NBS TECHNICAL NOTE 270-6

Selected Values of Chemical Thermodynamic Properties

Tables for the Alkaline Earth Elements (Elements 92 through 97 in the Standard Order of Arrangement)

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Selected Values of Chemical Thermodynamic Properties

Tables for the Alkaline Earth Elements (Elements 92 through 97 in the Standard Order of Arrangement)

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ABSTRACT

Contains tables of values for the standard heats and Gibbs (free) energies of formation, entropies and enthalpies at 298.15 K and heats of formation at 0 K for compounds of beryllium, magnesium, calcium, strontium, barium, and radium (elements 92-97 in the Standard Order of Arrangement). These tables are a continuation of the comprehensive revision of NBS Circular 500.

Key words: Enthalpy; entropy; Gibbs energy of formation; beryllium compounds; magnesium compounds; calcium compounds; strontium compounds; barium compounds; radium compounds.

PREFACE

This is the sixth of a series of Technical Notes containing the tables of material prepared as a revision of National Bureau of Standards Circular 500, Selected Values of Chemical Thermodynamic Properties, by F. D. Rossini, D. D. Wagman, W. H. Evans, S. Levine and I. Jaffe. This Note contains data for compounds of six elements, numbered 92 through 97 in the Standard Order of Arrangement.

The continued encouragement and support of the Office of Standard Reference Data of the National Bureau of Standards is gratefully acknowledged.

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INTRODUCTION

Substances and Properties Included in the Tables

The tables contain values where known of the enthalpy and Gibbs energy of formation, enthalpy, entropy and heat capacity at 298.15 K (25°C), and the enthalpy of formation at 0 K, for all inorganic substances and organic molecules containing not more than two carbon atoms. In some instances such as metal-organic compounds, data are given for substances in which each organic radical contains one or two carbon atoms.

No values are given in these tables for metal alloys or other solid solutions, fused salts, or for substances of undefined chemical composition.

Physical States

The physical state of each substance is indicated in the column headed "State" as crystalline solid (c), liquid (liq), glassy or amorphous (amorp), or gaseous (g). Solutions in water are listed as aqueous (aq). For non-aqueous systems the physical state is that normal for the indicated solvent at 298.15 K.

Definition of Symbols

The symbols used in these tables are defined as follows: P = pressure; V = volume; T = absolute temperature; E = intrinsic or internal energy; S = entropy; H = E + PV = enthalpy (heat content); G = H - TS = Gibbs energy (formerly the free energy); $C_p = (dH/dT)_P$ = heat capacity at constant pressure.

Conventions Regarding Pure Substances

The values of the thermodynamic properties of the pure substances given in these tables are for the substances in their standard states (indicated by the superscript ° on the thermodynamic symbol). These standard states are defined as follows:

For a pure solid or liquid, the standard state is the substance in the condensed phase under a pressure of one atmosphere.

For a gas the standard state is the hypothetical ideal gas at unit fugacity, in which state the enthalpy is that of the real gas at the same temperature and at zero pressure.

The values of Δ Hf° and Δ Gf° given in the tables represent the change in the appropriate thermodynamic quantity when one gram-formula weight of the substance in its standard state is formed, isothermally at the indicated temperature, from the elements, each in its appropriate standard reference state. The standard reference state at 25 °C for each element except phosphorus has been chosen to be the standard state that is thermodynamically stable at 25 °C and at one atmosphere pressure. For phosphorus the standard reference state is the crystalline white form; the more stable forms have not been well characterized thermochemically. The same reference states have been maintained for the elements at 0 K except for the liquid elements bromine and mercury, for which the reference states have been chosen as the stable crystalline forms. The standard reference states are indicated in the tables by the fact that the values of Δ Hf° and Δ Gf° are exactly zero.

The values of $H^\circ_{298.} - H^\circ_0$ represent the enthalpy difference for the given substance between 298.15 K and 0 K. If the indicated standard state at 25 °C is the gas, the corresponding state at 0 K is the hypothetical ideal gas; if the state at 25 °C is solid or liquid, the corresponding state at 0 K is the thermodynamically stable crystalline solid, unless otherwise specifically indicated.

The values of S° represent the virtual or "thermal" entropy of the substance in the standard state at 298.15 K, omitting contributions from nuclear spins. Isotope mixing effects, etc., are also excluded except in the case of the hydrogen-deuterium (^{1}H-^{2}H) system. Where data have been available only for a particular isotope, they have been corrected when possible to the normal isotopic composition.

The values of the enthalpies of formation of gaseous ionic species are computed on the convention that the value of ΔHf° for the electron is zero. Conversions between 0 and 298.15 K are calculated using the value of $H^\circ_{298} - H^\circ_0$ = 1.481 kcal per mole of electrons, and assuming that the values of $H^\circ_{298} - H^\circ_0$ for the ionized and un-ionized molecules are the same.

Conventions Regarding Solutions

Solutions in water are designated as aqueous (aq); other solvents are designated by name or chemical formula. The concentration of the solution is expressed in terms of the number of moles of solvent associated with one mole of the solute. If no concentration is indicated, the solution is assumed to be "dilute".

The standard state for a solute in aqueous solution is taken as the hypothetical ideal solution of unit molality (indicated as "std. state, m = 1"). In this state the partial molal enthalpy and heat capacity of the solute are the same as in the infinitely dilute real solution. For non-aqueous solutions the standard state of the solute is the hypothetical ideal solution of unit mole fraction of solute ("std. state, $x_2 = 1$").

The value of Δ Hf° given in the tables for a solute in its standard state is the apparent molal enthalpy of formation of the substance in the infinitely dilute real solution. At this dilution the partial molal enthalpy is equal to the apparent molal quantity. At concentrations other than the standard state, the value of Δ Hf° represents the apparent enthalpy of the reaction of formation of the solution from the elements comprising the solute, each in its standard reference state, and the appropriate total number of moles of solvent. In this representation the value of Δ Hf° for the solvent is not required. The experimental value for a heat of dilution is obtained directly as the difference between the two values of Δ Hf° at the corresponding concentrations.

The values of the thermodynamic properties tabulated for the individual ions in aqueous solution are based on the usual convention that the values of ΔHf°, ΔGf°, S° and C_p° for H^+ (aq, std. state, m = 1) are zero. The properties of a neutral electrolyte in aqueous solution in the standard state are equal to the algebraic sum of these values for the appropriate kinds and number of individual ions assumed to constitute the molecule of the given electrolyte. When the undissociated species, rather than the sum of the ions, is meant, the notation "undissociated" or "un-ionized" is used. For an ionic species the properties tabulated refer to that undissociated ion. By adopting the above convention with respect to aqueous H^+, it follows that the thermodynamic relation Δ Gf° = Δ Hf° - T Δ Sf° will not hold for an individual ionic species. However no problem arises when neutral chemical systems are considered.

Unit of Energy and Fundamental Constants

All of the energy values given in these tables are expressed in terms of the thermochemical calorie. This unit, defined as equal to 4.1840 joules, is generally accepted for the presentation of chemical thermodynamic data. Values reported in other units have been converted to calories by means of the conversion factors for molecular energy given in Table A.

The following values of the fundamental physical constants have been used in these calculations:

R = gas constant = 8.3143 ± 0.0012 J/deg mol = 1.98717 ± 0.00029 cal/deg mol

F = Faraday constant = 96487.0 ± 1.6 coulombs/mol = 23060.9 ± 0.4 cal/volt equivalent

Z = Nhc = 11.96258 ± 0.00107 J/cm^{-1} mol = 2.85912 ± 0.00026 cal/cm^{-1} mol

c_2 = second radiation constant = hc/k = 1.43879 ± 0.00015 cm deg

0°C = 273.15 K

These constants are consistent with those given in the Table of General Physical Constants, recommended by the National Academy of Sciences - National Research Council[1]. The formula weights in the tables have been calculated for the molecular formula given in the Formula and Description column using the 1961 Table of Relative Atomic Weights based on the atomic mass of ^{12}C = 12 exactly[2].

Internal Consistency of the Tables

All of the values given in these tables have been calculated from the original articles, using consistent values for all subsidiary and auxiliary quantities. The original data were corrected where possible for differences in energy units, molecular weights, temperature scales, etc. Thus we have sought to maintain a uniform scale of energies for all the substances in the tables. In addition the tabulated values of the properties of a substance satisfy all the known physical and thermodynamic relationships among these properties. The quantities Δ Hf°, Δ Gf°, and S° at 298.15 K satisfy the relation:

$$\Delta Gf^\circ = \Delta Hf^\circ - T \Delta Sf^\circ .$$

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[1] NBS Technical News Bulletin, October 1963.

[2] A. E. Cameron and E. Wichers, J. Am. Chem. Soc. 84, 4192 (1962).

Furthermore the calculated value of any thermodynamic quantity for a reaction is independent of the path chosen for the evaluation.

In some cases newer data may have become available on certain substances after the values were selected for these tables. Because of the need to maintain the internal consistency of the tables, it is not always possible to incorporate these newer data into the tables without a detailed analysis of the effect of such a change. Unless great care is used, relatively significant errors in calculated values of $\Delta H°$ or $\Delta G°$ for specific reactions may result from the introduction of such data.

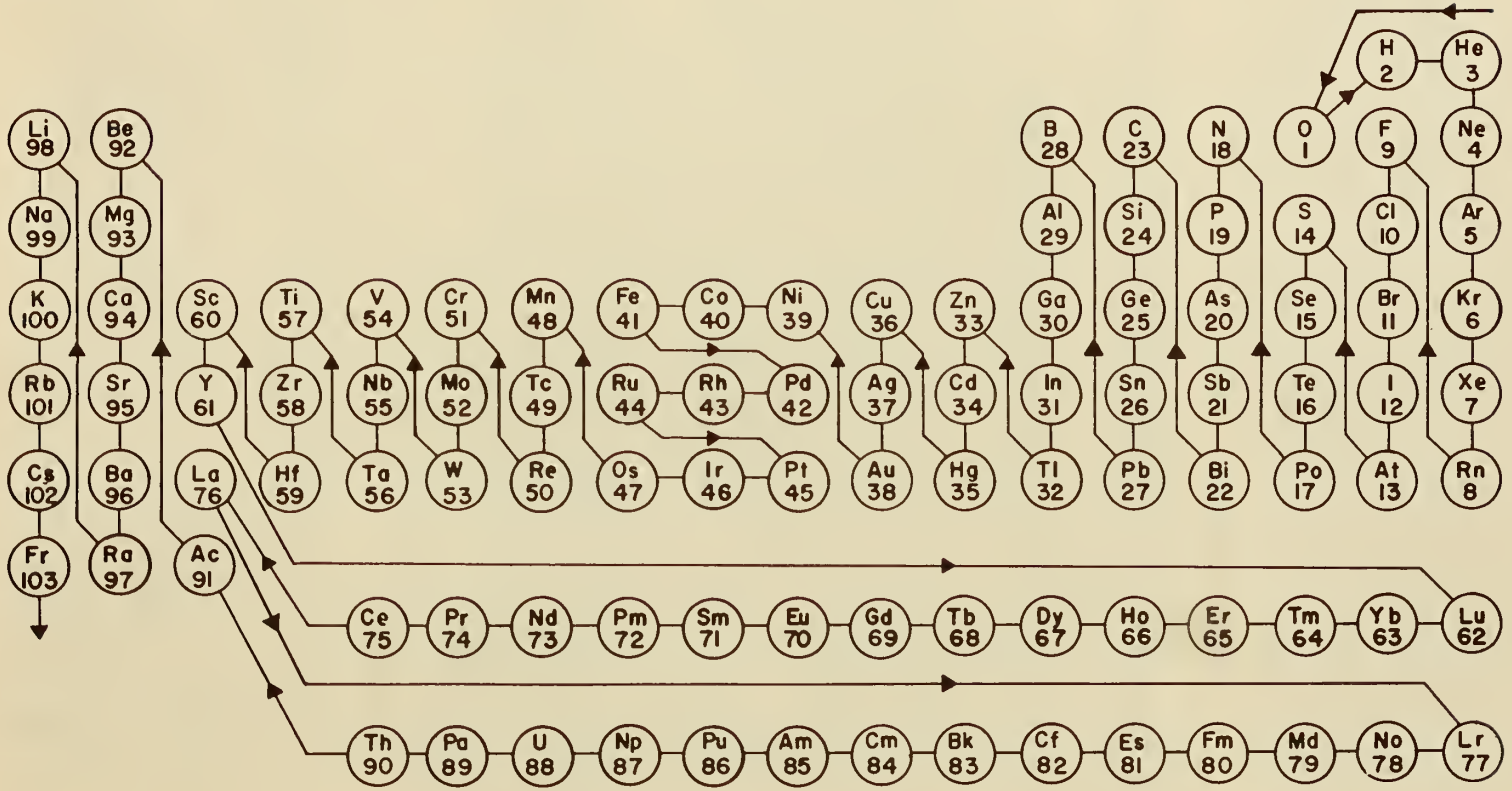
Uncertainties

The uncertainty in any value in the tables depends on the uncertainties of all the determinations in the total chain of reactions used to establish the value.

A discussion of the uncertainties will be included in the final publication of these tables in the National Standard Reference Data System. However we have followed certain rules with respect to significant figures to indicate these uncertainties. Values are tabulated in general such that the overall uncertainty lies between 2 and 20 units of the last figure. On the other hand, values are given so that the experimental data from which they are derived may be recovered with an accuracy equal to that of the original quantities. Thus the number of significant figures for any one value in the tables need not represent the absolute accuracy of that value. For solutions of varying composition values are frequently tabulated to more figures to make possible the recovery of enthalpies of solution and dilution. Similarly values of ΔHf°_{0} and $\Delta Hf^{\circ}_{298.15}$ may be given to different numbers of significant figures. In this instance the quantity with the lesser number of figures is used to represent the uncertainty estimate. The larger number of figures is used for the other quantity to retain the significance of the temperature correction term.

Arrangement of the Tables

The compounds in the tables are entered according to the Standard Order of Arrangement, (see Figure 1), by the principle of latest position. In this scheme, a compound is listed under the element occurring latest in the list; water of hydration is neglected. Within a given element-table will be found all of the compounds of that element with elements occurring earlier in the order; the arrangement within a table follows the same ordering. An exception occurs in the carbon tables (Table 23), which is divided into subgroups consisting of all compounds with one carbon atom, then all with two carbon atoms, etc.



Standard Order of Arrangement of the Elements and Compounds
based on the
Periodic Classification of the Elements

Figure 1

TABLE A

CONVERSION FACTORS FOR UNITS OF MOLECULAR ENERGY

	J/mol	cal/mol	cm^3 atm/mol	kWh/mol	Btu/lb-mol	cm^{-1}/molecule	eV/molecule
1 J/mol =	1	2.390057×10^{-1}	9.86923	2.77778×10^{-7}	0.429923	8.35940×10^{-2}	1.036409×10^{-5}
1 cal/mol =	4.18400	1	41.2929	1.162222×10^{-6}	1.798796	3.49757×10^{-1}	4.33634×10^{-5}
1 cm^3 atm/mol =	0.1013250	2.42173×10^{-2}	1	2.81458×10^{-8}	4.35619×10^{-2}	8.47016×10^{-3}	1.050141×10^{-6}
1 kWh/mol =	3,600,000	860,421	3.55292×10^{7}	1	1,547,721	300,938	37.3107
1 Btu/lb-mol =	2.32600	5.55927×10^{-1}	22.9558	6.46111×10^{-7}	1	1.944396×10^{-1}	2.41069×10^{-5}
1 cm^{-1}/molecule =	11.96258	2.85912	118.0614	3.32294×10^{-6}	5.14299	1	1.239812×10^{-4}
1 eV/molecule =	96487.0	23060.9	952,252	2.68019×10^{-2}	41482.0	8065.73	1

The underlined numbers represent the fundamental values used in deriving this table. The remaining factors were obtained by applying the relationships:

$$n_{ij} = n_{ik} \cdot n_{kj} \qquad n_{ii} = n_{ik} \cdot n_{ki} = 1$$

TABLES OF SELECTED VALUES OF PROPERTIES

SERIES I

Enthalpy of Formation at 0 K

Enthalpy of Formation at 298. 15 K

Gibbs Energy of Formation at 298. 15 K

Enthalpy at 298. 15 K

Entropy at 298. 15 K

Heat Capacity at 298. 15 K

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 92(1) — Beryllium

Substance				ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description		State	Formula Weight	0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
Be		c	9.0122	0	0	0	0.466	2.27	3.93
		g		76.49	77.5	68.5	1.481	32.543	4.968
Be^{+}		g		291.474	293.965				
Be^{2+}		g		711.426	715.398				
	std. state, m = 1	aq			-91.5	-90.75		-31.0	
Be^{3+}		g		4260.24	4265.69				
Be^{4+}		g		9280.86	9287.80				
BeO		c	25.0116	-144.86	-145.7	-138.7	0.669	3.38	6.10
		g			28.				
BeO_2^{2-}	std. state, m = 1	aq	41.0110		-189.0	-153.0		-38.	
Be_2O		g	34.0238		-20.				
$(BeO)_2$		g	50.0232		-103.				
$(BeO)_3$		g	75.0348		-260.				
$(BeO)_4$		g	100.0464		-391.				
$(BeO)_5$		g	125.0580		-518.				
$(BeO)_6$		g	150.0696		-651.				

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Table 92(2) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Beryllium

Substance		State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
BeH		g	10.0202	75.	75.6	68.3	2.062	42.21	6.95
BeH_2		c			-4.60				
$Be(OH)_2$	α	c	43.0269		-215.7	-194.8		12.4	
	β	c			-216.5	-195.4		12.	
	fresh precipitated	amorp			-214.6				
		g			-158.				
$Be(OH)_2 \cdot 3/4H_2O$		amorp	56.5		-266.9				
$Be_3(OH)_3^{3+}$	std. state, m = 1	aq	78.0587			-430.6			
BeF		g	28.0106	-42.41	-41.8	-48.6	2.082	49.15	7.14
BeF_2	α, quartz	c	47.0090	-244.85	-245.4	-234.1	2.024	12.75	12.39
	β, cristobalite	c			-244.7				
	glassy	amorp			-244.3				
		g			-189.7				
		aq			-250.0				
	in 100 ($HF + 1.5\ H_2O$)	aq			-251.40				
	100 ($HF + 2.0\ H_2O$)	aq			-251.78				
	100 ($HF + 3.0\ H_2O$)	aq			-252.38				
	100 ($HF + 4.0\ H_2O$)	aq			-252.84				
	100 ($HF + 5.0\ H_2O$)	aq			-253.15				

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Table 92(3) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Beryllium

Substance	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
BeF_2 in 100 ($HF + 6.0\ H_2O$)	aq			-253.32				
100 ($HF + 7.0\ H_2O$)	aq			-253.40				
100 ($HF + 8.0\ H_2O$)	aq			-253.46				
Be_2OF_2	g	72.0206		-292.				
BeCl	g	44.4652	13.4	14.	7.	2.12	52.0	7.56
$BeCl_2$ α	c	79.9182	-117.40	-117.2	-106.5	2.863	19.76	15.50
β	c		-118.57	-118.5	-107.3	2.729	18.12	14.92
	g			-85.7				
dilute	aq			-171.1				
in 45.8 ($HCl + 7.25\ H_2O$)	aq			-162.0				
38.3 ($HCl + 9.72\ H_2O$)	aq			-164.3				
6.38 ($HCl + 10.65\ H_2O$)	aq			-163.6				
in C_2H_5OH, ethyl alcohol				-155.				
$BeCl_2 \cdot 4H_2O$	c	151.9796		-432.2				
Be_2Cl_4	g	159.8364		-202.				

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Table 92(4) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity
Beryllium

Substance	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$BeBr_2$	c	168.8302		-84.5				
in 6.30 molal HCl	aq			-140.2				
BeI_2	c	262.8210		-46.0				
in 6.30 molal HCl	aq			-108.5				
BeS	c	41.0762		-56.0				
$BeSO_4$	c	105.0738	-285.505	-288.05	-261.44	3.125	18.62	20.48
α, tetragonal								
std. state, m = 1	aq			-308.8	-268.72		-26.2	
in 15 H_2O	aq			-304.77				
20 H_2O	aq			-305.33				
25 H_2O	aq			-305.68				
50 H_2O	aq			-306.36				
75 H_2O	aq			-306.61				
100 H_2O	aq			-306.76				
200 H_2O	aq			-307.06				
400 H_2O	aq			-307.34				
500 H_2O	aq			-307.43				

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Table 92(5) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity
Beryllium

Substance: Formula and Description	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
			0°K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$BeSO_4$ in 1,000 H_2O	aq			-307.73				
2,000 H_2O	aq			-308.00				
3,000 H_2O	aq			-308.20				
4,000 H_2O	aq			-308.26				
5,000 H_2O	aq			-308.37				
in 100 (HCl + 55.5 H_2O)	aq			-295.0				
200 (HCl + 27.75 H_2O)	aq			-294.6				
300 (HCl + 18.5 H_2O)	aq			-294.1				
400 (HCl + 13.88 H_2O)	aq			-293.8				
$BeSO_4 \cdot H_2O$	c	123.0891		-364.2				
$BeSO_4 \cdot 2H_2O$	c	141.1045	-429.814	-435.74	-381.99	5.865	39.01	36.63
$BeSO_4 \cdot 4H_2O$ tetragonal	c	177.1352	-569.682	-579.29	-497.29	8.306	55.68	51.77
$BeBr_2 \cdot 2H_2S$	c	236.9901		-112.1				
$BeI_2 \cdot 2H_2S$	c	330.9809		-69.8				

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Table 92(6) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity
Beryllium

Substance		State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$BeSeO_4$		c	151.970		-212.8				
	std. state, m = 1	aq			-234.7	-196.2		-18.1	
	in 800 H_2O	aq			-234.1				
$BeSeO_4 \cdot 2H_2O$		c	188.000		-360.3				
$BeSeO_4 \cdot 4H_2O$		c	224.031		-505.0				
Be_3N_2	α, cubic	c	55.0500		-140.6				
	β, hexagonal	c			-136.5				
$Be(NO_3)_2$		aq	133.0220		-191.0				
$BeCl_2 \cdot 2NH_3$		c	113.9794		-201.7				
$BeCl_2 \cdot 4NH_3$		c	148.0406		-260.4				
$BeCl_2 \cdot 6NH_3$		c	182.1019		-298.2				
$BeCl_2 \cdot 12NH_3$		c	284.2855		-409.9				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 92(7) — Beryllium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$BeBr_2 \cdot 4NH_3$	c	236.9526		-235.1				
$BeBr_2 \cdot 6NH_3$	c	271.0138		-274.4				
$BeBr_2 \cdot 10NH_3$	c	339.1363		-349.2				
$BeI_2 \cdot 4NH_3$	c	330.9434		-207.6				
$BeI_2 \cdot 6NH_3$	c	365.0047		-247.2				
$BeI_2 \cdot 13NH_3$	c	484.2189		-378.4				
Be_2C	c	30.0356		-28.0				
$BeCO_3$	c	69.0216		-245.				
Be_2SiO_4	c	110.1080	-510.77	-513.7	-485.8	2.922	15.37	22.84
$Be(BO_2)_2$	g	94.6318		-325.				
$Be_3B_2O_6$	c	144.6550		-750.3				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 92(8) — Beryllium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
BeOAl		g	51.9931		-5.				
$BeO \cdot Al_2O_3$	chrysoberyl	c	126.9728	-546.32	-549.9	-520.7	3.128	15.84	25.19
$BeO \cdot 3Al_2O_3$		c	330.8952	-1335.65	-1344.9	-1271.6	8.153	42.0	63.38
$BeMoO_4$		c	168.950		-328.				
$NbBe_2$		c	110.9304		-14.6				
$NbBe_8$		c	165.0036		-20.				
$NbBe_{12}$		c	201.0524		-30.				
UBe_{13}		c	355.189		-39.				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 93(1) — Magnesium

Substance: Formula and Description	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
Mg	c	24.312	0	0	0	1.195	7.81	5.95
	g		35.014	35.30	27.04	1.481	35.502	4.968
Mg^+	g		211.333	213.100				
Mg^{2+}	g		558.052	561.299				
std. state, m = 1	aq			-111.58	-108.7		-33.0	
Mg^{3+}	g		2406.08	2410.81				
Mg^{4+}	g		4927.14	4933.35				
Mg^{5+}	g		8184.9	8192.6				
Mg^{6+}	g		12486.7	12495.8				
Mg^{7+}	g		17674.3	17685.0				
Mg^{8+}	g		23809.1	23821.2				
Mg^{9+}	g		31372.7	31386.3				
Mg^{10+}	g		39847.	39862.				
Mg^{11+}	g		80472.	80489.				
Mg_2	g	48.624	+68.87	68.59				

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Table 93(2) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Magnesium

Substance		State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
MgO	macrocrystal (periclase)	c	40.3114	-142.813	-143.81	-136.10	1.235	6.44	8.88
	microcrystal	c		-141.954	-142.92	-135.27	1.266	6.67	9.00
		g			+4.				
MgH_2		c	26.3279	-16.05	-18.0	-8.6	1.270	7.43	8.45
$MgOH^+$	std. state, m = 1	aq	41.3194			-149.8			
$Mg(OH)_2$		c	58.3267	-218.402	-220.97	-199.23	2.725	15.10	18.41
	precipitate	amorp			-220.0				
		g			-134.				
	std. state, m = 1	aq			-221.52	-183.9		-35.6	
MgF		g	43.3104	-52.89	-53.0	-59.2	2.143	52.79	7.78
MgF_2		c	62.3088	-267.57	-268.5	-255.8	2.370	13.68	14.72
		g		-172.58	-173.0	-174.6	2.878	61.73	11.62
MgCl		g	59.765	-9.9	-10.	-16.	2.24	55.8	8.32
$MgCl_2$		c	95.218	-153.180	-153.28	-141.45	3.288	21.42	17.06
		g			-95.7				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 93(3) — Magnesium

Substance	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$MgCl_2$ std. state, m = 1	aq			-191.48	-171.4		-6.0	
in 10 H_2O	aq			-186.82				
12 H_2O	aq			-187.58				
15 H_2O	aq			-188.45				
20 H_2O	aq			-189.17				
25 H_2O	aq			-189.57				
50 H_2O	aq			-190.23				
75 H_2O	aq			-190.46				
100 H_2O	aq			-190.59				
200 H_2O	aq			-190.81				
300 H_2O	aq			-190.89				
400 H_2O	aq			-190.94				
500 H_2O	aq			-190.98				
600 H_2O	aq			-191.003				
800 H_2O	aq			-191.048				
1,000 H_2O	aq			-191.080				
2,000 H_2O	aq			-191.176				
5,000 H_2O	aq			-191.269				
10,000 H_2O	aq			-191.323				
20,000 H_2O	aq			-191.364				

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Table 93(4) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity
Magnesium

Substance		State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$MgCl_2$	in 50,000 H_2O	aq			-191.404				
	100,000 H_2O	aq			-191.425				
	∞ H_2O	aq			-191.48				
	in 75.2 HCl + 4190 H_2O	aq			-189.84				
$MgCl_2 \cdot H_2O$		c	113.2333		-231.03	-205.98		32.8	27.55
$MgCl_2 \cdot 2H_2O$		c	131.2487		-305.86	-267.24		43.0	38.05
$MgCl_2 \cdot 4H_2O$		c	167.2793		-453.87	-388.03		63.1	57.70
$MgCl_2 \cdot 6H_2O$		c	203.3100		-597.28	-505.49		87.5	75.30
$Mg(ClO_4)_2$		c	223.2132		-135.97				
	std. state, m = 1	aq			-173.40	-112.8		54.0	
	in 18 H_2O	aq			-171.549				
	20 H_2O	aq			-171.847				
	25 H_2O	aq			-172.230				
	30 H_2O	aq			-172.426				
	40 H_2O	aq			-172.633				
	50 H_2O	aq			-172.720				
	75 H_2O	aq			-172.815				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 93(5) Magnesium

Substance: Formula and Description	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Mg(ClO_4)_2$ in 100 H_2O	aq			-172.858				
200 H_2O	aq			-172.924				
300 H_2O	aq			-172.956				
400 H_2O	aq			-172.982				
500 H_2O	aq			-173.003				
600 H_2O	aq			-173.023				
800 H_2O	aq			-173.052				
1,000 H_2O	aq			-173.073				
2,000 H_2O	aq			-173.136				
5,000 H_2O	aq			-173.208				
10,000 H_2O	aq			-173.254				
20,000 H_2O	aq			-173.290				
50,000 H_2O	aq			-173.324				
100,000 H_2O	aq			-173.346				
∞ H_2O	aq			-173.40				

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Table 93(6) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity
Magnesium

Substance	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Mg(ClO_4)_2$ in 2,000 CH_3OH				-181.87				
in 4,000 C_2H_5OH				-181.2				
∞ C_2H_5OH				-181.5				
in 4,000 n-C_3H_7OH				-175.5				
∞ n-C_3H_7OH				-176.6				
in 4,000 i-C_3H_7OH				-179.5				
∞ i-C_3H_7OH				-181.1				
in 4,000 n-C_4H_9OH				-173.3				
∞ n-C_4H_9OH				-174.5				
$Mg(ClO_4)_2 \cdot 2H_2O$	c	259.2439		-291.3				
$Mg(ClO_4)_2 \cdot 4H_2O$	c	295.2746		-439.1				
$Mg(ClO_4)_2 \cdot 6H_2O$	c	331.3052		-584.5	-445.3		124.5	
$MgO \cdot MgCl_2$	c	135.5294		-312.5				
$MgO \cdot MgCl_2 \cdot 6H_2O$	c	243.6214		-744.4				
$MgO \cdot MgCl_2 \cdot 16H_2O$	c	423.7748		-1442.9				
MgOHCl	c	76.7724		-191.1	-174.9		20.0	

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Table 93(7) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity
Magnesium

Substance	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$3Mg(OH)_2 \cdot MgCl_2$	c	270.1982		-827.9				
$3Mg(OH)_2 \cdot MgCl_2 \cdot 4H_2O$	c	342.2596		-1123.7				
$3Mg(OH)_2 \cdot MgCl_2 \cdot 7H_2O$	c	396.3056		-1337.6				
$3Mg(OH)_2 \cdot MgCl_2 \cdot 8H_2O$	c	414.3209		-1408.8				
$5Mg(OH)_2 \cdot MgCl_2 \cdot 8H_2O$	c	530.9744		-1847.7				
$MgBr_2$	c	184.130		-125.3	-120.4		28.0	
	g			-74.0				
std. state, m = 1	aq			-169.68	-158.4		6.4	
in 100 H_2O	aq			-168.98				
200 H_2O	aq			-169.09				
300 H_2O	aq			-169.14				
400 H_2O	aq			-169.18				
500 H_2O	aq			-169.21				
600 H_2O	aq			-169.237				
800 H_2O	aq			-169.276				
1,000 H_2O	aq			-169.304				
2,000 H_2O	aq			-169.385				
5,000 H_2O	aq			-169.476				

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Table 93(8) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity
Magnesium

Substance	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$MgBr_2$ in 10,000 H_2O	aq			-169.528				
20,000 H_2O	aq			-169.568				
50,000 H_2O	aq			-169.606				
100,000 H_2O	aq			-169.626				
∞ H_2O	aq			-169.68				
in 81 HBr + 9,000 H_2O				-168.4				
$MgBr_2 \cdot 6H_2O$	c	292.2220		-576.0	-491.4		95.	
MgI_2	c	278.1208		-87.0	-85.6		31.0	
	g			-41.				
std. state, m = 1	aq			-137.96	-133.4		20.2	
in 400 H_2O	aq			-137.49				
800 H_2O	aq			-137.57				
1,000 H_2O	aq			-137.59				
2,000 H_2O	aq			-137.67				
5,000 H_2O	aq			-137.76				
∞ H_2O	aq			-137.96				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 93(9) Magnesium

Substance: Formula and Description	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
MgI_2 in 81 HI + 9,000 H_2O	aq			-136.8				
$MgIO_3^+$ un-ionized; std. state, m = 1	aq	199.2146			-140.3			
MgS	c	56.376	-82.44	-82.7	-81.7	1.992	12.03	10.89
$MgSO_3$	c	104.3742		-241.0				
$MgSO_3 \cdot 3H_2O$	c	158.4202		-461.7				
$MgSO_3 \cdot 6H_2O$	c	212.4662		-673.4				
$MgSO_4$	c	120.3736		-307.1	-279.8		21.9	23.06
undissociated; std. state, m = 1	aq			-324.1	-289.74		-1.7	
std. state, m = 1	aq			-328.90	-286.7		-28.2	
in 20 H_2O	aq			-327.12				
25 H_2O	aq			-327.20				
50 H_2O	aq			-327.41				
75 H_2O	aq			-327.52				
100 H_2O	aq			-327.59				
200 H_2O	aq			-327.74				
300 H_2O	aq			-327.82				
400 H_2O	aq			-327.88				

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Table 93(10) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity
Magnesium

$MgSO_4$ 93

Substance	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$MgSO_4$ in 500 H_2O	aq			-327.93				
600 H_2O	aq			-327.97				
800 H_2O	aq			-328.04				
1,000 H_2O	aq			-328.08				
2,000 H_2O	aq			-328.202				
5,000 H_2O	aq			-328.358				
10,000 H_2O	aq			-328.467				
20,000 H_2O	aq			-328.581				
50,000 H_2O	aq			-328.707				
100,000 H_2O	aq			-328.774				
∞ H_2O	aq			-328.90				
$MgSO_4$ in CH_3OH, std. state, m = 1				-310.9	-277.4		+1.	
$MgSO_4$ in C_2H_5OH, std. state, m= 1				-309.3	-276.1		+2.	
$MgSO_4 \cdot H_2O$	c	138.3889		-382.9	-341.5		30.2	
	amorp			-376.4	-335.8		33.0	
$MgSO_4 \cdot 2H_2O$	c	156.4043		-453.2				
$MgSO_4 \cdot 4H_2O$	c	192.4350		-596.7				
$MgSO_4 \cdot 6H_2O$	c	228.4656		-737.8	-629.1		83.2	83.20
$MgSO_4 \cdot 7H_2O$	c	246.4810		-809.92	-686.4		89.	

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 93(11) — Magnesium

Substance			ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$MgS_2O_3 \cdot 3H_2O$	c	190.4842		-465.6				
$MgS_2O_3 \cdot 6H_2O$	c	244.5302		-680.8				
$3Mg(OH)_2 \cdot MgSO_4 \cdot 8H_2O$	c	439.4765		-1543.3				
$MgSeO_3$	c	151.270		-215.15				
	amorp			-213.35				
$MgSeO_3 \cdot 6H_2O$	c	259.362		-647.00				
$MgSeO_4$	c	167.270		-231.48				
std. state, m = 1	aq			-254.8	-214.2		-20.1	
in 1,500 H_2O	aq			-254.31				
$MgSeO_4 \cdot H_2O$	c	185.285		-309.62				
$MgSeO_4 \cdot 4H_2O$	c	239.331		-523.40				
$MgSeO_4 \cdot 6H_2O$	c	275.362		-664.2				
MgTe	c	151.912		-50.				
Mg_3N_2	c	100.9494		-110.1				

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Table 93(12) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Magnesium

Substance	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Mg(NO_3)_2$	c	148.3218		-188.97	-140.9		39.2	33.92
std. state, m = 1	aq			-210.70	-161.9		37.0	
in 12 H_2O	aq			-209.62				
15 H_2O	aq			-209.89				
20 H_2O	aq			-210.07				
25 H_2O	aq			-210.11				
50 H_2O	aq			-210.14				
75 H_2O	aq			-210.15				
100 H_2O	aq			-210.16				
200 H_2O	aq			-210.21				
300 H_2O	aq			-210.25				
400 H_2O	aq			-210.28				
500 H_2O	aq			-210.30				
600 H_2O	aq			-210.317				
800 H_2O	aq			-210.344				
1,000 H_2O	aq			-210.364				
2,000 H_2O	aq			-210.423				
5,000 H_2O	aq			-210.502				
10,000 H_2O	aq			-210.551				
20,000 H_2O	aq			-210.590				

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Table 93(13) Magnesium

Substance: Formula and Description	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Mg(NO_3)_2$ in 50,000 H_2O	aq			-210.626				
100,000 H_2O	aq			-210.646				
∞ H_2O	aq			-210.70				
$Mg(NO_3)_2 \cdot 2H_2O$	c	184.3525		-336.8				
$Mg(NO_3)_2 \cdot 6H_2O$	c	256.4138		-624.59	-497.3		108.	
$Mg(NH_3)_2^{2+}$	aq	58.3732		-148.6				
$MgCl_2 \cdot NH_3$	c	112.2486		-185.7				
$MgCl_2 \cdot 2NH_3$	c	129.2792		-215.0				
$Mg(NH_3)_2Cl_2$	aq			-228.6				
$Mg(ClO_4)_2 \cdot 6NH_3$	c	325.3969		-302.0				
$MgBr_2 \cdot NH_3$	c	201.1606		-158.7				
$MgBr_2 \cdot 2NH_3$	c	218.1912		-190.3				
$MgI_2 \cdot 2NH_3$	c	312.1820		-156.9				
$Mg(NH_3)_2SO_4$	aq	154.4348		-365.9				
$3MgSO_3 \cdot (NH_4)_2SO_3 \cdot 6H_2O$	c	537.3540		-1379.9				
$3MgSO_3 \cdot (NH_4)_2SO_3 \cdot 18H_2O$	c	753.5381		-2229.8				

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$MgP_2O_7^{2-}$ 93

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 93(14) Magnesium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$MgP_2O_7^{2-}$	std. state, m = 1	aq	198.2554		-651.5	-577.2		-19.	
$Mg_2P_2O_7$	α	c	222.5674				6.467	37.02	42.53
$Mg_3(PO_4)_2$		c	262.8788	-896.98	-903.6	-845.8	7.825	45.22	51.02
$MgHPO_4$		aq	120.2914		-419.8				
$MgNH_4PO_4 \cdot 6H_2O$		c	245.4140		-880.0				
$MgAs_4$		c	323.9984		-30.				
Mg_3As_2		c	222.7792		-88.8				
$Mg_3(AsO_4)_2$		c	350.7744		-739.2				
$MgHAsO_4$		aq	164.2392		-325.9				
$Mg(H_2AsO_4)_2$		aq	306.1823		-545.5				
$MgNH_4AsO_4 \cdot 6H_2O$		c	289.3618		-792.7				
Mg_3Sb_2	α	c	316.436		-56.				
Mg_3Bi_2	β	c	490.896		-36.8				
MgC_2		c	48.3343		+20.				
Mg_2C_3		c	84.6574		+17.				

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Table 93(15) — Magnesium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$MgCO_3$	magnesite	c	84.3214		-261.9	-241.9		15.7	18.05
$MgCO_3 \cdot 3H_2O$	nesquehonite	c	138.3674			-412.6			
$MgCO_3 \cdot 5H_2O$	lansfordite	c	174.3980			-525.7			
MgC_2O_4		c	112.3319		-303.3				
	std. state, m = 1	aq			-308.8	-269.8		-22.1	
$MgC_2O_4 \cdot 2H_2O$		c	148.3626			-390.4			
$Mg(C_2O_4)_2^{2-}$	std. state, m = 1	aq	200.3518			-436.9			
$MgHCO_3^+$	un-ionized; std. state, m = 1	aq	85.3293			-250.3			
$Mg(CO_2H)_2$	magnesium formate	c	114.348				5.385	34.41	30.66
$Mg(C_2H_3O_2)^+$	std. state, m = 1	aq	83.3570			-198.7			
$Mg(C_2H_3O_3)_2$	magnesium glycollate	c	174.4008		-418.4				
		aq			-422.8				
$Mg(C_2H_3O_3)_2 \cdot 2H_2O$		c	210.4315		-561.2				
$3MgCO_3 \cdot Mg(OH)_2 \cdot 3H_2O$		c	365.3368			-1100.3			
$MgCl_2 \cdot 6CH_3OH$		c	287.4726		-508.				
$MgCl_2 \cdot 6C_2H_5OH$		c	371.6351		-609.				

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Table 93(16) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Magnesium

Substance: Formula and Description	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$MgCN_2$ magnesium cyanamide	c	64.3366		-60.3				
$Mg(CN)_2$	aq	76.3477		-39.2				
$Mg(NH_2CH_2COO)^+$ un-ionized; std. state, m = 1	aq	98.3717			-188.7			
$Mg(NO_3)_2 \cdot 6CH_3OH$	c	340.5764		-559.				
$Mg(NO_3)_2 \cdot 6C_2H_5OH$	c	424.7389		-603.				
Mg_2Si	c	76.710		-18.6	-18.0		18.	17.6
$MgSiO_3$ clinoenstatite	c	100.3962	-368.039	-370.22	-349.46	2.895	16.19	19.45
Mg_2SiO_4 forsterite	c	140.7076	-516.42	-519.6	-491.2	4.129	22.74	28.32
$Mg_3Si_2O_5(OH)_4$ chrysotile	c	277.1345		-1043.4	-965.1		52.9	65.41
antigorite	c						53.2	65.47
$Mg_3Si_4O_{10}(OH)_2$ talc	c	379.2887	-1405.57	-1415.5	-1324.8	11.20	62.3	76.9
Mg_2Ge	c	121.214	-25.73	-26.0	-25.3	3.229	20.67	16.62
Mg_2Sn	c	167.314		-19.3				
Mg_2Pb	c	255.814		-12.3				
$PbI_2 \cdot 2MgI_2$	c	1017.240		-206.5				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 93(17) Magnesium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
MgB_2	c	45.934				1.625	8.59	11.59
MgB_4	c	67.556				2.270	12.51	16.78
MgB_{12}	c	154.044	-52.8	-53.	-52.	4.49	21.4	36.2
$MgO \cdot Al_2O_3$	c	142.2726	-549.05	-552.9	-523.1	3.683	19.27	27.77
$Mg_2Al_4Si_5O_{18}$ cordierite	c	584.9692		-2177.	-2055.		97.3	108.1
MgTl	c	228.682		-12.				
MgZn	c	89.682		-4.0				
$MgZn_2$	c	155.052		-7.8				17.7
Mg_2Zn_{11}	c	767.874		-30.				
$MgCu_2$ β phase	c	151.392		-8.02	-8.1		24.	17.43
Mg_2Cu γ phase	c	112.164		-6.84				
MgCd	c	136.712	-3.814	-3.84	-3.71	2.66	19.76	12.32
$MgCd_3$	c	361.512	-4.662	-4.52	-4.71	5.81	45.56	28.24
Mg_3Cd	c	185.336	-5.244	-5.32	-5.14	5.00	35.20	24.04
$MgHgBr_4$	aq	544.538		-210.4				
$Mg(HgBr_3)_2$	aq	904.946		-249.1				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 93(18) Magnesium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$2MgBr_2 \cdot HgBr_2$	aq	728.668		-381.2				
$4MgBr_2 \cdot HgBr_2$	aq	1096.928		-721.2				
$MgHg(CN)_4$	aq	328.973		19.4				
$Mg[Hg(CN)_3]_2$	aq	581.599		81.6				
$2Hg(CN)_2 \cdot MgCl_2$	aq	600.469		-57.1				
$2Hg(CN)_2 \cdot MgCl_2 \cdot 6H_2O$	c	708.561		-476.5				
$2Hg(CN)_2 \cdot MgBr_2$	aq	689.381		-36.0				
$2Hg(CN)_2 \cdot MgBr_2 \cdot 8H_2O$	c	833.504		-597.9				
$2Hg(CN)_2 \cdot MgI_2$	aq	783.372		-8.4				
$2Hg(CN)_2 \cdot MgI_2 \cdot 8H_2O$	c	927.495		-574.2				
$MgNi_2$	c	141.732		-13.2	-12.9		21.20	17.54
Mg_2Ni	c	107.334		-9.5				
$MgFe_2O_4$	c	200.004		-341.4	-314.8		29.6	34.35

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 93(19) — Magnesium

Substance: Formula and Description	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$MgFe(CN)_6^-$ un-ionized; std. state, m=1	aq	236.2661			-286.8			
$MgFe(CN)_6^{2-}$ un-ionized; std. state, m=1	aq				-280.0			
$Mg_2Fe(CN)_6$ std. state, m = 1	aq	260.5781		-114.3	-51.3		-43.3	
in 1,500 H_2O	aq			-111.72				
2,000 H_2O	aq			-111.90				
5,000 H_2O	aq			-112.34				
7,500 H_2O	aq			-112.49				
10,000 H_2O	aq			-112.59				
20,000 H_2O	aq			-112.80				
50,000 H_2O	aq			-113.10				
100,000 H_2O	aq			-113.39				
200,000 H_2O	aq			-113.65				
500,000 H_2O	aq			-113.94				
1,000,000 H_2O	aq			-114.12				
∞ H_2O	aq			-114.3				
$MgCrO_4$	c	140.3056		-321.1				
	aq			-324.0				
$MgCr_2O_4$	c	192.3016		-426.3	-398.9		25.34	30.30

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 93(20) — Magnesium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$MgMoO_4$		c	184.250		-334.81	-309.69		28.4	26.57
		g		-224.					
$MgWO_4$		c	272.160	-363.88	-366.3	-339.6	4.115	24.18	26.14
		g		-222.					
MgV_2O_6	metavanadate	c	222.1924		-526.19	-487.43		38.4	39.47
$Mg_2V_2O_7$	pyrovanadate	c	262.5038		-677.80	-632.24		47.9	48.63
$MgTiO_3$	metatitanate	c	120.210	-373.69	-375.9	-354.8	3.240	17.82	21.96
$MgTi_2O_5$		c	200.109	-596.56	-599.8	-565.7	5.428	30.42	35.15
Mg_2TiO_4	orthotitanate	c	160.522	-514.32	-517.5	-489.2	4.502	26.13	30.75
MgY		c	113.217		-6.				
Mg_5Y_2		c	299.370		-21.				
$Mg_{17}Y_3$		c	680.019		-50.				
MgPr		c	165.219		-8.2				
Mg_3Pr		c	213.843		-11.1				
MgCe		c	164.432		-13.				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 93(21) Magnesium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
Mg_3Ce	c	213.056		-17.				
MgLa	c	163.222		-5.7				
Mg_3La	c	211.846		-12.8				
$2La(NO_3)_3 \cdot 3Mg(NO_3)_2 \cdot 24H_2O$	c	1527.183					525.	483.2

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(1) — Calcium

Substance	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
Ca	c	40.08	0	0	0	1.364	9.90	6.05
	g		42.48	42.6	34.5	1.481	36.992	4.968
Ca^+	g		183.45	185.05				
Ca^{2+}	g		457.21	460.29				
std. state, m.= 1	aq			-129.74	-132.30		-12.7	
Ca^{3+}	g		1631.19	1635.75				
Ca^{4+}	g		3178.6	3184.6				
Ca^{5+}	g		5125.1	5132.7				
Ca^{6+}	g		7633.7	7642.7				
Ca^{7+}	g		10579.	10589.				
Ca^{8+}	g		13974.	13986.				
CaO	c	56.079		-151.79	-144.37		9.50	10.23
	g		+11.					
CaO_2	c	72.079		-156.0				
$CaO_2 \cdot 8H_2O$	c	216.202		-718.2				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(2) — Calcium

Substance	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
CaH	g	41.088	55.	54.7	47.9	2.076	48.19	7.11
CaH_2	c	42.096		-44.5	-35.2		10.	
CaOH	g	57.087		-48.				
$CaOH^+$ std. state, m = 1	aq				-171.7			
$Ca(OH)_2$	c	74.095		-235.68	-214.76		19.93	20.91
	g			-130.				
std. state, m = 1	aq			-239.68	-207.49		-17.8	
$Ca(OH)_2 \cdot H_2O_2$	c	108.109		-291.2				
CaF	g	59.078	-64.76	-65.0	-71.2	2.181	54.8	8.03
CaF_2	c	78.077		-291.5	-279.0		16.46	16.02
	g		-186.35	-186.8	-188.9	3.025	65.55	12.25
std. state, m = 1	aq			-288.74	-265.58		-19.3	
CaCl	g	75.533	-23.23	-23.4	-29.7	2.292	57.70	8.58
$CaCl_2$	c	110.986		-190.2	-178.8		25.0	17.35
	g		-112.76	-112.7	-114.54	3.613	69.35	14.18
std. state, m = 1	aq			-209.64	-195.04		14.3	

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(3) — Calcium

Substance				ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description			State	Formula Weight	0 K	298.15 K (25°C)			
					kcal/mol			cal/deg mol	
$CaCl_2$	in	10 H_2O	aq			-206.20			
		11 H_2O	aq			-206.55			
		12 H_2O	aq			-206.83			
		13 H_2O	aq			-207.06			
		15 H_2O	aq			-207.42			
		20 H_2O	aq			-207.95			
		25 H_2O	aq			-208.19			
		40 H_2O	aq			-208.51			
		50 H_2O	aq			-208.63			
		75 H_2O	aq			-208.769			
		100 H_2O	aq			-208.849			
		300 H_2O	aq			-209.079			
		400 H_2O	aq			-209.144			
		500 H_2O	aq			-209.162			
		800 H_2O	aq			-209.227			
		1,000 H_2O	aq			-209.259			
		2,000 H_2O	aq			-209.343			
		5,000 H_2O	aq			-209.433			
		10,000 H_2O	aq			-209.485			
		20,000 H_2O	aq			-209.526			
		50,000 H_2O	aq			-209.565			

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(4) — Calcium

Substance: Formula and Description	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
			0 °K	298.15 °K (25 °C)				
			kcal/mol				cal/deg mol	
$CaCl_2$ in 100,000 H_2O	aq			-209.585				
500,000 H_2O	aq			-209.615				
∞ H_2O	aq			-209.64				
$CaCl_2 \cdot H_2O$	c	129.001		-265.1				
$CaCl_2 \cdot 2H_2O$	c	147.017		-335.3				
$CaCl_2 \cdot 4H_2O$	c	183.047		-480.3				
$CaCl_2 \cdot 6H_2O$	c	219.078		-623.3				
$CaOCl_2$	c	126.985		-178.4				
	aq			-188.9				
$CaOCl_2 \cdot H_2O$	c	145.001		-249.1				
$Ca(OCl)_2$	aq	142.985		-180.3				
$Ca(ClO_2)_2$	c	174.984		-162.1				
$Ca(ClO_4)_2$	c	238.981		-176.09				
std. state, m = 1	aq			-191.56	-136.42		74.3	
in 7 H_2O	aq			-187.59				
8 H_2O	aq			-188.22				
9 H_2O	aq			-188.72				
10 H_2O	aq			-189.12				
12 H_2O	aq			-189.78				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(5) — Calcium

Substance			State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description					0 K	298.15 K (25°C)				
					kcal/mol				cal/deg mol	
$Ca(ClO_4)_2$	in	15 H_2O	aq			-190.35				
		20 H_2O	aq			-190.75				
		25 H_2O	aq			-190.92				
		30 H_2O	aq			-190.99				
		40 H_2O	aq			-191.08				
		50 H_2O	aq			-191.14				
		75 H_2O	aq			-191.21				
		100 H_2O	aq			-191.20				
		200 H_2O	aq			-191.13				
		300 H_2O	aq			-191.17				
		500 H_2O	aq			-191.18				
		1,000 H_2O	aq			-191.25				
		10,000 H_2O	aq			-191.42				
		100,000 H_2O	aq			-191.51				
		∞ H_2O	aq			-191.56				

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(6) Calcium

Substance	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Ca(ClO_4)_2$ in CH_3OH; std. state, m = 1		238.981		-204.3				
in C_2H_5OH; std. state, m = 1				-197.9				
in n C_3H_7OH; std. state, m = 1				-194.2				
in i C_3H_7OH; std. state, m = 1				-196.3				
in n C_4H_9OH; std. state, m = 1				-192.7				
$Ca(ClO_4)_2 \cdot 4H_2O$	c	311.043		-465.8	-352.97		103.6	
$CaCl_2 \cdot 2CaO$	c	223.145		-505.				
$CaCl_2 \cdot 3CaO$	c	279.224		-654.				
$CaCl_2 \cdot 3CaO \cdot 3H_2O$	c	333.270		-910.				
$CaCl_2 \cdot 3CaO \cdot 16H_2O$	c	567.470		-1832.				
CaClH	c	76.541		-120.5				
$CaBr_2$	c	199.898		-163.2	-158.6		31.	
	g			-95.2				
std. state, m = 1	aq			-187.84	-182.00		26.7	

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(7) — Calcium

Substance	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$CaBr_2$ in 400 H_2O	aq			-187.39				
500 H_2O	aq			-187.42				
800 H_2O	aq			-187.47				
1,000 H_2O	aq			-187.494				
2,000 H_2O	aq			-187.566				
5,000 H_2O	aq			-187.644				
10,000 H_2O	aq			-187.693				
20,000 H_2O	aq			-187.729				
50,000 H_2O	aq			-187.767				
100,000 H_2O	aq			-187.786				
500,000 H_2O	aq			-187.815				
∞ H_2O	aq			-187.84				
$CaBr_2 \cdot 6H_2O$	c	307.990		-599.0	-514.6		98.	
$Ca(BrO_3)_2$	c	295.894		-171.8				
in 1,000 H_2O	aq			-170.4				
$CaBr_2 \cdot 3CaO \cdot 16H_2O$	c	656.382		-1811.				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(8) — Calcium

Substance	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
CaBrH	c	120.997		-106.0				
CaI_2	c	293.889		-127.5	-126.4		34.	
	g			-65.				
std. state, m = 1	aq			-156.12	-156.96		40.5	
in 400 H_2O	aq			-155.6				
$CaI_2 \cdot 8H_2O$	c	438.012		-700.2				
$Ca(IO_3)_2$	c	389.885		-239.6	-200.6		55.	
$Ca(IO_3)_2 \cdot H_2O$	c	407.901		-309.1				
$Ca(IO_3)_2 \cdot 6H_2O$	c	497.977		-664.6	-542.0		108.	
$CaI_2 \cdot 3CaO \cdot 16H_2O$	c	750.372		-1779.				
$Ca_5(IO_6)_2$	c	646.202		-915.				
CaIH	c	167.992		-87.5				
CaS	c	72.144		-115.3	-114.1		13.5	11.33
	g		+32.					
$CaSO_3$	c	120.142					24.23	12.92
$CaSO_3 \cdot 2H_2O$	c	156.173		-418.9	-371.7		44.	42.7

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(9) — Calcium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$CaSO_4$	insol., anhydrite	c	136.142		-342.76	-315.93		25.5	23.82
	sol., α	c			-340.64	-313.93		25.9	23.95
	sol., β	c			-339.58	-312.87		25.9	23.67
	std. state, m = 1	aq			-347.06	-310.27		-7.9	
	in 5,000 H_2O	aq			-346.414				
	7,500 H_2O	aq			-346.518				
	10,000 H_2O	aq			-346.566				
	20,000 H_2O	aq			-346.685				
	50,000 H_2O	aq			-346.827				
	100,000 H_2O	aq			-346.915				
	500,000 H_2O	aq			-347.009				
	1,000,000 H_2O	aq			-347.026				
	∞ H_2O	aq			-347.06				
$CaSO_4 \cdot 1/2H_2O$	macro; α	c	145.149		-376.85	-343.41		31.2	28.54
	micro; β	c			-376.35	-343.18		32.1	29.69
$CaSO_4 \cdot 2H_2O$	selenite	c	172.172		-483.42	-429.60		46.4	44.46

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(10) — Calcium

Substance	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
CaS_2O_3 in 35 H_2O	aq	152.206		-284.56				
100 H_2O	aq			-284.80				
200 H_2O	aq			-284.95				
400 H_2O	aq			-285.02				
1,000 H_2O	aq			-285.10				
∞ H_2O	aq			-285.6				
$CaS_2O_6 \cdot 4H_2O$ dithionate	c	272.266		-697.				
$Ca(HS)_2$	aq	106.224		-138.1				
CaSe	c	119.04		-88.0	-86.8		16.	
$CaSeO_3 \cdot 2H_2O$	c	203.069			-341.5			
precipitate				-384.9				
$CaSeO_4$	c	183.038		-265.25				
in 1,600 H_2O	aq			-273.30				
$CaSeO_4 \cdot 2H_2O$	c	219.068		-407.9	-355.4		53.	
CaTe	c	167.68					19.	

National Bureau of Standards — Washington, D. C.

Table 94(11) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Calcium

Substance	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Ca(N_3)_2$	c	124.120		+3.5				
$Ca(N_3)_2 \cdot 0.5H_2O$	c	133.128		-33.3				
$Ca(N_3)_2 \cdot 1.5H_2O$	c	151.143		-104.5				
$Ca(N_3)_2 \cdot 4H_2O$	c	196.182		-278.2				
Ca_3N_2	c	148.253		-103.				
$CaN_2O_2 \cdot 4H_2O$	c	172.154		-407.5				
$Ca(NO_2)_2$	c	132.091		-177.2				
in 800 H_2O	aq			-179.5				
$Ca(NO_2)_2 \cdot 4H_2O$	c	204.152		-450.7				
$Ca(NO_3)_2$	c	164.090		-224.28	-177.63		46.2	35.70
std. state, m = 1	aq			-228.86	-185.52		57.3	
in 3 H_2O	aq			-228.164				
4 H_2O	aq			-228.793				
5 H_2O	aq			-229.247				
6 H_2O	aq			-229.545				
7 H_2O	aq			-229.758				
8 H_2O	aq			-229.905				
9 H_2O	aq			-229.988				
10 H_2O	aq			-230.037				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(12) — Calcium

Substance	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Ca(NO_3)_2$ in 11 H_2O	aq			-230.062				
12 H_2O	aq			-230.071				
13 H_2O	aq			-230.068				
15 H_2O	aq			-230.041				
20 H_2O	aq			-229.904				
25 H_2O	aq			-229.731				
40 H_2O	aq			-229.361				
50 H_2O	aq			-229.220				
75 H_2O	aq			-229.030				
100 H_2O	aq			-228.925				
300 H_2O	aq			-228.699				
400 H_2O	aq			-228.657				
500 H_2O	aq			-228.643				
800 H_2O	aq			-228.632				
1,000 H_2O	aq			-228.632				
2,000 H_2O	aq			-228.649				
5,000 H_2O	aq			-228.695				
10,000 H_2O	aq			-228.729				
20,000 H_2O	aq			-228.759				
50,000 H_2O	aq			-228.791				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(13) — Calcium

Substance		State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$Ca(NO_3)_2$	in 100,000 H_2O	aq			-228.809				
	500,000 H_2O	aq			-228.836				
	∞ H_2O	aq			-228.86				
	in 100 C_2H_5OH				-231.56				
	in ∞ C_2H_5OH				-231.86				
$Ca(NO_3)_2 \cdot 2H_2O$		c	200.120		-368.25	-293.82		64.4	
$Ca(NO_3)_2 \cdot 3H_2O$		c	218.136		-439.3	-351.8		76.3	
$Ca(NO_3)_2 \cdot 4H_2O$		c	236.151		-509.64	-409.53		89.7	
$Ca(NH_2)_2$		c	72.125		-91.9				
$Ca(N_3)_2 \cdot N_2H_4$		c	156.165		+12.6				
$Ca(N_3)_2 \cdot 2N_2H_4$		c	188.211		+4.0				
$Ca(NO_3)_2 \cdot Ca(OH)_2$		c	238.185		-461.5				
$Ca(NO_3)_2 \cdot Ca(OH)_2 \cdot 2\frac{1}{2}H_2O$		c	283.223		-640.9				
$CaCl_2 \cdot NH_3$		c	128.017		-217.5				
$CaCl_2 \cdot 2NH_3$		c	145.047		-242.8				
$CaCl_2 \cdot 4NH_3$		c	179.108		-285.2				
$CaCl_2 \cdot 8NH_3$		c	247.231		-368.9				
$Ca(ClO_4)_2 \cdot 6NH_3$			341.165		-315.7				

National Bureau of Standards — Washington, D. C.

Table 94(14) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity
Calcium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$CaBr_2 \cdot NH_3$		c	216.929		-191.5				
$CaBr_2 \cdot 2NH_3$		c	233.959		-219.0				
$CaBr_2 \cdot 6NH_3$		c	302.082		-309.1				
$CaBr_2 \cdot 8NH_3$		c	336.143		-350.7				
$CaI_2 \cdot NH_3$		c	310.919		-157.4				
$CaI_2 \cdot 2NH_3$		c	327.950		-186.6				
$CaI_2 \cdot 6NH_3$		c	396.072		-284.9				
$CaI_2 \cdot 8NH_3$		c	430.134		-324.3				
Ca_3P_2		c	182.188		-121.				
$Ca(PO_3)_2$	β	c	198.024				5.715	35.05	34.68
	glassy	amorp			-587.0				
$Ca_2P_2O_7$	β	c	254.103	-792.88	-798.0	-748.6	7.430	45.23	44.89
$Ca_3(PO_4)_2$	β, low temp. form	c	310.183		-984.9	-928.5		56.4	54.45
	α, high temp. form	c			-982.3	-926.3		57.58	55.35
	std. state, m = 1	aq			-999.8	-883.9		-144.	

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(15) Calcium

Substance			ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Ca_3P_4O_{13}$ glassy	amorp	452.127		-1374.				
$CaHPO_4$	c	136.059	-430.299	-433.65	-401.83	4.455	26.62	26.30
std. state, m = 1	aq			-438.57	-392.64		-20.7	
$CaHPO_4 \cdot 2H_2O$	c	172.090	-559.496	-574.47	-515.00	7.490	45.28	47.10
$Ca(H_2PO_2)_2$	c	170.057		-418.9				
std. state, m = 1	aq			-423.1				
in 50 H_2O	aq			-419.8				
100 H_2O	aq			-420.6				
200 H_2O	aq			-421.4				
300 H_2O	aq			-421.8				
400 H_2O	aq			-422.1				
600 H_2O	aq			-422.4				
800 H_2O	aq			-422.6				
1,000 H_2O	aq			-422.8				
$Ca(H_2PO_4)_2$	c	234.055		-742.04				
std. state, m = 1	aq			-749.38	-672.64		30.5	
$Ca(H_2PO_4)_2 \cdot H_2O$	c	252.070	-797.013	-814.93	-730.98	9.950	62.1	61.86
$Ca_8H_2(PO_4)_6 \cdot 5H_2O$	c	982.561			-2931.			

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(16) — Calcium

Substance		State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$Ca_{10}(PO_4)_6(OH)_2$ hydroxyapatite		c	1004.643	-3201.4	-3221.	-3030.	30.71	186.6	184.0
	std. state, m = 1	aq			-3239.1	-2859.2		-450.	
$Ca_{10}(PO_4)_6F_2$ fluorapatite		c	1008.625	-3267.0	-3285.	-3103.	30.34	185.4	179.7
$Ca(H_2PO_4)_2 \cdot H_2O \cdot NH_3$		c	269.101		-837.5				
$Ca(H_2PO_4)_2 \cdot H_2O \cdot 2NH_3$		c	286.131		-857.6				
$Ca(H_2PO_4)_2 \cdot H_2O \cdot 4NH_3$		c	320.192		-894.8				
$Ca_3(AsO_4)_2$		c	398.078		-788.4	-732.1		54.	
	hydrated precipitate				-799.				
$CaHAsO_4$		aq	180.007		-345.6				
$Ca(H_2AsO_4)_2$		aq	321.950		-563.6				
Ca_3Sb_2		c	363.74		-174.				
Ca_3Bi_2		c	538.200		-107.				
CaC_2		c	64.102	-15.14	-14.3	-15.5	2.711	16.72	14.99
$CaCO_3$	calcite	c	100.089		-288.46	-269.80		22.2	19.57
	aragonite	c			-288.51	-269.55		21.2	19.42
	std. state, m = 1	aq			-291.58	-258.47		-26.3	

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Table 94(17) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Calcium

Substance: Formula and Description	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
CaC_2O_4	c	128.100		-325.2				
std. state, m = 1	aq			-326.9	-293.37		-1.8	
$CaC_2O_4 \cdot H_2O$	c	146.115		-400.30	-361.85		37.4	36.52
$Ca(HCOO)_2$	c	130.116		-331.4				
in 400 H_2O	aq			-332.5				
$Ca(C_2H_3O_2)^+$ std. state, m = 1	aq	99.125			-222.1			
$Ca(C_2H_3O_2)_2$	c	158.170		-353.6				
std. state, m = 1	aq			-362.06	-308.88		28.7	
in 100 H_2O	aq			-360.1				
200 H_2O	aq			-360.7				
300 H_2O	aq			-360.9				
400 H_2O	aq			-361.1				
1,000 H_2O	aq			-361.4				
3,000 H_2O	aq			-361.7				
5,000 H_2O	aq			-361.8				
10,000 H_2O	aq			-361.9				
50,000 H_2O	aq			-362.0				
∞ H_2O	aq			-362.06				
$Ca(C_2H_3O_2)_2 \cdot H_2O$	c	176.185		-423.6				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(18) — Calcium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Ca(C_2H_3O_3)_2$	c	190.169		-443.6				
	aq			-442.0				
$Ca(C_2H_3O_3)_2 \cdot 3H_2O$	c	244.215		-654.0				
$Ca(C_2H_3O_3)_2 \cdot 5H_2O$	c	280.246		-791.4				
$Ca(C_2H_5O)_2$	c	130.203		-227.0				
$Ca(C_2H_5O)_2 \cdot 2C_2H_5OH$	c	222.342		-368.2				
$3CaO \cdot 4C_2H_5OH$	c	352.516		-775.9				
$CaCl_2 \cdot 3C_2H_5OH$	c	249.195		-399.9				
$CaCl_2 \cdot 4C_2H_5OH$	c	295.264		-467.5				
$CaCN_2$	c	80.105		-83.8				
$Ca(CN)_2$	c	92.116		-44.1				
	aq			-56.9				
$3CaO \cdot Ca(CN)_2 \cdot 15H_2O$	c	530.584		-1606.				
$Ca(NO_3)_2 \cdot 2CH_3OH$	c	228.175		-343.0				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(19) — Calcium

Substance		State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$CaSi$		c	68.166		-36.				
$CaSi_2$		c	96.252		-36.				
Ca_2Si		c	108.246		-50.				
$CaO \cdot SiO_2$	wollastonite	c	116.164		-390.76	-370.39		19.58	20.38
	pseudowollastonite	c			-389.2	-369.2		20.88	20.67
	glassy	amorp			-382.65				
$2CaO \cdot SiO_2$	β	c	172.244	-548.95	-551.5	-524.1	5.098	30.53	30.78
	γ	c		-551.25	-554.0	-526.1	4.898	28.87	30.27
$3CaO \cdot SiO_2$		c	228.323		-700.1	-665.4		40.3	41.08
$3CaO \cdot 2SiO_2$	rankinite	c	288.408	-942.23	-946.7	-899.0	8.424	50.38	51.24
$3CaO \cdot 2SiO_2 \cdot CaF_2$	cuspidine	c	366.485		-1251.				
$CaO \cdot GeO_2$		c	160.668		-308.7				
$2CaO \cdot GeO_2$		c	216.748		-476.8				
$3CaO \cdot GeO_2$		c	272.827		-623.5				
$CaSn$		c	158.770		-38.				
Ca_2Sn		c	198.850		-75.				

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(20) Calcium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
CaPb	c	247.27		-29.				
$CaPb_3$	c	661.65		-30.				
Ca_2Pb	c	287.35		-51.				
$CaI_2 \cdot 2PbI_2$	c	1215.886		-222.9				
$CaI_2 \cdot 2PbI_2 \cdot 7H_2O$	c	1341.994		-712.4				
$CaO \cdot B_2O_3$	c	125.700		-485.41	-459.87		25.06	24.85
$CaO \cdot 2B_2O_3$	c	195.320		-803.12	-756.96		32.2	37.75
glassy	amorp			-790.48				
$2CaO \cdot B_2O_3$	c	181.779		-653.54	-620.62		34.68	35.16
$2CaO \cdot 3B_2O_3$	c	321.019		-1290.				
$2CaO \cdot 3B_2O_3 \cdot 13H_2O$ Inyoite	c	555.219		-2221.				
$3CaO \cdot B_2O_3$	c	237.858		-819.57	-779.14		43.9	44.90
$Ca(BF_4)_2$	c	213.689		-930.				
$2CaO \cdot B_2O_3 \cdot 2SiO_2$	c	301.949		-1100.				
$2CaO \cdot B_2O_3 \cdot 2SiO_2 \cdot H_2O$	c	319.964		-1170.				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(21) Calcium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$CaAl_2$	c	94.043		-52.				
$CaAl_4$	c	148.006		-51.				
$CaO \cdot Al_2O_3$	c	158.041	-552.87	-556.0	-527.9	4.569	27.30	28.87
glassy	amorp			-550.				
$CaO \cdot 2Al_2O_3$	c	260.002	-944.98	-950.7	-901.2	7.286	42.50	48.00
$2CaO \cdot Al_2O_3$	c	214.120		-707				
glassy	amorp			-701.				
$2CaO \cdot Al_2O_3 \cdot 5H_2O$	c	304.197		-1081.				
$3CaO \cdot Al_2O_3$	c	270.199	-853.21	-857.5	-815.4	8.216	49.2	50.16
glassy	amorp			-849.				
$3CaO \cdot Al_2O_3 \cdot 6H_2O$	c	378.291		-1326.				
$4CaO \cdot Al_2O_3$	c	326.279		-1008.				
$12CaO \cdot 7Al_2O_3$	c	1386.681	-4620.1	-4644.	-4414.	41.98	250.2	259.5
glassy	amorp			-4562.				
$3CaCl_2 \cdot 4AlCl_3$	c	866.320		-1265.				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(22) — Calcium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$3CaO \cdot Al_2O_3 \cdot CaSO_4 \cdot 12H_2O$		c	622.525		-2098.				
$3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 31H_2O$		c	1237.100		-4121.				
$3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 32H_2O$		c	1255.115		-4192.				
$3CaO \cdot Al_2O_3 \cdot CaCO_3 \cdot 10.68H_2O$		c	562.693		-1954.				
$3CaO \cdot Al_2O_3 \cdot 3CaCO_3 \cdot 30H_2O$		c	1110.928		-3876.				
$CaO \cdot Al_2O_3 \cdot 2SiO_2$	anorthite, triclinic	c	278.210		-1009.2	-955.5		48.4	50.46
	anorthite, hexagonal	c			-1004.3	-949.8		45.8	49.76
	glassy	amorp			-991.8				
$CaO \cdot Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$	lawsonite	c	314.241		-1161.2	-1076.8		56.8	68.16
$CaO \cdot Al_2O_3 \cdot 6SiO_2$	heulandite	c	518.549		-1907.				
$2CaO \cdot Al_2O_3 \cdot SiO_2$	gehlenite	c	274.205		-952.6	-904.3		47.4	49.10
	glassy	amorp			-940.7				
$2CaO \cdot 2Al_2O_3 \cdot 8SiO_2 \cdot 7H_2O$	leonhardite	c	922.867		-3396.6	-3146.0		220.4	228.0
$3CaO \cdot Al_2O_3 \cdot 2SiO_2$		c	390.369		-1329.				
$CaAlGaSi_2O_8$		c	320.949		-935.6				

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(23) Calcium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
CaTl	c	244.45		-39.				
$CaHgBr_4$	aq	560.306		-228.1				
$CaHg_2Br_6$	aq	920.714		-266.3				
$CaHg(CN)_4$ in 700 H_2O	aq	344.741		-2.0				
$CaHg_2(CN)_6$ in 1,000 H_2O	aq	597.367		+65.8				
$CaCl_2 \cdot 2Hg(CN)_2$ in 1,000 H_2O	aq	616.237		-74.5				
$CaCl_2 \cdot 2Hg(CN)_2 \cdot 6H_2O$	c	724.329		-498.0				
$CaBr_2 \cdot 2Hg(CN)_2$ in 1,000 H_2O	aq	705.149		-53.6				
$CaBr_2 \cdot 2Hg(CN)_2 \cdot 7H_2O$	c	831.257		-550.7				
$CaI_2 \cdot 2Hg(CN)_2$ in 1,000 H_2O	aq	799.140		-26.1				
$CaI_2 \cdot 2Hg(CN)_2 \cdot 7H_2O$	c	925.248		-525.8				
$CaAg(CN)_3$ in 1,200 H_2O	aq	226.004		-29.3				
$CaAg_2(CN)_4$ in 550 H_2O	aq	359.891		-0.9				

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(24) Calcium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$CaO \cdot Fe_2O_3$		c	215.772	-361.787	-363.37	-337.67	6.076	34.74	36.71
$2CaO \cdot Fe_2O_3$		c	271.851	-508.804	-511.30	-478.44	7.56[illegible]	45.12	46.19
$CaFe(CN)_6^-$	undissoc.; std. state, m=1	aq	252.034			+38.1			
$CaFe(CN)_6^{2-}$	undissoc.; std. state, m=1	aq				+28.6			
$Ca_2Fe(CN)_6$	std. state, m = 1	aq	292.114		-150.6	-98.51		-2.7	
	undissoc.; std. state, m=1	aq				-105.6			
	in 1,500 H_2O	aq			-149.27				
	2,000 H_2O	aq			-149.22				
	5,000 H_2O	aq			-149.28				
	7,500 H_2O	aq			-149.37				
	10,000 H_2O	aq			-149.44				
	20,000 H_2O	aq			-149.59				
	50,000 H_2O	aq			-149.76				
	100,000 H_2O	aq			-149.86				
	500,000 H_2O	aq			-150.17				
	1,000,000 H_2O	aq			-150.37				
	∞ H_2O	aq			-150.6				

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(25) Calcium

Substance	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Ca_2Fe(CN)_6 \cdot 11H_2O$	c	490.283		-903.7				
$Ca_3[Fe(CN)_6]_2$ std. state, m = 1	aq	544.148		-120.6	-48.3		91.1	
in 1,500 H_2O	aq			-118.91				
2,000 H_2O	aq			-118.96				
5,000 H_2O	aq			-119.13				
7,500 H_2O	aq			-119.22				
10,000 H_2O	aq			-119.28				
20,000 H_2O	aq			-119.43				
50,000 H_2O	aq			-119.65				
100,000 H_2O	aq			-119.82				
500,000 H_2O	aq			-120.20				
1,000,000 H_2O	aq			-120.32				
∞ H_2O	aq			-120.6				
$CaH_2Fe(CN)_6$	aq	254.050		-20.2				
$CaFeSiO_4$	c	188.011		-456.				
$CaCrO_4$	aq	156.074		-340.9				

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(26) Calcium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$CaMoO_3$		c	184.018		-296.				
$CaMoO_4$		c	200.018		-368.4	-342.9		29.3	27.32
		g		-197.					
	std. state, m = 1	aq			-368.2	-332.2		-6.2	
$CaWO_3$		g	271.928	-113.					
$CaWO_4$		c	287.928	-391.272	-393.20	-367.71	4.775	30.21	27.28
		g		-225.					
	std. state, m = 1	aq			-386.8				
$CaO \cdot V_2O_5$		c	237.960		-556.71	-518.57		42.8	39.86
$2CaO \cdot V_2O_5$		c	294.040		-736.94	-691.49		52.7	50.08
$3CaO \cdot V_2O_5$		c	350.119		-902.95	-851.12		65.7	60.29
$CaO \cdot TiO_2$	perovskite	c	135.978		-396.9	-376.5		22.38	23.34
$3CaO \cdot 2TiO_2$		c	328.036		-944.2	-896.6		56.1	57.20
$CaTiSiO_5$	sphene	c	196.063		-622.2	-588.4		30.88	33.21
$CaZrO_3$		c	197.298		-422.3	-401.8		23.92	23.88

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 94(27) — Calcium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$CaHfO_3$		c	266.568		-433.0				
$CaMg_2$	γ	c	88.704	-9.57	-9.6	-9.4	3.720	24.92	18.09
$CaCl_2 \cdot 2MgCl_2 \cdot 2H_2O$		c	337.453		-704.9				
$CaMgC_2O_6$	dolomite	c	184.411	-552.93	-556.0	-517.1	6.210	37.09	37.65
$CaO \cdot MgO \cdot SiO_2$	monticellite	c	156.476		-540.89				
$CaO \cdot MgO \cdot 2SiO_2$	diopside	c	216.560		-766.3	-724.7		34.16	39.80
	glassy	amorp			-744.				
$2CaO \cdot MgO \cdot 2SiO_2$	ankermanite	c	272.640		-926.67	-879.53		50.0	50.67
	glassy	amorp			-918.9				
$3CaO \cdot MgO \cdot 2SiO_2$	mervinite	c	328.719		-1091.7	-1037.4		60.5	60.29
$2CaO \cdot 5MgO \cdot 8SiO_2 \cdot H_2O$	tremolite	c	812.410		-2954.	-2780.	23.34	131 2	156.7

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(1) Strontium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
Sr	c	87.62	0	0	0		12.5	6.3
	g			39.3	31.3	1.481	39.32	4.968
Sr^+	g			172.11				
Sr^{2+}	g			427.96				
std. state, m = 1	aq			-130.45	-133.71		-7.8	
Sr^{3+}	g			1435.				
Sr^{4+}	g			2751.				
Sr^{5+}	g			4403.				
Sr^{6+}	g			6549.				
Sr^{7+}	g			8995.				
Sr^{8+}	g			11816.				
SrO	c	103.619		-141.5	-134.3		13.0	10.76
	g			-2.				
SrO_2	c	119.619		-151.4				
$SrO_2 \cdot 8H_2O$	c	263.742		-722.6				

National Bureau of Standards — Washington, D. C.

Table 95(2) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Strontium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
Sr_2O		c	191.239		-154.7				
		g			-56.				
SrH		g	88.628		+52.	45.	2.080	50.80	7.17
SrH_2		c	89.636		-43.1				
SrOH		g	104.627		-41.				
$SrOH^+$	std. state, m = 1	aq				-172.4			
$Sr(OH)_2$		c	121.635		-229.2				
		g			-135.				
	in 800 H_2O	aq			-240.1				
$Sr(OH)_2 \cdot H_2O$		c	139.650		-302.3				
$Sr(OH)_2 \cdot 8H_2O$		c	265.757		-801.2				
SrF		g	106.618		-69.0	-62.9	2.219	57.31	8.27
SrF_2		c	125.617		-290.7	-278.4	3.125	19.63	16.73
		g			-182.7	-185.3	3.192	69.54	12.66

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(3) — Strontium

Substance				ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description			State	Formula Weight	0 K	298.15 K (25°C)			
					kcal/mol			cal/deg mol	
SrCl			g	123.073		-30.2	-36.5	2.338	60.2	8.73
$SrCl_2$	α		c	158.526		-198.1	-186.7	3.880	27.45	18.07
			g			-116.1	-118.6	3.454	74.26	13.33
	std. state, m = 1		aq			-210.35	-196.45		19.2	
	in	200 H_2O	aq			-209.78				
		300 H_2O	aq			-209.83				
		400 H_2O	aq			-209.871				
		500 H_2O	aq			-209.900				
		800 H_2O	aq			-209.955				
		1,000 H_2O	aq			-209.977				
		2,000 H_2O	aq			-210.057				
		5,000 H_2O	aq			-210.144				
		10,000 H_2O	aq			-210.195				
		20,000 H_2O	aq			-210.236				
		50,000 H_2O	aq			-210.274				
		100,000 H_2O	aq			-210.295				
		500,000 H_2O	aq			-210.325				
		1,000,000 H_2O	aq			-210.332				
		∞ H_2O	aq			-210.35				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(4) — Strontium

Substance		State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$SrCl_2$	in 28 ($HCl + 59.5\ H_2O$)	aq			-209.2				
	37 ($HCl + 44.6\ H_2O$)	aq			-209.2				
	56 ($HCl + 29.8\ H_2O$)	aq			-208.8				
	115 ($HCl + 14.4\ H_2O$)	aq			-207.7				
	726 ($HCl + 12.8\ H_2O$)	aq			-207.2				
$SrCl_2 \cdot H_2O$		c	176.541		-271.7	-247.7		41.	28.7
$SrCl_2 \cdot 2H_2O$		c	194.557		-343.7	-306.4		52.	38.3
$SrCl_2 \cdot 6H_2O$		c	266.618		-627.1	-535.67		93.4	
$Sr(OCl)_2$		aq	190.525		-180.5				
$Sr(ClO_2)_2$		aq	222.524		-162.				
$Sr(ClO_4)_2$		c	286.521		-182.31				
	std. state, m = 1	aq			-192.27	-137.83		79.2	

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(5) Strontium

Substance: Formula and Description	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Sr(ClO_4)_2$ in 13 H_2O	aq			-191.85				
15 H_2O	aq			-192.03				
20 H_2O	aq			-192.21				
25 H_2O	aq			-192.28				
30 H_2O	aq			-192.30				
40 H_2O	aq			-192.252				
50 H_2O	aq			-192.204				
75 H_2O	aq			-192.111				
100 H_2O	aq			-192.052				
150 H_2O	aq			-191.996				
200 H_2O	aq			-191.975				
300 H_2O	aq			-191.960				
400 H_2O	aq			-191.958				
500 H_2O	aq			-191.962				
800 H_2O	aq			-191.978				
1,000 H_2O	aq			-191.992				
2,000 H_2O	aq			-192.033				
5,000 H_2O	aq			-192.092				
10,000 H_2O	aq			-192.132				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(6) — Strontium

Substance: Formula and Description	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Sr(ClO_4)_2$ in 20,000 H_2O	aq			-192.165				
50,000 H_2O	aq			-192.199				
100,000 H_2O	aq			-192.218				
500,000 H_2O	aq			-192.245				
1,000,000 H_2O	aq			-192.252				
∞ H_2O	aq			-192.27				
in CH_3OH				-206.9				
C_2H_5OH				-198.0				
n-C_3H_7OH				-195.7				
i-C_3H_7OH				-197.31				
n-C_4H_9OH				-194.7				
$Sr(ClO_4)_2 \cdot 2H_2O$	c	322.552		-328.5				
$Sr(ClO_4)_2 \cdot 4H_2O$	c	358.583		-469.0				
$SrCl_2 \cdot SrO \cdot H_2O$	c	280.161		-437.2				
$SrCl_2 \cdot SrO \cdot 9H_2O$	c	424.283		-1006.6				

National Bureau of Standards — Washington, D. C.

Table 95(7) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity
Strontium

Substance	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
SrClH	c	124.081		-125.5				
SrFCl	c	142.071		-250.0				
$SrBr_2$	c	247.438		-171.5	-166.6	4.261	32.29	18.01
	g			-98.	-106.	3.8	77.3	14.5
std. state, m = 1	aq			-188.55	-183.41		31.6	
in 400 H_2O	aq			-188.14				
500 H_2O	aq			-188.16				
800 H_2O	aq			-188.21				
1,000 H_2O	aq			-188.225				
2,000 H_2O	aq			-188.286				
5,000 H_2O	aq			-188.359				
10,000 H_2O	aq			-188.405				
20,000 H_2O	aq			-188.442				
50,000 H_2O	aq			-188.477				
100,000 H_2O	aq			-188.497				
500,000 H_2O	aq			-188.525				
1,000,000 H_2O	aq			-188.532				
∞ H_2O	aq			-188.55				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(8) — Strontium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$SrBr_2 \cdot H_2O$	c	265.453		-246.5	-228.1		43.	28.9
$SrBr_2 \cdot 6H_2O$	c	355.530		-605.0	-519.7		97.	82.1
$Sr(BrO_3)_2 \cdot H_2O$	c	361.450		-264.	-189.1		67.	
$SrBr_2 \cdot SrO \cdot 3H_2O$	c	405.103		-553.0				
$SrBr_2 \cdot SrO \cdot 9H_2O$	c	513.195		-985.0				
SrBrH	c	168.537		-111.0				
SrI_2	c	341.429		-133.4				19.5
	g			-65.				
std. state, m = 1	aq			-156.83	-158.37		45.4	
$SrI_2 \cdot H_2O$	c	359.444		-211.9				28.5
$SrI_2 \cdot 2H_2O$	c	377.459		-282.6				39.1
$SrI_2 \cdot 6H_2O$	c	449.521		-570.9				84.9

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(9) Strontium

Substance	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Sr(IO_3)_2$	c	437.425		-243.6	-204.4		56.	
$Sr(IO_3)_2 \cdot H_2O$	c	455.441		-313.2	-260.4		66.	
$Sr(IO_3)_2 \cdot 6H_2O$	c	545.517		-666.8	-543.7		109.	
SrIH	c	215.532		-92.2				
SrS	c	119.684		-108.3	-107.2		16.3	11.64
	g			26.				
$SrSO_3$	c	167.682		-281.3				
$SrSO_4$	c	183.682		-347.3	-320.5		28.	
precipitate	c			-346.5				
std. state, m = 1	aq			-347.77	-311.68		-3.0	
$SrS_2O_6 \cdot 4H_2O$	c	319.806		-699.1				
$SrI_2 \cdot 2SO_2$	c	469.554		-297.4				
$SrI_2 \cdot 4SO_2$	c	597.680		-460.8				

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Table 95(10) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Strontium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$SrSe$	c	166.58		-92.2				
$SrSeO_3$	c	214.578		-250.4				
$SrSeO_4$	c	230.578		-273.1				
$Sr(N_3)_2$	c	171.660		+2.1				
Sr_3N_2	c	290.873		-93.5				
$SrN_2O_2 \cdot 5H_2O$	c	237.709		-476.1				
$Sr(NO_2)_2$	c	179.631		-182.2				
in 800 H_2O	aq			-180.5				
$Sr(NO_2)_2 \cdot H_2O$	c	197.646		-254.2				
$Sr(NO_3)_2$	c	211.630		-233.80	-186.46	6.854	46.50	35.83
std. state, m = 1	aq			-229.57	-186.93		62.2	
in 20 H_2O	aq			-231.713				
25 H_2O	aq			-231.435				
30 H_2O	aq			-231.210				
40 H_2O	aq			-230.857				
50 H_2O	aq			-230.595				
75 H_2O	aq			-230.180				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(11) Strontium

Substance	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Sr(NO_3)_2$ in 100 H_2O	aq			-229.966				
150 H_2O	aq			-229.751				
200 H_2O	aq			-229.590				
300 H_2O	aq			-229.533				
400 H_2O	aq			-229.486				
500 H_2O	aq			-229.454				
800 H_2O	aq			-229.414				
1,000 H_2O	aq			-229.405				
2,000 H_2O	aq			-229.396				
5,000 H_2O	aq			-229.424				
10,000 H_2O	aq			-229.451				
20,000 H_2O	aq			-229.476				
50,000 H_2O	aq			-229.505				
100,000 H_2O	aq			-229.521				
500,000 H_2O	aq			-229.546				
1,000,000 H_2O	aq			-229.553				
∞ H_2O	aq			-229.57				
$Sr(NO_3)_2 \cdot 4H_2O$	c	283.691		-515.0	-413.65		88.2	

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(12) — Strontium

Substance			ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Sr(NH_2)_2$	c	119.665		-83.1				
$Sr(NH_3)_6$	c	189.804		-123.7				
$SrCl_2 \cdot NH_3$	c	175.557		-220.6				
$SrCl_2 \cdot 8NH_3$	c	294.771		-367.1				
$Sr(ClO_4)_2 \cdot 2NH_3$	c	320.582		-226.2				
$Sr(ClO_4)_2 \cdot 6NH_3$	c	388.705		-314.5				
$Sr(ClO_4)_2 \cdot 7NH_3$	c	405.735		-334.6				
$SrBr_2 \cdot NH_3$	c	264.469		-199.3				
$SrBr_2 \cdot 2NH_3$	c	281.499		-223.1				
$SrBr_2 \cdot 8NH_3$	c	383.683		-354.9				
$SrI_2 \cdot NH_3$	c	358.459		-162.7				
$SrI_2 \cdot 2NH_3$	c	375.490		-189.2				
$SrI_2 \cdot 6NH_3$	c	443.612		-283.5				
$SrI_2 \cdot 8NH_3$	c	477.674		-328.0				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(13) Strontium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Sr(NH_4)_2(SO_4)_2$	c	315.820		-630.8				
Sr_3P_2	c	324.808		-152.				
$Sr_3(PO_4)_2$	c	452.803		-985.4				
$SrHPO_4$	c	183.599		-435.4	-403.6		29.	
$Sr(H_2PO_4)_2$	c	281.595		-749.2				
Sr_3As_2	c	412.703		-147.3				
$Sr_3(AsO_4)_2$, hydrated precipitate	c	540.698		-792.8 -803.	-736.2		61.	
$SrHAsO_4$	aq	227.547		-345.7				
$Sr(H_2AsO_4)_2$	aq	369.490		-563.2				

National Bureau of Standards — Washington, D. C.

Table 95(14) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity
Strontium

Substance		State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
SrSb		c	209.37		-46.				
Sr_2Sb		c	296.99		-77.				
Sr_3Sb_2		c	506.36		-135.				
SrBi		c	296.600		-43.				
Sr_2Bi		c	384.220		-75.				
Sr_3Bi_2		c	680.820		-127.				
SrC_2		c	111.642		-18.				
$SrCO_3$	strontianite	c	147.629		-291.6	-272.5		23.2	19.46
	std. state, m = 1	aq			-292.29	-259.88		-21.4	
SrC_2O_4		c	175.640		-327.6				
	std. state, m = 1	aq			-327.6	-294.8		+2.1	

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(15) Strontium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Sr(CHO_2)_2$	c	177.656		-333.0				
$Sr(CHO_2)_2 \cdot 2H_2O$	c	213.687		-475.8				
$Sr(HCO_3)_2$	aq	209.655		-460.8				
$SrC_2H_3O_2^+$ std. state	aq	146.665			-223.5			
$Sr(C_2H_3O_2)_2$	c	205.710		-355.5				
	aq			-361.4				
$Sr(C_2H_3O_2)_2 \cdot 0.5H_2O$	c	214.718		-390.0				
$Sr(C_2H_3O_3)_2$	c	237.709		-441.4				
	aq			-441.2				
$SrBr_2 \cdot 1/2C_2H_5OH$	c	270.473		-205.				
$SrCN_2$	c	127.645		-72.5				
$Sr(CN)_2$	aq	139.656		-57.0				
$Sr(CN)_2 \cdot 4H_2O$	c	211.717		-333.7				

National Bureau of Standards — Washington, D. C.

Table 95(16) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity
Strontium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$SrSi$	c	115.706		-133.				
$SrSi_2$	c	143.792		-188.				
Sr_2Si	c	203.326		-116.				
$SrSiO_3$	c	163.704		-390.5	-370.4		23.1	21.16
glassy	amorp			-380.				
Sr_2SiO_4	c	267.324		-550.8	-523.7		36.6	32.09
Sr_2Ge	c	247.83		-75.				
Sr_2Sn	c	293.93		-83.				
Sr_2Pb	c	382.43		-80.				
$SrI_2 \cdot 2PbI_2$	c	1263.426		-222.4				
$SrI_2 \cdot 2PbI_2 \cdot 7H_2O$	c	1389.534		-714.0				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(17) — Strontium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Sr(BF_4)_2$	c	261.229		-921.				
$SrO \cdot Al_2O_3$	c	205.581		-555.6				
$3SrO \cdot Al_2O_3$	c	412.819		-847.2				
$4SrO \cdot Al_2O_3$ α	c	516.439		-978.2				
β	c			-976.7				
$3SrCl_2 \cdot 4AlCl_3$	c	1008.940		-1284.4				
$2SrO \cdot Al_2O_3 \cdot SiO_2$	c	369.285		-941.1				
$SrBr_2 \cdot HgBr_2$	aq	607.846		-229.2				
$SrBr_2 \cdot 2HgBr_2$	aq	968.254		-268.0				
$2SrBr_2 \cdot HgBr_2$	aq	855.284		-419.6				
$SrHg(CN)_4$	aq	392.281		-3.9				
$Sr[Hg(CN)_3]_2$	aq	644.907		+61.8				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(18) Strontium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$SrCl_2 \cdot 2Hg(CN)_2$	aq	663.777		-77.3				
$SrCl_2 \cdot 2Hg(CN)_2 \cdot 6H_2O$	c	771.869		-503.7				
$SrBr_2 \cdot 2Hg(CN)_2$	aq	752.689		-56.4				
$SrBr_2 \cdot 2Hg(CN)_2 \cdot 6H_2O$	c	860.781		-485.7				
$SrI_2 \cdot 2Hg(CN)_2$	aq	846.680		-29.1				
$SrI_2 \cdot 2Hg(CN)_2 \cdot 7H_2O$	c	972.788		-528.0				
$SrAg(CN)_3$	aq	273.544		-39.3				
$Sr[Ag(CN)_2]_2$	aq	407.431		-0.4				
$SrNi(CN)_4$	aq	250.401		-39.3				
$2SrO \cdot Fe_2O_3$	c	366.931		-510.9				
$3SrO \cdot Fe_2O_3$	c	470.550		-686.3				
$7SrO \cdot 5Fe_2O_3$	c	1523.797		-2038.				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(19) — Strontium

Substance: Formula and Description	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$SrFe(CN)_6^-$ std. state, m = 1	aq	299.574			+36.7			
$Sr_2Fe(CN)_6$ std. state, m = 1	aq	387.194		-152.0	-101.33		+7.1	
in 1,500 H_2O	aq			-150.04				
2,000 H_2O	aq			-150.08				
5,000 H_2O	aq			-150.21				
7,500 H_2O	aq			-150.29				
10,000 H_2O	aq			-150.36				
20,000 H_2O	aq			-150.57				
50,000 H_2O	aq			-150.84				
100,000 H_2O	aq			-151.03				
200,000 H_2O	aq			-151.80				
500,000 H_2O	aq			-151.49				
1,000,000 H_2O	aq			-151.73				
∞ H_2O	aq			-152.0				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(20) — Strontium

Substance	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Sr_3[Fe(CN)_6]_2$ std. state, m = 1	aq	686.768		-122.8	-52.5		105.8	
in 1,500 H_2O	aq			-121.16				
2,000 H_2O	aq			-121.22				
5,000 H_2O	aq			-121.43				
7,500 H_2O	aq			-121.54				
10,000 H_2O	aq			-121.62				
20,000 H_2O	aq			-121.79				
50,000 H_2O	aq			-121.99				
100,000 H_2O	aq			-122.12				
200,000 H_2O	aq			-122.25				
500,000 H_2O	aq			-122.43				
1,000,000 H_2O	aq			-122.55				
∞ H_2O	aq			-122.8				
$Sr_3[FeCO(CN)_5]_2$	c	690.754		-258.7				
	aq			-300.3				
$Sr_3[FeCO(CN)_5]_2 \cdot 4H_2O$	c	762.815		-540.0				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 95(21) Strontium

Substance			ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$SrMoO_3$	c	231.558		-306.				
	g			-130.				
$SrMoO_4$	c	247.558		-370.				
	g			-235.				
$SrWO_3$	g	319.468		-140.				
$SrWO_4$	c	335.468		-391.9	-366.		33.	
	g			-245.				
$SrTiO_3$	c	183.518		-399.71	-379.64		26.0	23.51
Sr_2TiO_4	c	287.138		-546.7	-520.7		38.0	34.34
$SrZrO_3$	c	226.838		-422.4	-402.2		27.5	24.71
$SrHfO_3$	c	314.108		-433.7				
$SrMg_2$ β phase	c	136.244		-5.1				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(1) Barium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
Ba	c	137.34	0	0	0	1.65	15.0	6.71
	g		43.2	43.	35.	1.481	40.663	4.968
Ba^+	g		163.39	164.67				
Ba^{2+}	g		394.09	396.86				
std. state, m = 1	aq			-128.50	-134.02		+2.3	
BaO	c	153.339	-132.00	-132.3	-125.5	2.385	16.83	11.42
	g			-28.				7.9
BaO_2	c	169.339		-151.6				16.0
$BaO_2 \cdot H_2O$	c	187.354		-222.3				
$BaO_2 \cdot 8H_2O$	c	313.462		-718.6				
Ba_2O	c	290.679		-147.1				
	g			-72.				
Ba_2O_2	g	306.679		-135.				

National Bureau of Standards — Washington, D. C.

Table 96(2) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Barium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
BaH		g	138.348	53.6	53.	47.	2.082	52.29	7.19
BaH_2		c	139.356		-42.7				
BaOH		g	154.347		-52.				
$BaOH^+$	std. state, m = 1	aq				-174.6			
$Ba(OH)_2$		c	171.355		-225.8				
		g			-140.				
	in 500 H_2O	aq			-237.9				
$Ba(OH)_2 \cdot H_2O$		c	189.370		-298.4				
$Ba(OH)_2 \cdot 3H_2O$		c	225.401		-442.0				
$Ba(OH)_2 \cdot 8H_2O$		c	315.477		-798.8	-667.6		102.	
$BaO_2 \cdot H_2O_2$		c	203.354		-208.5				

National Bureau of Standards — Washington, D. C.

Table 96(3) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Barium

Substance: Formula and Description	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
BaF	g	156.338	-77.53	-78.0	-83.8	2.232	58.8	8.33
BaF_2	c	175.337	-288.19	-288.5	-276.5	3.452	23.03	17.02
	g		-195.0	-195.5	-198.0	3.262	71.91	12.85
std. state, m = 1	aq			-287.50	-267.30		-4.3	
BaCl	c	172.793		-110.				
	g		-39.6	-40.	-46.	2.36	61.8	8.80
$BaCl_2$	c	208.246	-205.35	-205.2	-193.7	3.993	29.56	17.96
	g		-125.37	-125.7	-128.5	3.511	77.72	13.43
std. state, m = 1	aq			-208.40	-196.76		29.3	
in 30 H_2O	aq			-207.747				
40 H_2O	aq			-207.754				
50 H_2O	aq			-207.762				
75 H_2O	aq			-207.783				
100 H_2O	aq			-207.803				
150 H_2O	aq			-207.836				
200 H_2O	aq			-207.863				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(4) — Barium

Substance	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$BaCl_2$ in 300 H_2O	aq			-207.905				
400 H_2O	aq			-207.938				
500 H_2O	aq			-207.963				
800 H_2O	aq			-208.012				
1,000 H_2O	aq			-208.036				
2,000 H_2O	aq			-208.110				
5,000 H_2O	aq			-208.197				
10,000 H_2O	aq			-208.249				
20,000 H_2O	aq			-208.288				
50,000 H_2O	aq			-208.326				
100,000 H_2O	aq			-208.346				
500,000 H_2O	aq			-208.375				
1,000,000 H_2O	aq			-208.382				
∞ H_2O	aq			-208.40				

National Bureau of Standards — Washington, D. C.

Table 96(5) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Barium

Substance		State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$BaCl_2$	in 4.0 molal HCl	aq			-205.1				
	3.0 molal HCl	aq			-205.7				
	2.0 molal HCl	aq			-206.4				
	1.0 molal HCl	aq			-207.3				
	0.1 molal HCl	aq			-208.3				
$BaCl_2 \cdot H_2O$		c	226.261		-277.4	-252.32		39.9	
$BaCl_2 \cdot 2H_2O$		c	244.277		-348.98	-309.86		48.5	38.71
$Ba(OCl)_2$		aq	240.245		-179.3				
$Ba(ClO_2)_2$		c	272.244		-162.6	-127.0		47.	
$Ba(ClO_2)_2 \cdot 3.5H_2O$		c	335.297		-407.9				
$Ba(ClO_3)_2$		c	304.242		-182.3				
	in 400 H_2O	aq			-176.2				
$Ba(ClO_3)_2 \cdot H_2O$		c	322.258		-255.5				50.6
$Ba(ClO_4)_2$		c	336.241		-191.2				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(6) — Barium

Substance	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Ba(ClO_4)_2$ in 900 H_2O	aq			-190.2				
in ethanol, ∞ diln				-196.6				
in propanol, ∞ diln				-195.4				
in i-propanol, ∞ diln				-196.0				
in n-butanol, ∞ diln				-194.8				
$Ba(ClO_4)_2 \cdot 3H_2O$	c	390.287		-404.3	-303.7		94.	
$BaCl_2 \cdot BaO \cdot 3H_2O$	c	415.631		-578.0				
$BaCl_2 \cdot BaO \cdot 5H_2O$	c	451.662		-727.0				
$BaCl_2 \cdot BaO \cdot 8H_2O$	c	505.708		-931.2				
BaClH	c	173.801		-128.1				
BaClF	c	191.791		-254.4				
$BaBr_2$	c	297.158		-181.0	-176.1		35.	
	g		-101.4	-105.	-113.	3.9	79.	14.7

National Bureau of Standards — Washington, D. C.

Table 96(7) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Barium

Substance: Formula and Description	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$BaBr_2$ std. state, m = 1	aq			-186.60	-183.72		41.7	
in 400 H_2O	aq			-186.20				
500 H_2O	aq			-186.22				
800 H_2O	aq			-186.26				
1,000 H_2O	aq			-186.280				
2,000 H_2O	aq			-186.339				
5,000 H_2O	aq			-186.408				
10,000 H_2O	aq			-186.453				
20,000 H_2O	aq			-186.490				
50,000 H_2O	aq			-186.526				
100,000 H_2O	aq			-186.546				
500,000 H_2O	aq			-186.575				
1,000,000 H_2O	aq			-186.582				
∞ H_2O	aq			-186.60				
$BaBr_2 \cdot H_2O$	c	315.173		-255.3				
$BaBr_2 \cdot 2H_2O$	c	333.189		-326.5	-294.1		54.	

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(8) — Barium

Substance			ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Ba(BrO)_2$	aq	329.157		-174.5				
$Ba(BrO_3)_2$	c	393.154		-179.89	-138.0		58.	
in 100,000 H_2O	aq			-168.45				
50,000 H_2O	aq			-168.61				
20,000 H_2O	aq			-169.17				
$Ba(BrO_3)_2 \cdot H_2O$	c	411.170		-252.1	-197.09		69.9	52.90
$BaBr_2 \cdot BaO \cdot 2H_2O$	c	486.528		-486.0				
$BaBr_2 \cdot BaO \cdot 5H_2O$	c	540.574		-705.4				
BaBrH	c	218.257		-116.4				
BaI_2	c	391.149		-143.9				
	g		-77.2	-78.	-90.	4.0	82.	14.7
std. state, m = 1	aq			-154.88	-158.68		55.5	

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(9) — Barium

Substance			ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$BaI_2 \cdot H_2O$	c	409.164		-219.7				
$BaI_2 \cdot 2H_2O$	c	427.179		-290.8				
$BaI_2 \cdot 2.5H_2O$	c	436.187		-325.9				
$BaI_2 \cdot 7H_2O$	c	517.256		-639.7				
$Ba(IO_3)_2$	c	487.145	-243.31	-245.5	-206.7	8.84	59.6	44.8
std. state, m = 1	aq			-234.3	-195.2		58.9	
$Ba(IO_3)_2 \cdot H_2O$	c	505.161		-316.0	-263.9		71.	
$BaI_2 \cdot BaO \cdot 2H_2O$	c	580.519		-455.3				
$BaI_2 \cdot BaO \cdot 9H_2O$	c	706.626		-955.0				
BaIH	c	265.252		-98.1				
BaS	c	169.404		-110.	-109.		18.7	11.80
	g			+12.				
	aq			-117.9				
Ba_2S_2	g	338.808		-90.				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(10) — Barium

Substance	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$BaSO_3$	c	217.402		-281.9				
$BaSO_4$	c	233.402		-352.1	-325.6		31,6	24.32
precipitated	c			-350.5				
std. state, m = 1	aq			-345.82	-311.99		7.1	
BaS_2O_3	c	249.466						40.7
BaS_2O_6	aq	297.464		-415.4				
$BaS_2O_6 \cdot 2H_2O$	c	333.495		-558.6				
BaS_2O_8 in 800 H_2O	aq	329.463		-453.7				
$BaS_2O_8 \cdot 4H_2O$	c	401.525		-738.4				
$BaS_4O_6 \cdot 2H_2O$	c	397.623		-564.3				
$Ba(HS)_2$	aq	203.484		-134.3				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(11) — Barium

Substance			ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Ba(HSO_3)_2$	aq	299.480		-430.0				
$BaSO_4 \cdot H_2SO_4$	c	331.479		-548.6				
$BaSO_4 \cdot 2H_2SO_4 \cdot H_2O$	c	447.572		-819.8				
$BaI_2 \cdot 2SO_2$	c	519.274		-308.5				
$BaI_2 \cdot 4SO_2$	c	647.400		-470.2				
BaSe	c	216.30		-89.				
$BaSeO_3$	c	264.298		-248.7	-231.4		40.	
$BaSeO_4$	c	280.298		-274.0	-249.7		42.	
BaN_2	c	165.353		-41.				
$Ba(N_3)_2 \cdot H_2O$	c	239.396		-73.7	-25.1		45.	
Ba_2N	c	288.687		-52.0				
Ba_3N_2	c	440.033		-86.8				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(12) — Barium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$BaNO_3^+$	std. state, m = 1	aq	199.345		-175.8	-159.35		41.	
$Ba(NO_2)_2$		c	229.351		-183.6				
		aq			-178.5				
$Ba(NO_2)_2 \cdot H_2O$		c	247.366		-254.8				
$Ba(NO_3)_2$		c	261.350		-237.11	-190.42		51.1	36.18
	std. state, m = 1	aq			-227.62	-187.24		72.3	
	in 200 H_2O	aq			-228.474				
	300 H_2O	aq			-228.160				
	400 H_2O	aq			-228.005				
	500 H_2O	aq			-227.914				
	800 H_2O	aq			-227.770				
	1,000 H_2O	aq			-227.719				
	2,000 H_2O	aq			-227.617				
	5,000 H_2O	aq			-227.556				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(13) — Barium

Substance	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Ba(NO_3)_2$ in 10,000 H_2O	aq			-227.545				
20,000 H_2O	aq			-227.549				
50,000 H_2O	aq			-227.563				
100,000 H_2O	aq			-227.575				
500,000 H_2O	aq			-227.597				
1,000,000 H_2O	aq			-227.603				
∞ H_2O	aq			-227.62				
in 500 NH_3(liq)				-252.42				
BaNH	c	152.355		-53.4				
$Ba(NH_2)_2$	c	169.385		-78.5				
$Ba(NH_3)_6$	c	239.524		-124.0				

National Bureau of Standards — Washington, D. C.

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(14) — Barium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
Ba_2NCl	c	324.140		-147.3				
$BaCl_2 \cdot 8NH_3$	c	344.491		-364.5				
$Ba(ClO_4)_2 \cdot 2NH_3$	c	370.302		-233.0				
$Ba(ClO_4)_2 \cdot 6NH_3$	c	438.425		-314.0				
Ba_2NBr	c	368.596		-137.0				
$BaBr_2 \cdot NH_3$	c	314.189		-203.9				
$BaBr_2 \cdot 2NH_3$	c	331.219		-225.5				
$BaBr_2 \cdot 4NH_3$	c	365.280		-267.9				
$BaBr_2 \cdot 8NH_3$	c	433.403		-351.8				
Ba_6NI_9	c	1980.186		-701.				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(15) — Barium

Substance: Formula and Description	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$BaI_2 \cdot 2NH_3$	c	425.210		-192.9				
$BaI_2 \cdot 4NH_3$	c	459.271		-237.5				
$BaI_2 \cdot 6NH_3$	c	493.332		-281.7				
$BaI_2 \cdot 8NH_3$	c	527.394		-325.1				
$BaI_2 \cdot 9NH_3$	c	544.424		-346.1				
$BaI_2 \cdot 10NH_3$	c	561.455		-364.7				
$Ba_3(PO_4)_2$ colloidal		601.963		-978.				
$BaHPO_4$	c	233.319		-433.7				
$Ba(H_2PO_2)_2$	c	267.317		-421.2				
in 400 H_2O	aq			-421.4				
800 H_2O	aq			-421.6				
1,200 H_2O	aq			-421.8				
∞ H_2O	aq			-421.9				
$Ba(H_2PO_2)_2 \cdot H_2O$	c	285.332		-490.5				
$Ba(H_2PO_4)_2$	c	331.315		-747.				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(16) — Barium

Substance				ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description		State	Formula Weight	0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$Ba_3(AsO_4)_2$	hydrated precipitate		689.858		-819.				
$BaHAsO_4 \cdot H_2O$		c	295.283		-412.6				
$Ba(H_2AsO_4)_2 \cdot 2H_2O$		c	455.241		-696.9				
BaC_2		c	161.362		-18.				
$BaCO_3$	witherite	c	197.349		-290.7	-271.9		26.8	20.40
	std. state, m = 1	aq			-290.34	-260.19		-11.3	
BaC_2O_4		c	225.360		-327.1				
$BaC_2O_4 \cdot 0.5H_2O$		c	234.368		-365.4				
$BaC_2O_4 \cdot 2H_2O$		c	261.391		-471.1				
$BaC_2O_4 \cdot 3.5H_2O$		c	288.414		-576.6				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(17) — Barium

Substance		State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$Ba(CHO_2)_2$	barium formate	c	227.376		-333.6				
	in 440 H_2O	aq			-331.6				
$Ba(HCO_3)_2$	std. state, m = 1	aq	259.375		-459.28	-414.54		45.9	
$Ba(C_2H_3O_2)_2$		c	255.430		-354.8				
	std. state, m = 1	aq			-360.82	-310.60		43.7	
	in 500 H_2O	aq			-360.2				
$Ba(C_2H_3O_2)_2 \cdot 3H_2O$		c	309.476		-566.2				
$Ba(C_2H_3O_3)_2$	barium glycolate	c	287.429		-444.7				
		aq			-439.6				
$Ba(C_2H_5O)_2$	barium ethylate	c	227.463		-218.6				
$3BaO \cdot 4CH_3OH$		c	588.188		-712.2				
$3BaO \cdot 4C_2H_5OH$		c	644.296		-735.2				
$BaCS_3$		c	245.543		-127.				

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(18) Barium

Substance			ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$Ba(HSO_3)_2 \cdot C_2H_2O_2$	aq	357.517		-522.6				
$Ba(HSO_3)_2 \cdot C_2H_2O_2 \cdot 2.5H_2O$ glyoxal barium bisulfite	c	402.556		-701.6				
$Ba(C_2H_5SO_4)_2$ in 400 H_2O	aq	387.588		-547.3				
$Ba(C_2H_5SO_4)_2 \cdot 2H_2O$	c	423.618		-688.4				
$BaCN_2$	c	177.365		-63.6				
$Ba(CN)_2$	c	189.376		-52.2				
	aq			-55.0				
$Ba(CN)_2 \cdot H_2O$	c	207.391		-124.4				
$Ba(CN)_2 \cdot 2H_2O$	c	225.406		-195.4				
$Ba(CNO)_2$	c	221.374		-213.				

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Table 96(19) — Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity — Barium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$BaSi_3$	c	221.598		-458.				
Ba_2Si_2	c	330.852		-400.				
$BaO \cdot SiO_2$	c	213.424		-388.05	-368.13		26.2	21.51
glassy	amorp			-376.				
$BaO \cdot 2SiO_2$	c	273.509		-609.0	-576.2		36.6	32.05
$2BaO \cdot SiO_2$	c	366.764		-546.8	-519.8		42.1	32.24
$2BaO \cdot 3SiO_2$	c	486.933		-1000.2	-947.2		61.7	53.68
$BaSiF_6$	c	279.416		-705.6	-667.8		39.	
$BaO \cdot GeO_2$	c	257.928		-295.8				
$2BaO \cdot GeO_2$	c	411.268		-446.3				
$3BaO \cdot GeO_2$	c	564.607		-589.7				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(20) Barium

Substance			ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$BaI_2 \cdot 2PbI_2$	c	1313.146		-229.3				
$BaI_2 \cdot 2PbI_2 \cdot 7H_2O$	c	1439.254		-716.8				
$BaAl_4$	c	245.266		-28.				
$BaO \cdot Al_2O_3$	c	255.301		-556.				
$BaO \cdot Al_2O_3 \cdot H_2O$	c	273.316		-633.3				
$BaO \cdot Al_2O_3 \cdot 2H_2O$	c	291.331		-705.0				
$BaO \cdot Al_2O_3 \cdot 4H_2O$	c	327.362		-850.6				
$BaO \cdot Al_2O_3 \cdot 7H_2O$	c	381.408		-1061.5				
$2BaO \cdot Al_2O_3 \cdot 5H_2O$	c	498.717		-1084.8				
$3BaO \cdot Al_2O_3$	c	561.979		-841.				
$7BaO \cdot 6Al_2O_3 \cdot 36H_2O$	c	2333.695		-6058.				
$BaCl_2 \cdot Al_2Cl_6$	c	474.927		-547.1				
$3BaCl_2 \cdot 2Al_2Cl_6$	c	1158.100		-1303.4				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(21) Barium

Formula and Description	State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$2Ba(NO_2)_2 \cdot TlNO_2$	c	709.078		-381.9				
$BaHgBr_4$	aq	657.566		-227.5				
$Ba(HgBr_3)_2$	aq	1017.974		-266.2				
Ba_2HgBr_6	aq	954.724		-415.7				
Ba_4HgBr_{10}	aq	1549.040		-788.3				
$BaHg(CN)_4$	aq	442.001		-0.9				
$Ba[Hg(CN)_3]_2$	aq	694.627		+63.8				
$BaCl_2 \cdot 2Hg(CN)_2$	aq	713.497		-75.3				
$BaCl_2 \cdot 2Hg(CN)_2 \cdot 5H_2O$	c	803.574		-434.9				
$BaBr_2 \cdot 2Hg(CN)_2$	aq	802.409		-54.4				
$BaBr_2 \cdot 2Hg(CN)_2 \cdot 7H_2O$	c	928.517		-554.2				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(22) — Barium

Substance: Formula and Description	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$2Hg(CN)_2 \cdot BaI_2$	aq	896.400		-27.0				
$2Hg(CN)_2 \cdot BaI_2 \cdot 6H_2O$	c	1004.492		-460.0				
$BaAg(CN)_3$	aq	323.264		-28.6				
$Ba[Ag(CN)_2]_2$	aq	457.151		+1.9				
$Ba[Ni(CN)_4]$	aq	300.121		-34.1				
$Ba_2Fe(CN)_6$	aq	486.634		-145.7				
$Ba_2Fe(CN)_6 \cdot 6H_2O$	c	594.726		-567.0				
$Ba_3[Fe(CN)_6]_2$ std. state, m = 1	aq	835.928		-116.9	-53.5		136.1	
in 1,500 H_2O	aq			-115.03				
2,000 H_2O	aq			-115.07				
5,000 H_2O	aq			-115.24				
7,500 H_2O	aq			-115.35				
10,000 H_2O	aq			-115.43				

Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(23) Barium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$Ba_3[Fe(CN)_6]_2$	in 20,000 H_2O	aq			-115.66				
	50,000 H_2O	aq			-116.00				
	100,000 H_2O	aq			-116.18				
	200,000 H_2O	aq			-116.31				
	500,000 H_2O	aq			-116.51				
	1,000,000 H_2O	aq			-116.64				
	∞ H_2O	aq			-116.9				
$Ba_3[FeCO(CN)_5]_2$		c	839.914		-273.1				
		aq			-291.4				
$Ba_3[FeCO(CN)_5]_2 \cdot 11H_2O$		c	1038.082		-1049.6				
$BaH_2Fe(CN)_6$		aq	351.310		-18.7				
$BaPdCl_4$		c	385.552		-229.5				
$Ba_3(RhCl_6)_2$		c	1043.266		-686.				

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(24) — Barium

Substance			ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C_p°
Formula and Description	State	Formula Weight	0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
$BaRuO_4 \cdot H_2O$	c	320.423		-312.7				
$BaPtCl_6$	c	545.148		-283.2				
	aq			-292.5				
$BaPtCl_6 \cdot 6H_2O$	c	653.240		-703.5				
$BaOsCl_6$	c	540.258		-269.6				
$BaMnO_4$ barium manganate	c	256.276			-267.5			
$Ba(ReO_4)_2 \cdot 4H_2O$	c	709.797		-805.	-697.5		90.	
$BaCrO_4$	c	253.334		-345.6	-321.53		37.9	
$BaMoO_3$	c	281.278		-295.				
$BaMoO_4$	c	297.278		-370.	-344.1		33.	33.6

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 96(25) Barium

Substance		State	Formula Weight	ΔHf_0°	ΔHf°	ΔGf°	$H_{298}^\circ - H_0^\circ$	S°	C_p°
Formula and Description				0 K	298.15 K (25°C)				
				kcal/mol				cal/deg mol	
$BaWO_4$		c	385.188		-407.				
Ba_3WO_6		c	691.866		-752.				
$BaTiO_3$		c	233.238		-396.7	-375.8		25.8	24.49
Ba_2TiO_4		c	386.578		-536.1	-509.8		47.0	36.48
$BaZrO_3$		c	276.558		-425.3	-405.0		29.8	24.31
$BaHfO_3$		c	363.828		-437.9				
$BaMg_2$	β phase	c	185.964		-1.5				
$BaCa(CO_3)_2$	alstonite	c	297.439			-543.2			
	barytocalcite	c				-543.0			
$BaSrTiO_4$		c	336.858		-544.0	-518.1		45.8	34.95

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Enthalpy and Gibbs Energy of Formation; Entropy and Heat Capacity

Table 97(1) — Radium

Substance: Formula and Description	State	Formula Weight	ΔHf°_0	ΔHf°	ΔGf°	$H^\circ_{298} - H^\circ_0$	S°	C°_p
			0 K	298.15 K (25°C)				
			kcal/mol				cal/deg mol	
Ra	c	226.025	0	0	0		17.	
	g			38.	31.	1.481	42.15	4.97
Ra^+	g			161.22				
Ra^{2+}	g			396.70				
std. state, m = 1	aq			-126.1	-134.2		13.	
RaO	c	242.0244		-125.				
$RaCl_2$	c	296.931					32.	
std. state, m = 1	aq			-206.0	-196.9		40.	
$RaCl_2 \cdot 2H_2O$	c	332.9617		-350.	-311.4		51.	
$Ra(IO_3)_2$	c	575.8302		-245.4	-207.6		65.	
$RaSO_4$	c	322.0866		-351.6	-326.4		33.	
std. state, m = 1	aq			-343.4	-312.2		18.	
$Ra(NO_3)_2$	c	350.0348		-237.	-190.3		53.	
std. state, m = 1	aq			-225.2	-187.4		83.	

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