.8	....	....	34.4	....	....	....	....	....	....	....	......
4.5	12.3346	20.6	....	....	34.8	....	....	....	....	....	....	....	......
4.0	13.8765	21.3	....	....	35.2	....	....	....	....	....	....	....	......
3.5	15.8589	22.0	....	....	35.5	....	....	....	....	....	....	....	......
3.25	17.0788	22.2	....	....	35.6	....	....	....	....	....	....	....	......
3.0	18.5020	22.3	....	....	....	....	....	....	....	....	....	....	......
2.5	22.2024	22.2	....	....	....	....	....	....	....	....	....	....	......
2.0	27.7530	21.2	....	....	....	....	....	....	....	....	....	....	......

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TABLE VII. *Heat capacity: potassium compounds*

Φ_c, cal/deg mole, at 25 °C

n	m	KOH	KCl	KBr	KI	KIO₃	KNO₃	KC₂H₃O₂	KCNS	KMnO₄
∞	0.00	−30.3	−27.4	−28.7	−28.8	−24.4	−15.5	+3.7	−4.4	−14.4
100,000	.000555	−30.2	−27.3	−28.6	−28.7	−24.2	−15.3	3.8	−4.2	−14.3
50,000	.00111	−30.1	−27.2	−28.5	−28.6	−24.1	−15.3	3.9	−4.2	−14.2
20,000	.00278	−30.0	−27.1	−28.4	−28.5	−24.0	−15.1	4.0	−4.1	−14.1
10,000	.00555	−29.9	−27.0	−28.3	−28.4	−23.6	−15.0	4.1	−4.0	−13.9
7,000	.00793	−29.8	−26.9	−28.2	−28.3	−23.5	−14.9	4.2	−3.9	−13.8
5,000	.01110	−29.7	−26.8	−28.1	−28.2	−23.3	−14.8	4.3	−3.8	−13.6
4,000	.01388	−29.6	−26.7	−28.0	−28.1	−23.1	−14.7	4.4	−3.7	−13.5
3,000	.01850	−29.5	−26.6	−27.9	−27.9	−22.7	−14.5	4.5	−3.6	−13.3
2,000	.02775	−29.2	−26.4	−27.6	−27.7	−21.7	−14.2	4.7	−3.3	−12.9
1,500	.03700	−29.0	−26.2	−27.4	−27.5	−21.3	−13.8	4.9	−3.1	−12.5
1,000	.05551	−28.7	−25.9	−27.0	−27.0	−19.8	−13.3	5.3	−2.8	−11.6
900	.0617	−28.6	−25.7	−26.9	−26.9	−19.6	−13.1	5.4	−2.7	−11.4
800	.0694	−28.4	−25.6	−26.7	−26.7	−18.7	−12.8	5.5	−2.6	−11.0
700	.0793	−28.2	−25.4	−26.6	−26.5	−17.9	−12.5	5.7	−2.4	−10.5
600	.0925	−28.0	−25.3	−26.4	−26.3	−16.8	−12.2	5.9	−2.2	−9.9
500	.1110	−27.6	−25.0	−26.1	−26.0	−15.2	−11.7	6.2	−1.9	−9.2
400	.1388	−27.2	−24.7	−25.7	−25.5	−12.9	−11.0	6.7	−1.5	−8.0
300	.1850	−26.5	−24.1	−25.1	−24.8	−9.3	−9.9	7.4	−1.0	−6.2
200	.2775	−25.3	−23.3	−24.0	−23.5	−3.6	−8.1	8.6	0.0	−2.7
150	.3700	−24.3	−22.6	−23.1	−22.3	+1.4	−6.4	9.8	+0.8	+0.1
100	.5551	−22.6	−21.2	−21.6	−20.4	....	−3.8	11.8	2.0	4.7
75	.7401	−21.1	−20.0	−20.4	−18.8	....	−1.6	13.6	3.2	....
50	1.1101	−18.6	−17.8	−18.3	−16.3	....	+2.1	16.5	4.9	....
40	1.3877	−16.9	−16.4	−17.0	−14.8	....	4.4	18.2	6.0	....
30	1.8502	−14.4	−14.3	−14.9	−12.7	....	7.9	20.4	7.6	....
25	2.2202	−12.5	−12.8	−13.4	−11.2	....	10.3	21.9	8.7	....
20	2.7753	....	−10.8	−11.4	−9.3	....	13.5	23.5	10.2	....
15	3.7004	....	−8.1	−8.7	....	....	17.7	25.3	....	....
12	4.6255	....	−6.0	−6.5	....	....	....	26.5	....	....
10	5.5506	....	−4.2	−4.6	....	....	....	27.5	....	....
9.5	5.8427	....	....	−4.2	....	....	....	27.8	....	....
9.0	6.1674	....	....	....	....	....	....	28.1	....	....
8.5	6.5301	....	....	....	....	....	....	28.5	....	....
8.0	6.9383	....	....	....	....	....	....	28.8	....	....
7.5	7.4008	....	....	....	....	....	....	29.2	....	....
7.0	7.9295	....	....	....	....	....	....	29.6	....	....
6.5	8.5394	....	....	....	....	....	....	30.0	....	....
6.0	9.2510	....	....	....	....	....	....	30.4	....	....
5.5	10.0920	....	....	....	....	....	....	30.9	....	....
5.0	11.1012	....	....	....	....	....	....	31.5	....	....

TABLE VIII. *Heat capacity: rubidium compounds*

Φ_C, cal/deg mole, at 25 °C

n	m	RbOH*	RbCl*	RbBr*	RbI*	RbNO$_3$*
∞	0.00	(− 32.2)	(− 29.3)	(− 30.6)	(− 30.7)	(− 17.4)
100,000	.000555	(− 32.1)	(− 29.2)	(− 30.5)	(− 30.6)	(− 17.3)
50,000	.00111	(− 32.0)	(− 29.1)	(− 30.4)	(− 30.5)	(− 17.2)
20,000	.00278	(− 31.9)	(− 29.0)	(− 30.3)	(− 30.4)	(− 17.1)
10,000	.00555	(− 31.8)	(− 28.9)	(− 30.2)	(− 30.3)	(− 17.0)
7,000	.00793	(− 31.7)	(− 28.8)	(− 30.1)	(− 30.2)	(− 16.9)
5,000	.01110	(− 31.6)	(− 28.7)	(− 30.0)	(− 30.1)	(− 16.8)
4,000	.01388	(− 31.5)	(− 28.6)	(− 29.9)	(− 30.0)	(− 16.7)
3,000	.01850	(− 31.4)	(− 28.5)	(− 29.8)	(− 29.9)	(− 16.5)
2,000	.02775	(− 31.1)	(− 28.3)	(− 29.6)	(− 29.7)	(− 16.2)
1,500	.03700	(− 30.9)	(− 28.2)	(− 29.4)	(− 29.5)	(− 15.9)
1,000	.05551	(− 30.5)	(− 28.0)	(− 29.2)	(− 29.1)	(− 15.3)
900	.0617	(− 30.4)	(− 27.9)	(− 29.1)	(− 29.0)	(− 15.1)
800	.0694	(− 30.2)	(− 27.8)	(− 29.0)	(− 28.9)	(− 14.9)
700	.0793	(− 30.0)	(− 27.6)	(− 28.8)	(− 28.7)	(− 14.6)
600	.0925	(− 29.8)	(− 27.5)	(− 28.7)	(− 28.5)	(− 14.3)
500	.1110	(− 29.5)	(− 27.3)	(− 28.5)	(− 28.2)	(− 13.8)
400	.1388	(− 29.1)	(− 27.0)	(− 28.2)	(− 27.8)	(− 13.0)
300	.1850	(− 28.4)	(− 26.6)	(− 27.7)	(− 27.3)	(− 12.0)
200	.2775	(− 27.3)	(− 25.8)	(− 26.9)	(− 26.3)	(− 10.1)
150	.3700	(− 26.2)	(− 25.1)	(− 26.2)	(− 25.4)	(− 8.6)
100	.5551	(− 24.4)	(− 24.0)	(− 25.0)	(− 23.9)	(− 5.8)
75	.7401	(− 22.9)	(− 23.1)	(− 24.0)	(− 22.6)	(− 3.6)
50	1.1101	(− 20.2)	(− 21.5)	....	(− 20.3)	(+ 0.2)

*Estimated.

TABLE IX. *Heat capacity: cesium compounds*

Φ_C, cal/deg mole, at 25 °C

n	m	CsOH*	CsCl*	CsBr*	CsI	CsNO$_3$*
∞	0.00	− 33.6	− 30.7	− 32.0	− 32.1	− 18.8
100,000	.000555	(− 33.5)	(− 30.6)	(− 31.9)	-- 32.0	(− 18.7)
50,000	.00111	(− 33.5)	(− 30.5)	(− 31.8)	− 31.9	(− 18.6)
20,000	.00278	(− 33.4)	(− 30.4)	(− 31.7)	− 31.8	(− 18.5)
10,000	.00555	(− 33.3)	(− 30.3)	(− 31.6)	− 31.7	(− 18.4)
7,000	.00793	(− 33.2)	(− 30.3)	(− 31.5)	− 31.6	(− 18.3)
5,000	.01110	(− 33.1)	(− 30.2)	(− 31.4)	− 31.5	(− 18.2)
4,000	.01388	(− 33.0)	(− 30.1)	(− 31.3)	− 31.4	(− 18.1)
3,000	.01850	(− 32.9)	(− 30.0)	(− 31.2)	− 31.3	(− 17.9)
2,000	.02775	(− 32.7)	(− 29.8)	(− 31.0)	− 31.1	(− 17.6)
1,500	.03700	(− 32.4)	(− 29.6)	(− 30.8)	− 30.9	(− 17.3)
1,000	.05551	(− 32.1)	(− 29.3)	(− 30.5)	− 30.6	(− 16.7)
900	.0617	(− 31.9)	(− 29.2)	(− 30.4)	− 30.5	(− 16.5)
800	.0694	(− 31.8)	(− 29.1)	(− 30.3)	− 30.4	(− 16.3)
700	.0793	(− 31.6)	(− 29.0)	(− 30.2)	− 30.2	(− 16.0)
600	.0925	(− 31.4)	(− 28.8)	(− 30.0)	− 30.0	(− 15.7)
500	.1110	(− 31.1)	(− 28.6)	(− 29.8)	− 29.7	(− 15.2)
400	.1388	(− 30.7)	(− 28.3)	(− 29.5)	− 29.3	(− 14.4)
300	.1850	(− 30.1)	(− 27.9)	(− 29.1)	− 28.7	(− 13.4)
200	.2775	(− 29.1)	(− 27.2)	(− 28.3)	− 27.7	(− 11.5)
150	.3700	(− 28.0)	(− 26.6)	(− 27.6)	− 26.9	(− 9.7)
100	.5551	(− 26.4)	(− 25.5)	(− 26.5)	− 25.5	(− 7.2)
75	.7401	(− 25.0)	(− 24.6)	(− 25.5)	− 24.5	(− 5.0)
50	1.1101	(− 22.3)	(− 23.1)	(− 23.8)	− 22.6	(− 1.2)
40	1.3877	(− 20.6)	(− 22.1)	(− 22.7)	− 21.4	(+ 1.2)
30	1.8502	(− 17.5)	....	....	− 19.7	....
25	2.2202	(− 15.7)	....	....	− 18.3	....

*Estimated.

TABLE X. *Thermal properties of aqueous NaCl at 25 °C*

n	m	$d\Phi_L/dm^{1/2}$	Φ_L	$\bar{L}_2$
			cal/mole	cal/mole
∞	0.00	472	0	0
100,000	.000555	436	11	16
50,000	.00111	423	14	21
20,000	.00278	395	22	32
10,000	.00555	365	31	45
7,000	.00793	344	37	52
5,000	.01110	322	42	59
4,000	.01388	304	46	64
3,000	.01850	282	51	70
2,000	.02775	245	59	79
1,000	.05551	167	73	93
900	.0617	155	75	94
800	.0694	139	78	96
700	.0793	120	80	97
600	.0925	99	83	98
500	.1110	71	85	97
400	.1388	+ 35	87	94
300	.1850	− 14	88	85
200	.2775	− 87	83	+ 60
100	.5551	− 220	49	− 33
75	.7401	− 275	+ 20	− 98
50	1.1101	− 344	− 41	− 222
40	1.3877	− 373	− 85	− 304
30	1.8502	− 394	− 156	− 424
25	2.2202	− 394	− 207	− 501
20	2.7753	− 376	− 274	− 587
15	3.7004	− 321	− 367	− 676
12	4.6255	− 242	− 430	− 690
10	5.5506	− 135	− 469	− 628
9.5	5.8427	− 93	− 476	− 588

TABLE XI. *Heat of dilution: acids*

Φ_L, cal/mole, at 25 °C

n	m	HF	HCl	HClO$_4$	HBr	HI	HNO$_3$	CH$_2$O$_2$	C$_2$H$_4$O$_2$
∞	0.00	0	0	0	0	0	0	0	0
500,000	.000111	300	5	5	5	5	5	9	40
100,000	.000555	900	10	10	9	9	11	13	50
50,000	.00111	1,300	16	14	13	12	15	20	53
20,000	.00278	1,800	25	22	22	20	23	23	55
10,000	.00555	2,130	34	30	31	29	31	25	58
7,000	.00793	2,250	40	35	37	34	36	26	59
5,000	.01110	2,360	47	40	44	41	42	26	61
4,000	.01388	2,450	54	43	49	46	46	27	62
3,000	.01850	2,550	60	47	56	52	51	28	62
2,000	.02775	2,700	74	54	68	63	59	28	63
1,500	.03700	2,812	85	58	77	71	65	29	64
1,110	.05000	2,927	97	62	89	81	73	29	65
1,000	.05551	2,969	102	62	92	84	76	29	65
900	.0617	2,989	107	63	97	88	78	30	66
800	.0694	3,015	113	64	102	92	81	31	67
700	.0793	3,037	120	65	108	96	84	32	68
600	.0925	3,057	129	65	115	102	88	32	68
555.1	.1000	3,060	133	65	119	105	89	32	69
500	.1110	3,077	140	65	124	108	92	32	70
400	.1388	3,097	156	64	135	116	97	33	72

TABLE XI. *Heat of dilution: acids*—Continued

Φ_L, cal/mole, at 25 °C

n	m	HF	HCl	$HClO_4$	HBr	HI	HNO_3	CH_2O_2	$C_2H_4O_2$
300	.1850	3,126	176	61	150	125	103	34	76
277.5	.2000	3,129	182	59	155	128	105	35	79
200	.2775	3,142	212	50	176	140	117	36	82
150	.3700	3,148	242	36	197	154	118	39	88
111.0	.5000	3,156	280	18	225	170	119	42	97
100	.5551	3,160	295	+ 12	235	176	120	44	101
75	.7401	3,167	343	− 14	270	194	121	49	113
55.51	1.0000	3,179	405	− 48	314	223	121	54	130
50	1.1101	3,184	431	− 61	331	234	121	56	147
40	1.3877	3,192	493	− 91	379	260	121	60	155
37.00	1.5000	3,194	518	− 103	398	269	121	62	162
30	1.8502	3,200	595	− 138	455	301	124	65	183
27.75	2.0000	3,203	627	− 149	477	315	126	66	192
25	2.2202	3,208	674	− 162	510	336	130	67	204
22.20	2.5000	3,211	732	− 173	550	365	139	68	218
20	2.7753	3,214	792	− 182	590	396	149	69	233
18.50	3.0000	3,216	838	− 187	624	427	159	69	245
15.86	3.5000	3,221	946	− 196	709	503	189	69	268
15	3.7004	3,227	988	− 195	743	536	203	69	277
13.88	4.0000	3,234	1,052	− 188	796	588	229	69	291
12.33	4.5000	3,246	1,171	− 175	887	676	265	69	313
12	4.6255	3,249	1,190	− 170	911	700	277	69	318
11.10	5.0000	3,256	1,271	− 150	983	764	313	69	333
10	5.5506	3,265	1,396	− 117	1,097	855	368	68	353
9.5	5.8427	3,269	1,462	− 97	1,156	920	400	68	363
9.251	6.0000	3,272	1,498	− 84	1,196	950	418	67	368
9.0	6.1674	3,274	1,535	− 72	1,230	980	437	67	373
8.5	6.5301	3,278	1,618	− 40	1,313	1,050	480	66	383
8.0	6.9383	3,282	1,710	+ 4	1,401	1,115	530	65	392
7.929	7.0000	3,283	1,725	11	1,416	1,130	538	65	394
7.5	7.4008	3,286	1,820	61	1,497	1,210	595	63	402
7.0	7.9295	3,290	1,942	135	1,608	1,325	661	61	411
6.938	8.0000	3,291	1,960	146	1,622	1,340	667	61	412
6.5	8.5394	3,296	2,090	229	1,738	1,450	745	58	420
6.167	9.0000	3,302	2,202	306	1,845	1,570	805	55	426
6.0	9.2510	3,305	2,265	348	1,903	1,630	840	53	429
5.551	10.0000	3,316	2,447	481	2,078	1,820	940	49	436
5.5	10.0920	3.317	2,472	499	2,102	1,850	950	49	437
5.0	11.1012	3,335	2,721	730	2,344	2,100	1,098	43	445
4.5	12.3346	3,362	3,025	1,144	2,655	2,460	1,270	37	453
4.0	13.8765	3,400	3,404	1,574	3,089	2,960	1,495	29	462
3.700	15.0000	3,428	3,680	1,893	3,415	3,350	1,645	26	469
3.5	15.8589	3,450	3,882	2,150	3,668	3,660	1,770	21	473
3.25	17.0788	3,483	4,160	2,460	4,005	4,110	1,920	17	481
3.0	18.5020	3,520	4,460	2,880	4,370	4,630	2,101	13	488
2.775	20.0000	3,557	4,750	3,300	4,760	5,190	2,270	9	496
2.5	22.2024	3,607	5,180	4,000	5,300	6,000	2,520	+ 4	506
2.0	27.7530	3,712	6,260	5,500	6,650	....	3,060	− 5	528
1.5	37.0040	....	8,240	....	8,530	....	3,770	− 13	532
1.0	55.506	....	10,900	....	11,670	....	4,715	+ 11	518
0.5	111.012	....	....	....	....	....	....	77	495
0.25	222.02	....	....	....	....	....	....	129	.....

TABLE XII A. *Heat of dilution: ammonium compounds*

Φ_L, cal/mole, at 25 °C

n	m	NH$_4$OH	NH$_3$	NH$_4$Cl	NH$_4$Br*	NH$_4$I*	NH$_4$NO$_3$	NH$_4$C$_2$H$_3$O$_2$
∞	0.00	0	0	0	0	0	0	0
500,000	.000111	− 584	− 584	5	(5)	(5)	5	....
100,000	.000555	− 722	− 722	10	(10)	(10)	10	82
50,000	.00111	− 761	− 761	14	(14)	(13)	14	86
20,000	.00278	− 800	− 800	22	(22)	(21)	22	95
10,000	.00555	− 815	− 815	29	(29)	(28)	28	105
7,000	.00793	− 824	− 824	34	(33)	(32)	32	112
5,000	.01110	− 829	− 829	40	(39)	(38)	36	119
4,000	.01388	− 833	− 833	44	(43)	(42)	39	125
3,000	.01850	− 838	− 838	48	(46)	(44)	43	134
2,000	.02775	− 841	− 841	57	(55)	(53)	48	147
1,500	.03700	− 844	− 844	63	(61)	(59)	50	159
1,110	.05000	− 846	− 846	70	(65)	(63)	52	174
1,000	.05551	− 846	− 846	73	(70)	(68)	53	180
900	.0617	− 846	− 846	76	(73)	(71)	53	185
800	.0694	− 846	− 846	79	(74)	(72)	53	193
700	.0793	− 847	− 847	82	(76)	(73)	52	201
600	.0925	− 847	− 847	87	(80)	(74)	51	212
555.1	.1000	− 847	− 847	88	(82)	(76)	49	217
500	.1110	− 848	− 848	92	(86)	(80)	47	225
400	.1388	− 849	− 849	98	(90)	(82)	41	243
300	.1850	− 848	− 848	105	(95)	(85)	27	272
277.5	.2000	− 848	− 848	107	(96)	(84)	+ 23	279
200	.2775	− 846	− 845	117	(100)	(80)	− 2	315
150	.3700	− 845	− 844	124	(105)	(78)	− 36	355
111.0	.5000	− 843	− 842	131	(106)	(77)	− 88	404
100	.5551	− 843	− 842	133	(106)	(76)	− 110	423
75	.7401	− 840	− 838	136	....	......	− 182	480
55.51	1.0000	− 835	− 833	136	....	......	− 270	551
50	1.1101	− 834	− 831	136	....	......	− 308	579
40	1.3877	− 830	− 827	134	....	......	− 396	644
37.00	1.5000	− 824	− 821	133	....	......	− 442	699
30	1.8502	− 818	− 815	128	....	......	− 535	740
27.75	2.0000	− 816	− 813	125	....	......	− 575	769
25	2.2202	− 814	− 811	120	....	......	− 636	810
22.20	2.5000	− 808	− 805	114	....	......	− 704	850
20	2.7753	− 803	− 800	108	....	......	− 770	895
18.50	3.0000	− 798	− 795	104	....	......	− 810	930
15.86	3.5000	− 790	− 786	93	....	......	− 910	1,000
15	3.7004	− 787	− 783	89	....	......	− 950	1,040
13.88	4.0000	− 782	− 777	82	....	......	− 1,000	1,069
12.33	4.5000	− 774	− 768	72	....	......	− 1,085	1,130
12	4.6255	− 772	− 765	69	....	......	− 1,106	1,145
11.10	5.0000	− 766	− 759	62	....	......	− 1,165	1,190
10	5.5506	− 756	− 749	53	....	......	− 1,240	1,250
9.5	5.8427	− 754	− 744	48	....	......	− 1,285	1,290
9.251	6.0000	− 752	− 741	45	....	......	− 1,308	1,310
9.0	6.1674	− 749	− 737	42	....	......	− 1,330	1,330
8.5	6.5301	− 744	− 730	36	....	......	− 1,375	1,370
8.0	6.9383	− 737	− 721	30	....	......	− 1,430	1,425
7.929	7.0000	− 736	− 720	29	....	......	− 1,436	1,434

*Footnote at end of table.

TABLE XII A. *Heat of dilution: ammonium compounds* — Continued

Φ_L, cal/mole, at 25 °C

n	m	NH$_4$OH	NH$_3$	NH$_4$Cl	NH$_4$Br*	NH$_4$I*	NH$_4$NO$_3$	NH$_4$C$_2$H$_3$O$_2$
7.5	7.4008	−730	−711	.....	....	......	−1,485	1,478
7.0	7.9295	−721	−698	.....	....	......	−1,545	1,536
6.938	8.0000	−720	−696	.....	....	......	−1,550	1,542
6.5	8.5394	−711	−684	.....	....	......	−1,605	1,600
6.167	9.0000	−703	−672	.....	....	......	−1,650	1,646
6.0	9.2510	−698	−667	.....	....	......	−1,675	1,670
5.551	10.0000	−686	−648	.....	....	......	−1,738	1,732
5.5	10.0920	−684	−646	.....	....	......	−1,745	1,740
5.0	11.1012	−667	−620	.....	....	......	−1,820	1,810
4.5	12.3346	−646	−588	.....	....	......	−1,900	1,884
4.0	13.8765	−620	−548	.....	....	......	−1,988	1,950
3.700	15.0000	−602	−520	.....	....	......	−2,048	1,986
3.5	15.8589	−588	−498	.....	....	......	−2,090	2,008
3.25	17.0788	−570	−471	.....	....	......	−2,150	2,034
3.0	18.5020	−548	−438	.....	....	......	−2,255	2,060
2.775	20.0000	−530	−405	.....	....	......	−2,320	2,082
2.5	22.2024	−498	−358	.....	....	......	....	2,110
2.0	27.7530	−438	−235	.....	....	......	....	2,168
1.5	37.0040	−358	−39	.....	....	......	....	....
1.0	55.506	−235	+314	.....	....	......	....	....

*Estimated.

TABLE XII B. *Heat of dilution: alkyl ammonium compounds*

Φ_L, cal/mole, at 25 °C

n	m	(CH$_3$)NH$_3$Cl	(CH$_3$)$_2$NH$_2$Cl	(CH$_3$)$_3$NHCl	N(CH$_3$)$_4$Cl	NH$_2$CH$_3$	NH(CH$_3$)$_2$	N(CH$_3$)$_3$
∞	0.00	0	0	0	0	......	......	.....
500,000	.000111	5	5	5	5	......	......	.....
100,000	.000555	10	10	10	10	......	......	.....
50,000	.00111	14	14	13	13	......	......	.....
20,000	.00278	23	23	21	20	......	......	.....
10,000	.00555	30	30	26	23	......	......	.....
7,000	.00793	36	34	30	25	......	......	.....
5,000	.01110	41	39	34	27	......	......	.....
4,000	.01388	45	43	36	27	......	......	.....
3,000	.01850	50	48	39	27	......	......	.....
2,000	.02775	61	56	44	24	......	......	.....
1,500	.03700	68	61	44	19	......	......	.....
1,110	.05000	76	68	45	14	......	......	.....
1,000	.05551	79	70	45	10	0	0	0
900	.0617	82	72	45	7	20	......	.....
800	.0694	85	75	45	+1	50	......	.....
700	.0793	89	77	44	−5	80	100	100
600	.0925	93	81	43	−13	110	......	.....
555.1	.1000	96	82	42	−18	120	......	.....
500	.1110	99	84	41	−24	130	......	.....
400	.1388	105	88	38	−41	160	200	200
300	.1850	113	92	31	−67	210	......	.....
277.5	.2000	115	94	29	−75	......	......	.....
200	.2775	123	98	18	−110	......	......	.....
150	.3700	131	102	+2	−158	......	......	.....
111.0	.5000	139	106	−13	−211	......	......	.....
100	.5551	143	107	−24	−232	......	......	.....
75	.7401	152	112	−46	....	......	......	.....
55.51	1.0000	164	119	−72	....	......	......	.....
50	1.1101	167	121	−82	....	......	......	.....

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TABLE XIII. *Heat of dilution: silver and lithium compounds*

Φ_L, cal/mole, at 25 °C

n	m	AgF	AgNO₃	LiOH	LiF	LiCl	LiClO₄	LiBr	LiI*	LiNO₃
∞	0.00	....	0	0	0	0	0	0	0	0
500,000	.000111	....	4	5	5	5	5	5	(5)	5
100,000	.000555	....	9	11	11	10	10	10	(10)	10
50,000	.00111	....	12	16	16	14	14	13	(13)	13
20,000	.00278	....	17	25	25	23	23	21	(20)	20
10,000	.00555	....	19	35	35	32	31	29	(28)	28
7,000	.00793	....	21	42	42	37	37	34	(32)	33
5,000	.01110	....	21	49	49	43	43	40	(38)	38
4,000	.01388	....	21	55	54	48	48	44	(42)	42
3,000	.01850	....	20	62	62	54	55	50	(51)	49
2,000	.02775	....	16	74	76	65	65	60	(55)	58
1,500	.03700	....	12	84	87	73	73	67	(62)	65
1,110	.05000	....	5	97	101	82	82	76	(71)	74
1,000	.05551	....	+2	102	105	86	85	80	(74)	76
900	.0617	....	−1	106	110	89	88	83	(77)	80
800	.0694	....	−6	112	....	94	92	86	(78)	83
700	.0793	....	−13	120	....	99	97	92	(85)	88
600	.0925	....	−20	127	....	105	103	97	(89)	93
555.1	.1000	....	−25	132	....	108	106	100	(92)	96
500	.1110	....	−32	139	....	113	110	105	(97)	100
400	.1388	0	−49	153	....	124	119	115	(106)	107
300	.1850	1	−79	175	....	140	133	130	(120)	120
277.5	.2000	1	−88	181	....	144	137	134	(124)	123
200	.2775	2	−137	211	....	165	154	155	(145)	139
150	.3700	3	−196	240	....	186	170	176	(166)	153
111.0	.5000	5	−274	275	....	213	186	202	(192)	171
100	.5551	6	−307	289	....	223	192	212	(202)	177
75	.7401	9	−408	329	....	255	207	243	(232)	194
55.51	1.0000	12	−536	378	....	296	230	280	(267)	212
50	1.1101	14	−585	396	....	312	240	295	(280)	218
40	1.3877	18	....	440	....	352	263	330	....	234
37.00	1.5000	20	....	457	....	367	272	344	....	240
30	1.8502	25	....	508	....	415	300	386	....	254
27.75	2.0000	27	....	528	....	435	313	403	....	261
25	2.2202	31	....	558	....	465	334	429	....	271
22.20	2.5000	36	....	597	....	504	361	463	....	281
20	2.7753	41	....	635	....	542	390	496	....	*(293)
18.50	3.0000	45	....	667	....	575	414	524	....	(302)
15.86	3.5000	54	....	738	....	645	469	588	....	(329)
15	3.7004	58	....	766	....	674	491	614	....	(342)
13.88	4.0000	64	....	810	....	720	523	652	....	(363)
12.33	4.5000	72	....	882	....	799	....	716	....	(403)
12	4.6255	76	....	900	....	820	....	733	....	(415)
11.10	5.0000	87	....	......	....	880	....	785	....	(450)
10	5.5506	112	....	......	....	974	....	864	....	(500)
9.5	5.8427	128	....	......	....	1,025	....	905	....	(530)
9.251	6.0000	138	....	......	....	1,054	....	930	....	(550)
9.0	6.1674	144	....	......	....	1,083	....	953	....	(570)
8.5	6.5301	172	....	......	....	1,148	....	1,009	....	(608)
8.0	6.9383	200	....	......	....	1,225	....	1,069	....	(660)
7.929	7.0000	204	....	......	....	1,236	....	1,079	....	(670)

*Footnote at end of table.

TABLE XIII. *Heat of dilution: silver and lithium compounds* — Continued

Φ_L, cal/mole, at 25 °C

n	m	AgF	AgNO$_3$	LiOH	LiF	LiCl	LiClO$_4$	LiBr	LiI*	LiNO$_3$
7.5	7.4008	238	....	......	....	1,313	....	1,140	....	(720)
7.0	7.9295	276	....	......	....	1,416	....	1,228	....	(790)
6.938	8.0000	282	....	......	....	1,431	....	1,238	....	(800)
6.5	8.5394	329	....	......	....	1,542	....	1,332	....	(870)
6.167	9.0000	373	....	......	....	1,640	....	1,415	....	(920)
6.0	9.2510	398	....	......	....	1,694	....	1,463	....	(970)
5.551	10.0000	474	....	.....	....	1,858	....	1,611	....	(1,070)
5.5	10.0920	484	....	.....	....	1,880	....	1,630	....	(1,080)
5.0	11.1012	600	....	.....	....	2,115	....	1,848	....	(1,230)
4.5	12.3346	748	....	.....	....	2,411	....	2,147	....	....
4.0	13.8765	945	....	.....	....	2,794	....	2,571	....	....
3.700	15.0000	....	....	.....	......	3,070	....	2,907	....	....
3.5	15.8589	....	....	.....	......	3,282	....	3,171	....	....
3.25	17.0788	....	....	.....	......	3,573	....	3,539	....	....
3.0	18.5020	....	....	.....	......	3,893	....	....	....	....

*Estimated.

TABLE XIV A. *Heat of dilution: sodium compounds*

Φ_L, cal/mole, at 25 °C

n	m	NaOH	NaF*	NaCl	NaClO$_3$	NaClO$_4$	NaBr	NaBrO$_3$
∞	0.00	0	0	0	0	0	0	0
500,000	.000111	5	(5)	5	5	5	5	5
100,000	.000555	11	(11)	11	10	10	11	10
50,000	.00111	15	(15)	14	14	14	14	14
20,000	.00278	23	(23)	22	21	21	21	20
10,000	.00555	32	(32)	31	27	27	30	26
7,000	.00793	38	(38)	37	32	31	35	30
5,000	.01110	44	(44)	42	36	35	40	33
4,000	.01388	49	(49)	46	39	38	44	36
3,000	.01850	55	(55)	51	42	41	49	38
2,000	.02775	65	(65)	59	45	44	56	40
1,500	.03700	72	(72)	64	47	46	60	39
1,110	.05000	81	(81)	71	47	46	66	37
1,000	.05551	84	(84)	73	47	44	68	36
900	.0617	87	(87)	75	47	44	69	35
800	.0694	90	(90)	78	46	42	71	34
700	.0793	95	(95)	80	45	42	72	32
600	.0925	99	(99)	83	42	38	74	28
555.1	.1000	101	(101)	84	40	36	75	26
500	.1110	104	(104)	85	37	32	75	22
400	.1388	110	(110)	87	29	22	76	+12
300	.1850	116	(115)	88	11	+4	74	*(−6)
277.5	.2000	117	(116)	87	+7	−2	73	(−13)
200	.2775	121	(119)	83	−22	−37	66	(−46)
150	.3700	118	(115)	74	−58	−80	54	(−88)
111.0	.5000	115	(110)	57	−109	−140	32	(−145)
100	.5551	112	(107)	49	−130	−167	+23	(−170)
75	.7401	99	(92)	+20	−200	−250	−10	(−247)
55.51	1.0000	78	(69)	−23	−293	−360	−59	(−350)
50	1.1101	67	(57)	−41	−333	−404	−81	(−388)
40	1.3877	44	....	−85	−425	−508	−134	....

*Footnote at end of table.

TABLE XIV A. *Heat of dilution: sodium compounds*—Continued

Φ_L, cal/mole, 25 °C

n	m	NaOH	NaF*	NaCl	NaClO$_3$	NaClO$_4$	NaBr	NaBrO$_3$
37.00	1.5000	36	....	−104	−462	−551	−155	....
30	1.8502	13	....	−156	−570	−672	−219	....
27.75	2.0000	+4	....	−172	−613	−719	−245	....
25	2.2202	−4	....	−207	−675	−787	−282	....
22.20	2.5000	−14	....	−242	−747	−866	−326	....
20	2.7753	−20	....	−274	−814	−945	−368	....
18.50	3.0000	−22	....	−299	−866	−1,004	−400	....
15.86	3.5000	−16	....	−349	−973	−1,133	−465	....
15	3.7004	−10	....	−367	−1,012	−1,179	−489	....
13.88	4.0000	0	....	−390	−1,068	−1,243	−523	....
12.33	4.5000	+26	....	−423	−1,156	−1,339	−574	....
12	4.6255	34	....	−430	−1,177	−1,360	−586	....
11.10	5.0000	61	....	−449	−1,234	−1,424	−618	....
10	5.5506	112	....	−469	−1,310	−1,508	−659	....
9.5	5.8427	142	....	−476	−1,348	−1,549	−677	....
9.251	6.0000	161	....	−479	−1,369	−1,568	−686	....
9.0	6.1674	181	....	−480	−1,389	−1,590	−694	....
8.5	6.5301	229	....	....	−1,430	−1,632	−711	....
8.0	6.9383	289	....	....	−1,473	−1,676	−725	....
7.929	7.0000	299	....	....	−1,479	−1,683	−726	....
7.5	7.4008	364	....	....	−1,518	−1,725	−735	....
7.0	7.9295	457	....	....	−1,566	−1,777	−741	....
6.938	8.0000	469	....	....	−1,574	−1,783	−741	....
6.5	8.5394	575	....	....	−1,621	−1,833	−738	....
6.167	9.0000	672	....	....	−1,658	−1,872	−730	....
6.0	9.2510	727	....	....	−1,678	−1,892	....	....
5.551	10.0000	903	....	....	....	−1,945	....	....
5.5	10.0920	926	....	....	....	−1,951	....	....
5.0	11.1012	1,178	....	....	....	−2,006	....	....
4.5	12.3346	1,513	....	....	....	−2,058	....	....
4.0	13.8765	1,955	....	....	....	−2,109	....	....
3.700	15.0000	2,290	....	....	....	−2,139	....	....
3.5	15.8589	2,543	....	....	....	−2,159	....	....
3.25	17.0788	2,903	....	....	....	−2,185	....	....
3.0	18.5020	3,307	....	....	....	....	....	....
2.775	20.0000	3,722	....	....	....	....	....	....
2.5	22.2024	4,260	....	....	....	....	....	....

*Estimated.

TABLE XIV B. *Heat of dilution: sodium compounds*

Φ_L, cal/mole, at 25 °C

n	m	NaI	NaIO$_3$	NaNO$_2$	NaNO$_3$	NaC$_2$H$_3$O$_2$	NaCNS
∞	0.00	0	0	....	0	0	0
500,000	.000111	5	5	....	5	5	5
100,000	.000555	11	10	....	11	12	11
50,000	.00111	14	12	....	15	16	14
20,000	.00278	21	17	....	22	25	22
10,000	.00555	30	21	....	28	35	29
7,000	.00793	34	22	....	32	41	33
5,000	.01110	39	22	....	35	48	38
4,000	.01388	43	21	....	37	54	41
3,000	.01850	48	20	....	40	62	46
2,000	.02775	54	13	....	44	75	51
1,500	.03700	58	+6	....	44	86	54
1,110	.05000	64	−5	....	44	91	58
1,000	.05551	66	−11	....	44	104	58
900	.0617	67	−15	....	43	109	59
800	.0694	69	−23	....	41	116	60
700	.0793	70	−33	....	39	124	59
600	.0925	71	−46	....	35	132	58
555.1	.1000	72	−54	....	31	137	57
500	.1110	72	−65	....	29	143	55
400	.1388	71	....	....	+18	159	50
300	.1850	68	....	40	−2	180	43
277.5	.2000	66	....	+30	−8	187	40
200	.2775	55	....	−40	−43	215	+21
150	.3700	39	....	−100	−86	243	−3
111.0	.5000	12	....	−170	−147	274	−39
100	.5551	+1	....	−190	−173	286	−55
75	.7401	−39	....	−250	−255	318	−107
55.51	1.0000	−97	....	−310	−367	358	−179
50	1.1101	−122	....	−330	−412	372	−208
40	1.3877	−184	....	−375	−519	407	−277
37.00	1.5000	−209	....	−390	−560	421	−306
30	1.8502	−283	....	−420	−678	459	−384
27.75	2.0000	−313	....	−425	−724	474	−415
25	2.2202	−358	....	−450	−791	494	−460
22.20	2.5000	−410	....	−475	−869	522	−513
20	2.7753	−462	....	−490	−939	556	−564
18.50	3.0000	−501	....	−510	−994	564	−603
15.86	3.5000	−582	....	−540	−1,134	620	−686
15	3.7004	−613	....	−545	−1,144	645	−718
13.88	4.0000	−656	....	−560	−1,200	675	−763
12.33	4.5000	−719	....	−585	−1,284	732	−834
12	4.6255	−734	....	−590	−1,303	750	−852
11.10	5.0000	−775	....	−605	−1,359	794	−901
10	5.5506	−828	....	−630	−1,431	870	−966
9.5	5.8427	−854	....	−640	−1,464	914	−997
9.251	6.0000	−866	....	−645	−1,483	936	−1,014
9.0	6.1674	−878	....	−650	−1,501	966	−1,029
8.5	6.5301	−902	....	−665	−1,536	1,016	−1,060
8.0	6.9383	−924	....	−675	−1,573	1,100	−1,092
7.929	7.0000	−927	....	−680	−1,578	1,108	−1,096

TABLE XIV B. *Heat of dilution: sodium compounds* —Continued

Φ_L, cal/mole, at 25 °C

n	m	NaI	NaIO₃	NaNO₂	NaNO₃	NaC₂H₃O₂	NaCNS
7.5	7.4008	−943	....	−690	−1,608	1,180	−1,122
7.0	7.9295	−957	....	−700	−1,644	1,280	−1,149
6.938	8.0000	−959	....	−710	−1,648	1,290	−1,152
6.5	8.5394	−964	....	−720	−1,678	1,394	−1,173
6.167	9.0000	−963	....	−735	−1,699	1,480	−1,187
6.0	9.2510	−959	....	−740	−1,708	1,530	−1,193
5.551	10.0000	−941	....	−760	....	1,674	−1,201
5.5	10.0920	−938	....	−765	....	1,692	−1,202
5.0	11.1012	−891	....	−785	....	1,890	−1,197
4.5	12.3346	−805	....	−810	....	2,120	−1,175
4.0	13.8765	....	....	....	....	2,410	−1,144
3.700	15.0000	....	....	....	....	2,612	−1,113
3.5	15.8589	....	....	....	....	2,760	....
3.25	17.0788	....	....	....	....	2,980	....
3.0	18.5020	....	....	....	....	3,230	....

TABLE XV A. *Heat of dilution: potassium compounds*

Φ_L, cal/mole, at 25 °C

n	m	KOH	KF	KCl	KClO₃	KClO₄	KBr	KBrO₃*
∞	0.00	0	0	0	0	0	0	0
500,000	.000111	5	5	5	5	4	5	(5)
100,000	.000555	11	11	10	10	9	10	(10)
50,000	.00111	16	15	14	13	12	14	(13)
20,000	.00278	23	23	22	20	15	21	(20)
10,000	.00555	32	32	31	24	16	29	(24)
7,000	.00793	38	38	36	27	16	34	(26)
5,000	.01110	44	44	41	28	14	38	(26)
4,000	.01388	50	49	45	29	11	42	(25)
3,000	.01850	56	56	50	30	+5	46	(24)
2,000	.02775	67	67	57	27	−9	53	(21)
1,500	.03700	75	75	62	20	−22	57	(17)
1,110	.05000	86	86	68	17	−40	61	(8)
1,000	.05551	89	89	70	14	−49	63	(4)
900	.0617	92	92	72	11	−58	64	(0)
800	.0694	97	96	74	+5	−69	65	(−6)
700	.0793	102	101	77	−2	−84	66	(−13)
600	.0925	108	107	79	−12	−103	67	(−24)
555.1	.1000	111	110	80	−14	−113	67	(−30)
500	.1110	115	113	82	−27	....	67	(−40)
400	.1388	124	121	84	−50	....	67	....
300	.1850	134	132	85	−94	....	64	....
277.5	.2000	138	135	85	−108	....	62	....
200	.2775	151	146	81	−193	....	53	....
150	.3700	161	154	72	−310	....	38	....
110.0	.5000	172	162	57	−480	....	13	....
100	.5551	176	165	50	−546	....	+2	....
75	.7401	186	171	+23	....	....	−37	....
55.51	1.0000	200	178	−15	....	....	−96	....
50	1.1101	204	181	−32	....	....	−120	....
40	1.3877	218	187	−73	....	....	−179	....
37.00	1.5000	224	189	−89	....	....	−203	....
30	1.8502	240	195	−139	....	....	−273	....
27.75	2.0000	246	198	−162	....	....	−302	....
25	2.2202	256	203	−190	....	....	−343	....
22.20	2.5000	268	208	−228	....	....	−393	....

*Footnote at end of table.

TABLE XV A. *Heat of dilution: potassium compound*—Continued

Φ_L, cal/mole, at 25 °C

n	m	KOH	KF	KCl	KClO$_3$	KClO$_4$	KBr	KBrO$_3$*
20	2.7753	283	213	−263	....	....	−440	....
18.50	3.0000	299	218	−289	....	....	−476	....
15.86	3.5000	347	233	−344	....	....	−555	....
15	3.7004	370	241	−365	....	....	−584	....
13.88	4.0000	407	253	−395	....	....	−628	....
12.33	4.5000	476	276	−440	....	....	−696	....
12	4.6255	494	284	−450	....	....	−714	....
11.10	5.0000	548	306	−480	....	....	−760	....
10	5.5506	633	342	....	....	....	−825	....
9.5	5.8427	679	364	....	....	....	....	....
9.251	6.0000	706	377	....	....	....	....	....
9.0	6.1674	732	389	....	....	....	....	....
8.5	6.5301	792	420	....	....	....	....	....
8.0	6.9383	860	458	....	....	....	....	....
7.929	7.0000	870	464	....	....	....	....	....
7.5	7.4008	940	504	....	....	....	....	....
7.0	7.9295	1,032	559	....	....	....	....	....
6.938	8.0000	1,045	568	....	....	....	....	....
6.5	8.5394	1,138	629	....	....	....	....	....
6.167	9.0000	1,216	686	....	....	....	....	....
6.0	9.2510	1,262	719	....	....	....	....	....
5.551	10.0000	1,391	817	....	....	....	....	....
5.5	10.0920	1,407	830	....	....	....	....	....
5.0	11.1012	1,592	970	....	....	....	....	....
4.5	12.3346	1,881	1,150	....	....	....	....	....
4.0	13.8765	2,251	1,379	....	....	....	....	....
3.700	15.0000	2,485	1,543	....	....	....	....	....
3.5	15.8589	2,646	1,665	....	....	....	....	....
3.25	17.0788	2,860	....	....	....	....	....	....
3.0	18.5020	3,086	....	....	....	....	....	....

*Estimated.

TABLE XV B. *Heat of dilution: potassium compounds*

Φ_L, cal/mole, at 25 °C

n	m	KI	KIO$_3$*	KNO$_3$	KC$_2$H$_3$O$_2$	KCNS	KMnO$_4$
∞	0.00	0	0	0	0	0	0
500,000	.000111	5	(5)	5	5	5	4
100,000	.000555	10	(10)	10	12	11	7
50,000	.00111	14	(12)	14	16	14	9
20,000	.00278	21	(16)	19	25	22	13
10,000	.00555	29	(20)	23	35	29	13
7,000	.00793	33	(19)	24	42	33	12
5,000	.01110	37	(18)	25	49	38	9
4,000	.01388	41	(16)	25	55	40	6
3,000	.01850	45	(13)	24	63	45	+1
2,000	.02775	51	(+6)	19	76	49	−13
1,500	.03700	53	(−5)	14	87	52	−24
1,110	.05000	57	(−21)	4	93	55	−42
1,000	.05551	57	(−29)	+1	107	56	−50
900	.0617	58	(−38)	−4	112	56	−58
800	.0694	59	(−47)	−11	119	56	−67
700	.0793	59	(−62)	−20	127	56	−81
600	.0925	58	(−82)	−31	136	55	−96
555.1	.1000	57	(−95)	−38	141	54	−105
500	.1110	57	(−122)	−48	148	52	−117
400	.1388	53	....	−73	165	47	−149

*Footnote at end of table.

TABLE XV B. *Heat of dilution: potassium compounds* – Continued

Φ_L, cal/mole, at 25 °C

n	m	KI	KIO₃*	KNO₃	KC₂H₃O₂	KCNS	KMnO₄
300	.1850	44	....	−114	190	35	−195
277.5	.2000	41	....	−127	197	31	−209
200	.2775	+22	....	−196	232	+7	−277
150	.3700	−2	....	−274	265	−24	−352
111.0	.5000	−39	....	−376	306	−70	....
100	.5551	−55	....	−418	322	−89	....
75	.7401	−110	....	−547	372	−154	....
55.51	1.0000	−184	....	−715	435	−243	....
50	1.1101	−214	....	−779	460	−280	....
40	1.3877	−293	....	−931	516	−368	....
37.00	1.5000	−324	....	−987	537	−403	....
30	1.8502	−417	....	−1,150	594	−507	....
27.75	2.0000	−455	....	−1,215	616	−550	....
25	2.2202	−509	....	−1,307	647	−611	....
22.20	2.5000	−575	....	−1,414	694	−684	....
20	2.7753	−639	....	−1,513	732	−755	....
18.50	3.0000	−688	....	−1,586	753	−810	....
15.86	3.5000	−793	....	−1,741	836	−923	....
15	3.7004	−832	....	−1,799	870	−965	....
13.88	4.0000	−888	....	....	908	−1,029	....
12.33	4.5000	−977	....	....	977	−1,120	....
12	4.6255	−999	....	....	990	−1,145	....
11.10	5.0000	−1,063	....	....	1,046	−1,212	....
10	5.5506	−1,148	....	....	1,120	−1,310	....
9.5	5.8427	−1,191	....	....	1,164	−1,354	....
9.251	6.0000	−1,214	....	....	1,184	−1,382	....
9.0	6.1674	−1,237	....	....	1,212	−1,408	....
8.5	6.5301	−1,287	....	....	1,256	−1,460	....
8.0	6.9383	−1,338	....	....	1,320	−1,520	....
7.929	7.0000	−1,346	....	....	1,332	−1,528	....
7.5	7.4008	−1,392	....	....	1,398	−1,580	....
7.0	7.9295	−1,450	....	....	1,470	−1,638	....
6.938	8.0000	−1,457	....	....	1,480	−1,652	....
6.5	8.5394	−1,510	....	....	1,562	−1,713	....
6.167	9.0000	....	....	....	1,632	−1,764	....
6.0	9.2510	....	....	....	1,670	−1,790	....
5.551	10.0000	....	....	....	1,782	−1,862	....
5.5	10.0920	....	....	....	1,798	−1,870	....
5.0	11.1012	....	....	....	1,950	−1,960	....
4.5	12.3346	....	....	....	2,160	−2,062	....
4.0	13.8765	....	....	....	....	−2,170	....
3.700	15.0000	....	....	....	....	−2,236	....
3.5	15.8589	....	....	....	....	−2,296	....
3.25	17.0788	....	....	....	....	−2,330	....
3.0	18.5020	....	....	....	....	−2,390	....
2.775	20.0000	....	....	....	....	−2,442	....
2.5	22.2024	....	....	....	....	−2,510	....
2.0	27.7530	....	....	....	....	−2,640	....

*Estimated.

TABLE XVI. *Heat of dilution: rubidium and cesium compounds*

Φ_L, cal/mole, at 25 °C

n	m	RbF	RbCl*	RbBr*	RbI*	RbNO₃*	CsF*	CsCl	CsBr*	CsI*	CsNO₃
∞	0.00	0	0	0	0	0	0	0	0	0	0
500,000	.000111	5	(5)	(5)	(5)	(5)	(5)	5	(5)	(5)	4
100,000	.000555	10	(10)	(10)	(10)	(10)	(10)	10	(10)	(10)	9
50,000	.00111	13	(13)	(13)	(13)	(13)	(13)	13	(13)	(13)	12
20,000	.00278	21	(21)	(20)	(20)	(17)	(20)	21	(20)	(20)	15
10,000	.00555	29	(28)	(26)	(26)	(20)	(27)	28	(26)	(26)	17
7,000	.00793	34	(34)	(32)	(31)	(22)	(31)	32	(30)	(29)	17
5,000	.01110	39	(39)	(36)	(35)	(22)	(35)	36	(33)	(32)	16
4,000	.01388	43	(42)	(39)	(38)	(24)	(39)	39	(36)	(35)	14
3,000	.01850	48	(47)	(43)	(42)	(19)	(42)	43	(39)	(38)	11
2,000	.02775	57	(53)	(49)	(47)	(14)	(50)	49	(45)	(43)	+2
1,500	.03700	63	(57)	(52)	(48)	(+7)	(54)	52	(46)	(43)	−8
1,110	.05000	71	(61)	(55)	(49)	(−4)	(60)	55	(48)	(43)	−23
1,000	.05551	74	(63)	(56)	(50)	(−10)	(62)	56	(49)	(43)	−29
900	.0617	77	(64)	(56)	(50)	(−15)	(65)	56	(48)	(42)	−35
800	.0694	80	(66)	(57)	(51)	(−22)	(70)	57	(48)	(42)	−44
700	.0793	84	(67)	(56)	(49)	(−32)	(75)	56	(45)	(38)	−56
600	.0925	89	(68)	(56)	(47)	(−43)	(80)	56	(44)	(35)	−70
555.1	.1000	91	(68)	(55)	(45)	(−52)	(82)	55	(42)	(32)	−79
500	.1110	95	(69)	(54)	(44)	(−62)	(85)	54	(39)	(29)	−90
400	.1388	102	(69)	......	......	(−92)	(80)	50	......	......	−123
300	.1850	111	(65)	......	......	(−137)	......	42	......	......	−173
277.5	.2000	113	(63)	......	......	(−151)	......	38	......	......	−189
200	.2775	122	(56)	......	......	(−220)	......	22	......	......	−266
150	.3700	130	(44)	......	......	(−303)	......	+1	......	......	−354
111.0	.5000	137	(24)	......	......	(−413)	......	−30	......	......	−463
100	.5551	140	(15)	......	......	(−455)	......	−45	......	......	−508
75	.7401	....	......	......	......	(−587)	......	−91	......	......	−652
55.51	1.0000	....	......	......	......	(−760)	......	−152	......	......	−831
50	1.1101	....	......	......	......	....	......	−178	......	......	*(−900)
40	1.3877	....	......	......	......	....	......	....	......	......	(−1067)

*Estimated.

TABLE XVII. ΔH_N° at 25 °C

Investigator	System	n, moles H$_2$O/mole solute			Original temp of meas	No. of meas	$-\Delta H_N$,(T)	$-\Delta H_N$, (25 °C)	$-\Delta H_N^\circ$, (25 °C)
		Acid	Base	Salt					
					°C		cal/mole	cal/mole	cal/mole
Richards and Rowe [224]	NaCl	100	100	201	16.80	5	14,059 ± 15	13,687	13,364
					15.67	4	14,114 ± 8	13,689	13,366
	KCl	100	100	201	16.77	3	14,157 ± 10	13,763	13,372
					15.63	4	14,218 ± 10	13,768	13,377
	NaNO$_3$	100	100	201	16.76	4	13,988 ± 6	13,604	13,330
					15.56	7	14,050 ± 6	13,608	13,334
	KNO$_3$	100	100	201	16.77	3	14,220 ± 5	13,808	13,317
					15.63	6	14,293 ± 6	13,821	13,330
Gillespie, Lambert and Gibson [356]	NaCl	540	540	1081	20	1	13,773	13,516	13,349
		283	283	567	20	1	13,793	13,545	13,333
		550	550	1101	24.99	1	13,571	13,571	13,407
		284	284	569	32.27	1	13,199	13,525	13,315
		282.5	282.5	566	32.27	1	13,261	13,588	13,376
		260	260	521	32.30	1	13,271	13,596	13,377
	KCl	273.4	273.4	548	20	1	13,858	13,625	13,384
Bender and Biermann [213]	NaCl	18.42	18.42	37.84	25	2	14,249 ± 12	14,249	13,332
		17.14	17.14	35.30	25	4	14,314 ± 10	14,314	13,331
Pitzer [206]	NaCl	46.5	1065.5	1112	25	3	13,828 ± 12	13,828	13,366
Vanderzee and Swanson [357]	NaClO$_4$	5050	178.4	5261	25	2	13,465 ± 15	13,465	13,332
		188.6	4060.4	5160	25	6	13,398 ± 5	13,398	13,337

TABLE XVIII. $\Delta H_{\infty}^{\circ}$ of KCl(c) in H$_2$O at 25 °C

Investigator	Year reported	Temp of meas	No. of meas	Conc. range moles KCl/ 1000g H$_2$O	$\Delta H_{\infty}^{\circ}$
		°C			cal/mole
1. Winkelmann [94]	1873	26–31	17	5.59 to 0.42	4,104 ±50
2. Berthelot [377]	1875	21	?	0.28	3,970 ±150
3. von Rechenberg [381]	1879	16–20	7	.28	4,113 ±100
[382]	1880	17–20	7	.28	4,200 ±100
4. Berthelot and Ilosvay [383]	1883	18	?	.54	4,000 ±150
5. Thomsen [30]	1883	18	?	.28	4,107 ±50
6. Pickering [384]	1887	15–25	30	.28	4,143 ±50
7. von Stackelberg [275]	1898	18	3	4.44 to 0.55	4,110 ±100
8. Brönsted [385]	1906	25	4	0.46 to 0.09	4,167 ±20
9. Haigh [388]	1912	21	2	.14	4,081 ±50
10. Colson [350]	1915	18, 21	2	.17	4,184
11. Cohen, Helderman, and Moesveld [386]	1920	18	7	.28	4,070 ±30
12. Mees [387]	1920	18	2	.28	4,062
13. Mondain-Monval [268]	1923	18	1	.37	3,954
14. Sandonnini and Gerosa [141]	1925	18.5	4	.75 to 0.17	4,100 ±100
15. Wüst and Lange [21]	1925	25	12	4.47 to 0.37	4,157 ±40
16. Lange and Dürr [389]	1926	25	10	0.56	4,147 ±40
17. Holluta and Werner [390]	1927	18.5, 20	2	.27	4,183 ±50
18. Cohen and Kooy [391]	1928	20	5	.28	4,110 ±10
		25	3	.28	4,110 ±5
19. Chipman, Johnson, and Maass [133]	1929	15–27	16	.66 to 0.07	4,100 ±100
20. Partington and Soper [334]	1929	25	12	3.55 to 0.31	4,160 ± 20
21. Roth and Eymann [392]	1929	21	8	0.37	4,112 ± 15
22. Lange and Rounsefell [393]	1930	25	6	.28	4,116 ± 10
23. Mishchenko [303]	1930	25	6	.25	4,114 ± 10
24. Popov, Bundel, and Choller [165]	1930	20	10	.19	4,082 ± 25
25. Moles and Perez-Vitoria [394]	1932	20.5	1	.34	4,298
26. Smeets [395]	1933	20	3	.34	4,107 ± 20
27. Popov, Khomyakov, Feodos'ev, and Schirokich [166]	1933	20	10	.19	4,077 ± 20
		21	8	.28	4,115 ± 10
		23	19	.28	4,114 ± 15
28. Drucker [45]	1935	17–23	12	.56 to 0.11	4,095 ± 35
29. Shibata and Terasaki [396]	1936	25	10	.15 to 0.07	4,164 ± 20
30. Fedorov and Sil'chenko [271]	1937	20	3	.56 to 0.14	4,150 ± 100
31. Lange and Martin [397]	1937	25	1	.13	4,147
32. Fontell [398]	1938	22.5	4	.06 to 0.01	4,124 ± 10
		25	6		4,117 ± 15
33. Popov, Skuratov, and Strel'tsova [172]	1940	20	?	.28	4,125 ± 20
34. Slansky [399]	1940	25	?	?	[a] 4,075 ± 40
35. Voskresenskaya and Ponomareva [400]	1946	25	?	0.18	4,124 ± 20
36. Tichelaar [401]	1946	25	6	.02?	4,146 ± 40
37. Foz and Colomina [402]	1946	25	1	.37	[b] 4,115 ±10
[403]			5		4,098 ±20
38. Fineman and Wallace [404]	1948	25	?	?	[a] 4,113
39. Mishchenko and Kaganovich [405]	1949	25	6	0.28	4,115 ± 10
40. Barieau and Giauque [406]	1950	25	3	.18	4,113 ±10
41. Samoïlov [407, 408]	1951	25	1	.06	4,169
42. Kaganovich and Mishchenko [409]	1952	25	?	.26	4,117 ±10
43. Evans and Richards [410]	1952	25	4	.01	4,121 ±10
44. Kapustinskiĭ and Drakin [411]	1952	25	?	.001	4,077 ±25
45. Spedding and Miller [412]	1952	25	6	.19 to 0.03	4,132 ±15
46. Voskresenskaya and Patsukova [413]	1952	25	?	.12	4,114 ±15
47. Westrum and Eyring [414]	1952	25	?	.02	4,109 ±15
48. Davies, Singer, and Stavely [368]	1954	25	5	.32	4,108 ±10
49. Hutchinson, Manchester, and Winslow [415]	1954	25	8	.28, 0.03	4,120 ±8
50. Chernyaev, Sokolov, and Palkin [416]	1954	25	3	.02	4,129 ±15
51. Hutchinson and White [417]	1955	25	4	.01 to 0.007	4,120 ±25
52. Higgins [418]	1955	25	3	.11	4,133 ±10

Footnotes at end of table.

TABLE XVIII. ΔH_x° of KCl(c) in H$_2$O at 25 °C — Continued

Investigator	Year reported	Temp of meas	No. of meas	Conc. range moles KCl/ 1000g H$_2$O	ΔH_x°
		°C			cal/mole
53. Papadopoulos and Giauque [419]	1955	25	3	0.28	4,107 ±6
54. Coops, Balk, and Tolk [420]	1956	25	16	.01	4,082 ±20
55. Gunn [421]	1958	25	8	.28	4,122 ±2
56. Balk and Benson [422]	1959	25	9	.20	4,125 ±5
57. Sacconi, Paoletti, and Ciampolini [205, 423]	1959	25	10	.33	4,119 ±10
58. Sunner and Wadsö [424]	1959	25	11	.12	4,100 ±5
59. Bills and Cotton [425]	1960	25	4	.28	4,121 ±10
60. Hietala [426]	1960	25	3	.28	4,116 ±10
61. Gallagher and King [427]	1960	25	14	.14–0.7	4,120 ±10
62. Dekker [428]	1961	25	?	.28	4,109; 4,106
63. Reshetnikov [429]	1961	25	6	.19 to 0.11	4,112 ±10
64. Ciampolini and Paoletti [430]	1961	25	8	.33	4,118 ±10
65. Higgins and Westrum [431]	1961	25	3	.11	4,133 ±10
66. Argue, Mercer, and Cobble [432]	1961	25	4	.005	4,117 ±10
67. Coops, Somsen, and Tolk [433]	1961	25	10	.02 to 0.007	4,109 ±5
	1959		10		4,106 ±5
	1958		4		4,107 ±8
	1957		5		[c] 4,105 ±10
	1957		6		[c] 4,107 ±10
68. Busey, Dearman, and Bevan [434]	1962	25	?	.10	4,117 ±10
69. Newman [435]	1962	25	12	.04	4,124 ±10
70. Talakin et al., [436]	1962	25	3	.19	4,088 ±25

[a] Authors' extrapolation.
[b] Foz and Colomina report this as their best value.
[c] Measurements made by Tolk in apparatus of Coops, Balk and Tolk.

TABLE XIX. ΔH_∞° of NaCl in H$_2$O at 25 °C

Investigator	Year reported	Temp of meas	No. of meas	Conc. range moles NaCl/ 1000g H$_2$O	ΔH_x°
		°C			cal/mole
1. Winkelmann [94]	1873	16–30	20	5.50 to 0.53	914 ±30
2. Ostwald [443]	1882	16–17	4	0.19	970
3. Thomsen [30]	1883	16.8	2	.56	897 ±20
4. Pickering [384]	1887	15–25	35	.28	935 ±20
5. Colson [535]	1915	21	1	.42	894
6. Randall and Bisson [143]	1920	25	7	.54 to 0.13	929 ±5
7. Wüst and Lange [21]	1925	25	14	5.62 to 0.52	[a] 931 ±10
8. Lange and Dürr [389]	1926	25	10	0.56	841
9. Lipsett, Johnson, and Maass [323]	1927	25	20	5.50 to 0.07	923 ±5
[536]	1927	20	15	5.92 to 0.04	922 ±8
10. Cohen and Kooy [391]	1928	25	4	0.56	915 ±5
		20	5	.56	921 ±8
11. Askew, Bullock, Smith, Tinkler, Gatty, and Wolfenden [499]	1934	20	9	.03	904 ±30
12. Becker and Roth [228]	1935	19.7	5	.09 to 0.04	918 ±10
13. Lange and Martin [397]	1937	25	1	.25	934
14. Slansky [399]	1940	25	?	?	[a] 915 ±10
15. Tichelaar [401]	1946	25	5	0.02?	950 ±30
16. Voskresenskaya and Ponomareva [400]	1946	25	?	.37	970
17. Fineman and Wallace [404]	1948	25	?	?	[a] 925 ±5
18. Samoïlov [407, 408]	1951	25	1	0.19	932
19. Kapustinskiĭ and Drakin [411]	1952	25	1	.0008	932 ±30
20. Seki and Suzuki [537]	1953	18	?	.14	913 ±20
21. Benson and Benson [324]	1955	25	16	1.3 to 0.05	928 ±3
22. Benson, Goddard, and Hoeve [538]	1956	25	3	0.50	927 ±3
23. Attree, Cushing, Ladd, and Pieroni [539]	1958	25	?	.01	927 ±10
24. Lister and Myers [540]	1958	25	?	.18	914 ±10
25. Samoïlov and Buslaeva [444]	1960	15, 35	2	.14	874 ±100
26. Criss and Cobble [541]	1961	25	17	.02 to 0.001	914 ±10

[a] Authors' extrapolation.

TABLE XX. ΔH_∞° of KNO_3 in H_2O at 25 °C

Investigator	Year reported	Temp of meas	No. of meas	Conc. range moles KNO_3/ 1000g H_2O	ΔH_∞°
		°C			cal/mole
1. Winkelmann [94]	1873	27–29	14	2.41 to 0.31	8,350 ± 50
2. Thomsen [30]	1883	18	3	0.28	8,300 ± 50
3. Tilden [560]	1884	15, 34	4	.56	8,295 ± 100
4. Pickering [384]	1887	15–25	27	.28	8,430 ± 75
5. von Stackelberg [275]	1898	15	10	2.44 to 0.22	8,361 ± 50
6. Haigh [388]	1912	21	3	0.14	8,240 ± 75
7. Mondain-Monval [267]	1925	16.9	1	.20	8,200
8. Berenger-Calvet [351]	1927	14–16	30	2.49 to 0.09	8,355 ± 40
9. Holluta and Werner [390]	1927	18.5	1	0.16	8,592
10. Roth [576]	1927	20.5	6	.16	8,455
11. Roth and Müller [577]	1927	20.5	3	.16	8,304
12. Roth and Eymann [392]; Roth [578]	1929	21	4	.16	8,372 ± 20
13. Cohen and Kooy [391]	1928	20, 20.5	6	.28, 0.16	8,373 ± 20
14. Nacken [477]	1930	20?	2	.27	8,585
15. Lange and Monheim [173]	1930	25	5	.07 to 0.05	8,375 ± 40
16. Drucker [45]	1934	18.1	1	.23	8,285
17. Fedorov and Sil'chenko [271]	1937	22	3	.56 to 0.14	8,380 ± 75
18. Hieber and Feder [579]	1938	20	1	.16	8,340
19. Hückel, Datow, and Simmersbach [580]	1940	18.5	3	.12	8,407 ± 40
20. Voskresenskaya and Ponomareva [581]	1944	25	1	.18	8,298
21. Voskresenskaya and Ponomareva [400]	1946	25	1	.18	8,290
22. Westrum and Eyring [414]	1952	25	4	.01	8,325 ± 20
23. Lipilina and Samoĭlov [582]	1954	25	1	1.11	9,320
24. Bills and Cotton [425]	1960	25	3	0.14	8,400 ± 40
25. Turnbull [583]	1961	25	1	.11	8,600 ± 100

Table XXI. *Heat of Solution*

ΔH°_∞, 25 °C for uni-univalent electrolytes in H_2O

Substance	State	ΔH°_∞	Substance	State	ΔH°_∞	Substance	State	ΔH°_∞
		cal/mole			*cal/mole*			*cal/mole*
HF	g	−14,700	$LiBr \cdot 2H_2O$	c	−2,250	KCl	c	4,115
HCl	g	−17,888	$LiBrO_3$	c	340	$KClO_3$	c	9,890
$HClO_4$	l	−21,215	LiI	c	−15,130	$KClO_4$	c	12,200
$HClO_4 \cdot H_2O$	c	−7,875	$LiI \cdot H_2O$	c	−7,090	KBr	c	4,750
HBr	g	−20,350	$LiI \cdot 2H_2O$	c	−3,530	$KBrO_3$	c	9,830
HI	g	−19,520	$LiI \cdot 3H_2O$	c	140	KI	c	4,860
HIO_3	c	2,100	$LiNO_2$	c	−2,630	KIO_3	c	6,630
HNO_3	l	−7,954	$LiNO_2 \cdot H_2O$	c	1,680	KNO_2	c	3,190
HCOOH	l	−205	$LiNO_3$	c	−600	KNO_3	c	8,340
CH_3COOH	l	−360				$KC_2H_3O_2$	c	−3,665
			NaOH	c	−10,637	KCN	c	2,800
NH_3	g	−7,290	$NaOH \cdot H_2O$	c	−5,118	KCNO	c	4,840
NH_4Cl	c	3,533	NaF	c	218	KCNS	c	5,790
NH_4ClO_4	c	8,000	NaCl	c	928	$KMnO_4$	c	10,410
NH_4Br	c	4,010	$NaClO_2$	c	80			
NH_4I	c	3,280	$NaClO_2 \cdot 3H_2O$	c	6,830	RbOH	c	−14,900
NH_4IO_3	c	7,600	$NaClO_3$	c	5,191	$RbOH \cdot H_2O$	c	−4,310
NH_4NO_2	c	4,600	$NaClO_4$	c	3,317	$RbOH \cdot 2H_2O$	c	210
NH_4NO_3	c	6,140	$NaClO_4 \cdot H_2O$	c	5,380	RbF	c	−6,240
$NH_4C_2H_3O_2$	c	−570	NaBr	c	−144	$RbF \cdot H_2O$	c	−100
NH_4CN	c	4,200	$NaBr \cdot 2H_2O$	c	4,454	$RbF \cdot 1\frac{1}{2}H_2O$	c	320
NH_4CNS	c	5,400	$NaBrO_3$	c	6,430	RbCl	c	4,130
CH_3NH_3Cl	c	1,378	NaI	c	−1,800	$RbClO_3$	c	11,410
$(CH_3)_3NHCl$	c	350	$NaI \cdot 2H_2O$	c	3,855	$RbClO_4$	c	13,560
$N(CH_3)_4Cl$	c	975	$NaIO_3$	c	4,850	RbBr	c	5,230
$N(CH_3)_4Br$	c	5,800	$NaNO_2$	c	3,320	$RbBrO_3$	c	11,700
$N(CH_3)_4I$	c	10,055	$NaNO_3$	c	4,900	RbI	c	6,000
			$NaC_2H_3O_2$	c	−4,140	$RbNO_3$	c	8,720
$AgClO_4$	c	1,760	$NaC_2H_3O_2 \cdot 3H_2O$	c	4,700			
$AgNO_2$	c	8,830	NaCN	c	290	CsOH	c	−17,100
$AgNO_3$	c	5,400	$NaCN \cdot \frac{1}{2}H_2O$	c	790	$CsOH \cdot H_2O$	c	−4,900
			$NaCN \cdot 2H_2O$	c	4,440	CsF	c	−8,810
LiOH	c	−5,632	NaCNO	c	4,590	$CsF \cdot H_2O$	c	−2,500
$LiOH \cdot H_2O$	c	−1,600	NaCNS	c	1,632	$CsF \cdot 1\frac{1}{2}H_2O$	c	−1,300
LiF	c	1,130				CsCl	c	4,250
LiCl	c	−8,850	KOH	c	−13,769	$CsClO_4$	c	13,250
$LiCl \cdot H_2O$	c	−4,560	$KOH \cdot H_2O$	c	−3,500	CsBr	c	6,210
$LiClO_4$	c	−6,345	$KOH \cdot 1\frac{1}{2}H_2O$	c	−2,500	$CsBrO_3$	c	12,060
$LiClO_4 \cdot 3H_2O$	c	7,795	KF	c	−4,238	CsI	c	7,970
LiBr	c	−11,670	$KF \cdot 2H_2O$	c	1,666	$CsNO_3$	c	9,560
$LiBr \cdot H_2O$	c	−5,560						