Thermodynamic Properties of Minerals and Related Substances at 298.15°K (25.0°C) and One Atmosphere (1.013 Bars) Pressure and at Higher Temperatures

GEOLOGICAL SURVEY BULLETIN 1259

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By RICHARD A. ROBIE and DAVID R. WALDBAUM

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A summary of the thermodynamic data for minerals at 298.15°K *together with calculated values of the functions* $\Delta H^\circ_f,T$, $\Delta G^\circ_f,T$, S°_T, *and* $-(G^\circ_T - H^\circ_{298.5}/T)$ *at temperatures up to* 2,000°K

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THERMODYNAMIC PROPERTIES OF MINERALS AND RELATED SUBSTANCES AT 298.15°K (25.0°C) AND ONE ATMOSPHERE (1.013 BARS) PRESSURE AND AT HIGHER TEMPERATURES

By RICHARD A. ROBIE and DAVID R. WALDBAUM

ABSTRACT

Critically selected values for the entropy ($S°_{298.15}$), molar volume ($V°_{298.15}$), and for the heat and Gibbs free energy of formation ($\Delta H°_{f,298.15}$ and $\Delta G°_{f,298.15}$) are given for 50 reference elements and 285 minerals and related substances. For 211 materials for which high-temperature heat-capacity or heat-content data are available $\Delta H°_{f,T}$, $\Delta G°_{f,T}$, $S°_T$, $\log K_{f,T}$ and $(G°_T - H°_{298.15}/T)$ are tabulated at 100°K intervals for temperatures up to 2,000°K. For substances having solid-state phase changes or whose melting or boiling point is less than 2,000°K, we also have tabulated the properties listed above at the temperature of the phase change so that the heat or entropy changes associated with the transformation form an integral part of the high-temperature tables.

INTRODUCTION

The purpose of these tables is to present a critical summary of the available thermodynamic data for minerals and related substances in a convenient form for the use of earth scientists. To make the tables as useful as possible we have tried to include as much of the necessary auxiliary data as possible so that a single set of tables would suffice for most calculations, to insure internal consistency and to provide for the means of rapid revision and expansion as new data become available.

This compilation is divided into two sections. In the first section we give values for the entropy ($S°_{298.15}$), molar volume ($V°_{298.15}$), the heat (enthalpy, $\Delta H°_{f,298.15}$) and Gibbs free energy ($\Delta G°_{f,298.15}$), and the logarithm of the equilibrium constant of formation (log $K_{f,298.15}$) for the reference elements, minerals, a number of oxides, and other substances of geological interest. The data have been critically evaluated and uncertainties assigned to the 298.15°K properties. The sources of data are indicated numerically in the tables and listed in complete form following the tables.

The data are arranged in order of their conventional mineralogical groups. Within each group (for example the oxides) the listing is by alphabetical order of the chemical symbol of the principal cation.

The tables in the second section contain values for the high-temperature thermodynamic properties, $H°_T - H°_{298.15}$, $(G°_T - H°_{298.15})/T$, $S°_T$, $\Delta G°_{f,T}$, $\Delta H°_{f,T}$, and log $K_{f,T}$ at 100°K intervals up to 2000°K. Heat-capacity data, as such, have been omitted from these tables in favor of the function $H°_T - H°_{298.15}$ which is the quantity actually measured in most high-temperature experiments. Heat capacities, C_p, derived from $H°_T - H°_{298.15}$ data are at best only approximate and their use should be avoided when possible. Approximate values for C_p are readily obtained from the first differences of the tabulated $H°_T - H°_{298.15}$ function.

Thermodynamic properties of gases at high pressures have not been included in these tables. High pressure-high temperature functions of the geologically important gases H_2O and CO_2 are given by Bain (1964), Hilsenrath and others (1955), and Robie (1966).

These tables entirely supersede two earlier reports on the same subject matter by Robie (1959, 1966).

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Computer facilities at the Massachusetts Institute of Technology were used initially to develop the program for compiling high-temperature thermodynamic functions. More recent revisions of the program and the present set of tables were prepared at the Harvard Computing Center, with computer costs supported by the Higgins Fund and the Committee on Experimental Geology and Geophysics of Harvard University.

PHYSICAL CONSTANTS AND ATOMIC WEIGHTS

The symbols and constants adopted for this report are listed in table 1. Values for the physical constants used in the calculations were those recommended by the National Academy of Science-National Research Council (U.S. Natl. Bur. Standards Tech. News Bull., v. 47, p. 175–177, 1963). For convenience we also give values of the international atomic weights for 1963 (scale $C^{12}=12.0000$) in alphabetical order by their chemical symbol in table 2. Elements for which no atomic weight is listed have no stable isotope.

TABLE 1.—*Symbols and constants*

T	Temperature in degrees Kelvin, (°K)
gfw	Gram formula weight
$H^\circ_T - H^\circ_{298.15}$	Enthalpy at temperature T relative to 298.15°K in cal gfw^{-1}, also called the heat content.
S°_T	Entropy at temperature T in cal deg-gfw^{-1}
$\frac{G^\circ_T - H^\circ_{298.15}}{T}$	Gibbs free energy function in cal deg-gfw^{-1}
ΔH°_f	Heat of formation from reference state in cal gfw^{-1}
ΔG°_f	Gibbs free energy of formation from reference state in cal gfw^{-1}
K_f	Equilibrium constant of formation
C_p	Heat capacity at constant pressure in cal deg-gfw^{-1}
°	Superscript indicates the substance is in its standard state
ΔH°_{melt}	Heat of melting at one atmosphere in cal gfw^{-1}
ΔH°_{vap}	Heat of vaporization to ideal gas at one atmosphere at the normal boiling point in cal gfw^{-1}
$V^\circ_{298.15}$	Volume of one gram formula weight at one atmosphere and 298.15°K in cm^3
R	Gas constant, $1.98717 \pm .00030$ cal deg-gfw^{-1}, 8.31469 joules deg-gfw^{-1}
cal	Calorie, unit of energy, 4.1840 absolute joules, 41.2929 cm^3 atmosphere
A	Avogadro's number, $(6.02252 \pm .00028) \times 10^{23}$ formula units gfw^{-1}
P	Pressure, either in atmosphere or bars
atm	Atmosphere, 1,013,250 dynes cm^{-2}
bar	Bar, 1,000,000 dynes cm^{-2}
log	Common logarithm, base 10
ln	Natural logarithm, base e=2.71828...

TABLE 2.— *Atomic weights for 1963*

Element	*Symbol*	*Atomic weight*	*Element*	*Symbol*	*Atomic weight*
Actinium	Ac		Nitrogen	N	14.0067
Silver	Ag	107.870	Sodium	Na	22.9898
Aluminum	Al	26.9815	Niobium	Nb	92.906
Americium	Am^{243}	243.061	Neodymium	Nd	144.24
Argon	Ar	39.948	Neon	Ne	20.183
Arsenic	As	74.9216	Nickel	Ni	58.71
Astatine	At		Neptunium	Np^{237}	237.048
Gold	Au	196.967	Oxygen	O	15.9994
Boron	B	10.811	Osmium	Os	190.2
Barium	Ba	137.34	Phosphorus	P	30.9738
Beryllium	Be	9.0122	Protactinium	Pa	
Bismuth	Bi	208.980	Lead	Pb	207.19
Bromine	Br	79.909	Palladium	Pd	106.4
Carbon	C	12.01115	Polonium	Po	
Calcium	Ca	40.08	Promethium	Pm	
Cadmium	Cd	112.40	Praseodymium	Pr	140.907
Cerium	Ce	140.12	Platinum	Pt	195.09
Chlorine	Cl	35.453	Plutonium	Pu^{239}	239.052
Cobalt	Co	58.9332	Radium	Ra	
Chromium	Cr	51.996	Rubidium	Rb	85.47
Cesium	Cs	132.905	Rhenium	Re	186.2
Copper	Cu	63.54	Rhodium	Rh	102.905
Dysprosium	Dy	162.50	Radon	Rn	
Erbium	Er	167.26	Ruthenium	Ru	101.07
Europium	Eu	151.96	Sulfur	S	32.064
Fluorine	F	18.9984	Antimony	Sb	121.75
Iron	Fe	55.847	Scandium	Sc	44.956
Francium	Fr		Selenium	Se	78.96
Gallium	Ga	69.72	Silicon	Si	28.086
Gadolinium	Gd	157.25	Samarium	Sm	150.35
Germanium	Ge	72.59	Tin	Sn	118.69
Hydrogen	H	1.00797	Strontium	Sr	87.62
Helium	He	4.0026	Tantalum	Ta	180.948
Hafnium	Hf	178.49	Terbium	Tb	158.924
Mercury	Hg	200.59	Technetium	Tc	
Holmium	Ho	164.930	Tellurium	Te	127.60
Iodine	I	126.9044	Thorium	Th	232.038
Indium	In	114.82	Titanium	Ti	47.90
Iridium	Ir	192.2	Thallium	Tl	204.37
Potassium	K	39.102	Thulium	Tm	168.934
Krypton	Kr	83.80	Uranium	U	238.03
Lanthanum	La	138.91	Vanadium	V	50.942
Lithium	Li	6.939	Tungsten	W	183.85
Lutetium	Lu	174.97	Xenon	Xe	131.30
Magnesium	Mg	24.312	Yttrium	Y	88.905
Manganese	Mn	54.9380	Ytterbium	Yb	173.04
Molybdenum	Mo	95.94	Zinc	Zn	65.37
			Zirconium	Zr	91.22

REFERENCE STATES AND TRANSITIONS

The reference states for $\Delta H°_f$, $\Delta G°_f$, and log K_f of the compounds are the elements in their standard state at one atmosphere pressure and the stated temperature. The standard states for the condensed elements are the most stable form at one atmosphere and the stated temperature. For gaseous elements the standard state is the ideal gas at one atmosphere pressure. Data are listed for 50 elements used as reference phases in their standard reference states, and for a few in nonstandard states, for example, S_2 gas and the diamond form of carbon. Melting and boiling points and their associated enthalpy changes are listed at the bottom of each of the tables of high-temperature properties. A solid horizontal line in the tables indicates a transition in the phase. A dashed line in the columns $\Delta H°_f$, $\Delta G°_f$, and log K_f indicates a transition in one of the reference elements. Transitions in the reference elements are also listed separately at the bottom of each table. Inasmuch as most of the high-temperature "heat-capacity" data are actually heat-content measurements and not true specific heats, we have followed the practice of Kelley (1960) and treated all of the high-temperature transitions as first order at a single temperature. At the transition temperature the functions $H°_T - H°_{298.15}$, $S°_T$, and $\Delta H°_{f,T}$ make a stepwise change; $\Delta G°_{f,T}$ and $(G°_T - H°_{298.15})/T$ are continuous but their temperature derivatives change abruptly. These properties of the functions must be borne in mind when interpolating in the tables.

Heats and free energies of formation for multiple oxide phases using the binary oxides as reference states have been computed as an internal check for errors in the input data, but are not tabulated because of the lack of reliable data for K_2O, Na_2O, and FeO. We do, however, give values for most of the common oxides for those who wish to use them as reference states.

SOURCES OF DATA

Many summaries of thermochemical data have been particularly helpful in constructing these tables. In table 3 we give an abbreviated chronological listing of the more important contributions to the critical evaluation and collection of thermodynamic data of particular interest to earth scientists.

For the thermodynamic functions of the elements we have adopted the values chosen by Hultgren, Orr, Anderson, and Kelley (1963 and supplements) and (or) the JANAF tables (Stull and others, 1966) whenever these tabulations clearly superseded the

TABLE 3.—*Chronological list of important critical summaries of thermodynamic data for inorganic substances*

[Dates in brackets refer to earlier reports superseded by a more recent compilation. Only the most recent summary is listed in the references]

Authors and date	*Type of data*
K. K. Kelley [1932, 1949], K. K. Kelley and E. G. King, 1961	$S^\circ_{298.15}$
K. K. Kelley [1934, 1949], 1960	$H^\circ_T - H^\circ_{298.15}$, $S^\circ_T - S^\circ_{298.15}$
K. K. Kelley and C. T. Anderson, 1935	$\Delta H^\circ_{f,298.15}$ and $\Delta G^\circ_{f,298.15}$ of carbonates
F. R. Bichowsky and F. D. Rossini, 1936	$\Delta H^\circ_{f,298.15}$
K. K. Kelley, 1937	$\Delta H^\circ_{f,298.15}$ and $\Delta G^\circ_{f,298.15}$ of sulfur compounds
F. D. Rossini and others, 1952	$S^\circ_{298.15}$, $\Delta H^\circ_{f,298.15}$, and $\Delta G^\circ_{f,298.15}$
J. P. Coughlin, 1954	$\Delta H^\circ_{f,T}$ and $\Delta G^\circ_{f,T}$ of oxides
D. R. Stull and G. C. Sinke, 1956	$H^\circ_T - H^\circ_{298.15}$, $(G^\circ - H^\circ)/T$, S°_T for the elements
JANAF Tables (D. R. Stull, ed.) 1959—(continuing)	$\Delta H^\circ_{f,T}$, $\Delta G^\circ_{f,T}$, S°_T, log $K_{f,T}$ of light element compounds
R. D. Freeman, 1962	$\Delta H^\circ_{f,298.15}$, $(G^\circ_T - H^\circ_{298.15})/T$ of sulfides
R. Hultgren and others, 1963 (continuing)	$H^\circ_T - H^\circ_{298.15}$, $S^\circ_T - S^\circ_{298.15}$, $(G^\circ_T - H^\circ_{298.15})/T$ of metallic elements and alloys
D. D. Wagman and others, 1965, 1966 (continuing)	$\Delta H^\circ_{f,298.15}$, $\Delta G^\circ_{f,298.15}$, $S^\circ_{298.15}$
R. A. Robie, 1966	$\Delta H^\circ_{f,298.15}$, $\Delta G^\circ_{f,298.15}$, and $S^\circ_{298.15}$ for minerals

earlier comprehensive summary by Stull and Sinke (1956). For compounds we have accepted the high-temperature enthalpy and entropy data selected by Kelley (1960) with the addition of data which has become available since then. Two important sources of data for the heat of formation, $\Delta H°_{f,298.15}$, and entropy, $S°_{298.15}$, were the tables of Robie (1966) and of Wagman and others (1965, 1966).

Values for $\Delta G°_{f,298.15}$ for the more common aqueous ions, are also listed, in order to facilitate calculations of aqueous equilibria. The reference state for the free energies of the aqueous ions is the hypothetical ideal solution of unit molality. Values for $\Delta G°_f$ are listed based on the usual convention that $\Delta G°_f$, $\Delta H°_f$, $S°_f$, and $C°_p$ are 0.00 for aqueous H^+ ion in the hypothetical one molal ideal solution. A more complete discussion of the conventions adopted for tabulating the thermodynamic properties of aqueous ions is given by Wagman and others (1965). The molar volumes are virtually all from a critical summary by Robie, Bethke, and Beardsley (1967).

Although the principal sources of data for $\Delta H°_f$ have been solution or combustion calorimetry, for many compounds the best available data are from solubilities, electrochemical cells, reduction equilibrium, or decomposition pressure data. For the simpler gases the thermodynamic constants calculated from spectroscopic data are usually the most precise.

In order to insure internal consistency in these tables and because of the complex nature of many of the reaction schemes used to obtain $\Delta H°_f$ or $\Delta G°_f$, we have corrected all the older data to the values adopted here. For multiple oxide compounds, the heats of formation are most commonly measured utilizing the binary oxides as reference phases. However, stoichiometric K_2O and Na_2O cannot be prepared reproducibily and FeO is thermodynamically unstable. Furthermore, α-Al_2O_3, corundum, is insoluble in all common calorimetric solvents. Consequently mixed sets of reactants such as the alkali halides, aluminum hydroxide (gibbsite), or an element have frequently been used as the reference phases. For example the heat of formation of muscovite was determined from the reaction $3SiO_2 + 3Al(OH)_3 + KCl + 9.731H_2O = KAl_2[AlSi_3O_{10}](OH)_2 + HCl \cdot 12.731H_2O$ and by utilizing literature data for the heats of formation of the other phases. Accordingly any improvement in $\Delta H°_f$ of quartz, gibbsite, sylvite, or aqueous HCl will alter the heat of formation of muscovite. We have accepted the values of Wagman and others (1965, 1966) for

aqueous hydrochloric, sulfuric, and hydrofluoric acids and for crystalline $PbSO_4$ and Hg_2SO_4 in order to correct the older heat or free energy values of the chlorides, sulfates, and alkali-aluminum silicates. We have also made a small correction to the enthalpies of formation of those sulfides for which $\Delta H°_f$ has been obtained from hydrogen reduction equilibria.

METHODS OF CALCULATION

Having chosen what we believe are the currently "best available" values for $H°_T - H°_{298.15}$, $S°_T - S°_{298.15}$, and $\Delta H°_{f,298.15}$, we have calculated the Gibbs free energy function, and the enthalpy, free energy, and equilibrium constant of formation at 100°K intervals using the following relations:

$$\frac{G°_T - H°_{298.15}}{T} = \frac{H°_T - H°_{298.15}}{T} - S°_T \tag{1}$$

$$\Delta H°_{f,T} = \Delta H°_{f,298.15} + \Delta[H°_T - H°_{298.15}] \tag{2}$$

$$\Delta G°_{f,T} = \Delta H°_{f,298.15} + T\Delta\left[\frac{G°_T - H°_{298.15}}{T}\right] \tag{3}$$

and

$$\log K_{f,T} = \frac{-\Delta G°_{f,T}}{4.57562\,T} \tag{4}$$

These values are tabulated in the second section.

A Fortran II source program written for an IBM 7094 computer was used for the above calculations. The essential feature of the program is that internally consistent thermodynamic functions can be calculated for several hundred compounds in a single run of the computer. This consistency is accomplished by first calculating the thermodynamic functions for 50 reference elements and holding this data in memory for later computations involving substances having these elements as reference states. As new thermodynamic data become available, only a minimum number of changes in punched cards of the master data deck are needed to prepare a completely revised set of internally consistent tables.

The input data supplied to the computer are the identifying name of the substance, the entropy and enthalpy at 298.15°K and their uncertainties, and the entropy and enthalpy increments, $S°_T - S°_{298.15}$ and $H°_T - H°_{298.15}$ at 100° intervals, together with the number of atoms of each element in the chemical formula. Auxiliary data such as the melting and boiling points and heats of melting and vaporization are also included as input. The pro-

gram computes the formula weight of the compound and values for $S°_T$, $\Delta H°_{f,T}$, $\Delta G°_{f,T}$, log $K_{f,T}$ and $(G°_T - H°_{298.15})/T$ at 100° intervals and the uncertainties in the 298.15°K properties.

The algorithms for calculating high-temperature functions from discrete 100°-interval data are relatively inefficient computer routines, and could be greatly simplified by the use of analytical functions (see for example, the JANAF thermochemical tables, Stull, 1966). We have purposely avoided the use of simple analytical representations of the high-temperature functions, in that such analytical functions are only approximate representations of the experimental data. The precision and accuracy of the original data are best served by using the graphically smoothed data directly.

Although the absolute value of $\Delta G°_{f,T}$ or $\Delta H°_{f,T}$ is rarely known to better than ±500 calories these quantities are tabulated to the nearest calorie. This procedure is justified because the temperature derivatives of $\Delta G°_f$, and $\Delta H°_f$,

$$(d\Delta G°_f/dT)_p = \Delta S°_f \tag{5}$$

and

$$(d\Delta H°_f/dT)_p = \Delta C_p \tag{6}$$

are calculated from the heat-content data which are known independently of the heat or free energy. The practice of rounding tabulated values of $\Delta G°_f$ or $\Delta H°_f$ on the basis of the uncertainty in the absolute value does not utilize the full accuracy of the heat-capacity information and destroys the necessary internal consistency between $\Delta H°_{f,298.15}$ and the Gibbs free energy function, (eq 1). Furthermore, in many instances the differences between $\Delta H°_f$ or $\Delta G°_f$ for polymorphs are known much more accurately from phase diagram or calorimetric investigations than the individual $\Delta H°_f$ or $\Delta G°_f$ values, so that rounding off again tends to obscure small differences of major importance in calculations of geological interest.

The uncertainties assigned to the properties apply only to the values at 298.15°K and were taken principally from the original source of experimental data. By convention the uncertainty reported for calorimetric measurements is two standard errors, that is,

$$\sigma = 2\left[\Sigma (x_i - \bar{x})^2/n(n-1)\right]^{1/2} \tag{7}$$

where x_i is the value for an individual measurement, $\bar{x}$ is the arithmetic mean of all the measurements, and n is the number of observations.

For substances where $\Delta H^\circ_{f,298.15}$ is the directly measured quantity, the free energy was calculated from,

$$\Delta G^\circ_{f,298.15} = \Delta H^\circ_{f,298.15} - 298.15 \Delta S^\circ_{298.15} \tag{8}$$

and the uncertainty in the free energy was calculated from

$$\sigma_G = \left[(\sigma_H)^2 + (298\sigma_s)^2 + \sum_i (298 n_i \sigma_{s_i})^2 \right]^{1/2} \tag{9}$$

where σ_s is the uncertainty in the entropy of the substance, the σ_{s_i} are the uncertainties in the entropies of the i reference elements, and the n_i are the numbers of each element in the chemical formula of the substance. Uncertainties derived in this manner were rounded upward to the nearest ten calories, and σ_G is therefore greater than σ_H by at least 10 cal gfw^{-1}.

For substances where σ_G is less than σ_H, the basic quantities used in the calculations were $\Delta G^\circ_{f,298}$ and σ_G derived from electrochemical cell measurements, solubilities, or phase equilibrium data. Hence, $\Delta H^\circ_{f,298.15}$ is a more distantly derived quantity having a larger uncertainty. For these substances σ_H was calculated from

$$\sigma_H = \left[(\sigma_G)^2 + (298\sigma_s)^2 + \sum_i (298 n_i \sigma_{s_i})^2 \right]^{1/2} \tag{10}$$

The tables in the first section were prepared by standard data processing techniques using a Burroughs 280 computer and a Photon phototypesetting machine. The tables of thermodynamic properties at high temperatures were prepared from a punched card deck generated by the IBM computer program described above. Note that the functions S°_T and $(G^\circ_T - H^\circ_{298.15})/T$ are tabulated to 0.001 cal deg^{-1} for the reference elements and to 0.01 cal deg^{-1} for all other substances. Values of the high-temperature functions at the transition temperatures were calculated by hand and inserted as punched cards into the master card deck. Several of the tables in the second section are incomplete due to the lack of adequate data on the enthalpies of formation of these substances. The tables are nonetheless included so that when such data become available, one may readily calculate the remaining functions using equations 2, 3, and 4 given above.

Name and formula	Gram formula weight	Entropy $S°_{298.15}$ (cal deg gfw^{-1})	Molar volume (cm^3)	$\Delta H°_{f,298.15}$ (cal gfw^{-1})	$\Delta G°_{f,298.15}$ (cal gfw^{-1})	Log $K_{f,298.15}$	References $S°_{298.15}$	References $\Delta H°_{f,298.15}$ or $\Delta G°_{f,298.15}$	References $H_T - H°_{298}$
			Elements						
Silver Ag	107.870	10.20 ± .05	10.272 ± .002	0	0	0.000	68 158		68
Ag^+ aqueous ion Std. state, m = 1	107.870				18433 ± 50	-13.512 ± .037		158	
Aluminum Al	26.982	6.77 ±.02	9.9993 ±.0005	0	0	.000	68 159		148
Al^{+++} aqueous ion Std. state, m = 1	26.982				-116000 ± 300	85.030 ± .220		159	
Arsenic As	74.922	8.40 ±.20	12.963 ± .015	0	0	.000	68 158		68
Gold Au	196.967	11.31 ± .05	10.215 ± .002	0	0	.000	68		68
Boron B (Rhombohedral)	10.811	1.403 ±.100	4.386 ±.007	0	0	.000	148 159		148
Barium Ba	137.34	16.0 ±1.0	38.21 ± .02	0	0	.000	149		149
Ba^{+++} aqueous ion Std. state, m = 1	137.34				-134000 ± 300	98.225 ± .220		141	
Beryllium Be	9.012	2.28 ±.02	4.880 ±.002	0	0	.000	68		68
Bismuth Bi	208.980	13.56 ± .10	21.309 ± .011	0	0	.000	158 68		68
Bi^{+++} aqueous ion Std. state, m = 1	208.980				19800 ± 100	-14.514 ± .073		158	
Bromine Br_2 (Liquid)	159.818	36.384 ± .080	54.58 ± .20	0	0	.000	158 148		148
Br^- aqueous ion Std. state, m = 1	79.909				-24850 ± 50	18.216 ± .037		158	
Bromine Br_2 (Ideal gas)	159.818	58.647 ± .010	24465.0 ± 3.4	7387 ± 30	749 ±30	-.549 ±.022	158 148	158 148	148
Graphite C	12.011	1.372 ±.005	5.2982 ±.0009	0	0	.000	158 28		148
Diamond C	12.011	.568 ±.003	3.4166 ±.0003	453 ±10	693 ±15	-.508 ±.011	158 27	158 56	155
Calcium Ca	40.08	9.95 ±.10	26.19 ± .04	0	0	.000	68		68
Ca^{++} aqueous ion Std. state, m = 1	40.08				-132180 ± 200	96.890 ± .147		141	
Cadmium Cd	112.40	12.38 ± .04	13.005 ± .003	0	0	.000	68		68
Cerium Ce	140.12	15.3 ±2.0	20.77 ± .02	0	0	.000	68		68
Ce^{+++} aqueous ion Std. state, m = 1	140.12				-170500 ± 300	124.980 ± .220		141	
Chlorine Cl_2 (Ideal gas)	70.906	53.288 ± .010	24465.0 ± 3.4	0	0	.000	158		148
Cl^- aqueous ion Std. state, m = 1	35.453				-31372 ± 50	22.996 ± .037		158	

Name and formula	Gram formula weight	Entropy $S°_{298.15}$ (cal deg^{-1} gfw.$^{-1}$)	Molar volume (cm^3)	$\Delta H°_{f,298.15}$ (cal gfw^{-1})	$\Delta G°_{f,298.15}$ (cal gfw^{-1})	Log $K_{f,298.15}$	References $S°_{298.15}$	References $\Delta H°_{f,298.15}$ or $\Delta G°_{f,298.15}$	References $H_T - H°_{298}$
			Elements						
Cobalt Co (Hexagonal)	58.933	7.18 ±.10	6.670 ±.002	0	0	0.000	68		68
Co^{++} aqueous ion Std. state, m = 1	58.933				-12300 ± 200	9.016 ±.147		141	
Chromium Cr	51.996	5.65 ±.05	7.231 ±.001	0	0	.000	68		68
Copper Cu	63.54	7.97 ±.04	7.113 ±.003	0	0	.000	68 114		68
Cu^{+} aqueous ion Std. state, m = 1	63.54				12000 ± 100	-8.796 ± .073		141	
Cu^{++} aqueous ion Std. state, m = 1	63.54				15530 ± 50	-11.384 ± .037		141	
Fluorine F_2 (Ideal gas)	37.997	48.44 ± .05	24465.0 ± 3.4	0	0	.000	148 158		148
F^{-} aqueous ion Std. state, m = 1	18.998				-66640 ± 100	48.848 ± .073		158	
α-Iron Fe	55.847	6.52 ±.03	7.092 ±.004	0	0	.000	68		68
Fe^{++} aqueous ion Std. state, m = 1	55.847				-20300 ± 100	14.880 ± .073		141	
Fe^{+++} aqueous ion Std. state, m = 1	55.847				-2520 ± 50	1.847 ±.037		141	
Hydrogen H_2 (Ideal gas)	2.016	31.208 ± .010	24465.0 ± 3.4	0	0	.000	158 148		148
H^{+} aqueous ion Std. state, m = 1	1.008				0	.000		158	
Hafnium Hf	178.49	10.41 ± .05	13.479 ± .010	0	0	.000	68		68
Mercury Hg (Liquid)	200.59	18.17 ± .02	14.822 ± .002	0	0	.000	158		68
Hg^{++} aqueous ion Std. state, m = 1	200.59				39380 ± 50	-28.866 ± .037		141	
Hg_2^{++} aqueous ion Std. state, m = 1	401.18				36790 ± 50	-26.968 ± .037		141	
Iodine I_2 (Crystal)	253.809	27.757 ± .040	51.29 ± .06	0	0	.000	148 158		148
I^{-} aqueous ion Std. state, m = 1	126.904				-12330 ± 50	9.038 ±.037		158	
Iodine I_2 (Ideal gas)	253.809	62.28 ± .05	24465.0 ± 3.4	14923 ± 20	4627 ± 20	-3.392 ± .015	158	158 148	148
Potassium K	39.102	15.48 ± .02	45.36 ± .09	0	0	.000	68		148
K^{+} aqueous ion Std. state, m = 1	39.102				-67700 ± 100	49.625 ± .073		158	
Lithium Li	6.939	6.95 ±.04	13.017 ± .007	0	0	.000	113		148
Li^{+} aqueous ion Std. state, m = 1	6.939				-70220 ± 50	51.473 ± .037		141	

Name and formula	Gram formula weight	Entropy $S°_{298.15}$ (cal deg gfw^{-1})	Molar volume (cm^3)	$\Delta H°_{f,298.15}$ (cal gfw^{-1})	$\Delta G°_{f,298.15}$ (cal gfw^{-1})	Log $K_{f,298.15}$	References $S°_{298.15}$	$\Delta H°_{f,298.15}$ or $\Delta G°_{f,298.15}$	$H_T - H°_{298}$
			Elements						
Magnesium Mg	24.312	7.81 ±.03	13.996	0	0	0.000	68		68
Mg^{++} aqueous ion Std. state, m = 1	24.312				-108900 ± 200	79.826 ± .147		141 143	
Manganese Mn	54.938	7.65 ±.02	7.354 ±.007	0	0	.000	68		68
Mn^{++} aqueous ion Std. state, m = 1	54.938				-53400 ± 200	39.143 ± .147		141	
Molybdenum Mo	95.94	6.85 ±.05	9.387 ±.005	0	0	.000	68		68
Nitrogen N_2 (Ideal gas)	28.013	45.77 ± .02	24465.0 ± 3.4	0	0	.000	158 148		148
Sodium Na	22.990	12.24 ± .12	23.812 ± .010	0	0	.000	112 158		148
Na^+ aqueous ion Std. state, m = 1	22.990				-62539 ± 50	45.842 ± .037		158	
Niobium Nb	92.906	8.70 ±.10	10.828 ± .005	0	0	.000	68		68
Nickel Ni	58.71	7.14 ±.02	6.588 ±.003	0	0	.000	68		68
Ni^{++} aqueous ion Std. state, m = 1	58.71				-11100 ± 200	8.137 ±.147		141	
Oxygen O_2 (Ideal gas)	31.999	48.996 ± .010	24465.0 ± 3.4	0	0	.000	158		148
Phosphorus P (Red V)	30.974	5.45 ±.02	17.2 ± .3	0	0	.000	148		148
Lead Pb	207.19	15.55 ± .10	18.267 ± .006	0	0	.000	68		68
Pb^{++} aqueous ion Std. state, m = 1	207.19				-5830 ± 50	4.274 ±.037		159	
Platinum Pt	195.09	9.95 ±.05	9.091 ±.004	0	0	.000	68		68
Orthorhombic sulfur S	32.046	7.60 ±.04	15.511 ± .005	0	0	.000	158 78		148
S^{--} aqueous ion Std. state, m = 1	32.046				20500 ± 200	-15.027 ± .147		158	
Monoclinic sulfur S	32.064	7.78 ±.06	16.49 ± .08	80 ±20	26 ±20	-.019 ±.015	78	158	148
Di-Atomic sulfur S_2 (Ideal gas)	64.128	54.51 ± .10	24465.0 ± 3.4	30840 ± 150	19120 ± 160	-14.015 ± .117	158 148	148 158	148
Octa-Atomic sulfur S_8 (Ideal gas)	256.512	102.82 ± .40	24465.0 ± 3.4	24200 ± 150	11620 ± 200	-8.518 ± .147	148 158	148 158	148
Antimony Sb	121.75	10.92 ± .05	18.178 ± .009	0	0	.000	68 158		68
Selenium Se	78.96	10.144 ± .050	16.420 ± .007	0	0	.000	158		149
Silicon Si	28.086	4.50 ±.02	12.056 ± .002	0	0	.000	68 35		68

Name and formula	Gram formula weight	Entropy $S°_{298.15}$ (cal deg^{-1} gfw^{-1})	Molar volume (cm^3)	$\Delta H°_{f,298.15}$ (cal gfw^{-1})	$\Delta G°_{f,298.15}$ (cal gfw^{-1})	Log $K_{f,298.15}$	References $S°_{298.15}$	References $\Delta H°_{f,298.15}$ or $\Delta G°_{f,298.15}$	References $H_T - H°_{298}$
			Elements						
β-Tin Sn (White)	118.69	12.32 ± .06	16.289 ± .005	0	0	0.000	68 159		68
Strontium Sr	87.62	12.5 ± .5	33.921 ±.020	0	0	.000	68		68
Sr^{++} aqueous ion Std. state, m = 1	87.62				-133200 ± 200	97.638 ± .147		141	
Tellurium Te	127.60	11.88 ± .10	20.476 ± .008	0	0	.000	158 68		68
Thorium Th	232.038	12.76 ± .20	19.788 ± .010	0	0	.000	68		68
Titanium Ti	47.90	7.32 ±.02	10.631 ± .010	0	0	.000	68		68
Uranium U	238.03	12.00 ± .03	12.497 ± .020	0	0	.000	68		68
U^{+++} aqueous ion Std. state, m = 1	236.03				-124400 ± 200	91.188 ± .147		141	
U^{++++} aqueous ion Std. state, m = 1	238.03				-138400 ± 200	101.450 ± .147		141	
Vanadium V	50.942	6.91 ±.10	8.350 ±.004	0	0	.000	68		68
V^{++} aqueous ion Std. state, m = 1	50.942				54200 ± 200	-39.730 ± .147		42	
V^{+++} aqueous ion Std. state, m = 1	50.942				-60100 ± 200	44.054 ± .147		42	
Tungsten (Wolfram) W	183.85	7.80 ±.10	9.545 ±.004	0	0	.000	68		68
Zinc Zn	65.37	9.95 ±.05	9.162 ±.007	0	0	.000	68		68
Zn^{++} aqueous ion Std. state, m = 1	65.37				-35184 ± 50	25.791 ± .037		141	
Zirconium Zr	91.22	9.31 ±.04	14.016 ± .007	0	0	.000	148 31		148
Ammonia NH_3 (Ideal gas)	17.031	45.97 ± .05	24465.0 3.4	-11020 ± 100	-3945 ± 110	2.892 ±.081	158 148	158	148
NH_4^+ aqueous ion Std. state, m = 1	18.039				-18970 ± 50	13.905 ± .037		158	
Methane CH_4 (Ideal gas)	16.043	44.49 ± .05	24465.0 ± 3.4	-17880 ± 80	-12127 ± 90	8.889 ±.066	158	158	148
Cementite Fe_3C	179.552	24.96 ± .80	23.23 ± .05	5960 ±320	4759 ±410	-3.488 ± .301	68	162 68	68
	Sulfides, arsenides, tellurides, selenides, and sulphosalts								
Acanthite Ag_2S III	247.804	34.14 ± .10	34.19 ± .04	-7731 ± 210	-9562 ± 200	7.009 ±.147	52	47 139	74
Realgar AsS	106.986	15.18 ± .15	29.80 ± .24	-17050 ± 500	-16806 ± 510	12.319 ± .374	173	158	
Orpiment As_2S_3	246.035	39.1 ± .7	70.51 ± .25	-40400 ± 1000	-40250 ± 1050	29.504 ± .770	138	158	
Bismuthinite Bi_2S_3	514.152	47.9 ± .8	75.52 ± .04	-33900 ± 250	-33298 ± 200	24.408 ± .147	138	15	

Name and formula	Gram formula weight	Entropy $S°_{298.15}$ (cal deg-gfw^{-1})	Molar volume (cm^3)	$\Delta H°_{f,298.15}$ (cal gfw^{-1})	$\Delta G°_{f,298.15}$ (cal gfw^{-1})	Log $K_{f,298.15}$	References $S°_{298.15}$	References $\Delta H°_{f,298.15}$ or $\Delta G°_{f,298.15}$	References $H_T - H°_{298}$
	Sulfides, arsenides, tellurides, selenides, and sulphosalts								
Oldhamite CaS	72.144	13.54 ± .30	27.72 ± .09	-114265 ± 510	-113070 ± 500	82.882 ± .367	78		128
Greennockite CdS	144.464	16.80 ± .40	29.934 ± .015	-35755 ± 300	-34807 ± 330	25.514 ± .242	78	2	38
Covellite CuS	95.604	15.93 ± .40	20.42 ± .02	-11610 ± 1000	-11720 ± 1010	8.591 ±.740	78	38	73
Chalcocite Cu_2S III	159.144	28.86 ± .50	27.475 ± .016	-19148 ± 300	-20734 ± 340	15.198 ± .249	78 160	20 127	74
Troilite FeS	87.911	14.42 ± .04	18.20 ± .03	-24130 ± 350	-24219 ± 360	17.753 ± .264	53	133 2	74
Pyrrhotite $Fe_{.877}S$	81.042	14.53 ± .05	17.58 ± .03				53		
Pyrite FeS_2	119.975	12.65 ± .03	23.940 ± .007	-41000 ± 400	-38296 ± 410	28.072 ± .301	52	154	74
Ferroselite $FeSe_2$	213.767	20.76 ± .06	29.96 ± .05				52		
Frohbergite $FeTe_2$	311.047	23.94 ± .03	38.43 ± .05				52		
Hydrogen sulfide H_2S (Ideal gas)	34.080	49.16 ± .05	24465.0 ± 3.4	-4930 ± 150	-8016 ± 160	5.876 ±.117	158	158	148
HS^- aqueous ion Std. state, m = 1	33.072				-2880 ± 200	2.111 ±.147		158	
Cinnabar HgS (Red)	232.654	19.72 ± .50	28.416 ± .015	-13900 ± 500	-12096 ± 530	8.867 ±.389	88	73	38
Metacinnabar HgS (Black)	232.654	23.0 ±1.0	30.169 ± .016	-11170 ± 360	-10344 ± 200	7.582 ±.147	78	46	
Alabandite MnS	87.002	18.69 ± .40	21.46 ± .01	-51115 ± 200	-52140 ± 240	38.220 ± .176	78	2 30	74
Molybdenite MoS_2	160.068	14.96 ± .05	32.02 ± .02	-73200 ± 200	-71086 ± 210	52.107 ± .154	52	38 147	
Millerite NiS	90.774	15.80 ±1.00	16.89 ± .01	-20284 ± 1000	-20600 ± 1050	15.100 ± .770	52 173	140	74
Galena PbS	239.254	21.84 ± .30	31.49 ± .01	-23353 ± 230	-22962 ± 200	16.832 ± .147	78	146 92	74
Clausthalite PbSe	286.15	24.48 ± .50	34.61 ± .01	-24662 ± 530	-24300 ± 500	17.812 ± .367	78	159	
Altaite PbTe	334.79	26.26 ± .50	40.60 ± .01	-16949 ± 340	-16600 ± 300	12.168 ± .220	78	141 159	
Cooperite PtS	227.154	13.16 ± .03	22.15 ± .01	-19700 ± 800	-18391 ± 810	13.481 ± .594	52	52	
Stibnite Sb_2S_3	339.692	43.5 ± .8	73.41 ± .04	-41800 ± 1000	-41460 ± 1010	30.391 ± .740	89	158	
Herzenbergite SnS	150.754	18.36 ± .20	29.01 ± .02	-25464 ± 350	-24999 ± 360	18.325 ± .264	78	133	74
Tungstenite WS_2	247.978	22.7 ±2.0	32.07 ± .02	-71300 ± 200	-71210 ± 640	52.198 ± .469	52	38	
Sphalerite ZnS	97.434	13.77 ± .20	23.83 ± .01	-49750 ± 500	-48623 ± 510	35.642 ± .374	78	38 126	123
Wurtzite ZnS	97.434	16.56 ±1.00	23.846 ± .013	-46095 ± 200	-45760 ± 300	33.543 ± .220	132	2	123

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			Oxides and hydroxides						
Corundum Al_2O_3	101.961	12.18 ± .03	25.575 ± .007	-400400 ± 300	-378082 ± 310	277.141 ± .227	78 39	103	39
Boehmite AlO(OH)	59.988	11.58 ± .05	19.535 ± .026	-235500 ± 3500	-217674 ± 3510	159.559 ± 2.573	78	141	74
Diaspore AlO(OH)	59.988	8.43 ±.04	17.760 ± .026				86 78		
Gibbsite $Al(OH)_3$	78.004	16.75 ± .10	31.956 ± .015	-306380 ± 300	-273486 ± 310	200.470 ± .227	78	12	74
Arsenolite As_2O_3	197.841	25.6 ± .5	51.118 ± .069	-157020 ± 400	-137731 ± 450	100.959 ± .330	158	158	
Claudetite As_2O_3	197.841	28.0 ±1.0	47.26 ± .03	-156483 ± 300	-137910 ± 250	101.091 ± .183	158	158	
Boric Oxide B_2O_3	69.620	12.90 ± .10	27.22 ± .06	-303640 ± 400	-284729 ± 410	208.712 ± .301	148 159	148 159	148
Barium Oxide BaO	153.339	16.8 ± .3	25.588 ± .010	-139060 ± 700	-131994 ± 770	96.754 ± .564	78	108	74
Bromellite BeO	25.012	3.37 ±.02	8.309 ±.003	-143100 ± 150	-136121 ± 160	99.779 ± .117	78 148	22 66	157
Bismite α-Bi_2O_3	465.958	36.2 ± .5	49.73 ± .06	-137160 ± 300	-117955 ± 350	86.463 ± .257	158	105 158	74
Carbon Monoxide CO (Ideal gas)	28.011	47.219 ± .010	24465.0 ± 3.4	-26416 ± 20	-32781 ± 30	24.029 ± .022	158	158	148
Carbon Dioxide CO_2 (Ideal gas)	44.010	51.06 ± .01	24465.0 ± 3.4	-94051 ± 30	-94257 ± 40	69.092 ± .029	158 58	158	148
CO_3^- aqueous ion Std. state, m = 1	60.009				-126170 ± 150	92.485 ± .110		158	
HCO_3^- aqueous ion Std. state, m = 1	61.017				-140260 ± 150	102.813 ± .110		158	
H_2CO_3 un-ionized Std. state, m = 1	62.025				-148940 ± 50	109.176 ± .037		158	
Lime CaO	56.079	9.5 ±.5	16.764 ± .005	-151790 ± 300	-144352 ± 340	105.813 ± .249	78	65	74
Portlandite $Ca(OH)_2$	74.095	19.93 ± .10	33.056 ± .016	-235610 ± 450	-214673 ± 460	157.359 ± .337	78	54 55	74
Monteponite CdO	128.399	13.1 ± .3	15.585 ± .010	-61200 ± 200	-54111 ± 220	39.664 ± .161	78	102	
Cerianite CeO_2	172.119	14.89 ± .02	23.853 ± .026	-260180 ± 350	-245450 ± 700	179.920 ± .513	179	64	84
Cobalt Oxide CoO	74.933	12.66 ± .08	11.64 ± .02	-57100 ± 300	-51430 ± 310	37.699 ± .227	78	18	74
Eskolaite Cr_2O_3	151.990	19.4 ± .3	29.090 ± .032	-272700 ± 400	-253203 ± 420	185.603 ± .308	78	102	74
Tenorite CuO	79.539	10.19 ± .05	12.22 ± .03	-37140 ± 300	-30498 ± 310	22.356 ± .227	78	15	74
Cuprite Cu_2O	143.079	22.4 ± .4	23.437 ± .016	-40400 ± 1500	-35022 ± 1510	25.672 ±1.107	78	22	74
Wustite $Fe_{.947}O$	68.887	13.76 ± .10	12.04 ± .04	-63640 ± 200	-58599 ± 210	42.954 ± .154	78 148	70 148	74

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		Oxides and hydroxides							
Ferrous Oxide FeO (Fictive)	71.846	14.52 ± .40	12.00 ± .05	-65020 ± 500	-60097 ± 600	44.052 ± .440	148	148	148
Hematite Fe_2O_3	159.692	20.89 ± .05	30.274 ± .012	-197300 ± 300	-177728 ± 310	130.278 ± .227	51 148	26 148	74
Magnetite Fe_3O_4	231.539	36.03 ± .10	44.524 ± .008	-267400 ± 500	-243094 ± 510	178.193 ± .374	52	70 148	74
Goethite α-FeO(OH)	88.854		20.82 ± .04	-133750 ± 250				10	
Germanium Dioxide GeO_2 (Quartz form)	104.589	13.21 ± .10	24.44 ± .02	-129080 ± 130	-116195 ± 140	85.173 ± .103	78	109	
Water H_2O (Liquid)	18.015	16.71 ± .03	18.069 ± .003	-68315 ± 10	-56688 ± 20	41.553 ± .015	158	158	74
OH^- aqueous ion Std. state, m = 1	17.007				-37594 ± 10	27.557 ± .007		158	
Steam H_2O (Ideal gas)	18.015	45.104 ± .010	24465.0 ± 3.4	-57796 ± 10	-54635 ± 20	40.048 ± .015	158	158	148
Ice H_2O (Metastable)	18.015	10.68 ± .10	19.64 ± .01	-66879 ± 50	-53455 ± 60	39.184 ± .044	78	141	
Hafnia HfO_2	210.489	14.18 ± .10	20.823 ± .008	-266050 ± 300	-252566 ± 310	185.136 ± .227	78	22	74
Montroydite HgO	216.589	16.80 ± .08	19.32 ± .02	-21711 ± 90	-13998 ± 100	10.261 ± .073	78	22	74
Potassium Oxide K_2O	94.203	22.5 ±1.5	40.38 ± .20	-86800 ± 500	-76974 ± 680	56.423 ± .498	148	148	148
Lithium Oxide Li_2O	29.877	8.98 ±.02	14.76 ± .01	-143100 ± 500	-134329 ± 510	98.466 ± .374	148	148	148
Periclase MgO	40.311	6.44 ±.04	11.248 ± .004	-143800 ± 100	-136087 ± 110	99.754 ± .081	14 120	22 148	157
Brucite $Mg(OH)_2$	58.327	15.09 ± .05	24.63 ± .07	-221200 ± 700	-199460 ± 730	146.208 ± .535	78	150 63	74
Manganosite MnO	70.937	14.27 ± .10	13.221 ± .004	-92050 ± 110	-86720 ± 120	63.567 ± .088	78	22	74
Pyrolusite MnO_2	86.937	12.68 ± .10	16.61 ± .02	-124450 ± 200	-111342 ± 210	81.616 ± .154	78	22	74
Bixbyite Mn_2O_3	157.874	26.40 ± .50	31.37 ± .05	-228700 ± 500	-210097 ± 530	154.005 ± .389	78	118 22	74
Hausmanite Mn_3O_4	228.812	36.8 ±1.0	46.95 ± .06	-331400 ± 400	-306313 ± 500	224.533 ± .367	118	22	74
Molybdite MoO_3	143.938	18.58 ± .10	30.56 ± .04	-178160 ± 100	-159745 ± 110	117.096 ± .081	78	103	74
Nitrogen Dioxide NO_2 (Ideal gas)	46.005	57.35 ± .02	24465.0 ± 3.4	7930 ±100	12262 ± 110	-8.988 ± .081	158	158	148
NO_3^- aqueous ion Std. state, m = 1	62.005				-26610 ± 200	19.506 ± .147		158	
Sodium Oxide Na_2O	61.979	17.99 ± .20		-99400 ± 1500	-90161 ± 1510	66.090 ±1.107	50	22	148
Bunsenite NiO	74.709	9.08 ±.04	10.97 ± .02	-57300 ± 100	-50574 ± 110	37.072 ± .081	78	18	74

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			Oxides and hydroxides						
Phosphorus Pentoxide P_2O_5 (Dimeric)	283.889	54.70 ± .10	118.8 ± .4	-713200 ± 400	-649968 ± 410	476.439 ± .301	158	158	148
PO_4^{---} aqueous ion Std. state, m = 1	94.971				-244000 300	178.857 ± .220		158	
Litharge PbO (Red)	223.189	15.6 ± .2	23.91 ± .05	-52410 ± 160	-45121 ± 180	33.075 ± .132	78 159	148 22	74
Massicot PbO (Yellow)	223.189	16.1 ± .2	23.15 ± .03	-52070 ± 170	-44930 ± 180	32.935 ± .132	78 159	148 22	148
Minium Pb_3O_4	685.568	50.5 ±1.5	76.81 ± .09	-171700 ± 2000	-143632 ± 2060	105.285 ± 1.510	159 78	159	148
Sulfur Dioxide SO_2 (Ideal gas)	64.063	59.30 ± .10	24465.0 ± 3.4	-70944 ± 50	-71750 ± 60	52.594 ± .044	158 34	158	148
Sulfur Trioxide SO_3 (Ideal gas)	80.062	61.34 ± .20	24465.0 ± 3.4	-94580 ± 170	-88690 ± 190	65.011 ± .139	158	158	148
SO_3^{--} aqueous ion Std. state, m = 1	80.062				-116300 ± 300	85.250 ± .220		158	
SO_4^{--} aqueous ion Std. state, m = 1	96.062				-117970 ± 100	86.474 ± .073		158	
Valentinite Sb_2O_3	291.498	29.4 ± .6	50.01 ± .05	-169350 ± 700	-149692 ± 730	109.727 ± .535	158 78	107	158
Scandium Sesquioxide Sc_2O_3	137.910	18.4 ± .1	35.92 ± .05	-447280 ± 230	-425916 ± 250	312.205 ± .183	176	106	
Silicon Monoxide SiO (Ideal gas)	44.085	50.55 ± .20	24465.0 ± 3.4	-23800 ± 1000	-30226 ± 1010	22.156 ± .740	158	158	148
α-quartz SiO_2	60.085	9.88 ±.02	22.688 ± .001	-217650 ± 400	-204646 ± 410	150.009 ± .301	178	180 49	74
H_2SiO_3 un-ionized Std. state, m = 1	78.100				-258000 ± 300	189.119 ± .220	159		
α-Cristobalite SiO_2	60.085	10.38 ± .02	25.739 ± .033	-216930 ± 450	-204075 ± 460	149.591 ± .337	178 69	95 36	74
α-Tridymite SiO_2	60.085	10.50 ± .10	26.53 ± .20	-216895 ± 570	-204076 ± 580	149.592 ± .425	131	95	74
Coesite SiO_2	60.085	9.65 ±.10	20.641 ± .036	-216440 ± 500	-203367 ± 510	149.072 ± .374	61 131	61	163
Stishovite SiO_2	60.085	6.64 ±.10	14.014 ± .009	-205860 ± 500	-191890 ± 510	140.659 ± .374	61	61	163
Silica Glass SiO_2	60.085	11.33 ± .05	27.27 ± .10	-215870 ± 500	-203298 ± 510	149.021 ± .374	161 178	180 95	74
Cassiterite SnO_2	150.689	12.5 ± .3	21.55 ± .03	-138820 ± 150	-124266 ± 180	91.089 ± .132	78	22	74
Strontium Oxide SrO	103.619	13.0 ± .2	20.69 ± .01	-144440 ± 400	-137285 ± 440	100.633 ± .323	78	108	74
Tellurite TeO_2	159.599	16.8 ±1.0	27.75 ± .02	-77740 ± 770	-64600 ± 700	47.353 ± .513	78	22	
Thorianite ThO_2	264.037	15.59 ± .05	26.373 ± .007	-293200 ± 400	-279436 ± 410	204.832 ± .301	78	22	156
Rutile TiO_2	79.899	12.04 ± .04	18.820 ± .008	-225760 ± 100	-212559 ± 110	155.810 ± .081	78	111	74

Name and formula	Gram formula weight	Entropy $S°_{298.15}$ (cal deg-gfw^{-1})	Molar volume (cm^3)	$\Delta H°_{f,298.15}$ (cal gfw^{-1})	$\Delta G°_{f,298.15}$ (cal gfw^{-1})	Log $K_{f,298.15}$	References $S°_{298.15}$	$\Delta H°_{f,298.15}$ or $\Delta G°_{f,298.15}$	$H_T - H°_{298}$
Oxides and hydroxides									
Anatase TiO_2	79.899	11.93 ± .07	20.52 ± .03	-225860 ± 110	-212626 ± 120	155.859 ± .088	78	162	74
Uraninite UO_2	270.029	18.63 ± .10	24.618 ± .014	-259200 ± 600	-246569 ± 610	180.740 ± .447	78	22	74
Karelianite V_2O_3	149.882	23.53 ± .30	29.85 ± .03	-291290 ± 380	-272273 ± 400	199.581 ± .293	78	110	74
Tungsten Trioxide WO_3	231.848	18.14 ± .12	31.61 ± .10	-201460 ± 200	-182631 ± 210	133.872 ± .154	90	170	90
Zincite ZnO	81.369	10.43 ± .10	14.338 ± .005	-83250 ± 200	-76089 ± 210	55.775 ± .154	78	22	74
Baddeleyite ZrO_2	123.219	12.04 ± .08	21.15 ± .01	-262300 ± 400	-248505 ± 410	182.159 ± .301	148	67 148	74
Multiple oxides									
Chrysoberyl $BeAl_2O_4$	126.973	15.58 ± .03	34.320 ± .023				40		
Perovskite $CaTiO_3$	135.978	22.4 ± .1	33.626 ± .010	-396900 ± 410	-376517 ± 420	275.994 ± .308	78	80 151	74
Hercynite $FeAl_2O_4$	173.808	25.4 ± .2	40.75 ± .05				78		
Chromite $FeCr_2O_4$	223.837	34.90 ± .40	44.01 ± .10				78		74
Ilmenite $FeTiO_3$	151.745	25.3 ± .3	31.69 ± .08	-295560 ± 380	-277065 ± 390	203.094 ± .286	78	80	74
Titanomagnetite Fe_2TiO_4	223.592	40.36 ± .60	46.82 ± .05				78		74
Pseudobrookite Fe_2TiO_5	239.591	37.40 ± .30	54.53 ± .05				78		74
Spinel $MgAl_2O_4$	142.273	19.26 ± .10	39.71 ± .03	-552800 ± 500	-522961 ± 510	383.340 ± .374	78	115 151	148
Picrochromite $MgCr_2O_4$	192.302	25.3 ± .2	43.56 ± .05				78		74
Magnesioferrite $MgFe_2O_4$	200.004	29.60 ± .20	44.57 ± .05	-341720 ± 600	-315113 ± 700	230.984 ± .513	78	93	74
Geikielite $MgTiO_3$	120.210	17.82 ± .10	30.86 ± .07	-375900 ± 270	-354790 ± 280	260.068 ± .205	78	80	74
Trevorite $NiFe_2O_4$	234.402	31.5 ± .2	43.65 ± .05				78		
Halides									
Bromargyrite AgBr	187.779	25.60 ± .10	28.991 ± .008	-23990 ± 300	-23158 ± 310	16.975 ± .227	78 158	158	74
Chlorargyrite AgCl	143.323	23.00 ± .10	25.727 ± .007	-30370 ± 300	-26242 ± 310	19.236 ± .227	78 158	158 101	74
Hydrophilite $CaCl_2$	110.986	27.2 ± .3	50.75 ± .10	-190000 ± 150	-179255 ± 180	131.397 ± .132	78	141	74

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			Halides						
Lawrencite $FeCl_2$	126.753	28.19 ± .50	39.46 ± .21	-81700 ± 120	-72273 ± 200	52.977 ± .147	148	94 148	148
Molysite $FeCl_3$	162.206	34.02 ± .60	57.86 ± .10	-95460 ± 200	-79827 ± 360	58.515 ± .264	148	94 148	148
Hydrogen Chloride HCl (Ideal gas)	36.461	44.646 ± .010	24465.0 ± 3.4	-22062 ± 150	-22777 ± 160	16.696 ± .117	158 148	158	148
Calomel HgCl	236.043	23.08 ± .30	32.939 ± .075	-31695 ± 300	-25215 ± 320	18.483 ± .235	78	158	
Sylvite KCl	74.555	19.73 ± .04	37.524 ± .004	-104370 ± 200	-97693 ± 210	71.611 ± .154	148 78	148	148
Chloromagnesite $MgCl_2$	95.218	21.42 ± .20	40.81 ± .10	-153350 ± 110	-141521 ± 130	103.738 ± .095	78	141 148	74
Scacchite $MnCl_2$	125.844	28.26 ± .05	42.11 ± .17	-115038 ± 200	-105295 ± 210	77.183 ± .154	21	94	74
Salammoniac NH_4Cl	53.492	22.7 ±1.0	35.06 ± .03	-75180 ± 200	-48572 ± 360	35.604 ± .264	148 158	158 148	148
Halite NaCl	58.443	17.24 ± .05	27.015 ± .003	-98260 ± 300	-91807 ± 310	67.296 ± .227	148	148	148
Cotunnite $PbCl_2$	278.096	32.5 ± .5	47.09 ± .10	-86200 ± 70	-75366 ± 170	55.245 ± .125	78 159	148 159	74
Fluorite CaF_2	78.077	16.46 ± .08	24.542 ± .007	-290300 ± 400	-277799 ± 410	203.632 ± .301	78	141	74
Sellaite MgF_2	62.309	13.68 ± .07	19.61 ± .01	-268700 ± 300	-256008 ± 310	187.659 ± .227	78	142 148	74
Villiaumite NaF	41.988	12.26 ± .07	14.984 ± .005	-137027 ± 200	-129812 ± 210	95.155 ± .154	78	23	148
Cryolite Na_3AlF_6	209.941	56.98 ± .40	70.81 ± .20	-790000 ± 2000	-750695 ± 2010	550.274 ± 1.473	148 78	23 148	37
Iodargyrite AgI	234.774	27.60 ± .40	41.301 ± .040	-14780 ± 400	-15830 ± 420	11.604 ± .308	78 158	158	74
Coccinite HgI_2	454.399	42.4 ±1.5	71.84 ± .10	-25200 ± 400	-24148 ± 610	17.701 ± .447	78	148 141	74
			Carbonates						
Witherite $BaCO_3$	197.349	26.8 ± .5	45.81 ± .06	-297460 ± 870	-278359 ± 930	204.042 ± .682	78	4 98	74
Aragonite $CaCO_3$	100.089	21.18 ± .30	34.15 ± .05	-288651 ± 340	-269678 ± 350	197.679 ± .257	78	100 43	74
Calcite $CaCO_3$	100.089	22.15 ± .20	36.934 ± .015	-288592 ± 320	-269908 ± 330	197.848 ± .242	78	100 43	74
Dolomite $CaMg(CO_3)_2$	184.411	37.09 ± .07	64.34 ± .03	-557613 ± 520	-518734 ± 530	380.242 ± .389	144	144	144
Otavite $CdCO_3$	172.409	23.3 ± .6	34.300 ± .015	-179030 ± 600	-159964 ± 630	117.257 ± .462	78	141 76	
Malachite $Cu_2(OH)_2CO_3$	221.104		54.86 ± .08		-216440 ± 500	158.655 ± .367		42	
Azurite $Cu_3(OH)_2(CO_3)_2$	344.653		91.01 ± .13		-343730 ± 500	251.961 ± .367		42	

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			Carbonates						
Siderite $FeCO_3$	115.856	25.1 ± .6	29.378 ± .014	-177812 ± 540	-161030 ± 500	118.038 ± .367	133	141 76	
Magnesite $MgCO_3$	84.321	15.7 ± .2	28.018 ± .013	-266081 ± 320	-246112 ± 330	180.405 ± .242	78	133 99	74
Huntite $Mg_3Ca(CO_3)_4$	353.053	67.0 ±1.5	122.58 ± .10	-1086960 ± 1200	-1007700 ± 1000	738.663 ± .733	132	43	
Rhodochrosite $MnCO_3$	114.947	23.90 ± .50	31.073 ± .014	-212521 ± 290	-195045 ± 330	142.972 ± .242	122	133	74
Cerussite $PbCO_3$	267.199	31.3 ± .8	40.59 ± .06	-167951 ± 300	-150325 ± 360	110.191 ± .264	78	4	
Strontianite $SrCO_3$	147.629	23.2 ± .4	39.01 ± .06	-294581 ± 650	-275450 ± 670	201.910 ± .491	78	4 98	74
Smithsonite $ZnCO_3$	125.379	19.70 ± .30	28.275 ± .013	-194200 ± 700	-174786 ± 710	128.121 ± .520	78	141 43	
			Nitrates						
Nitrobarite $BaNO_3$	261.350	51.14 ± .20	80.58 ± .08	-237060 ± 500	-190066 ± 590	139.322 ± .432	78	141	74
Niter KNO_3	101.107	31.81 ± .15	48.04 ± .06	-117760 ± 300	-93893 ± 310	68.825 ± .227	78	141	74
Ammonia-Niter NH_4NO_3	80.043	36.11 ± .05	46.49 ± .10	-87373 ± 200	-43971 ± 210	32.232 ± .154	158	158	74
Soda Niter $NaNO_3$	84.995	27.85 ± .10	37.60 ± .02	-111540 ± 300	-87459 ± 310	64.109 ± .227	78	141	74
			Sulfates and borates						
Barite $BaSO_4$	233.402	31.6 ± .2	52.10 ± .06	-352131 ± 2030	-325300 ± 2000	238.451 ± 1.466	78	135 73	74
Anhydrite $CaSO_4$	136.142	25.5 ± .4	45.94 ± .06	-343321 ± 1010	-316475 ± 1000	231.982 ± .733	78	135 29	74
Gypsum $CaSO_4 \cdot 2H_2O$	172.172	46.36 ± .30	74.69 ± .22	-483981 ± 1110	-430137 ± 1100	315.299 ± .806	141	135 73	
Chalcanthite $CuSO_4 \cdot 5H_2O$	249.678	73.0 ±1.0	108.97 ± .22	-544340 ± 800	-449203 ± 860	329.274 ± .630	141	3 73	
Brochantite $Cu_4SO_4(OH)_6$	452.266		113.6 ± .2		-435310 ± 600	319.091 ± .440		15	
Szomolnokite $FeSO_4 \cdot H_2O$	169.924		55.9 ± .4	-297305 ± 130				1	
Melanterite $FeSO_4 \cdot 7H_2O$	278.016	97.8 ± .3	146.54 ± .25	-720470 ± 150	-599942 ± 300	439.769 ± .220	78	1	
Sulfuric Acid H_2SO_4 (Liquid)	98.078	37.50 ± .05	53.57 ± .07	-194548 ± 100	-164942 ± 110	120.906 ± .081	45 158	158 48	
Arcanite K_2SO_4	174.266	42.0 ± .4	65.50 ± .07	-343481 ± 620	-315290 ± 600	231.114 ± 440	78	135 73	74
Alunite $K_2Al_6(OH)_{12}(SO_4)_4$	828.440	156.8 ± .9	293.6 ± .4				78		74

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			Sulfates and borates						
Epsomite $MgSO_4 \cdot 7H_2O$	246.481		146.83 ± .23	-808700 ± 2000				141	
Thenardite Na_2SO_4	142.041	35.73 ± .07	53.33 ± .06	-331528 510	-303400 500	222.398 ± .367	78	135 73	74
Mirabilite $Na_2SO_4 \cdot 10H_2O$	322.195	141.46 ± .15	219.8 ± .4	-1034237 ± 950	-871545 ± 800	638.859 ± .586	19	19 141	
Mascagnite $(NH_4)_2SO_4$	132.139	52.6 ± .3	74.68 ± .09	-282230 ± 300	-215565 ± 320	158.013 ± .235	78 158	158	74
Retgersite α-$NiSO_4 \cdot 6H_2O$	262.864	79.94 ± .10	126.59 ± .16				145		
Morenosite $NiSO_4 \cdot 7H_2O$	280.879	90.57 ± .10	143.82 ± .50				145		
Anglesite $PbSO_4$	303.252	35.51 ± .07	47.95 ± .06	-219891 ± 260	-194360 ± 250	142.470 ± .183	41	159	74
Celestite $SrSO_4$	183.682	28.2 ±1.0	46.25 ± .06	-346646 ± 1700	-319830 ± 1500	234.441 ± 1.100	78	135 73	
Zinkosite $ZnSO_4$	161.432	26.4 ± .3	41.57 ± .07	-233600 ± 200	-207022 ± 230	151.751 ± .169	170	3 135	74
Bianchite $ZnSO_4 \cdot 6H_2O$	269.524	86.9 ± .3	130.2 ± .5				78		
Goslarite $ZnSO_4 \cdot 7H_2O$	287.539	92.9 ± .3	145.79 ± .11				78		
Borax $Na_2B_4O_7 \cdot 10H_2O$	381.373		222.66 ± .17	-1497200 ± 2000				141	
			Phosphates, molybdates, and tungstates						
Berlinite $AlPO_4$	121.953	21.70 ± .05	46.58 ± .10	-414400 ± 500	-388010 ± 510	284.419 ± .374	32	159	
Whitlockite $Ca_3(PO_4)_2$	310.183	57.58 ± .20	97.62 ± .09	-986200 ± 500	-932785 ± 520	683.749 ± .381	78	141	74
Hydroxylapatite $Ca_5(PO_4)_3OH$	502.322	93.30 ± .40	159.6 ± .2	-3215000 ± 3000	-3123504 ± 3010	2289.588 ± 2.206	78	97	74
Fluorapatite $Ca_5(PO_4)_3F$	504.313	92.70 ± .40	157.56 ± .12				78		74
Strengite $Fe(PO_4) \cdot 2H_2O$	186.849	40.93 ± .30	64.54 ± .30	-451500 ± 1000	-397700 ± 1010	291.522 ± .740	33	33	
Powellite $CaMoO_4$	200.018	29.3 ± .2	47.00 ± .09	-369500 ± 300	-344011 ± 310	252.167 ± .227	175	7	
Wulfenite $PbMoO_4$	367.128	39.7 ± .5	53.86 ± .10				3		
Scheelite $CaWO_4$	287.928	30.2 ± .2	47.05 ± .09	-402410 ± 500	-376906 ± 510	276.279 ± .374	85	7	
Ferberite $FeWO_4$	303.695	31.5 ± .4	40.38 ± .05				171		
Stolzite $PbWO_4$	455.038	40.2 ± .5	54.10 ± .06				3		

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Ortho and ring structure silicates									
Kyanite Al_2SiO_5	162.046	20.02 ± .08	44.09 ± .07	-619930 ± 540	-584000 ± 550	428.083 ± .403	78	59 60	121
Andalusite Al_2SiO_5	162.046	22.28 ± .10	51.53 ± .04	-619390 ± 710	-584134 ± 720	428.181 ± .528	78	60 164	121
Sillimanite Al_2SiO_5	162.046	22.97 ± .10	49.90 ± .04	-618650 ± 710	-583600 ± 720	427.790 ± .528	78	60 164	121
3.2 Mullite $3Al_2O_3 \cdot 2SiO_2$	426.053	64.43 ±1.00	134.55 ± .07	-1629543 ± 1700	-1539002 ± 1730	1128.118 ± 1.268	60 124	60 164	124
Phenacite Be_2SiO_4	110.108	15.37 ± .08	37.19 ± .04				78		
Larnite β-Ca_2SiO_4	172.244	30.50 ± .20	51.60 ± .27	-551420 ± 770	-524022 ± 780	384.118 ± .572	78	81	74
Calcium Olivine γ-Ca_2SiO_4	172.244	28.80 ± .20	59.11 ± .18	-553973 ± 940	-526069 ± 950	385.619 ± .696	78	81 129	74
Gehlenite $Ca_2Al_2SiO_7$	274.205	47.4 ± .4	90.24 ± .09	-952740 ± 960	-904432 ± 970	662.966 ± .711	172	8	122
Grossular $Ca_3Al_2Si_3O_{12}$	450.454	57.7 ±1.3	125.30 ± .03	-1588393 ± 1830	-1500986 ± 1880	1100.251 ± 1.378	57	57	163
Lawsonite $CaAl_2Si_2O_7(OH)_2 \cdot H_2O$	314.241	56.79 ± .50	101.32 ± .12	-1161315 ± 1090	-1076910 ± 1110	789.396 ± .814	87	6	
Monticellite $CaMgSiO_4$	156.476	24.5 ±1.0	51.36 ± .07	-540800 ± 790	-512252 ± 850	375.490 ± .623	132	117	
Merwinite $Ca_3Mg(SiO_4)_2$	328.719	60.5 ± .5	104.4 ± 1.5	-1091490 ± 1270	-1037184 ± 1290	760.276 ± .946	172	117 75	122
Akermanite $Ca_2MgSi_2O_7$	272.640	50.03 ± .50	92.81 ± .09	-926510 ± 1070	-879353 ± 1090	644.583 ± .799	172	116 75	122
Sphene $CaTiSiO_5$	196.063	30.88 ± .20	55.65 ± .17	-622050 ± 570	-588246 ± 580	431.196 ± .425	78	152	74
Fayalite Fe_2SiO_4	203.778	35.45 ± .40	46.39 ± .09	-353544 ± 700	-329668 ± 720	241.653 ± .528	151 78	82 151	74
Forsterite Mg_2SiO_4	140.708	22.75 ± .20	43.79 ± .03	-520370 ± 520	-491938 ± 530	360.600 ± .389	78	153	74
Cordierite $Mg_2Al_3(AlSi_5O_{18})$	584.969	97.33 ± .90	233.22 ± .13				172		122
Tephroite Mn_2SiO_4	201.960	39.00 ±1.00	48.61 ± .07	-413520 ± 760	-390028 ± 820	285.898 ± .601	78	71	104
Willemite Zn_2SiO_4	222.824	31.40 ± .20	52.42 ± .08	-391140 ± 590	-364011 ± 600	266.827 ± .440	78	81	
Zircon $ZrSiO_4$	183.304	20.08 ± .30	39.26 ± .07				148 78		74
Chain and band structure silicates									
Wollastonite $CaSiO_3$	116.164	19.60 ± .20	39.93 ± .10	-390640 ± 870	-370313 ± 880	271.446 ± .645	78	152 16	74
Pseudowollastonite $CaSiO_3$	116.164	20.90 ± .20	40.08 ± .14	-389070 ± 620	-369031 ± 630	270.507 ± .462	78	75	74
Ca-Al Pyroxene $CaAl_2SiO_6$	218.125	34.6 ± .8	63.50 ± .09	-786984 ± 660	-745130 ± 710	546.194 ± .520	57	57	163

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Chain and band structure silicates									
Diopside $CaMg(SiO_3)_2$	216.560	34.20 ± .20	66.09 ± .10	-767390 ± 2180	-725784 ± 2190	532.014 ± 1.605	78	95 116	74
Spodumene $LiAl(SiO_3)_2$	186.090		58.37 ± .02	-727735 ± 820				13	
Clinoenstatite $MgSiO_3$	100.396	16.22 ± .10	31.47 ± .05	-370140 ± 440	-349394 ± 450	256.112 ± .330	78	153	74
Rhodonite $MnSiO_3$	131.022	24.50 ± .50	35.16 ± .02	-315620 ± 470	-297390 ± 500	217.993 ± .367	132	82	74
Jadeite $NaAl(SiO_3)_2$	202.140	31.90 ± .30	60.40 ± .10	-719871 ± 1000	-677206 ± 1010	496.405 ± .740	78	165 96	74
Tremolite $Ca_2Mg_5[Si_8O_{22}](OH)_2$	812.410	131.19 ± .30	272.92 ± .73	-2952935 ± 4140	-2779137 ± 4150	2037.160 ± 3.042	137	169	132
Framework structure silicates									
Anorthite $CaAl_2Si_2O_8$	278.210	48.45 ± .30	100.79 ± .05	-1009300 ± 1150	-955626 ± 1160	700.492 ± .850	78	6 72	74
Hexagonal Anorthite $CaAl_2Si_2O_8$	278.210	45.84 ± .30	99.85 ± .79	-1004410 ± 1700	-949958 ± 1710	696.337 ± 1.253	87	6	
Leonhardite $Ca_2Al_4Si_8O_{24}\cdot 7H_2O$	922.867	220.4 ± 2.6	404.4 ± 2.0	-3397535 ± 2500	-3146948 ± 2700	2306.773 ± 1.979	87	6	
Microcline $KAlSi_3O_8$	278.337	52.47 ± .80	108.72 ± .10	-946265 ± 930	-892817 ± 970	654.452 ± .711	167 79	166 168	167
High Sanidine $KAlSi_3O_8$	278.337	56.94 ±1.00	109.05 ± .10	-944378 ± 930	-892263 ± 980	654.046 ± .718	167 168	166	167
Adularia $KAlSi_3O_8$	278.337	55.99 ±1.00	108.29 ± .15	-945000 ± 1200	-892602 ± 1240	654.294 ± .909	167 79	44	74
$KAlSi_3O_8$ Glass $KAlSi_3O_8$	278.337	63.28 ±1.00	116.5 ± 1.0	-933276 ± 910	-883051 ± 960	647.293 ± .704	167 166	166	74
Kaliophilite $KAlSiO_4$	158.167	31.85 ± .30	59.89 ± .05	-503926 ± 420	-476230 ± 430	349.086 ± .315	78	13	
Leucite $KAlSi_2O_6$	218.252	44.05 ± .40	88.39 ± .05	-721650 ± 750	-681642 ± 760	499.657 ± .557	78	13	
β-Spodumene $LiAl(SiO_3)_2$	186.090		78.22 ± .02	-720995 ± 810				13	
Eucryptite $LiAlSiO_4$	126.004			-505126 ± 550				13	
Low Albite $NaAlSi_3O_8$	262.224	50.20 ± .40	100.07 ± .13	-937146 ± 740	-883988 ± 760	647.980 ± .557	78 79	166	74
High Albite (Analbite) $NaAlSi_3O_8$	262.224	54.67 ± .45	100.43 ± .09	-934513 ± 770	-882687 ± 790	647.026 ± .579	168 167	166	62
$NaAlSi_3O_8$ Glass $NaAlSi_3O_8$	262.224	62.95 ± .60	110.09 ± .19	-922609 ± 760	-873252 ± 790	640.110 ± .579	166	166	74
Nepheline $NaAlSiO_4$	142.055	29.72 ± .30	54.16 ± .06	-497029 ± 1000	-469664 ± 1010	344.273 ± .740	78	165	74
Nepheline *s. s.* $Na_{.8}K_{.2}AlSiO_4$	145.277			-500993 ± 450				11	
Analcime $NaAlSi_2O_6\cdot H_2O$	220.155	56.03 ± .60	97.49 ± .10	-786341 ± 860	-734262 ± 880	538.228 ± .645	78	6	

Name and formula	Gram formula weight	Entropy $S°_{298.15}$ (cal deg-gfw^{-1})	Molar volume (cm^3)	$\Delta H°_{f,298.15}$ (cal gfw^{-1})	$\Delta G°_{f,298.15}$ (cal gfw^{-1})	Log $K_{f,298.15}$	References $S°_{298.15}$	References $\Delta H°_{f,298.15}$ or $\Delta G°_{f,298.15}$	References $H_T - H°_{298}$
			Sheet structure silicates						
Dickite $Al_2Si_2O_5(OH)_4$	258.161	47.10 ± .30	99.30 ± .07	-979165 ± 900	-902142 ± 910	661.287 ± .667	86	12	
Kaolinite $Al_2Si_2O_5(OH)_4$	258.161	48.53 ± .30	99.52 ± .26	-979465 ± 950	-902868 ± 960	661.819 ± .704	86	12 91	
Halloysite $Al_2Si_2O_5(OH)_4$	258.161	48.6 ± .3	99.3 ±1.0	-974995 ± 900	-898419 ± 910	658.558 ± .667	86	12	
Muscovite $KAl_2[AlSi_3O_{10}](OH)_2$	398.313	69.0 ± .7	140.71 .18	-1421180 ± 1300	-1330103 ± 1320	974.991 ± .968	177	9 125	119
Phlogopite $KMg_3[AlSi_3O_{10}](OH)_2$	417.286	76.4 ±1.0	149.91 ± .36				132		
Fluor-Phlogopite $KMg_3[AlSi_3O_{10}]F_2$	421.268	75.90 ± .50	146.37 ± .18	-1522020 ± 1200	-1439522 ± 1210	1055.197 ± .887	78	77	74
Talc $Mg_3Si_4O_{10}(OH)_2$	379.289	62.34 ± .15	136.25 ± .26	-1415205 ± 1710	-1324486 ± 1720	970.873 ± 1.261	137	8 137	137
Chrysotile $Mg_3[Si_2O_5](OH)_4$	277.134		108.5 ± .6	-1043180 ± 1000				83	

SILVER (REFERENCE STATE) **GRAM FORMULA WEIGHT 107.870**

Ag: Face-centered cubic crystals 298.15° to melting point 1234°K.

Liquid 1234° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	10.200	10.200	0.000	0.000	0.000
UNCERTAINTY		0.050	0.050			
400	0.625	12.010	10.447	.000	.000	.000
500	1.245	13.390	10.900	.000	.000	.000
600	1.885	14.550	11.408	.000	.000	.000
700	2.535	15.560	11.939	.000	.000	.000
800	3.195	16.440	12.446	.000	.000	.000
900	3.880	17.250	12.939	.000	.000	.000
1000	4.585	17.990	13.405	.000	.000	.000
1100	5.310	18.680	13.853	.000	.000	.000
1200	6.060	19.330	14.280	.000	.000	.000
1234	6.315	19.540	14.420	.000	.000	.000
1234	9.170	21.850	14.420	.000	.000	.000
1300	9.650	22.230	14.807	.000	.000	.000
1400	10.380	22.770	15.356	.000	.000	.000
1500	11.110	23.270	15.863	.000	.000	.000
1600	11.840	23.750	16.350	.000	.000	.000
1700	12.570	24.190	16.796	.000	.000	.000
1800	13.300	24.610	17.221	.000	.000	.000
1900	14.030	25.000	17.616	.000	.000	.000
2000	14.760	25.380	18.000	.000	.000	.000

MELTING POINT	1234 DEG K	BOILING POINT	2437 DEG K
HEAT OF FUSION	2.855 KCAL	HEAT OF VAPOR.	60.780 KCAL
H -H 298 0	1.3730 KCAL	MOLAR VOLUME	0.24551 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 158 COMPILED 6-13-66

ALUMINUM (REFERENCE STATE) **GRAM FORMULA WEIGHT 26.981**

Al: Face-centered cubic crystals 298.15° to melting point 933°K.

Liquid 933° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	6.770	6.770	0.000	0.000	0.000
UNCERTAINTY		0.020	0.020			
400	0.610	8.259	6.734	.000	.000	.000
500	1.241	9.935	7.453	.000	.000	.000
600	1.900	11.135	7.968	.000	.000	.000
700	2.585	12.191	8.498	.000	.000	.000
800	3.302	13.148	9.020	.000	.000	.000
900	4.064	14.045	9.529	.000	.000	.000
933	4.329	14.331	9.691	.000	.000	.000
933	6.889	17.075	9.691	.000	.000	.000
1000	7.397	17.604	10.207	.000	.000	.000
1100	8.156	18.327	10.912	.000	.000	.000
1200	8.915	18.987	11.558	.000	.000	.000
1300	9.673	19.594	12.153	.000	.000	.000
1400	10.432	20.157	12.706	.000	.000	.000
1500	11.191	20.680	13.219	.000	.000	.000
1600	11.950	21.170	13.701	.000	.000	.000
1700	12.709	21.630	14.154	.000	.000	.000
1800	13.467	22.064	14.582	.000	.000	.000
1900	14.226	22.474	14.987	.000	.000	.000
2000	14.985	22.863	15.370	.000	.000	.000

MELTING POINT	933 DEG K	BOILING POINT	2767 DEG K
HEAT OF FUSION	2.560 KCAL	HEAT OF VAPOR.	69.497 KCAL
H -H 298 0	1.0940 KCAL	MOLAR VOLUME	0.23899 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 158 68 159 COMPILED 3-31-67

ARSENIC (REFERENCE STATE) GRAM FORMULA WEIGHT 74.922

As: Rhombohedral crystals 298.15° to sublimation point 885°K.

Ideal tetratomic gas 885° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	8.400	8.400	0.000	0.000	0.000
UNCERTAINTY		0.200	0.200			
400	0.614	10.170	8.635	.000	.000	.000
500	1.239	11.560	9.082	.000	.000	.000
600	1.880	12.730	9.597	.000	.000	.000
700	2.541	13.750	10.120	.000	.000	.000
800	3.229	14.670	10.634	.000	.000	.000
885	3.837	15.350	11.014	.000	.000	.000
885	11.448	23.950	11.014	.000	.000	.000
900	11.522	24.070	11.268	.000	.000	.000
1000	12.014	24.600	12.586	.000	.000	.000
1100	12.506	25.080	13.711	.000	.000	.000
1200	12.999	25.490	14.657	.000	.000	.000
1300	13.492	25.890	15.512	.000	.000	.000
1400	13.985	26.270	16.281	.000	.000	.000
1500	14.478	26.610	16.958	.000	.000	.000
1600	14.972	26.930	17.572	.000	.000	.000
1700	15.467	27.230	18.132	.000	.000	.000
1800	15.962	27.510	18.642	.000	.000	.000
1900	16.457	27.770	19.108	.000	.000	.000
2000	16.952	28.020	19.544	.000	.000	.000

MELTING POINT DEG K BOILING POINT 885 DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. 7.611 KCAL

$H_{298} - H_0$ 1.226 KCAL MOLAR VOLUME 0.30982 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 3-31-67

GOLD (REFERENCE STATE) GRAM FORMULA WEIGHT 196.967

Au: Face-centered cubic crystals 298.15° to melting point 1336°K.

Liquid 1336° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	11.310	11.310	0.000	0.000	0.000
UNCERTAINTY		0.050	0.050			
400	0.625	13.110	11.547	.000	.000	.000
500	1.245	14.500	12.010	.000	.000	.000
600	1.880	15.650	12.517	.000	.000	.000
700	2.525	16.660	13.053	.000	.000	.000
800	3.180	17.520	13.545	.000	.000	.000
900	3.850	18.310	14.032	.000	.000	.000
1000	4.530	19.030	14.500	.000	.000	.000
1100	5.220	19.690	14.945	.000	.000	.000
1200	5.930	20.310	15.368	.000	.000	.000
1300	6.660	20.890	15.767	.000	.000	.000
1336	6.925	21.090	15.906	.000	.000	.000
1336	9.880	23.300	15.906	.000	.000	.000
1400	10.330	23.630	16.251	.000	.000	.000
1500	11.030	24.110	16.757	.000	.000	.000
1600	11.730	24.560	17.229	.000	.000	.000
1700	12.430	24.980	17.668	.000	.000	.000
1800	13.130	25.380	18.086	.000	.000	.000
1900	13.830	25.760	18.481	.000	.000	.000
2000	14.530	26.120	18.855	.000	.000	.000

MELTING POINT	1336 DEG K	BOILING POINT	3081 DEG K
HEAT OF FUSION	2.955 KCAL	HEAT OF VAPOR.	80.080 KCAL
$H_{298} - H_0$	1.4340 KCAL	MOLAR VOLUME	0.24414 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 6-13-66

BORON (REFERENCE STATE) GRAM FORMULA WEIGHT 10.811

B: Rhombohedral crystals 298.15° to melting point 2450°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	1.403	1.403	0.000	0.000	0.000
UNCERTAINTY		0.100	0.100			
400	0.327	2.339	1.521	.000	.000	.000
500	0.740	3.257	1.777	.000	.000	.000
600	1.215	4.122	2.097	.000	.000	.000
700	1.731	4.917	2.444	.000	.000	.000
800	2.276	5.644	2.799	.000	.000	.000
900	2.842	6.310	3.152	.000	.000	.000
1000	3.427	6.927	3.500	.000	.000	.000
1100	4.031	7.502	3.837	.000	.000	.000
1200	4.650	8.041	4.166	.000	.000	.000
1300	5.284	8.548	4.483	.000	.000	.000
1400	5.931	9.028	4.792	.000	.000	.000
1500	6.592	9.483	5.088	.000	.000	.000
1600	7.265	9.918	5.377	.000	.000	.000
1700	7.950	10.333	5.657	.000	.000	.000
1800	8.645	10.730	5.927	.000	.000	.000
1900	9.348	11.110	6.190	.000	.000	.000
2000	10.057	12.113	7.084	.000	.000	.000

MELTING POINT	2450	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	5.390	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	0.2920	KCAL	MOLAR VOLUME	0.10483	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148	148	COMPILED
	159	4-15-67

BARIUM (REFERENCE STATE) **GRAM FORMULA WEIGHT 137.340**

Ba: Body-centered cubic crystals 298.15° to 648°K. β crystals 648° to melting point 983°K. Liquid 983° to boiling point 1895°K. Ideal monatomic gas 1895° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	16.000	16.000	0.000	0.000	0.000
UNCERTAINTY		1.000	1.000			
400	0.656	17.900	16.260	.000	.000	.000
500	1.334	19.410	16.742	.000	.000	.000
600	2.046	20.710	17.300	.000	.000	.000
643	2.360	21.210	17.538	.000	.000	.000
643	2.510	21.440	17.538	.000	.000	.000
700	2.921	22.070	17.897	.000	.000	.000
800	3.694	23.100	18.482	.000	.000	.000
900	4.537	24.090	19.049	.000	.000	.000
983	5.290	24.870	19.493	.000	.000	.000
983	7.120	26.740	19.493	.000	.000	.000
1000	7.247	26.880	19.633	.000	.000	.000
1100	7.997	27.600	20.330	.000	.000	.000
1200	8.747	28.250	20.961	.000	.000	.000
1300	9.497	28.850	21.545	.000	.000	.000
1400	10.247	29.410	22.091	.000	.000	.000
1500	10.997	29.920	22.589	.000	.000	.000
1600	11.747	30.410	23.068	.000	.000	.000
1700	12.497	30.860	23.509	.000	.000	.000
1800	13.247	31.290	23.931	.000	.000	.000
1895	50.665	51.030	24.293	.000	.000	.000
1895	50.665	51.030	24.293	.000	.000	.000
1900	50.692	50.560	23.880	.000	.000	.000
2000	51.354	50.900	25.223	.000	.000	.000

MELTING POINT 983 DEG K BOILING POINT 1895 DEG K

HEAT OF FUSION 1.830 KCAL HEAT OF VAPOR. 36.700 KCAL

$H_{298} - H_0$ KCAL MOLAR VOLUME 0.91324 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 149 78 COMPILED 4-15-67

BERYLLIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 9.012

Be: Hexagonal close packed crystals 298.15° to melting point 1556°K. Liquid 1556° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	2.280	2.280	0.000	0.000	0.000
UNCERTAINTY		0.020	0.020			
400	0.440	3.540	2.440	.000	.000	.000
500	0.940	4.650	2.770	.000	.000	.000
600	1.485	5.640	3.165	.000	.000	.000
700	2.060	6.530	3.587	.000	.000	.000
800	2.655	7.320	4.001	.000	.000	.000
900	3.270	8.050	4.417	.000	.000	.000
1000	3.910	8.730	4.820	.000	.000	.000
1100	4.580	9.360	5.196	.000	.000	.000
1200	5.270	9.960	5.568	.000	.000	.000
1300	5.980	10.530	5.930	.000	.000	.000
1400	6.720	11.080	6.280	.000	.000	.000
1500	7.480	11.600	6.613	.000	.000	.000
1556	7.920	11.920	6.830	.000	.000	.000
1556	10.720	13.720	6.830	.000	.000	.000
1600	11.050	13.920	7.014	.000	.000	.000
1700	11.800	14.390	7.449	.000	.000	.000
1800	12.550	14.810	7.838	.000	.000	.000
1900	13.300	15.210	8.210	.000	.000	.000
2000	14.050	15.600	8.575	.000	.000	.000

MELTING POINT	1556 DEG K	BOILING POINT	2756 DEG K
HEAT OF FUSION	2.800 KCAL	HEAT OF VAPOR.	78.040 KCAL
$H_{298} - H_0$	0.4670 KCAL	MOLAR VOLUME	0.11663 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 6-13-66

BISMUTH (REFERENCE STATE) **GRAM FORMULA WEIGHT 208.980**

Bi: Rhombohedral crystals 298.15° to melting point 544.5°K.

Liquid 544.5° to boiling point 2040°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H T 298)/T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	13.560	13.560	0.000	0.000	0.000
UNCERTAINTY		0.100	0.100			
400	0.650	15.430	13.805	.000	.000	.000
500	1.340	16.970	14.290	.000	.000	.000
544.5	1.660	17.580	14.533	.000	.000	.000
544.5	4.260	22.360	14.533	.000	.000	.000
600	4.680	23.100	15.300	.000	.000	.000
700	5.430	24.260	16.503	.000	.000	.000
800	6.180	25.260	17.535	.000	.000	.000
900	6.930	26.140	18.440	.000	.000	.000
1000	7.680	26.930	19.250	.000	.000	.000
1100	8.430	27.650	19.986	.000	.000	.000
1200	9.180	28.300	20.650	.000	.000	.000
1300	9.930	28.900	21.262	.000	.000	.000
1400	10.680	29.450	21.821	.000	.000	.000
1500	11.430	29.970	22.350	.000	.000	.000
1600	12.180	30.460	22.847	.000	.000	.000
1700	12.930	30.910	23.304	.000	.000	.000
1800	13.680	31.340	23.740	.000	.000	.000
1852	14.075	31.562	23.961	.000	.000	.000
2000	15.190	32.110	24.515	.000	.000	.000
1900	14.440	31.720	24.120	.000	.000	.000

MELTING POINT	544.5 DEG K	BOILING POINT	2040 DEG K
HEAT OF FUSION	2.600 KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	1.536 KCAL	MOLAR VOLUME	0.50930 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 74 158 COMPILED 5-18-67

BROMINE (REFERENCE STATE) GRAM FORMULA WEIGHT 159.818

Br_2: Liquid 298.15° to boiling point 332.62°K. Ideal diatomic gas 332.62° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	36.384	36.384	0.000	0.000	0.000
UNCERTAINTY		0.080	0.080			
332.62	.623	38.328	36.455	.000	.000	.000
332.62	7.687	59.565	36.455	.000	.000	.000
400	8.273	61.203	40.520	.000	.000	.000
500	9.156	63.172	44.860	.000	.000	.000
600	10.044	64.791	48.051	.000	.000	.000
700	10.937	66.167	50.543	.000	.000	.000
800	11.833	67.363	52.572	.000	.000	.000
900	12.731	68.421	54.275	.000	.000	.000
1000	13.631	69.370	55.739	.000	.000	.000
1100	14.533	70.229	57.017	.000	.000	.000
1200	15.436	71.015	58.152	.000	.000	.000
1300	16.341	71.740	59.170	.000	.000	.000
1400	17.247	72.411	60.092	.000	.000	.000
1500	18.155	73.037	60.934	.000	.000	.000
1600	19.064	73.624	61.709	.000	.000	.000
1700	19.974	74.176	62.427	.000	.000	.000
1800	20.885	74.696	63.093	.000	.000	.000
1900	21.797	75.190	63.718	.000	.000	.000
2000	22.711	75.658	64.302	.000	.000	.000

MELTING POINT	265.90 DEG K	BOILING POINT	332.62 DEG K
HEAT OF FUSION	2.527 KCAL	HEAT OF VAPOR.	7.064 KCAL
H -H 298 0	5.8590 KCAL	MOLAR VOLUME	1.3044 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148	148	COMPILED
	158	12-10-66

CARBON (REFERENCE STATE) GRAM FORMULA WEIGHT 12.011

C: Graphite 298.15° to 2000°K.

TEMP, DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	1.372	1.372	0.000	0.000	0.000
UNCERTAINTY		0.005	0.005			
400	0.250	2.088	1.463	.000	.000	.000
500	0.569	2.797	1.659	.000	.000	.000
600	0.947	3.484	1.906	.000	.000	.000
700	1.372	4.139	2.179	.000	.000	.000
800	1.831	4.752	2.463	.000	.000	.000
900	2.318	5.324	2.748	.000	.000	.000
1000	2.824	5.857	3.033	.000	.000	.000
1100	3.347	6.355	3.312	.000	.000	.000
1200	3.883	6.822	3.586	.000	.000	.000
1300	4.432	7.261	3.852	.000	.000	.000
1400	4.988	7.674	4.111	.000	.000	.000
1500	5.552	8.063	4.362	.000	.000	.000
1600	6.122	8.430	4.604	.000	.000	.000
1700	6.696	8.778	4.839	.000	.000	.000
1800	7.275	9.109	5.067	.000	.000	.000
1900	7.857	9.424	5.289	.000	.000	.000
2000	8.442	9.724	5.503	.000	.000	.000

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	0.2520 KCAL	MOLAR VOLUME	0.12663 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 158 28 COMPILED 5-18-67

DIAMOND GRAM FORMULA WEIGHT 12.011

C: Diamond 298.15° to 1200°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	0.57	0.57	0.453	0.693	-0.508
UNCERTAINTY		0.003	0.003	0.010	0.020	0.015
400	0.200	1.14	0.64	0.403	0.783	-0.428
500	0.486	1.77	0.80	0.370	0.884	-0.387
600	0.842	2.42	1.01	0.348	0.988	-0.360
700	1.251	3.05	1.26	0.332	1.096	-0.342
800	1.700	3.65	1.52	0.322	1.205	-0.329
900	2.180	4.22	1.80	0.315	1.310	-0.318
1000	2.685	4.75	2.06	0.314	1.423	-0.311
1100	3.212	5.25	2.33	0.318	1.536	-0.305
1200	3.760	5.73	2.59	0.330	1.643	-0.299

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.08166 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 155	158 27	158 56	COMPILED 5-17-67

CALCIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 40.080

Ca: α crystals (face-centered cubic) 298.15° to 737°K. β crystals (body-centered cubic) 737° to melting point 1123°K. Liquid 1123° to boiling point 1756°K. Ideal monatomic gas 1756° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	9.950	9.950	0.000	0.000	0.000
UNCERTAINTY		0.100	0.100			
400	0.650	11.830	10.205	.000	.000	.000
500	1.335	13.350	10.680	.000	.000	.000
600	2.060	14.670	11.237	.000	.000	.000
700	2.825	15.850	11.814	.000	.000	.000
737	3.120	16.260	12.026	.000	.000	.000
737	3.180	16.340	12.026	.000	.000	.000
800	3.660	16.960	12.385	.000	.000	.000
900	4.490	17.940	12.951	.000	.000	.000
1000	5.390	18.890	13.500	.000	.000	.000
1100	6.350	19.800	14.027	.000	.000	.000
1123	6.570	20.010	14.160	.000	.000	.000
1123	8.540	21.760	14.160	.000	.000	.000
1200	9.110	22.250	14.658	.000	.000	.000
1300	9.850	22.850	15.273	.000	.000	.000
1400	10.590	23.390	15.826	.000	.000	.000
1500	11.330	23.910	16.357	.000	.000	.000
1600	12.070	24.380	16.836	.000	.000	.000
1700	12.810	24.830	17.295	.000	.000	.000
1756	13.220	25.070	17.542	.000	.000	.000
1756	49.622	45.800	17.542	.000	.000	.000
1800	49.829	45.920	18.237	.000	.000	.000
1900	50.329	46.190	19.701	.000	.000	.000
2000	50.829	46.440	21.025	.000	.000	.000

MELTING POINT 1123 DEG K BOILING POINT 1756 DEG K

HEAT OF FUSION 1.970 KCAL HEAT OF VAPOR. 36.402 KCAL

$H_{298} - H_0$ 1.3750 KCAL MOLAR VOLUME 0.62596 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 4-15-67

CADMIUM (REFERENCE STATE) **GRAM FORMULA WEIGHT 112.400**

Cd: Hexagonal close packed crystals 298.15° to melting point 594.18°K. Liquid 594.18° to boiling point 1040°K. Ideal monatomic gas 1040° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H 298)/T T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	12.380	12.380	0.000	0.000	0.000
UNCERTAINTY		0.040	0.040			
400	0.646	14.240	12.625	.000	.000	.000
500	1.310	15.720	13.100	.000	.000	.000
594.18	1.960	16.910	13.611	.000	.000	.000
594.18	3.440	19.400	13.611	.000	.000	.000
600	3.483	19.480	13.675	.000	.000	.000
700	4.193	20.570	14.580	.000	.000	.000
800	4.903	21.520	15.391	.000	.000	.000
900	5.613	22.360	16.123	.000	.000	.000
1000	6.323	23.110	16.787	.000	.000	.000
1040	6.607	23.390	17.037	.000	.000	.000
1040	30.402	46.270	17.037	.000	.000	.000
1100	30.703	46.550	18.638	.000	.000	.000
1200	31.200	46.980	20.980	.000	.000	.000
1300	31.697	47.380	22.998	.000	.000	.000
1400	32.194	47.750	24.754	.000	.000	.000
1500	32.691	48.090	26.296	.000	.000	.000
1600	33.188	48.410	27.667	.000	.000	.000
1700	33.685	48.710	28.895	.000	.000	.000
1800	34.182	48.990	30.000	.000	.000	.000
1900	34.679	49.250	30.998	.000	.000	.000
2000	35.176	49.520	31.932	.000	.000	.000

MELTING POINT	594.18 DEG K	BOILING POINT	1040 DEG K
HEAT OF FUSION	1.480 KCAL	HEAT OF VAPOR.	23.795 KCAL
$H_{298} - H_0$	1.4940 KCAL	MOLAR VOLUME	0.31083 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 3-31-67

CERIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 140.120

Ce: α crystals (face-centered cubic) 298.15° to 1003°K.
β crystals 1003° to melting point 1077°K. Liquid 1077° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	15.300	15.300	0.000	0.000	0.000
UNCERTAINTY		2.000	2.000			
400	0.672	17.240	15.560	.000	.000	.000
500	1.365	18.780	16.050	.000	.000	.000
600	2.090	20.110	16.627	.000	.000	.000
700	2.860	21.280	17.194	.000	.000	.000
800	3.660	22.360	17.785	.000	.000	.000
900	4.510	23.350	18.339	.000	.000	.000
1000	5.400	24.290	18.890	.000	.000	.000
1003	5.420	24.320	18.917	.000	.000	.000
1003	6.120	25.020	18.917	.000	.000	.000
1077	6.790	25.660	19.355	.000	.000	.000
1077	8.030	26.810	19.355	.000	.000	.000
1100	8.250	27.010	19.510	.000	.000	.000
1200	9.180	27.820	20.170	.000	.000	.000
1300	10.120	28.570	20.785	.000	.000	.000
1400	11.050	29.260	21.367	.000	.000	.000
1500	11.850	29.810	21.910	.000	.000	.000
1600	12.650	30.330	22.424	.000	.000	.000
1700	13.450	30.810	22.898	.000	.000	.000
1800	14.250	31.270	23.353	.000	.000	.000
1900	15.050	31.700	23.779	.000	.000	.000
2000	15.850	32.110	24.185	.000	.000	.000

MELTING POINT 1077 DEG K BOILING POINT DEG K

HEAT OF FUSION 1.240 KCAL HEAT OF VAPOR. KCAL

H -H 298 0 1.6700 KCAL MOLAR VOLUME 0.49642 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 4-15-67

CHLORINE (REFERENCE STATE) GRAM FORMULA WEIGHT 70.906

Cl_2: Ideal diatomic gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	53.288	53.288	0.000	0.000	0.000
UNCERTAINTY		0.010	0.010			
400	0.845	55.723	53.610	.000	.000	.000
500	1.698	57.627	54.231	.000	.000	.000
600	2.567	59.211	54.933	.000	.000	.000
700	3.445	60.564	55.643	.000	.000	.000
800	4.331	61.746	56.332	.000	.000	.000
900	5.221	62.795	56.994	.000	.000	.000
1000	6.115	63.736	57.621	.000	.000	.000
1100	7.012	64.591	58.216	.000	.000	.000
1200	7.912	65.374	58.781	.000	.000	.000
1300	8.814	66.096	59.316	.000	.000	.000
1400	9.718	66.766	59.825	.000	.000	.000
1500	10.624	67.391	60.308	.000	.000	.000
1600	11.532	67.977	60.769	.000	.000	.000
1700	12.441	68.529	61.211	.000	.000	.000
1800	13.352	69.049	61.631	.000	.000	.000
1900	14.264	69.543	62.036	.000	.000	.000
2000	15.179	70.012	62.422	.000	.000	.000

MELTING POINT	172.16 DEG K	BOILING POINT	239.10 DEG K
HEAT OF FUSION	1.531 KCAL	HEAT OF VAPOR.	4.878 KCAL
H -H 298 0	2.1940 KCAL	MOLAR VOLUME	584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 158 COMPILED 6-13-66

COBALT (REFERENCE STATE) **GRAM FORMULA WEIGHT 58.933**

Co: α crystals (hexagonal close packed) 298.15° to 700°K.
β crystals (face-centered cubic) 700° to melting point 1768°
Liquid 1768° to 2000°K. Curie point at 1394°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	7.180	7.180	0.000	0.000	0.000
UNCERTAINTY		0.100	0.100			
400	0.625	8.970	7.407	.000	.000	.000
500	1.280	10.440	7.880	.000	.000	.000
600	1.972	11.700	8.413	.000	.000	.000
700	2.700	12.820	8.963	.000	.000	.000
700	2.808	12.970	8.963	.000	.000	.000
800	3.560	13.980	9.530	.000	.000	.000
900	4.360	14.920	10.076	.000	.000	.000
1000	5.214	15.810	10.596	.000	.000	.000
1100	6.131	16.690	11.116	.000	.000	.000
1200	7.122	17.550	11.615	.000	.000	.000
1300	8.213	18.420	12.102	.000	.000	.000
1394	9.379	19.280	12.552	.000	.000	.000
1400	9.448	19.330	12.581	.000	.000	.000
1500	10.438	20.010	13.051	.000	.000	.000
1600	11.368	20.610	13.505	.000	.000	.000
1700	12.276	21.160	13.939	.000	.000	.000
1768	12.890	21.510	14.220	.000	.000	.000
1768	16.760	23.700	14.220	.000	.000	.000
1800	17.070	23.880	14.397	.000	.000	.000
1900	18.038	24.410	14.916	.000	.000	.000
2000	19.006	24.910	15.407	.000	.000	.000

MELTING POINT	1768 DEG K	BOILING POINT	3201 DEG K
HEAT OF FUSION	3.870 KCAL	HEAT OF VAPOR.	89.998 KCAL
H -H 298 0	1.1390 KCAL	MOLAR VOLUME	0.15942 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 4-15-67

CHROMIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 51.996

Cr: Body-centered cubic crystals 298.15° to melting point 2176°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	5.650	5.650	0.000	0.000	0.000
UNCERTAINTY		0.050	0.050			
400	0.591	7.350	5.872	.000	.000	.000
500	1.213	8.740	6.314	.000	.000	.000
600	1.871	9.940	6.822	.000	.000	.000
700	2.558	11.000	7.346	.000	.000	.000
800	3.270	11.950	7.862	.000	.000	.000
900	4.000	12.810	8.366	.000	.000	.000
1000	4.752	13.600	8.848	.000	.000	.000
1100	5.538	14.350	9.315	.000	.000	.000
1200	6.362	15.070	9.768	.000	.000	.000
1300	7.233	15.760	10.196	.000	.000	.000
1400	8.142	16.430	10.614	.000	.000	.000
1500	9.088	17.090	11.031	.000	.000	.000
1600	10.080	17.730	11.430	.000	.000	.000
1700	11.114	18.350	11.812	.000	.000	.000
1800	12.188	18.970	12.199	.000	.000	.000
1900	13.303	19.570	12.568	.000	.000	.000
2000	14.449	20.160	12.935	.000	.000	.000

MELTING POINT	2130 DEG K	BOILING POINT	2945 DEG K
HEAT OF FUSION	4.047 KCAL	HEAT OF VAPOR.	82.283 KCAL
$H_{298} - H_0$	0.9700 KCAL	MOLAR VOLUME	0.17283 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 3-31-67

COPPER (REFERENCE STATE) GRAM FORMULA WEIGHT 63.540

Cu: Face-centered cubic crystals 298.15° to melting point 1356°K.

Liquid 1356° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	7.970	7.970	0.000	0.000	0.000
UNCERTAINTY		0.040	0.040			
400	0.600	9.700	8.200	.000	.000	.000
500	1.215	11.070	8.640	.000	.000	.000
600	1.845	12.220	9.145	.000	.000	.000
700	2.480	13.200	9.657	.000	.000	.000
800	3.130	14.070	10.157	.000	.000	.000
900	3.800	14.860	10.638	.000	.000	.000
1000	4.490	15.580	11.090	.000	.000	.000
1100	5.190	16.250	11.532	.000	.000	.000
1200	5.895	16.870	11.957	.000	.000	.000
1300	6.615	17.440	12.352	.000	.000	.000
1357	7.040	17.760	12.572	.000	.000	.000
1357	10.160	20.060	12.572	.000	.000	.000
1400	10.480	20.290	12.804	.000	.000	.000
1500	11.230	20.810	13.323	.000	.000	.000
1600	11.980	21.290	13.803	.000	.000	.000
1700	12.730	21.740	14.252	.000	.000	.000
1800	13.480	22.170	14.681	.000	.000	.000
1900	14.230	22.580	15.091	.000	.000	.000
2000	14.980	22.960	15.470	.000	.000	.000

MELTING POINT	1356.6 DEG K	BOILING POINT	2846 DEG K
HEAT OF FUSION	3.120 KCAL	HEAT OF VAPOR.	72.610 KCAL
$H_{298} - H_0$	1.2010 KCAL	MOLAR VOLUME	0.17000 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 114 COMPILED 4-15-67

FLUORINE (REFERENCE STATE) GRAM FORMULA WEIGHT 37.997

F_2: Ideal diatomic gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	48.440	48.440	0.000	0.000	0.000
UNCERTAINTY		0.050	0.050			
400	0.784	50.700	48.740	.000	.000	.000
500	1.591	52.498	49.316	.000	.000	.000
600	2.423	54.015	49.977	.000	.000	.000
700	3.274	55.327	50.650	.000	.000	.000
800	4.140	56.482	51.307	.000	.000	.000
900	5.016	57.514	51.941	.000	.000	.000
1000	5.901	58.446	52.545	.000	.000	.000
1100	6.793	59.296	53.121	.000	.000	.000
1200	7.690	60.077	53.669	.000	.000	.000
1300	8.593	60.800	54.190	.000	.000	.000
1400	9.500	61.472	54.686	.000	.000	.000
1500	10.411	62.101	55.160	.000	.000	.000
1600	11.326	62.691	55.612	.000	.000	.000
1700	12.244	63.248	56.046	.000	.000	.000
1800	13.166	63.774	56.460	.000	.000	.000
1900	14.090	64.274	56.858	.000	.000	.000
2000	15.017	64.750	57.241	.000	.000	.000

MELTING POINT	53.54 DEG K	BOILING POINT	85.02 DEG K
HEAT OF FUSION	0.122 KCAL	HEAT OF VAPOR.	1.562 KCAL
H -H 298 0	2.1100 KCAL	MOLAR VOLUME	584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 148 158 COMPILED 12-10-66

IRON (REFERENCE STATE) GRAM FORMULA WEIGHT 55.847

Fe: α crystals (body-centered cubic) 298.15° to 1184°K. Curie point 1033°K. γ crystals (face-centered cubic) 1184° to 1665°K. δ crystals (body-centered cubic) 1665° to melting point 1809°K. Liquid 1809° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	6.520	6.520	0.000	0.000	0.000
UNCERTAINTY		0.030	0.030			
400	0.635	8.350	6.762	.000	.000	.000
500	1.310	9.860	7.240	.000	.000	.000
600	2.040	11.190	7.790	.000	.000	.000
700	2.830	12.400	8.357	.000	.000	.000
800	3.700	13.560	8.935	.000	.000	.000
900	4.680	14.720	9.520	.000	.000	.000
1000	5.840	15.940	10.100	.000	.000	.000
1100	7.220	17.260	10.696	.000	.000	.000
1184	8.030	17.970	11.188	.000	.000	.000
1184	8.255	18.160	11.188	.000	.000	.000
1200	8.390	18.270	11.278	.000	.000	.000
1300	9.210	18.920	11.835	.000	.000	.000
1400	10.050	19.540	12.361	.000	.000	.000
1500	10.900	20.130	12.863	.000	.000	.000
1600	11.770	20.690	13.334	.000	.000	.000
1665	12.340	21.040	13.630	.000	.000	.000
1665	12.600	21.200	13.630	.000	.000	.000
1700	12.940	21.400	13.788	.000	.000	.000
1800	13.930	21.970	14.231	.000	.000	.000
1809	14.020	22.020	14.270	.000	.000	.000
1809	17.650	24.030	14.270	.000	.000	.000
1900	18.610	24.540	14.745	.000	.000	.000
2000	19.660	25.080	15.250	.000	.000	.000

MELTING POINT 1809 DEG K BOILING POINT 3148 DEG K

HEAT OF FUSION 3.630 KCAL HEAT OF VAPOR. 83.710 KCAL

$H_{298} - H_0$ 1.0730 KCAL MOLAR VOLUME 0.16950 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 6-13-66

HYDROGEN (REFERENCE STATE) GRAM FORMULA WEIGHT 2.016

H_2: Ideal diatomic gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	31.208	31.208	0.000	0.000	0.000
UNCERTAINTY		0.010	0.010			
400	0.707	33.247	31.479	.000	.000	.000
500	1.406	34.806	31.994	.000	.000	.000
600	2.106	36.082	32.572	.000	.000	.000
700	2.808	37.165	33.154	.000	.000	.000
800	3.514	38.107	33.714	.000	.000	.000
900	4.226	38.946	34.250	.000	.000	.000
1000	4.944	39.702	34.758	.000	.000	.000
1100	5.670	40.394	35.239	.000	.000	.000
1200	6.404	41.033	35.696	.000	.000	.000
1300	7.148	41.628	36.130	.000	.000	.000
1400	7.902	42.187	36.543	.000	.000	.000
1500	8.668	42.716	36.937	.000	.000	.000
1600	9.446	43.217	37.313	.000	.000	.000
1700	10.233	43.695	37.676	.000	.000	.000
1800	11.030	44.150	38.022	.000	.000	.000
1900	11.836	44.586	38.357	.000	.000	.000
2000	12.651	45.004	38.678	.000	.000	.000

MELTING POINT	13.96 DEG K	BOILING POINT	20.39 DEG K
HEAT OF FUSION	0.028 KCAL	HEAT OF VAPOR.	0.216 KCAL
$H_{298} - H_0$	2.0240 KCAL	MOLAR VOLUME	584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 148 158 COMPILED 12-10-66

HAFNIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 178.490

Hf: Hexagonal close packed crystals 298.15° to melting point 2500°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	10.410	10.410	0.000	0.000	0.000
UNCERTAINTY		0.050	0.050			
400	0.636	12.240	10.650	.000	.000	.000
500	1.278	13.680	11.124	.000	.000	.000
600	1.939	14.880	11.648	.000	.000	.000
700	2.618	15.930	12.190	.000	.000	.000
800	3.316	16.860	12.715	.000	.000	.000
900	4.031	17.700	13.221	.000	.000	.000
1000	4.765	18.470	13.705	.000	.000	.000
1100	5.517	19.190	14.175	.000	.000	.000
1200	6.287	19.860	14.621	.000	.000	.000
1300	7.076	20.490	15.047	.000	.000	.000
1400	7.882	21.090	15.460	.000	.000	.000
1500	8.707	21.660	15.855	.000	.000	.000
1600	9.550	22.200	16.231	.000	.000	.000
1700	10.412	22.720	16.595	.000	.000	.000
1800	11.291	23.230	16.957	.000	.000	.000
1900	12.189	23.710	17.295	.000	.000	.000
2000	13.105	24.180	17.627	.000	.000	.000

MELTING POINT	2500 DEG K	BOILING POINT	4876 DEG K
HEAT OF FUSION	5.750 KCAL	HEAT OF VAPOR.	137.462 KCAL
H -H 298 0	1.397 KCAL	MOLAR VOLUME	0.32216 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 4-15-67

MERCURY (REFERENCE STATE) GRAM FORMULA WEIGHT 200.590

Hg: Liquid 298.15° to boiling point 629.73°K. Ideal monatomic gas 629.73° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	18.170	18.170	0.000	0.000	0.000
UNCERTAINTY		0.020	0.020			
400	0.673	20.114	18.431	.000	.000	.000
500	1.325	21.569	18.919	.000	.000	.000
600	1.974	22.751	19.461	.000	.000	.000
629.73	2.167	23.064	19.622	.000	.000	.000
629.73	16.339	45.567	19.622	.000	.000	.000
700	16.649	46.033	22.249	.000	.000	.000
800	17.146	46.697	25.265	.000	.000	.000
900	17.642	47.282	27.680	.000	.000	.000
1000	18.139	47.805	29.666	.000	.000	.000
1100	18.636	48.279	31.337	.000	.000	.000
1200	19.133	48.711	32.767	.000	.000	.000
1300	19.630	49.109	34.009	.000	.000	.000
1400	20.126	49.477	35.101	.000	.000	.000
1500	20.623	49.820	36.071	.000	.000	.000
1600	21.120	50.140	36.940	.000	.000	.000
1700	21.617	50.442	37.726	.000	.000	.000
1800	22.114	50.725	38.439	.000	.000	.000
1900	22.610	50.994	39.094	.000	.000	.000
2000	23.107	51.249	39.695	.000	.000	.000

MELTING POINT	234.29 DEG K	BOILING POINT	629.73 DEG K
HEAT OF FUSION	0.549 KCAL	HEAT OF VAPOR.	14.172 KCAL
$H_{298} - H_0$	2.2330 KCAL	MOLAR VOLUME	0.35425 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 158 COMPILED 4-15-67

IODINE (REFERENCE STATE) GRAM FORMULA WEIGHT 253.809

I_2: Crystals 298.15° to melting point 386.75°K. Liquid 386.75° to boiling point 458.39°K. Ideal diatomic gas 458.39° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	27.757	27.757	0.000	0.000	0.000
UNCERTAINTY		0.040	0.040			
386.75	1.232	31.312	28.126	.000	.000	.000
386.75	4.941	40.901	28.126	.000	.000	.000
400	5.196	41.601	28.611	.000	.000	.000
458.39	6.322	44.221	30.429	.000	.000	.000
458.39	16.348	66.092	30.429	.000	.000	.000
500	16.719	66.876	33.438	.000	.000	.000
600	17.616	68.510	39.150	.000	.000	.000
700	18.515	69.896	43.446	.000	.000	.000
800	19.416	71.100	46.830	.000	.000	.000
900	20.320	72.164	49.586	.000	.000	.000
1000	21.225	73.118	51.893	.000	.000	.000
1100	22.132	73.982	53.862	.000	.000	.000
1200	23.041	74.773	55.572	.000	.000	.000
1300	23.950	75.501	57.078	.000	.000	.000
1400	24.862	76.177	58.418	.000	.000	.000
1500	25.775	76.806	59.623	.000	.000	.000
1600	26.689	77.397	60.716	.000	.000	.000
1700	27.605	77.952	61.714	.000	.000	.000
1800	28.522	78.476	62.630	.000	.000	.000
1900	29.441	78.973	63.478	.000	.000	.000
2000	30.361	79.444	64.263	.000	.000	.000

MELTING POINT	386.75 DEG K	BOILING POINT	458.39 DEG K
HEAT OF FUSION	3.709 KCAL	HEAT OF VAPOR.	10.026 KCAL
H -H 298 0	3.1540 KCAL	MOLAR VOLUME	1.22586 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 148 158 COMPILED 4-15-67

POTASSIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 39.102

K: Body-centered cubic crystals 298.15° to melting point 336.4°K. Liquid 336.4° to fictive boiling point 1043.7°K. Ideal monatomic gas 1043.7° to 2000°K. The equilibrium boiling point to the real gas is 1037°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	15.480	15.480	0.000	0.000	0.000
UNCERTAINTY		0.020	0.020			
336.4	.280	16.364	15.530	.000	.000	.000
336.4	.842	18.030	15.530	.000	.000	.000
400	1.327	19.355	16.037	.000	.000	.000
500	2.070	21.013	16.873	.000	.000	.000
600	2.796	22.338	17.678	.000	.000	.000
700	3.512	23.442	18.425	.000	.000	.000
800	4.224	24.392	19.112	.000	.000	.000
900	4.936	25.231	19.747	.000	.000	.000
1000	5.657	25.990	20.333	.000	.000	.000
1043.7	5.970	26.300	20.580	.000	.000	.000
1043.7	25.014	44.547	20.580	.000	.000	.000
1100	25.294	44.805	21.810	.000	.000	.000
1200	25.791	45.238	23.745	.000	.000	.000
1300	26.288	45.635	25.413	.000	.000	.000
1400	26.785	46.004	26.872	.000	.000	.000
1500	27.282	46.347	28.159	.000	.000	.000
1600	27.779	46.668	29.306	.000	.000	.000
1700	28.277	46.969	30.335	.000	.000	.000
1800	28.775	47.254	31.268	.000	.000	.000
1900	29.275	47.524	32.116	.000	.000	.000
2000	29.775	47.781	32.893	.000	.000	.000

MELTING POINT	336.4 DEG K	BOILING POINT	1043.7 DEG K
HEAT OF FUSION	0.562 KCAL	HEAT OF VAPOR.	19.044 KCAL
$H_{298} - H_0$	1.6930 KCAL	MOLAR VOLUME	1.0841 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 68 COMPILED 4-15-67

LITHIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 6.939

Li: Crystals 298.15° to melting point 453.69°K. Liquid 453.69° to boiling point 1638°K. Ideal monatomic gas 1638° to 2000°K. The equilibrium boiling point to the real gas is 1620°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	6.950	6.950	0.000	0.000	0.000
UNCERTAINTY		0.040	0.040			
400	0.632	8.770	7.190	.000	.000	.000
453.69	.999	9.626	7.424	.000	.000	.000
453.69	1.716	11.207	7.424	.000	.000	.000
500	2.050	11.911	7.811	.000	.000	.000
600	2.763	13.212	8.607	.000	.000	.000
700	3.463	14.290	9.343	.000	.000	.000
800	4.155	15.214	10.020	.000	.000	.000
900	4.846	16.028	10.644	.000	.000	.000
1000	5.536	16.755	11.219	.000	.000	.000
1100	6.224	17.411	11.753	.000	.000	.000
1200	6.912	18.009	12.249	.000	.000	.000
1300	7.598	18.558	12.713	.000	.000	.000
1400	8.283	19.066	13.150	.000	.000	.000
1500	8.966	19.537	13.560	.000	.000	.000
1600	9.647	19.977	13.948	.000	.000	.000
1638	9.905	20.137	14.090	.000	.000	.000
1638	45.065	41.602	14.090	.000	.000	.000
1700	45.374	41.786	15.095	.000	.000	.000
1800	45.871	42.071	16.587	.000	.000	.000
1900	46.368	42.340	17.936	.000	.000	.000
2000	46.866	42.595	19.162	.000	.000	.000

MELTING POINT	453.69 DEG K	BOILING POINT	1638 DEG K
HEAT OF FUSION	0.717 KCAL	HEAT OF VAPOR.	35.160 KCAL
$H_{298} - H_0$	1.1050 KCAL	MOLAR VOLUME	0.31111 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 113 COMPILED 4-15-67

MAGNESIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 24.312

Mg: Hexagonal close packed crystals 298.15° to melting point 922°K. Liquid 922° to boiling point 1378°K. Ideal monatomic gas 1363° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	7.810	7.810	0.000	0.000	0.000
UNCERTAINTY		0.030	0.030			
400	0.621	9.600	8.047	.000	.000	.000
500	1.260	11.020	8.500	.000	.000	.000
600	1.926	12.240	9.030	.000	.000	.000
700	2.620	13.310	9.567	.000	.000	.000
800	3.342	14.270	10.092	.000	.000	.000
900	4.093	15.160	10.612	.000	.000	.000
922	4.261	15.340	10.719	.000	.000	.000
922	6.401	17.660	10.719	.000	.000	.000
1000	7.010	18.290	11.280	.000	.000	.000
1100	7.790	19.040	11.958	.000	.000	.000
1200	8.570	19.710	12.568	.000	.000	.000
1300	9.350	20.340	13.148	.000	.000	.000
1363	9.841	20.710	13.490	.000	.000	.000
1363	40.290	43.050	13.490	.000	.000	.000
1400	40.475	43.184	14.273	.000	.000	.000
1500	40.972	43.527	16.212	.000	.000	.000
1600	41.469	43.847	17.929	.000	.000	.000
1700	41.966	44.149	19.463	.000	.000	.000
1800	42.463	44.433	20.842	.000	.000	.000
1900	42.960	44.701	22.090	.000	.000	.000
2000	43.457	44.956	23.227	.000	.000	.000

MELTING POINT	922 DEG K	BOILING POINT	1363 DEG K
HEAT OF FUSION	2.140 KCAL	HEAT OF VAPOR.	30.449 KCAL
$H_{298} - H_0$	1.1950 KCAL	MOLAR VOLUME	0.33451 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 4-15-67

MANGANESE (REFERENCE STATE) GRAM FORMULA WEIGHT 54.938

Mn: α crystals 298.15° to 990°K. β crystals 990° to 1360°K. γ crystals 1360° to 1410°K. δ crystals 1410° to melting point 1517°K. Liquid 1517° to boiling point 2324°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	7.650	7.650	0.000	0.000	0.000
UNCERTAINTY		0.020	0.020			
400	0.690	9.640	7.915	.000	.000	.000
500	1.385	11.190	8.420	.000	.000	.000
600	2.190	12.530	8.880	.000	.000	.000
700	2.895	13.720	9.584	.000	.000	.000
800	3.715	14.810	10.166	.000	.000	.000
900	4.570	15.820	10.742	.000	.000	.000
990	5.360	16.660	11.245	.000	.000	.000
990	5.895	17.200	11.245	.000	.000	.000
1000	5.985	17.280	11.295	.000	.000	.000
1100	6.890	18.150	11.886	.000	.000	.000
1200	7.795	18.930	12.434	.000	.000	.000
1300	8.715	19.670	12.966	.000	.000	.000
1400	10.220	20.780	13.480	.000	.000	.000
1410	10.330	20.860	13.534	.000	.000	.000
1410	10.760	21.160	13.534	.000	.000	.000
1500	11.780	21.860	14.007	.000	.000	.000
1517	11.970	21.990	14.099	.000	.000	.000
1517	15.470	24.297	14.099	.000	.000	.000
1600	16.380	24.940	14.702	.000	.000	.000
1700	17.480	25.610	15.328	.000	.000	.000
1800	18.580	26.240	15.918	.000	.000	.000
1900	19.680	26.830	16.472	.000	.000	.000
2000	20.780	27.400	17.010	.000	.000	.000

MELTING POINT 1517 DEG K BOILING POINT 2324 DEG K

HEAT OF FUSION 3.500 KCAL HEAT OF VAPOR. 52.790 KCAL

$H_{298} - H_0$ 1.1940 KCAL MOLAR VOLUME 0.17576 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 4-15-67

MOLYBDENUM (REFERENCE STATE) GRAM FORMULA WEIGHT 95.940

Mo: Body-centered cubic crystals 298.15° to melting point 2890°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	6.850	6.850	0.000	0.000	0.000
UNCERTAINTY		0.050	0.050			
400	0.598	8.570	7.075	.000	.000	.000
500	1.205	9.930	7.520	.000	.000	.000
600	1.828	11.060	8.013	.000	.000	.000
700	2.462	12.040	8.523	.000	.000	.000
800	3.104	12.900	9.020	.000	.000	.000
900	3.756	13.660	9.487	.000	.000	.000
1000	4.422	14.370	9.948	.000	.000	.000
1100	5.102	15.010	10.372	.000	.000	.000
1200	5.802	15.620	10.785	.000	.000	.000
1300	6.518	16.190	11.176	.000	.000	.000
1400	7.253	16.740	11.559	.000	.000	.000
1500	8.006	17.260	11.923	.000	.000	.000
1600	8.777	17.760	12.274	.000	.000	.000
1700	9.566	18.230	12.603	.000	.000	.000
1800	10.373	18.690	12.927	.000	.000	.000
1900	11.198	19.140	13.246	.000	.000	.000
2000	12.041	19.570	13.549	.000	.000	.000

MELTING POINT 2890 DEG K BOILING POINT 4883 DEG K

HEAT OF FUSION 6.650 KCAL HEAT OF VAPOR. 141.680 KCAL

$H_{298} - H_0$ 1.0980 KCAL MOLAR VOLUME 0.22435 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 6-13-66

NITROGEN (REFERENCE STATE) GRAM FORMULA WEIGHT 28.013

N_2: Ideal diatomic gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	45.770	45.770	0.000	0.000	0.000
UNCERTAINTY		0.020	0.020			
400	0.710	47.818	46.043	.000	.000	.000
500	1.413	49.386	46.560	.000	.000	.000
600	2.125	50.685	47.143	.000	.000	.000
700	2.853	51.806	47.730	.000	.000	.000
800	3.596	52.798	48.303	.000	.000	.000
900	4.355	53.692	48.853	.000	.000	.000
1000	5.129	54.507	49.378	.000	.000	.000
1100	5.917	55.258	49.879	.000	.000	.000
1200	6.718	55.955	50.357	.000	.000	.000
1300	7.529	56.604	50.812	.000	.000	.000
1400	8.350	57.212	51.248	.000	.000	.000
1500	9.179	57.784	51.665	.000	.000	.000
1600	10.015	58.324	52.065	.000	.000	.000
1700	10.858	58.835	52.448	.000	.000	.000
1800	11.707	59.320	52.816	.000	.000	.000
1900	12.560	59.782	53.171	.000	.000	.000
2000	13.418	60.222	53.513	.000	.000	.000

MELTING POINT	63.18 DEG K	BOILING POINT	77.36 DEG K
HEAT OF FUSION	0.172 KCAL	HEAT OF VAPOR.	1.335 KCAL
$H_{298} - H_0$	2.0720 KCAL	MOLAR VOLUME	584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 148 158 COMPILED 12-10-66

SODIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 22.990

Na: Body-centered cubic crystals 298.15° to melting point 370.98°K. Liquid 370.98° to fictive boiling point 1176.9°K. Ideal monatomic gas 1176.9° to 2000°K. The equilibrium boiling point to the real gas is 1156°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	12.240	12.240	0.000	0.000	0.000
UNCERTAINTY		0.120	0.120			
370.98	.514	13.778	12.394	.000	.000	.000
370.98	1.135	15.454	12.394	.000	.000	.000
400	1.356	16.028	12.638	.000	.000	.000
500	2.097	17.683	13.489	.000	.000	.000
600	2.818	18.998	14.301	.000	.000	.000
700	3.524	20.085	15.051	.000	.000	.000
800	4.219	21.014	15.740	.000	.000	.000
900	4.909	21.827	16.373	.000	.000	.000
1000	5.599	22.554	16.955	.000	.000	.000
1100	6.295	23.216	17.493	.000	.000	.000
1176.9	6.836	23.688	17.880	.000	.000	.000
1176.9	30.121	43.473	17.880	.000	.000	.000
1200	30.235	43.573	18.377	.000	.000	.000
1300	30.732	43.971	20.331	.000	.000	.000
1400	31.229	44.339	22.033	.000	.000	.000
1500	31.726	44.682	23.531	.000	.000	.000
1600	32.223	45.003	24.864	.000	.000	.000
1700	32.719	45.304	26.058	.000	.000	.000
1800	33.216	45.588	27.135	.000	.000	.000
1900	33.713	45.857	28.113	.000	.000	.000
2000	34.211	46.112	29.006	.000	.000	.000

MELTING POINT	370.98 DEG K	BOILING POINT	1176.9 DEG K
HEAT OF FUSION	0.622 KCAL	HEAT OF VAPOR.	23.285 KCAL
H -H 298 0	1.5410 KCAL	MOLAR VOLUME	0.56912 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 112 158 COMPILED 4-15-67

NIOBIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 92.906

Nb: Body-centered cubic crystals 298.15° to melting point 2740°K.

TEMP. DEG K	H -H 298 T (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	8.700	8.700	0.000	0.000	0.000
UNCERTAINTY		0.100	0.100			
400	0.611	10.460	8.932	.000	.000	.000
500	1.226	11.830	9.378	.000	.000	.000
600	1.849	12.970	9.888	.000	.000	.000
700	2.482	13.940	10.394	.000	.000	.000
800	3.126	14.800	10.892	.000	.000	.000
900	3.778	15.570	11.372	.000	.000	.000
1000	4.442	16.270	11.828	.000	.000	.000
1100	5.116	16.910	12.259	.000	.000	.000
1200	5.799	17.510	12.677	.000	.000	.000
1300	6.493	18.060	13.065	.000	.000	.000
1400	7.196	18.580	13.440	.000	.000	.000
1500	7.911	19.070	13.796	.000	.000	.000
1600	8.635	19.540	14.143	.000	.000	.000
1700	9.369	19.980	14.469	.000	.000	.000
1800	10.113	20.410	14.792	.000	.000	.000
1900	10.868	20.820	15.100	.000	.000	.000
2000	11.632	21.210	15.394	.000	.000	.000

MELTING POINT 2740 DEG K BOILING POINT 5017 DEG K

HEAT OF FUSION 6.302 KCAL HEAT OF VAPOR. 163.003 KCAL

H -H 298 0 1.2550 KCAL MOLAR VOLUME 0.25880 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 6-13-66

NICKEL (REFERENCE STATE) GRAM FORMULA WEIGHT 58.710

Ni: Face-centered cubic crystals (magnetic) to Curie point 630°K. Non magnetic 630° to melting point 1726°K. Liquid 1726° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	7.140	7.140	0.000	0.000	0.000
UNCERTAINTY		0.020	0.020			
400	0.666	9.060	7.395	.000	.000	.000
500	1.373	10.640	7.894	.000	.000	.000
600	2.155	12.060	8.468	.000	.000	.000
631	2.423	12.500	8.660	.000	.000	.000
700	2.945	13.290	9.083	.000	.000	.000
800	3.685	14.280	9.674	.000	.000	.000
900	4.439	15.170	10.238	.000	.000	.000
1000	5.215	15.990	10.775	.000	.000	.000
1100	6.014	16.750	11.283	.000	.000	.000
1200	6.836	17.470	11.773	.000	.000	.000
1300	7.680	18.140	12.232	.000	.000	.000
1400	8.539	18.780	12.681	.000	.000	.000
1500	9.404	19.380	13.111	.000	.000	.000
1600	10.269	19.940	13.522	.000	.000	.000
1700	11.134	20.460	13.911	.000	.000	.000
1726	11.359	20.600	14.019	.000	.000	.000
1726	15.535	23.020	14.019	.000	.000	.000
1800	16.296	23.450	14.397	.000	.000	.000
1900	17.326	24.000	14.881	.000	.000	.000
2000	18.356	24.530	15.352	.000	.000	.000

MELTING POINT 1726 DEG K BOILING POINT 3187 DEG K

HEAT OF FUSION 4.176 KCAL HEAT OF VAPOR. 88.523 KCAL

H -H 298 0 1.1440 KCAL MOLAR VOLUME 0.15746 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 4-15-67

OXYGEN (REFERENCE STATE) GRAM FORMULA WEIGHT 31.999

O_2: Ideal diatomic gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	48.996	48.996	0.000	0.000	0.000
UNCERTAINTY		0.010	0.010			
400	0.724	51.083	49.273	.000	.000	.000
500	1.455	52.714	49.804	.000	.000	.000
600	2.210	54.090	50.407	.000	.000	.000
700	2.988	55.289	51.020	.000	.000	.000
800	3.786	56.353	51.620	.000	.000	.000
900	4.600	57.312	52.201	.000	.000	.000
1000	5.427	58.184	52.757	.000	.000	.000
1100	6.266	58.983	53.287	.000	.000	.000
1200	7.114	59.721	53.793	.000	.000	.000
1300	7.971	60.407	54.275	.000	.000	.000
1400	8.835	61.047	54.736	.000	.000	.000
1500	9.706	61.648	55.177	.000	.000	.000
1600	10.583	62.214	55.600	.000	.000	.000
1700	11.465	62.749	56.005	.000	.000	.000
1800	12.354	63.257	56.394	.000	.000	.000
1900	13.249	63.741	56.768	.000	.000	.000
2000	14.149	64.202	57.127	.000	.000	.000

MELTING POINT	54.39 DEG K	BOILING POINT	90.13 DEG K
HEAT OF FUSION	0.106 KCAL	HEAT OF VAPOR.	1.629 KCAL
$H_{298} - H_0$	2.0750 KCAL	MOLAR VOLUME	584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 158 COMPILED 6-13-66

PHOSPHORUS (REFERENCE STATE) GRAM FORMULA WEIGHT 30.974

P: Crystals (red triclinic, V) 298.15° to sublimation point 704°K.

Ideal diatomic gas 704° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	5.450	5.450	0.000	0.000	0.000
UNCERTAINTY		0.020	0.020			
400	0.542	7.011	5.656	.000	.000	.000
500	1.113	8.283	6.057	.000	.000	.000
600	1.714	9.377	6.520	.000	.000	.000
700	2.347	10.352	6.999	.000	.000	.000
704	2.373	10.388	7.017	.000	.000	.000
704	23.015	29.571	-3.121	.000	.000	.000
800	23.430	30.124	0.836	.000	.000	.000
900	23.866	30.638	4.120	.000	.000	.000
1000	24.305	31.100	6.795	.000	.000	.000
1100	24.746	31.520	9.024	.000	.000	.000
1200	25.189	31.905	10.914	.000	.000	.000
1300	25.633	32.261	12.543	.000	.000	.000
1400	26.078	32.591	13.964	.000	.000	.000
1500	26.524	32.899	15.216	.000	.000	.000
1600	26.971	33.187	16.330	.000	.000	.000
1700	27.419	33.459	17.330	.000	.000	.000
1800	27.867	33.715	18.233	.000	.000	.000
1900	28.316	33.958	19.055	.000	.000	.000
2000	28.766	34.188	19.805	.000	.000	.000

MELTING POINT DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 0.8620 KCAL MOLAR VOLUME 0.41109 CAL/BAR
298 0

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 148 COMPILED 4-15-67

LEAD (REFERENCE STATE) GRAM FORMULA WEIGHT 207.190

Pb: Faced-centered cubic crystals 298.15° to melting point 600.6°K.

Liquid 600.6° to boiling point 2023°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	15.550	15.550	0.000	0.000	0.000
UNCERTAINTY		0.100	0.100			
400	0.655	17.440	15.802	.000	.000	.000
500	1.320	18.920	16.280	.000	.000	.000
600	2.013	20.180	16.825	.000	.000	.000
600.6	2.017	20.190	16.832	.000	.000	.000
600.6	3.164	22.100	16.832	.000	.000	.000
700	3.886	23.210	17.659	.000	.000	.000
800	4.610	24.180	18.417	.000	.000	.000
900	5.322	25.020	19.107	.000	.000	.000
1000	6.028	25.760	19.732	.000	.000	.000
1100	6.727	26.420	20.305	.000	.000	.000
1200	7.417	27.030	20.849	.000	.000	.000
1300	8.104	27.570	21.336	.000	.000	.000
1400	8.788	28.080	21.803	.000	.000	.000
1500	9.472	28.550	22.235	.000	.000	.000
1600	10.156	28.980	22.632	.000	.000	.000
1700	10.840	29.410	23.034	.000	.000	.000
1800	11.524	29.800	23.398	.000	.000	.000
1900	12.208	30.170	23.745	.000	.000	.000
2000	12.892	30.520	24.074	.000	.000	.000
2023	13.049	30.600	24.148	.000	.000	.000
2023	55.520	51.590	24.148	.000	.000	.000

MELTING POINT	600.6 DEG K	BOILING POINT	2023 DEG K
HEAT OF FUSION	1.147 KCAL	HEAT OF VAPOR.	42.471 KCAL
H -H 298 0	1.6430 KCAL	MOLAR VOLUME	0.43659 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 4-15-67

PLATINUM (REFERENCE STATE) GRAM FORMULA WEIGHT 195.090

Pt: Face-centered cubic crystals 298.15° to melting point 2043°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW),	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	9.950	9.950	0.000	0.000	0.000
UNCERTAINTY		0.050	0.050			
400	0.635	11.780	10.192	.000	.000	.000
500	1.270	13.200	10.660	.000	.000	.000
600	1.920	14.380	11.180	.000	.000	.000
700	2.580	15.400	11.714	.000	.000	.000
800	3.260	16.310	12.235	.000	.000	.000
900	3.950	17.120	12.731	.000	.000	.000
1000	4.660	17.870	13.210	.000	.000	.000
1100	5.380	18.550	13.659	.000	.000	.000
1200	6.110	19.190	14.098	.000	.000	.000
1300	6.850	19.780	14.511	.000	.000	.000
1400	7.600	20.330	14.901	.000	.000	.000
1500	8.360	20.860	15.287	.000	.000	.000
1600	9.140	21.360	15.647	.000	.000	.000
1700	9.930	21.840	15.999	.000	.000	.000
1800	10.730	22.300	16.339	.000	.000	.000
1900	11.540	22.740	16.666	.000	.000	.000
2000	12.360	23.160	16.980	.000	.000	.000

MELTING POINT 2043 DEG K BOILING POINT 4097 DEG K

HEAT OF FUSION 4.700 KCAL HEAT OF VAPOR. 121.830 KCAL

H -H 1.3740 KCAL MOLAR VOLUME 0.21728 CAL/BAR
298 0

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 4-15-67

SULFUR (REFERENCE STATE) GRAM FORMULA WEIGHT 32.064

S: Orthorhombic crystals 298.15° to 368.54°K monoclinic crystals 368.54° to melting point 388.36°K. Liquid 388.36° to boiling point 717.75°K. Ideal diatomic gas 717.75° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	7.600	7.600	0.000	0.000	0.000
UNCERTAINTY		0.040	0.040			
368.54	.394	8.786	7.717	.000	.000	.000
368.54	.490	9.047	7.717	.000	.000	.000
388.36	.609	9.360	7.792	.000	.000	.000
388.36	1.019	10.417	7.792	.000	.000	.000
400	1.109	10.645	7.872	.000	.000	.000
500	2.048	12.738	8.642	.000	.000	.000
600	2.904	14.302	9.462	.000	.000	.000
700	3.704	15.536	10.245	.000	.000	.000
717.75	3.842	15.730	10.377	.000	.000	.000
717.75	17.171	30.900	6.977	.000	.000	.000
800	17.529	31.363	9.452	.000	.000	.000
900	17.967	31.879	11.916	.000	.000	.000
1000	18.408	32.344	13.936	.000	.000	.000
1100	18.851	32.765	15.628	.000	.000	.000
1200	19.295	33.152	17.073	.000	.000	.000
1300	19.740	33.509	18.324	.000	.000	.000
1400	20.187	33.840	19.421	.000	.000	.000
1500	20.635	34.148	20.391	.000	.000	.000
1600	21.083	34.438	21.261	.000	.000	.000
1700	21.532	34.710	22.044	.000	.000	.000
1800	21.982	34.967	22.755	0.000	0.000	0.000
1900	22.432	35.210	23.404	.000	.000	.000
2000	22.883	35.442	24.000	.000	.000	.000

MELTING POINT 388.36 DEG K BOILING POINT 717.75 DEG K

HEAT OF FUSION 0.411 KCAL HEAT OF VAPOR. 2.300 KCAL

$H_{298} - H_0$ 1.0530 KCAL MOLAR VOLUME 0.37072 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 158 78 COMPILED 5-11-67

DIATOMIC SULFUR (IDEAL GAS) GRAM FORMULA WEIGHT 64.128

S_2: Ideal diatomic gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	54.51	54.51	30.840	19.120	-14.015
UNCERTAINTY		0.10	0.10	0.150	0.160	0.117
400	0.811	56.85	54.82	29.433	15.210	-8.310
500	1.639	58.69	55.41	28.383	11.775	-5.147
600	2.486	60.24	56.09	27.518	8.538	-3.110
700	3.347	61.56	56.78	26.779	5.435	-1.697
800	4.217	62.73	57.45	0.000	0.000	0.000
900	5.093	63.76	58.10	0.000	0.000	0.000
1000	5.975	64.69	58.71	0.000	0.000	0.000
1100	6.860	65.53	59.29	0.000	0.000	0.000
1200	7.749	66.30	59.85	0.000	0.000	0.000
1300	8.640	67.02	60.37	0.000	0.000	0.000
1400	9.533	67.68	60.87	0.000	0.000	0.000
1500	10.428	68.30	61.34	0.000	0.000	0.000
1600	11.325	68.87	61.80	0.000	0.000	0.000
1700	12.223	69.42	62.23	0.000	0.000	0.000
1800	13.123	69.93	62.64	0.000	0.000	0.000
1900	14.024	70.42	63.04	0.000	0.000	0.000
2000	14.926	70.88	63.42	0.000	0.000	0.000

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	2.1410 KCAL	MOLAR VOLUME	584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SULFUR..... ORTHO-MCNO 368.54, M. P. MONO 388.36,
B. P. 717.75 DEG K.

REFERENCES	148	148	COMPILED
	158	158	4-15-67

OCTA-ATOMIC SULFUR GRAM FORMULA WEIGHT 256.512

S_8: Ideal octatomic gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	102.82	102.82	24.200	11.672	-8.556
UNCERTAINTY		0.40	0.40	0.150	0.220	0.161
400	3.944	114.18	104.32	19.272	7.664	-4.187
500	7.999	123.22	107.22	15.815	5.157	-2.254
600	12.153	130.80	110.54	13.121	3.291	-1.199
700	16.367	137.29	113.91	10.935	1.834	-0.572
800	20.619	142.97	117.20	-95.413	-9.066	2.477
900	24.897	148.01	120.35	-94.639	1.681	-0.408
1000	29.193	152.53	123.34	-93.871	12.351	-2.699
1100	33.503	156.64	126.18	-93.105	22.923	-4.554
1200	37.823	160.40	128.88	-92.337	33.442	-6.091
1300	42.151	163.86	131.44	-91.569	43.907	-7.381
1400	46.485	167.08	133.88	-90.811	54.285	-8.474
1500	50.824	170.07	136.19	-90.056	64.615	-9.414
1600	55.168	172.87	138.39	-89.296	74.918	-10.233
1700	59.514	175.51	140.50	-88.542	85.147	-10.946
1800	63.864	177.99	142.51	-87.792	95.351	-11.577
1900	68.216	180.35	144.45	-87.040	105.487	-12.134
2000	72.569	182.58	146.30	-86.295	115.617	-12.634

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	7.4870 KCAL	MOLAR VOLUME	584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36,
B. P. 717.75 DEG K.

REFERENCES	148	148	COMPILED
	158	158	5-18-67

ANTIMONY (REFERENCE STATE) GRAM FORMULA WEIGHT 121.750

Sb: Rhombohedral crystals 298.15° to melting point 903°K. Liquid 903° to boiling point 1908°K. Ideal diatomic gas 1908° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	10.920	10.920	0.000	0.000	0.000
UNCERTAINTY		0.050	0.050			
400	0.625	12.720	11.157	.000	.000	.000
500	1.250	14.110	11.610	.000	.000	.000
600	1.890	15.280	12.130	.000	.000	.000
700	2.550	16.300	12.657	.000	.000	.000
800	3.240	17.220	13.170	.000	.000	.000
900	3.950	18.060	13.671	.000	.000	.000
903	4.020	18.130	13.676	.000	.000	.000
903	8.710	23.320	13.676	.000	.000	.000
1000	9.440	24.100	14.660	.000	.000	.000
1100	10.190	24.810	15.546	.000	.000	.000
1200	10.940	25.460	16.343	.000	.000	.000
1300	11.690	26.060	17.068	.000	.000	.000
1400	12.440	26.620	17.734	.000	.000	.000
1500	13.190	27.130	18.337	.000	.000	.000
1600	13.940	27.620	18.907	.000	.000	.000
1700	14.690	28.070	19.429	.000	.000	.000
1800	15.440	28.500	19.922	.000	.000	.000
1900	16.190	28.900	20.379	.000	.000	.000
1908	16.250	28.940	20.423	.000	.000	.000
1908	34.834	38.680	20.423	.000	.000	.000
2000	35.775	38.890	21.003	.000	.000	.000

MELTING POINT	903 DEG K	BOILING POINT	1908 DEG K
HEAT OF FUSION	4.690 KCAL	HEAT OF VAPOR.	18.584 KCAL
$H_{298} - H_0$	1.4100 KCAL	MOLAR VOLUME	0.43446 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68, 158 COMPILED 4-29-67

SELENIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 78.960

Se: Crystals 298.15° to melting point 490°K. Liquid 490° to boiling point 958°K. Ideal diatomic gas 958° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	10.144	10.144	0.000	0.000	0.000
UNCERTAINTY		0.050	0.050			
400	0.650	12.014	10.389	.000	.000	.000
490	1.266	13.464	10.880	.000	.000	.000
490	2.566	16.117	10.880	.000	.000	.000
500	2.650	16.204	10.904	.000	.000	.000
600	3.490	17.734	11.917	.000	.000	.000
700	4.330	19.034	12.848	.000	.000	.000
800	5.170	20.154	13.691	.000	.000	.000
900	6.010	21.144	14.466	.000	.000	.000
958	6.497	21.171	14.389	.000	.000	.000
958	19.972	35.237	14.389	.000	.000	.000
1000	20.160	35.424	15.264	.000	.000	.000
1100	20.610	35.854	17.118	.000	.000	.000
1200	21.060	36.244	18.694	.000	.000	.000
1300	21.510	36.614	20.068	.000	.000	.000
1400	21.970	36.944	21.251	.000	.000	.000
1500	22.420	37.264	22.317	.000	.000	.000
1600	22.880	37.554	23.254	.000	.000	.000
1700	23.340	37.834	24.105	.000	.000	.000
1800	23.810	38.104	24.876	.000	.000	.000
1900	24.270	38.354	25.580	.000	.000	.000
2000	24.740	38.594	26.224	.000	.000	.000

MELTING POINT 490 DEG K BOILING POINT 958 DEG K

HEAT OF FUSION 1.300 KCAL HEAT OF VAPOR. 13.473 KCAL

$H_{298} - H_0$ 1.3190 KCAL MOLAR VOLUME 0.39245 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 149 158 COMPILED 4-15-67

SILICON (REFERENCE STATE) GRAM FORMULA WEIGHT 28.086

Si: Crystals 298.15° to melting point 1685°K. Liquid 1685° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	4.500	4.500	0.000	0.000	0.000
UNCERTAINTY		0.020	0.020			
400	0.516	5.980	4.690	.000	.000	.000
500	1.062	7.200	5.076	.000	.000	.000
600	1.634	8.240	5.517	.000	.000	.000
700	2.225	9.150	5.971	.000	.000	.000
800	2.831	9.960	6.421	.000	.000	.000
900	3.451	10.690	6.856	.000	.000	.000
1000	4.081	11.360	7.279	.000	.000	.000
1100	4.720	11.970	7.679	.000	.000	.000
1200	5.366	12.530	8.058	.000	.000	.000
1300	6.018	13.050	8.421	.000	.000	.000
1400	6.676	13.540	8.771	.000	.000	.000
1500	7.340	13.990	9.097	.000	.000	.000
1600	8.010	14.420	9.414	.000	.000	.000
1685	8.583	14.770	9.676	.000	.000	.000
1685	20.665	21.940	9.676	.000	.000	.000
1700	20.756	21.990	9.781	.000	.000	.000
1800	21.366	22.340	10.470	.000	.000	.000
1900	21.976	22.670	11.104	.000	.000	.000
2000	22.586	22.980	11.687	.000	.000	.000

MELTING POINT	1685	DEG K	BOILING POINT	3553	DEG K
HEAT OF FUSION	12.082	KCAL	HEAT OF VAPOR.	93.891	KCAL
H -H 298 0	0.7690	KCAL	MOLAR VOLUME	0.28815	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 35 COMPILED 5-06-67

TIN (REFERENCE STATE) GRAM FORMULA WEIGHT 118.690

Sn: Crystals 298.15° to melting point 505°K. Liquid 505° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	12.320	12.320	0.000	0.000	0.000
UNCERTAINTY		0.060	0.060			
400	0.680	14.280	12.580	.000	.000	.000
500	1.390	15.860	13.080	.000	.000	.000
505	1.430	15.940	13.110	.000	.000	.000
505	3.100	19.250	13.110	.000	.000	.000
600	3.760	20.450	14.183	.000	.000	.000
700	4.445	21.510	15.160	.000	.000	.000
800	5.130	22.430	16.017	.000	.000	.000
900	5.820	23.230	16.763	.000	.000	.000
1000	6.500	23.950	17.450	.000	.000	.000
1100	7.190	24.610	18.074	.000	.000	.000
1200	7.870	25.200	18.642	.000	.000	.000
1300	8.560	25.750	19.165	.000	.000	.000
1400	9.240	26.260	19.660	.000	.000	.000
1500	9.930	26.730	20.110	.000	.000	.000
1600	10.610	27.170	20.539	.000	.000	.000
1700	11.300	27.590	20.943	.000	.000	.000
1800	11.980	27.980	21.324	.000	.000	.000
1900	12.670	28.350	21.682	.000	.000	.000
2000	13.350	28.700	22.025	.000	.000	.000

MELTING POINT	505 DEG K	BOILING POINT	2896 DEG K
HEAT OF FUSION	1.670 KCAL	HEAT OF VAPOR.	70.770 KCAL
H -H 298 0	1.5050 KCAL	MOLAR VOLUME	0.38932 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 159 COMPILED 12-10-66

STRONTIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 87.620

Sr: α crystals (face-centered cubic) 298.15° to 862°K. γ crystals (body-centered cubic) 862° to melting point 1043°K. Liquid 1043° to boiling point 1648°K. Ideal monatomic gas 1648° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	12.500	12.500	0.000	0.000	0.000
UNCERTAINTY		0.500	0.500			
400	0.660	14.400	12.750	.000	.000	.000
500	1.340	15.920	13.240	.000	.000	.000
600	2.050	17.220	13.803	.000	.000	.000
700	2.800	18.370	14.370	.000	.000	.000
800	3.580	19.410	14.935	.000	.000	.000
862	4.080	20.010	15.276	.000	.000	.000
862	4.280	20.240	15.276	.000	.000	.000
900	4.610	20.620	15.498	.000	.000	.000
1000	5.520	21.580	16.060	.000	.000	.000
1043	5.930	21.980	16.293	.000	.000	.000
1043	8.330	24.280	16.293	.000	.000	.000
1100	8.750	24.670	16.715	.000	.000	.000
1200	9.490	25.320	17.412	.000	.000	.000
1300	10.230	25.910	18.041	.000	.000	.000
1400	10.970	26.460	18.624	.000	.000	.000
1500	11.710	26.970	19.163	.000	.000	.000
1600	12.450	27.450	19.669	.000	.000	.000
1648	12.810	27.670	19.897	.000	.000	.000
1648	46.010	47.820	19.897	.000	.000	.000
1700	46.269	48.080	20.863	.000	.000	.000
1800	46.769	48.370	22.387	.000	.000	.000
1900	46.269	48.640	24.288	.000	.000	.000
2000	46.769	48.900	25.515	.000	.000	.000

MELTING POINT 1043 DEG K BOILING POINT 1648 DEG K

HEAT OF FUSION 2.400 KCAL HEAT OF VAPOR. 33.200 KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.81073 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 6-13-66

TELLURIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 127.600

Te: Crystals 298.15° to melting point 723°K. Liquid 723° to boiling point 1262°K. Ideal diatomic gas 1260° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	11.880	11.880	0.000	0.000	0.000
UNCERTAINTY		0.100	0.100			
400	0.653	13.760	12.127	.000	.000	.000
500	1.347	15.310	12.616	.000	.000	.000
600	2.094	16.670	13.180	.000	.000	.000
700	2.894	17.900	13.766	.000	.000	.000
723	3.085	18.120	13.853	.000	.000	.000
723	7.265	23.900	13.853	.000	.000	.000
800	7.960	24.860	14.910	.000	.000	.000
900	8.860	25.920	16.076	.000	.000	.000
1000	9.760	26.870	17.110	.000	.000	.000
1100	10.660	27.720	18.029	.000	.000	.000
1200	11.560	28.510	18.877	.000	.000	.000
1262	12.118	28.910	19.308	.000	.000	.000
1262	24.402	38.644	19.308	.000	.000	.000
1300	24.250	38.580	19.926	.000	.000	.000
1400	24.700	38.910	21.267	.000	.000	.000
1500	25.145	39.220	22.457	.000	.000	.000
1600	25.590	39.510	23.516	.000	.000	.000
1700	26.040	39.780	24.462	.000	.000	.000
1800	26.485	40.030	25.316	.000	.000	.000
1900	26.930	40.280	26.106	.000	.000	.000
2000	27.380	40.510	26.820	.000	.000	.000

MELTING POINT	723 DEG K	BOILING POINT	1262 DEG K
HEAT OF FUSION	4.180 KCAL	HEAT OF VAPOR.	12.284 KCAL
H -H 298 0	1.4630 KCAL	MOLAR VOLUME	0.48939 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 158 COMPILED 5-17-67

THORIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 232.038

Th: α crystals (face-centered cubic) 298.15° to 1673°K.
β crystals (body-centered cubic) 1673° to melting point 1968°K. Liquid 1968° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	12.760	12.760	0.000	0.000	0.000
UNCERTAINTY		0.200	0.200			
400	0.680	14.730	13.030	.000	.000	.000
500	1.380	16.290	13.530	.000	.000	.000
600	2.110	17.620	14.103	.000	.000	.000
700	2.870	18.790	14.690	.000	.000	.000
800	3.660	19.850	15.275	.000	.000	.000
900	4.480	20.810	15.832	.000	.000	.000
1000	5.330	21.710	16.380	.000	.000	.000
1100	6.220	22.550	16.895	.000	.000	.000
1200	7.130	23.350	17.408	.000	.000	.000
1300	8.070	24.100	17.892	.000	.000	.000
1400	9.040	24.820	18.363	.000	.000	.000
1500	10.050	25.510	18.810	.000	.000	.000
1600	11.080	26.180	19.255	.000	.000	.000
1673	11.850	26.660	19.577	.000	.000	.000
1673	12.520	27.060	19.577	.000	.000	.000
1700	12.820	27.240	19.699	.000	.000	.000
1800	13.920	27.870	20.137	.000	.000	.000
1900	15.020	28.470	20.565	.000	.000	.000
1968	15.770	28.860	20.850	.000	.000	.000
1968	20.270	31.150	20.850	.000	.000	.000
2000	20.620	31.330	21.020	.000	.000	.000

MELTING POINT	1968 DEG K	BOILING POINT	5120 DEG K
HEAT OF FUSION	4.500 KCAL	HEAT OF VAPOR.	121.930 KCAL
H -H 298 0	1.5560 KCAL	MOLAR VOLUME	0.47294 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 6-13-66

TITANIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 47.900

Ti: Hexagonal close packed crystals 298.15° to melting point 1943°K. Liquid 1943° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY.	LOG K
298.15	0.000	7.320	7.320	0.000	0.000	0.000
UNCERTAINTY		0.020	0.020			
400	0.627	9.130	7.562	.000	.000	.000
500	1.270	10.560	8.020	.000	.000	.000
600	1.935	11.770	8.545	.000	.000	.000
700	2.624	12.840	9.091	.000	.000	.000
800	3.337	13.790	9.619	.000	.000	.000
900	4.075	14.660	10.132	.000	.000	.000
1000	4.836	15.460	10.624	.000	.000	.000
1100	5.621	16.210	11.100	.000	.000	.000
1155	6.063	16.600	11.350	.000	.000	.000
1155	7.080	17.480	11.350	.000	.000	.000
1200	7.397	17.750	11.586	.000	.000	.000
1300	8.120	18.330	12.084	.000	.000	.000
1400	8.867	18.880	12.546	.000	.000	.000
1500	9.639	19.410	12.984	.000	.000	.000
1600	10.436	19.930	13.407	.000	.000	.000
1700	11.258	20.430	13.808	.000	.000	.000
1800	12.105	20.910	14.185	.000	.000	.000
1900	12.976	21.380	14.551	.000	.000	.000
1943	13.358	21.580	14.705	.000	.000	.000
1943	17.050	23.480	14.705	.000	.000	.000
2000	17.563	23.740	14.958	.000	.000	.000

MELTING POINT	1943 DEG K	BOILING POINT	3562 DEG K
HEAT OF FUSION	3.692 KCAL	HEAT OF VAPOR.	100.629 KCAL
H -H 298 0	1.1490 KCAL	MOLAR VOLUME	0.25409 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 4-15-67

URANIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 238.030

U: α crystals (orthorhombic) 298.15° to 941°K. β crystals (tetragonal) 941° to 1048°K. γ crystals (body-centered cubic) 1048° to melting point 1405°K. Liquid 1405° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H 298)/T T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	12.000	12.000	0.000	0.000	0.000
UNCERTAINTY		0.030	0.030			
400	0.700	14.010	12.260	.000	.000	.000
500	1.435	15.650	12.780	.000	.000	.000
600	2.230	17.100	13.383	.000	.000	.000
700	3.100	18.440	14.011	.000	.000	.000
800	4.050	19.710	14.647	.000	.000	.000
900	5.100	20.940	15.273	.000	.000	.000
941	5.560	21.440	15.530	.000	.000	.000
941	6.230	22.150	15.530	.000	.000	.000
1000	6.840	22.780	15.940	.000	.000	.000
1048	7.330	23.260	16.267	.000	.000	.000
1048	8.460	24.340	16.267	.000	.000	.000
1100	8.940	24.780	16.653	.000	.000	.000
1200	9.850	25.580	17.372	.000	.000	.000
1300	10.770	26.310	18.025	.000	.000	.000
1400	11.680	26.990	18.647	.000	.000	.000
1405	11.730	27.020	18.671	.000	.000	.000
1405	14.820	29.220	18.671	.000	.000	.000
1500	15.690	29.820	19.360	.000	.000	.000
1600	16.610	30.430	20.049	.000	.000	.000
1700	17.525	30.980	20.671	.000	.000	.000
1800	18.440	31.510	21.266	.000	.000	.000
1900	19.355	32.000	21.813	.000	.000	.000
2000	20.270	32.460	22.325	.000	.000	.000

MELTING POINT 1405 DEG K BOILING POINT 4473 DEG K

HEAT OF FUSION 3.090 KCAL HEAT OF VAPOR. 117.380 KCAL

$H_{298} - H_0$ 1.5210 KCAL MOLAR VOLUME 0.29869 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 4-15-67

VANADIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 50.942

V: Body-centered cubic crystals 298.15° to melting point 2175°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	6.910	6.910	0.000	0.000	0.000
UNCERTAINTY		0.100	0.100			
400	0.624	8.710	7.150	.000	.000	.000
500	1.260	10.130	7.610	.000	.000	.000
600	1.911	11.310	8.125	.000	.000	.000
700	2.574	12.330	8.653	.000	.000	.000
800	3.251	13.240	9.176	.000	.000	.000
900	3.945	14.060	9.677	.000	.000	.000
1000	4.660	14.810	10.150	.000	.000	.000
1100	5.402	15.520	10.609	.000	.000	.000
1200	6.172	16.190	11.047	.000	.000	.000
1300	6.969	16.820	11.459	.000	.000	.000
1400	7.792	17.430	11.864	.000	.000	.000
1500	8.644	18.020	12.257	.000	.000	.000
1600	9.531	18.590	12.633	.000	.000	.000
1700	10.457	19.150	12.999	.000	.000	.000
1800	11.421	19.710	13.365	.000	.000	.000
1900	12.420	20.250	13.713	.000	.000	.000
2000	13.457	20.780	14.051	.000	.000	.000

MELTING POINT	2175 DEG K	BOILING POINT	3682 DEG K
HEAT OF FUSION	5.002 KCAL	HEAT OF VAPOR.	108.005 KCAL
$H_{298} - H_0$	1.1090 KCAL	MOLAR VOLUME	0.19957 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 12-10-66

TUNGSTEN (REFERENCE STATE) GRAM FORMULA WEIGHT 183.850

W: Body-centered cubic crystals 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	7.800	7.800	0.000	0.000	0.000
UNCERTAINTY		0.100	0.100			
400	0.602	9.540	8.035	.000	.000	.000
500	1.208	10.890	8.474	.000	.000	.000
600	1.826	12.010	8.967	.000	.000	.000
700	2.452	12.980	9.477	.000	.000	.000
800	3.085	13.820	9.964	.000	.000	.000
900	3.726	14.580	10.440	.000	.000	.000
1000	4.373	15.260	10.887	.000	.000	.000
1100	5.028	15.900	11.329	.000	.000	.000
1200	5.692	16.470	11.727	.000	.000	.000
1300	6.363	17.010	12.115	.000	.000	.000
1400	7.043	17.520	12.489	.000	.000	.000
1500	7.731	17.990	12.836	.000	.000	.000
1600	8.427	18.440	13.173	.000	.000	.000
1700	9.131	18.870	13.499	.000	.000	.000
1800	9.843	19.270	13.802	.000	.000	.000
1900	10.563	19.660	14.101	.000	.000	.000
2000	11.291	20.040	14.394	.000	.000	.000

MELTING POINT 3680 DEG K BOILING POINT 5828 DEG K

HEAT OF FUSION 8.460 KCAL HEAT OF VAPOR. 196.920 KCAL

H -H 298 0 1.1900 KCAL MOLAR VOLUME 0.22813 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 4-29-67

ZINC (REFERENCE STATE) GRAM FORMULA WEIGHT 65.370

Zn: Hexagonal close packed crystals 298.15° to melting point 692.7°K. Liquid 692.7° to boiling point 1181°K. Ideal monatomic gas 1181° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	9.950	9.950	0.000	0.000	0.000
UNCERTAINTY		0.050	0.050			
400	0.630	11.760	10.185	.000	.000	.000
500	1.270	13.200	10.660	.000	.000	.000
600	1.940	14.410	11.177	.000	.000	.000
692.7	2.580	15.400	11.676	.000	.000	.000
692.7	4.345	17.950	11.676	.000	.000	.000
700	4.400	18.030	11.744	.000	.000	.000
800	5.150	19.030	12.592	.000	.000	.000
900	5.900	19.920	13.364	.000	.000	.000
1000	6.650	20.710	14.060	.000	.000	.000
1100	7.400	21.420	14.693	.000	.000	.000
1184	8.030	21.970	15.188	.000	.000	.000
1184	35.650	45.300	15.188	.000	.000	.000
1200	35.660	45.370	15.653	.000	.000	.000
1300	36.157	45.770	17.957	.000	.000	.000
1400	36.654	46.140	19.959	.000	.000	.000
1500	37.150	46.480	21.713	.000	.000	.000
1600	37.647	46.800	23.271	.000	.000	.000
1700	38.144	47.100	24.662	.000	.000	.000
1800	38.641	47.380	25.913	.000	.000	.000
1900	39.138	47.650	27.051	.000	.000	.000
2000	39.634	47.910	28.093	.000	.000	.000

MELTING POINT	692.7 DEG K	BOILING POINT	1184 DEG K
HEAT OF FUSION	1.765 KCAL	HEAT OF VAPOR.	27.620 KCAL
$H_{298} - H_0$	1.3500 KCAL	MOLAR VOLUME	0.21898 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 68 68 COMPILED 4-15-67

ZIRCONIUM (REFERENCE STATE) GRAM FORMULA WEIGHT 91.220

Zr: Hexagonal close packed crystals 298.15° to 1143.2°K. Body-centered cubic crystals 1143.2° to melting point 2128°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	9.310	9.310	0.000	0.000	0.000
UNCERTAINTY		0.040	0.040			
400	0.646	11.170	9.555	.000	.000	.000
500	1.317	12.667	10.033	.000	.000	.000
600	2.021	13.950	10.582	.000	.000	.000
700	2.746	15.067	11.144	.000	.000	.000
800	3.484	16.052	11.697	.000	.000	.000
900	4.229	16.930	12.231	.000	.000	.000
1000	4.983	17.725	12.742	.000	.000	.000
1100	5.753	18.458	13.228	.000	.000	.000
1143.2	6.087	18.752	13.427	.000	.000	.000
1143.2	7.049	19.594	13.427	.000	.000	.000
1200	7.491	19.975	13.732	.000	.000	.000
1300	8.265	20.594	14.236	.000	.000	.000
1400	9.047	21.173	14.711	.000	.000	.000
1500	9.835	21.717	15.160	.000	.000	.000
1600	10.630	22.231	15.587	.000	.000	.000
1700	11.433	22.717	15.992	.000	.000	.000
1800	12.242	23.180	16.379	.000	.000	.000
1900	13.058	23.621	16.748	.000	.000	.000
2000	13.882	24.043	17.102	.000	.000	.000

MELTING POINT	2128 DEG K	BOILING POINT	4747 DEG K
HEAT OF FUSION	4.890 KCAL	HEAT OF VAPOR.	136.400 KCAL
H -H 298 0	1.3170 KCAL	MOLAR VOLUME	0.33499 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 31 148 COMPILED 11-14-66

AMMONIA (IDEAL GAS) GRAM FORMULA WEIGHT 17.031

NH_3: Ideal gas 298.15° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	45.97	45.97	-11.020	-3.946	2.892
UNCERTAINTY		0.05	0.05	0.100	0.110	0.081
400	0.883	48.51	46.31	-11.552	-1.446	0.790
500	1.819	50.60	46.96	-12.016	1.135	-0.496
600	2.827	52.43	47.72	-12.414	3.804	-1.386
700	3.905	54.10	48.52	-12.753	6.535	-2.040
800	5.053	55.63	49.31	-13.036	9.310	-2.543
900	6.265	57.05	50.09	-13.271	12.118	-2.943
1000	7.540	58.40	50.86	-13.460	14.950	-3.267
1100	8.873	59.67	51.60	-13.610	17.799	-3.536
1200	10.260	60.87	52.32	-13.725	20.660	-3.763
1300	11.697	62.02	53.03	-13.809	23.528	-3.955
1400	13.180	63.12	53.71	-13.868	26.402	-4.122
1500	14.704	64.17	54.37	-13.907	29.280	-4.266
1600	16.267	65.18	55.02	-13.929	32.159	-4.393
1700	17.864	66.15	55.64	-13.934	35.042	-4.505
1800	19.491	67.08	56.25	-13.927	37.921	-4.604
1900	21.146	67.97	56.85	-13.908	40.802	-4.693
2000	22.826	68.84	57.42	-13.879	43.682	-4.773

MELTING POINT	195.36 DEG K	BOILING POINT	239.68 DEG K
HEAT OF FUSION	1.352 KCAL	HEAT OF VAPOR.	5.581 KCAL
H -H 298 0	2.3940 KCAL	MOLAR VOLUME	584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148	148	158	COMPILED
	158		3-31-67

METHANE (IDEAL GAS) GRAM FORMULA WEIGHT 16.043

CH_4: Ideal gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	44.49	44.49	-17.880	-12.126	8.889
UNCERTAINTY		0.05	0.05	0.080	0.090	0.066
400	0.923	47.14	44.84	-18.621	-10.046	5.489
500	1.960	49.45	45.53	-19.301	-7.823	3.419
600	3.138	51.60	46.37	-19.901	-5.470	1.993
700	4.454	53.62	47.26	-20.414	-3.021	0.943
800	5.897	55.55	48.18	-20.842	-0.508	0.139
900	7.458	57.38	49.10	-21.192	2.056	-0.499
1000	9.125	59.14	50.02	-21.467	4.653	-1.017
1100	10.887	60.82	50.92	-21.680	7.276	-1.446
1200	12.732	62.42	51.81	-21.839	9.918	-1.806
1300	14.652	63.96	52.69	-21.956	12.568	-2.113
1400	16.637	65.43	53.55	-22.035	15.229	-2.377
1500	18.679	66.84	54.39	-22.089	17.893	-2.607
1600	20.772	68.19	55.21	-22.122	20.555	-2.808
1700	22.910	69.49	56.01	-22.132	23.227	-2.986
1800	25.086	70.73	56.79	-22.129	25.893	-3.144
1900	27.298	71.93	57.56	-22.111	28.562	-3.285
2000	29.540	73.08	58.31	-22.084	31.228	-3.412

MELTING POINT 90.60 DEG K BOILING POINT 111.70 DEG K

HEAT OF FUSION 0.224 KCAL HEAT OF VAPOR. 1.988 KCAL

$H_{298} - H_0$ 2.3960 KCAL MOLAR VOLUME 584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 158 158 COMPILED 3-31-67

CEMENTITE GRAM FORMULA WEIGHT 179.552

Fe_3C: Crystals 298.15° to 1500°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	24.96	24.96	5.960	4.759	-3.488
UNCERTAINTY		0.80	0.80	0.320	0.410	0.301
400	2.690	32.72	25.99	6.495	4.262	-2.329
500	5.670	39.37	28.03	7.131	3.634	-1.589
600	8.390	44.33	30.35	7.283	2.917	-1.063
700	11.150	48.58	32.65	7.248	2.179	-0.680
800	13.940	52.31	34.88	6.969	1.467	-0.401
900	16.760	55.62	37.00	6.362	0.840	-0.204
1000	19.610	58.63	39.02	5.226	0.273	-0.060
1100	22.490	61.37	40.92	3.443	-0.116	0.023
1200	25.400	63.91	42.74	2.307	-0.427	0.078
1300	28.340	66.26	44.46	2.238	-0.673	0.113
1400	31.310	68.46	46.10	2.132	-0.900	0.141
1500	34.310	70.53	47.66	2.018	-1.097	0.160

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	4.3290 KCAL	MOLAR VOLUME	0.55521 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.

REFERENCES				
74	68	162		COMPILED
		68		1-12-67

ACANTHITE (ARGENTITE) GRAM FORMULA WEIGHT 247.804

Ag_2S: Monoclinic crystals 298.15° to 452°K. Cubic crystals (argentite) 452° to 1000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	34.14	34.14	-7.731	-9.562	7.009
UNCERTAINTY		0.10	0.10	0.210	0.200	0.147
400	1.970	39.80	34.87	-8.120	-10.174	5.559
452	3.085	42.42	35.59	-8.150	-10.436	5.046
452	4.095	44.65	35.59	-7.140	-10.436	5.046
500	5.140	46.85	36.57	-7.129	-10.795	4.718
600	7.300	50.79	38.62	-7.105	-11.538	4.203
700	9.460	54.12	40.61	-7.045	-12.270	3.831
800	11.630	57.02	42.48	-20.020	-14.242	3.891
900	13.790	59.56	44.24	-19.668	-13.531	3.286
1000	15.960	61.64	45.68	-19.349	-12.665	2.768

MELTING POINT	1061	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	0.81716	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SILVER..... M. P. 1234 DEG K.
SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36, B. P. 717.75 DEG K.

REFERENCES 74 52 47 139 COMPILED 2-12-67

CHALCOCITE GRAM FORMULA WEIGHT 159.144

Cu_2S: Orthorhombic crystals 298.15° to 376°K. Hexagonal crystals 376° to 623°K. Cubic crystals 623° to melting point 1403°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	28.86	28.86	-19.148	-20.734	15.199
UNCERTAINTY		0.50	0.50	0.300	0.340	0.249
376	1.520	33.39	29.35	-19.650	-21.190	12.317
376	2.440	35.84	29.35	-18.730	-21.190	12.317
400	3.000	37.28	29.78	-18.457	-21.351	11.666
500	5.320	42.45	31.81	-18.306	-22.092	9.656
600	7.650	46.70	33.95	-18.092	-22.867	8.329
623	8.180	47.57	34.44	-18.040	-23.052	8.087
623	8.380	47.89	34.44	-17.840	-23.052	8.087
700	9.950	50.26	36.05	-17.862	-23.689	7.396
800	11.980	52.98	38.00	-30.957	-25.739	7.031
900	14.010	55.36	39.79	-30.705	-25.090	6.093
1000	16.040	57.51	41.47	-30.496	-24.502	5.355
1100	18.080	59.45	43.01	-30.299	-23.902	4.749
1200	20.110	61.22	44.46	-30.123	-23.317	4.247
1300	22.140	62.84	45.81	-29.978	-22.764	3.827
1400	24.170	64.34	47.08	-36.125	-22.013	3.436

MELTING POINT	1403	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	0.65667	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

COPPER..... M. P. 1357 DEG K.
SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36, B. P. 717.75 DEG K.

REFERENCES	74	78	20	COMPILED
		160	127	5-06-67

TROILITE GRAM FORMULA WEIGHT 87.911

FeS: α crystals 298.15° to 411°K. β crystals 411° to Curie point 598°K. γ crystals 598° to melting point 1468°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	14.42	14.42	-24.130	-24.219	17.753
UNCERTAINTY		0.04	0.04	0.350	0.360	0.264
400	1.470	18.63	14.95	-24.404	-24.258	13.254
411	1.640	19.05	15.06	-24.391	-24.253	12.896
411	2.210	20.44	15.06	-23.821	-24.253	12.896
500	3.760	23.85	16.33	-23.728	-24.354	10.645
598	5.460	26.95	17.82	-23.580	-24.492	8.951
598	5.580	27.15	17.82	-23.460	-24.492	8.951
600	5.610	27.21	17.86	-23.464	-24.495	8.922
700	7.020	29.38	19.35	-23.644	-24.655	7.698
800	8.430	31.26	20.72	-36.929	-25.999	7.102
900	9.840	32.92	21.99	-36.937	-24.626	5.980
1000	11.250	34.41	23.16	-37.128	-23.254	5.082
1100	12.680	35.77	24.24	-37.521	-21.840	4.339
1200	14.150	37.05	25.26	-37.665	-20.419	3.719
1300	15.680	38.28	26.22	-37.400	-19.006	3.195
1400	17.260	39.45	27.12	-37.107	-17.605	2.748
1468	18.350	40.21	27.71	-36.897	-16.701	2.486
1468	26.080	45.47	27.71	-29.167	-16.701	2.486
1500	26.620	45.84	28.09	-29.045	-16.388	2.388
1600	28.320	46.93	29.23	-28.663	-15.546	2.124
1700	30.020	47.96	30.30	-28.582	-14.727	1.893
1800	31.720	48.93	31.31	-28.322	-13.909	1.689
1900	33.420	49.85	32.26	-31.752	-12.942	1.489
2000	35.120	50.73	33.17	-31.553	-11.969	1.308

MELTING POINT 1468 DEG K BOILING POINT DEG K

HEAT OF FUSION 7.730 KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.43499 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.
SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36, B. P. 717.75 DEG K.

REFERENCES 74 53 133 2 COMPILED 4-15-67

PYRITE GRAM FORMULA WEIGHT 119.975

FeS_2: Crystals 298.15° to 1000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	12.65	12.65	-41.000	-38.296	28.071
UNCERTAINTY		0.03	0.03	0.400	0.410	0.301
400	1.670	17.46	13.28	-42.183	-37.311	20.386
500	3.350	21.20	14.50	-43.056	-35.988	15.730
600	5.060	24.32	15.89	-43.788	-34.504	12.568
700	6.820	27.03	17.29	-44.418	-32.909	10.274
800	8.650	29.47	18.66	-71.108	-33.655	9.194
900	10.550	31.71	19.99	-71.064	-28.973	7.036
1000	12.520	33.79	21.27	-71.136	-24.298	5.310

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	2.3020 KCAL	MOLAR VOLUME	0.57218 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.

SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36, B. P. 717.75 DEG K.

REFERENCES 74 52 154 COMPILED 2-12-67

HYDROGEN SULFIDE (IDEAL GAS) GRAM FORMULA WEIGHT 34.080

H_2S: Ideal gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	49.16	49.16	-4.930	-8.016	5.876
UNCERTAINTY		0.05	0.05	0.150	0.160	0.117
400	0.849	51.61	49.48	-5.897	-8.983	4.908
500	1.718	53.54	50.11	-6.666	-9.666	4.225
600	2.627	55.20	50.82	-7.313	-10.203	3.717
700	3.579	56.67	51.56	-7.863	-10.640	3.322
800	4.575	58.00	52.28	-21.398	-12.219	3.338
900	5.611	59.22	52.98	-21.512	-11.064	2.687
1000	6.687	60.35	53.66	-21.595	-9.898	2.163
1100	7.799	61.41	54.32	-21.652	-8.727	1.734
1200	8.942	62.40	54.95	-21.687	-7.549	1.375
1300	10.114	63.34	55.56	-21.704	-6.365	1.070
1400	11.312	64.23	56.15	-21.707	-5.190	0.810
1500	12.532	65.07	56.72	-21.701	-4.010	0.584
1600	13.771	65.87	57.26	-21.688	-2.832	0.387
1700	15.029	66.63	57.79	-21.666	-1.654	0.213
1800	16.302	67.36	58.30	-21.640	-0.479	0.058
1900	17.590	68.06	58.80	-21.608	0.696	-0.080
2000	18.890	68.72	59.28	-21.574	1.870	-0.204

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	2.3810 KCAL	MOLAR VOLUME	584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36,
B. P. 717.75 DEG K.

REFERENCES 148 158 158 COMPILED 4-15-67

ALABANDITE GRAM FORMULA WEIGHT 87.002

MnS: Crystals 298.15° to melting point 1803°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	18.69	18.69	-51.115	-52.141	38.220
UNCERTAINTY		0.40	0.40	0.200	0.240	0.176
400	1.220	22.21	19.16	-51.694	-52.464	28.665
500	2.440	24.93	20.05	-52.108	-52.609	22.995
600	3.690	27.21	21.06	-52.519	-52.746	19.213
700	4.970	29.18	22.08	-52.744	-52.691	16.451
800	6.260	30.90	23.07	-66.099	-53.881	14.719
900	7.560	32.43	24.03	-66.092	-52.350	12.712
1000	8.850	33.79	24.94	-66.658	-50.824	11.108
1100	10.150	35.03	25.80	-66.706	-49.232	9.782
1200	11.450	36.16	26.62	-66.755	-47.649	8.678
1300	12.770	37.22	27.40	-66.800	-46.053	7.742
1400	14.130	38.23	28.14	-67.392	-44.446	6.938
1500	15.530	39.19	28.84	-68.000	-42.773	6.232
1600	16.970	40.12	29.51	-71.608	-40.795	5.572
1700	18.450	41.02	30.17	-71.677	-38.867	4.997
1800	19.970	41.89	30.80	-71.707	-36.936	4.485
1803	20.020	41.91	30.81	-71.710	-36.910	4.470
1803	26.260	45.37	30.81	-65.470	-36.910	4.470
1900	27.810	46.21	31.57	-65.417	-35.340	4.065
2000	29.410	47.03	32.32	-65.368	-33.744	3.687

MELTING POINT 1803 DEG K BOILING POINT DEG K

HEAT OF FUSION 6.240 KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.51291 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MANGANESE.. ALPHA-BETA 990, BETA-GAMMA 1360, GAMMA-DELTA 1410, M. P. DELTA 1517 DEG K.

SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36, B. P. 717.75 DEG K.

REFERENCES 74 78 2 30 COMPILED 4-15-67

MILLERITE GRAM FORMULA WEIGHT 90.774

NiS: Crystals 298.15° to 600°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	15.80	15.80	-20.284	-20.600	15.100
UNCERTAINTY		1.00	1.00	1.000	1.050	0.770
400	1.170	19.17	16.24	-20.889	-20.675	11.296
500	2.380	21.87	17.11	-21.325	-20.571	8.992
600	3.660	24.20	18.10	-21.683	-20.386	7.426

MELTING POINT DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H KCAL MOLAR VOLUME 0.40368 CAL/BAR
298 0

TRANSITIONS IN REFERENCE STATE ELEMENTS

NICKEL..... CURIE P. 631, M. P. 1726 DEG K.
SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36,
B. P. 717.75 DEG K.

REFERENCES 74 52 140 COMPILED
173 4-15-67

GALENA GRAM FORMULA WEIGHT 239.254

PbS: Crystals 298.15° to melting point 1385°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	21.84	21.84	-23.353	-22.962	16.832
UNCERTAINTY		0.30	0.30	0.230	0.200	0.147
400	1.240	25.42	22.32	-23.877	-22.811	12.463
500	2.450	28.12	23.22	-24.271	-22.502	9.836
600	3.710	30.41	24.23	-24.560	-22.117	8.056
700	5.040	32.46	25.26	-25.903	-21.503	6.713
800	6.430	34.32	26.28	-39.062	-22.084	6.033
900	7.880	36.02	27.26	-38.762	-19.971	4.850

MELTING POINT	1385	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	0.75263	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

LEAD..... M. P. 600.6, B. P. 2023 DEG K.
SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36,
B. P. 717.75 DEG K.

REFERENCES	74	78	146 92	COMPILED 2-12-67

HERZENBERGITE GRAM FORMULA WEIGHT 150.754

SnS: α crystals 298.15° to 875°K. β crystals 875° to melting point 1153°K. Liquid 1153° to 1200°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	18.36	18.36	-25.464	-24.999	18.325
UNCERTAINTY		0.20	0.20	0.350	0.360	0.264
400	1.210	21.85	18.82	-26.043	-24.813	13.557
500	2.450	24.61	19.71	-26.452	-24.458	10.691
600	3.750	26.98	20.73	-28.378	-23.715	8.638
700	5.090	29.05	21.78	-28.523	-22.926	7.158
800	6.520	30.96	22.81	-41.603	-23.337	6.375
875	7.650	32.30	23.56	-41.330	-21.673	5.413
875	7.810	32.49	23.56	-41.170	-21.673	5.413
900	8.140	32.86	23.82	-41.111	-21.087	5.121
1000	9.470	34.26	24.79	-40.902	-18.868	4.124
1100	10.840	35.57	25.72	-40.665	-16.679	3.314
1153	11.580	36.22	26.18	-40.538	-15.572	2.952
1153	19.130	42.77	26.18	-32.988	-15.572	2.952
1200	19.970	43.49	26.85	-32.659	-14.825	2.700

MELTING POINT 1153 DEG K BOILING POINT DEG K

HEAT OF FUSION 7.550 KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.69336 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36, B. P. 717.75 DEG K.
TIN..... M. P. 505 DEG K.

REFERENCES 74 78 133 COMPILED 1-12-67

SPHALERITE GRAM FORMULA WEIGHT 97.434

ZnS: Cubic crystals 298.15° to 1200°K. Wurtzite is the stable phase of ZnS above 1293 ± 5°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	13.77	13.77	-49.750	-48.623	35.642
UNCERTAINTY		0.20	0.20	1.000	1.010	0.740
400	1.140	17.05	14.20	-50.349	-48.207	26.339
500	2.320	19.68	15.04	-50.748	-47.619	20.814
600	3.530	21.89	16.01	-51.064	-46.971	17.109
700	4.760	23.79	16.99	-53.094	-46.251	14.440
800	6.010	25.46	17.95	-66.419	-46.473	12.696
900	7.280	26.95	18.86	-66.337	-43.973	10.678
1000	8.560	28.30	19.74	-66.248	-41.494	9.068
1100	9.860	29.54	20.58	-66.141	-39.031	7.755
1200	11.170	30.68	21.37	-93.535	-36.125	6.579
1300	12.500	31.74	22.12	-93.147	-31.346	5.270

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.56955 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36, B. P. 717.75 DEG K.
ZINC..... M. P. 692.7, B. P. 1184 DEG K.

REFERENCES			
123	78	38	COMPILED
		126	5-18-67

WURTZITE GRAM FORMULA WEIGHT 97.434

ZnS: Crystals 298.15° to 1300°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	16.56	16.56	-46.095	-45.800	33.572
UNCERTAINTY		1.00	1.00	0.200	0.360	0.264
400	1.160	19.90	17.00	-46.674	-45.672	24.954
500	2.340	22.54	17.86	-47.073	-45.374	19.833
600	3.550	24.74	18.82	-47.389	-45.006	16.393
700	4.780	26.64	19.81	-49.419	-44.571	13.916
800	6.030	28.31	20.77	-62.744	-45.078	12.315
900	7.290	29.79	21.69	-62.672	-42.864	10.409
1000	8.570	31.14	22.57	-62.583	-40.669	8.888
1100	9.870	32.38	23.41	-62.476	-38.490	7.647
1200	11.180	33.52	24.20	-89.870	-35.868	6.532
1300	12.500	34.58	24.96	-89.492	-31.383	5.276

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.56993 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SULFUR..... ORTHO-MCNO 368.54, M. P. MONO 388.36,
B. P. 717.75 DEG K.
ZINC..... M. P. 692.7, B. P. 1184 DEG K.

REFERENCES 123 132 2 COMPILED 5-08-67

CORUNDUM GRAM FORMULA WEIGHT 101.961

Al_2O_3: (Corundum), crystals 298.15° to melting point 2345°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	12.18	12.18	-400.400	-378.082	277.141
UNCERTAINTY		0.03	0.03	0.300	0.310	0.227
400	2.147	18.34	12.98	-400.559	-370.640	202.508
500	4.577	23.76	14.60	-400.487	-362.896	158.621
600	7.193	28.52	16.53	-400.322	-355.393	129.451
700	9.940	32.75	18.55	-400.112	-347.920	108.625
800	12.778	36.54	20.57	-399.905	-340.479	93.014
900	15.685	39.97	22.54	-399.743	-333.061	80.878
1000	18.644	43.08	24.44	-404.690	-325.290	71.092
1100	21.644	45.94	26.27	-404.467	-317.364	63.054
1200	24.677	48.58	28.02	-404.224	-309.456	56.359
1300	27.735	51.03	29.70	-403.967	-301.568	50.698
1400	30.814	53.31	31.30	-403.702	-293.701	45.849
1500	33.910	55.45	32.84	-403.431	-285.855	41.649
1600	37.020	57.45	34.32	-403.154	-278.023	37.976
1700	40.140	59.35	35.73	-402.875	-270.212	34.738
1800	43.269	61.13	37.10	-402.596	-262.413	31.861
1900	46.405	62.83	38.41	-402.320	-254.634	29.290
2000	49.547	64.44	39.67	-402.046	-246.871	26.977

MELTING POINT	2345	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	2.3940	KCAL	MOLAR VOLUME	0.61126	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.

REFERENCES				
39	78	103	COMPILED	
	39		6-13-66	

BOEHMITE GRAM FORMULA WEIGHT 59.988

AlO(OH): Crystals 298.15° to 500°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	11.58	11.58	-235.500	-217.674	159.559
UNCERTAINTY		0.05	0.05	3.500	3.510	2.573
400	1.558	16.06	12.16	-235.629	-211.667	115.649
500	3.425	20.20	13.35	-235.474	-205.550	89.846

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	2.110 KCAL	MOLAR VOLUME	0.46690 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.

REFERENCES 74 78 141 COMPILED 2-12-67

GIBBSITE GRAM FORMULA WEIGHT 78.004

$Al(OH)_3$: Crystals 298.15° to 400°K.

TEMP. DEG K	H -H 298 (KCAL)	S (CAL/DEG-GFW)	-(G -H)/T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	16.75	16.75	-306.380	-273.486	200.470
UNCERTAINTY		0.10	0.10	0.300	0.310	0.227
400	2.505	23.93	17.67	-306.631	-262.304	143.316

MELTING POINT		DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	3.040	KCAL	MOLAR VOLUME	0.76377	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.

REFERENCES 74 78 12 COMPILED 2-12-67

BORIC OXIDE — GRAM FORMULA WEIGHT 69.620

B_2O_3: Crystals 298.15° to melting point 723°K. Liquid 723° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	12.87	12.87	-303.640	-284.728	208.711
UNCERTAINTY		0.10	0.10	0.400	0.410	0.301
400	1.712	17.79	13.51	-303.668	-278.263	152.035
500	3.671	22.15	14.81	-303.631	-271.914	118.853
600	5.872	26.15	16.36	-303.513	-265.576	96.736
700	8.339	29.95	18.04	-303.245	-259.273	80.948
723	8.950	30.80	18.42	-303.154	-257.825	77.935
723	14.210	38.08	18.42	-297.894	-257.825	77.935
800	16.673	41.32	20.48	-297.198	-253.600	69.280
900	19.853	45.07	23.01	-296.371	-248.205	60.272
1000	23.006	48.39	25.38	-295.628	-242.888	53.083
1100	26.128	51.37	27.62	-294.973	-237.654	47.217
1200	29.217	54.06	29.71	-294.394	-232.470	42.338
1300	32.284	56.51	31.68	-293.880	-227.325	38.217
1400	35.340	58.78	33.54	-293.414	-222.229	34.691
1500	38.394	60.88	35.28	-292.989	-217.152	31.639
1600	41.448	62.85	36.94	-292.596	-212.105	28.972
1700	44.503	64.70	38.52	-292.234	-207.082	26.622
1800	47.549	66.45	40.03	-291.912	-202.100	24.538
1900	50.603	68.01	41.38	-291.606	-196.946	22.654
2000	53.648	69.66	42.84	-291.329	-189.592	20.718

MELTING POINT	723	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	5.260	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	2.2180	KCAL	MOLAR VOLUME	0.65057	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

BORON..... M. P. BETA 2300 DEG K.

REFERENCES	148	148	COMPILED
	159	159	4-29-67

BARIUM OXIDE GRAM FORMULA WEIGHT 153.339

BaO: Crystals 298.15° to melting point 2291°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	16.80	16.80	-139.060	-131.994	96.754
UNCERTAINTY		0.30	0.30	0.700	0.770	0.564
400	1.170	20.16	17.23	-138.908	-129.595	70.807
500	2.380	22.87	18.11	-138.741	-127.293	55.640
600	3.660	25.20	19.10	-138.551	-125.018	45.538
700	4.980	27.23	20.12	-138.495	-122.756	38.326
800	6.300	29.00	21.12	-138.347	-120.526	32.926
900	7.620	30.55	22.08	-138.277	-118.301	28.727
1000	8.950	31.95	23.00	-140.070	-116.048	25.362
1100	10.300	33.24	23.88	-139.890	-113.653	22.581
1200	11.680	34.44	24.71	-139.684	-111.279	20.267
1300	13.090	35.57	25.50	-139.452	-108.924	18.312
1400	14.520	36.63	26.26	-139.204	-106.580	16.638
1500	15.970	37.63	26.98	-138.940	-104.269	15.192
1600	17.440	38.58	27.68	-138.658	-101.959	13.927
1700	18.920	39.47	28.34	-138.369	-99.670	12.813
1800	20.420	40.33	28.99	-138.064	-97.405	11.827
1900	21.930	41.15	29.61	-174.446	-96.014	11.044
2000	23.450	41.93	30.20	-174.038	-91.897	10.042

MELTING POINT	2291	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	0.61157	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

BARIUM..... ALPHA-BETA 643, M. P. BETA 983, B. P. 1895 DEG K.

REFERENCES 74 78 108 COMPILED 4-15-67

BROMELLITE GRAM FORMULA WEIGHT 25.012

BeO: Crystals 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	3.37	3.37	-143.100	-136.121	99.779
UNCERTAINTY		0.02	0.02	0.150	0.160	0.117
400	0.727	5.45	3.64	-143.175	-133.724	73.063
500	1.594	7.38	4.19	-143.173	-131.361	57.418
600	2.567	9.15	4.88	-143.123	-129.005	46.990
700	3.614	10.77	5.61	-143.040	-126.655	39.544
800	4.716	12.24	6.34	-142.932	-124.326	33.964
900	5.855	13.58	7.07	-142.815	-122.002	29.626
1000	7.019	14.81	7.79	-142.704	-119.688	26.158
1100	8.200	15.93	8.48	-142.613	-117.402	23.325
1200	9.399	16.97	9.14	-142.528	-115.113	20.965
1300	10.614	17.95	9.78	-142.451	-112.829	18.968
1400	11.847	18.86	10.40	-142.390	-110.551	17.258
1500	13.098	19.72	10.99	-142.335	-108.285	15.777
1600	14.366	20.54	11.56	-145.075	-105.900	14.465
1700	15.652	21.32	12.11	-144.980	-103.428	13.297
1800	16.955	22.07	12.65	-144.872	-101.001	12.263
1900	18.275	22.78	13.16	-144.749	-98.579	11.339
2000	19.613	23.47	13.66	-144.611	-96.142	10.506

MELTING POINT	2820	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	0.6870	KCAL	MOLAR VOLUME	0.19859	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

BERYLLIUM.. M. P. 1556 DEG K.

REFERENCES 157	78		22	COMPILED
	148		66	4-15-67

BISMITE GRAM FORMULA WEIGHT 465.958

Bi_2O_3: Crystals 298.15° to melting point 1098°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	36.20	36.20	-137.160	-117.955	86.463
UNCERTAINTY		0.50	0.50	0.300	0.350	0.257
400	2.770	44.19	37.26	-136.776	-111.458	60.898
500	5.630	50.56	39.30	-136.392	-105.167	45.968
600	8.550	55.89	41.64	-141.285	-98.418	35.849
700	11.550	60.51	44.01	-140.952	-91.292	28.502
800	14.620	64.61	46.33	-140.579	-84.227	23.010

MELTING POINT	1098	DEG K	BOILING POINT	2040	DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	1.1885	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

BISMUTH.... M. P. 544.5, B. P. 1852 DEG K.

REFERENCES 74 158 158 105 COMPILED 5-06-67

CARBON MONOXIDE GRAM FORMULA WEIGHT 28.011

CO: Ideal gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	47.22	47.22	-26.416	-32.781	24.029
UNCERTAINTY		0.01	0.01	0.020	0.030	0.022
400	0.711	49.27	47.49	-26.317	-34.973	19.108
500	1.417	50.85	48.01	-26.295	-37.141	16.234
600	2.137	52.16	48.60	-26.331	-39.308	14.318
700	2.873	53.29	49.19	-26.409	-41.465	12.946
800	3.627	54.30	49.76	-26.513	-43.609	11.913
900	4.397	55.20	50.32	-26.637	-45.739	11.107
1000	5.183	56.03	50.85	-26.770	-47.854	10.459
1100	5.983	56.79	51.36	-26.913	-49.956	9.925
1200	6.794	57.50	51.84	-27.062	-52.044	9.479
1300	7.616	58.16	52.30	-27.217	-54.120	9.098
1400	8.446	58.77	52.74	-27.375	-56.183	8.770
1500	9.285	59.35	53.16	-27.536	-58.235	8.485
1600	10.130	59.90	53.57	-27.699	-60.277	8.233
1700	10.980	60.41	53.96	-27.864	-62.309	8.010
1800	11.836	60.90	54.33	-28.032	-64.330	7.811
1900	12.697	61.37	54.69	-28.200	-66.340	7.631
2000	13.561	61.81	55.03	-28.371	-68.345	7.468

MELTING POINT	68.05 DEG K	BOILING POINT	81.61 DEG K
HEAT OF FUSION	0.200 KCAL	HEAT OF VAPOR.	1.444 KCAL
H -H 298 0	2.0720 KCAL	MOLAR VOLUME	584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 158 158 COMPILED 2-12-67

CARBON DIOXIDE GRAM FORMULA WEIGHT 44.010

CO_2: Ideal gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	51.06	51.06	-94.051	-94.257	69.092
UNCERTAINTY		0.01	0.01	0.030	0.040	0.029
400	0.958	53.82	51.42	-94.067	-94.326	51.537
500	1.987	56.11	52.14	-94.088	-94.387	41.257
600	3.087	58.11	52.97	-94.121	-94.445	34.401
700	4.245	59.90	53.83	-94.166	-94.495	29.503
800	5.453	61.51	54.69	-94.215	-94.539	25.827
900	6.702	62.98	55.53	-94.267	-94.577	22.966
1000	7.984	64.33	56.35	-94.318	-94.609	20.677
1100	9.296	65.58	57.13	-94.368	-94.636	18.802
1200	10.632	66.74	57.88	-94.416	-94.657	17.239
1300	11.988	67.83	58.61	-94.466	-94.675	15.916
1400	13.362	68.85	59.30	-94.512	-94.688	14.781
1500	14.750	69.80	59.97	-94.559	-94.700	13.798
1600	16.152	70.71	60.61	-94.604	-94.710	12.937
1700	17.565	71.57	61.23	-94.647	-94.713	12.176
1800	18.987	72.38	61.83	-94.693	-94.716	11.500
1900	20.418	73.15	62.41	-94.739	-94.716	10.895
2000	21.857	73.89	62.96	-94.785	-94.715	10.350

MELTING POINT		DEG K	BOILING POINT	DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	2.2380	KCAL	MOLAR VOLUME 584.727	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148	158 58	158	COMPILED 5-06-67

LIME GRAM FORMULA WEIGHT 56.079

CaO: Crystals 298.15° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	9.50	9.50	-151.790	-144.352	105.812
UNCERTAINTY		0.50	0.50	0.300	0.340	0.249
400	1.100	12.67	9.92	-151.702	-141.821	77.487
500	2.230	15.19	10.73	-151.622	-139.364	60.916
600	3.400	17.32	11.65	-151.555	-136.918	49.872
700	4.600	19.17	12.60	-151.509	-134.482	41.987
800	5.820	20.80	13.52	-151.523	-132.054	36.075
900	7.040	22.23	14.41	-151.540	-129.611	31.474
1000	8.270	23.53	15.26	-151.623	-127.171	27.793
1100	9.520	24.72	16.07	-151.753	-124.724	24.780
1200	10.800	25.84	16.84	-153.657	-122.132	22.243
1300	12.110	26.88	17.56	-153.515	-119.490	20.088
1400	13.430	27.86	18.27	-153.367	-116.893	18.248
1500	14.760	28.78	18.94	-153.213	-114.282	16.651
1600	16.100	29.64	19.58	-153.051	-111.696	15.257
1700	17.440	30.46	20.20	-152.892	-109.127	14.029
1800	18.780	31.22	20.79	-189.016	-105.625	12.825
1900	20.130	31.95	21.36	-188.613	-101.004	11.618
2000	21.480	32.65	21.91	-188.213	-96.432	10.538

MELTING POINT 2887 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.40067 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.

REFERENCES 74 78 65 COMPILED 6-13-66

PORTLANDITE GRAM FORMULA WEIGHT 74.095

$Ca(OH)_2$: Crystals 298.15° to 700°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	19.93	19.93	-235.610	-214.673	157.359
UNCERTAINTY		0.10	0.10	0.450	0.460	0.337
400	2.300	26.56	20.81	-235.391	-207.551	113.400
500	4.720	31.95	22.51	-235.086	-200.626	87.693
600	7.240	36.58	24.51	-234.746	-193.789	70.587
700	9.830	40.54	26.50	-234.401	-186.966	58.373

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	3.3840 KCAL	MOLAR VOLUME	0.79006 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.

REFERENCES 74 78 54 55 COMPILED 2-12-67

CERIANITE GRAM FORMULA WEIGHT 172.119

CeO_2: Crystals 298.15° to 1800°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H 298)/T T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	14.89	14.89	-260.180	-245.450	179.919
UNCERTAINTY		0.02	0.02	0.350	0.700	0.513
400	1.580	19.44	15.49	-259.996	-240.443	131.371
500	3.220	23.10	16.66	-259.780	-235.583	102.973
600	4.940	26.23	18.00	-259.540	-230.758	84.053
700	6.720	28.97	19.37	-259.308	-225.989	70.557
800	8.540	31.40	20.72	-259.086	-221.236	60.439
900	10.380	33.57	22.04	-258.910	-216.527	52.580
1000	12.250	35.54	23.29	-258.757	-211.823	46.294
1100	14.140	37.34	24.49	-260.556	-207.038	41.134
1200	16.050	39.00	25.62	-260.424	-202.175	36.821
1300	17.980	40.55	26.72	-260.291	-197.336	33.175
1400	19.930	41.99	27.75	-260.135	-192.491	30.049
1500	21.900	43.35	28.75	-259.836	-187.674	27.344
1600	23.890	44.63	29.70	-259.523	-182.861	24.978
1700	25.910	45.86	30.62	-259.185	-178.097	22.896
1800	27.960	47.03	31.50	-258.824	-173.329	21.045

MELTING POINT DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.57010 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CERIUM..... BETA-GAMMA 1003, M. P. 1077 DEG K.

REFERENCES 84 179 64 COMPILED 4-15-67

COBALT OXIDE GRAM FORMULA WEIGHT 74.933

CoO: Crystals 298.15° to melting point 2078°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	12.66	12.66	-57.100	-51.430	37.699
UNCERTAINTY		0.08	0.08	0.300	0.310	0.227
400	1.290	16.38	13.15	-56.797	-49.544	27.070
500	2.570	19.24	14.10	-56.537	-47.759	20.875
600	3.860	21.59	15.16	-56.317	-46.024	16.764
700	5.160	23.59	16.22	-56.134	-44.322	13.838
800	6.470	25.34	17.25	-56.083	-42.630	11.646
900	7.790	26.90	18.24	-55.970	-40.962	9.947
1000	9.120	28.30	19.18	-55.907	-39.306	8.590
1100	10.460	29.58	20.07	-55.904	-37.642	7.479
1200	11.820	30.76	20.91	-55.959	-35.978	6.553
1300	13.210	31.87	21.71	-56.088	-34.309	5.768
1400	14.640	32.93	22.47	-56.325	-32.633	5.094
1500	16.100	33.94	23.21	-56.291	-30.950	4.509
1600	17.600	34.91	23.91	-56.159	-29.268	3.998
1700	19.140	35.84	24.58	-55.968	-27.588	3.547
1800	20.730	36.75	25.23	-59.617	-25.852	3.139
1900	22.360	37.63	25.86	-59.402	-23.967	2.757
2000	24.020	38.48	26.47	-59.160	-22.099	2.415

MELTING POINT	2078 DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.27820 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

COBALT..... ALPHA-BETA 700, CURIE P. 1394, M. P. BETA 1768 DEG K.

REFERENCES 74 78 18 COMPILED 6-13-66

ESKOLAITE GRAM FORMULA WEIGHT 151.990

Cr_2O_3: β crystals 298.15° to melting point 2603°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	19.40	19.40	-272.700	-253.203	185.602
UNCERTAINTY		0.30	0.30	0.400	0.420	0.308
400	2.740	27.34	20.49	-272.228	-246.634	134.754
500	5.540	33.59	22.51	-271.768	-240.288	105.030
600	8.380	38.76	24.79	-271.377	-234.024	85.243
700	11.280	43.22	27.11	-271.018	-227.819	71.128
800	14.230	47.16	29.37	-270.689	-221.673	60.558
900	17.210	50.67	31.55	-270.390	-215.564	52.346
1000	20.240	53.86	33.62	-270.104	-209.488	45.784
1100	23.320	56.80	35.60	-269.855	-203.443	40.420
1200	26.430	59.51	37.48	-269.665	-197.411	35.953
1300	29.550	62.00	39.27	-269.572	-191.403	32.178
1400	32.670	64.31	40.97	-269.566	-185.398	28.942
1500	35.790	66.47	42.61	-269.645	-179.372	26.134
1600	38.920	68.48	44.15	-269.814	-173.333	23.676
1700	42.050	70.38	45.64	-270.075	-167.322	21.511
1800	45.180	72.17	47.07	-270.427	-161.247	19.578
1900	48.320	73.87	48.44	-270.859	-155.185	17.850
2000	51.460	75.48	49.75	-271.361	-149.076	16.290

MELTING POINT 2603 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.69527 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CHROMIUM... M. P. 2130 DEG K.

REFERENCES 74 78 102 COMPILED 6-13-66

TENORITE GRAM FORMULA WEIGHT 79.539

CuO: Crystals 298.15° to 1200°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	10.19	10.19	-37.140	-30.498	22.355
UNCERTAINTY		0.05	0.05	0.300	0.310	0.227
400	1.110	13.40	10.62	-36.992	-28.255	15.438
500	2.260	15.95	11.43	-36.822	-26.084	11.401
600	3.460	18.14	12.37	-36.630	-23.955	8.726
700	4.710	20.07	13.34	-36.404	-21.862	6.826
800	6.000	21.79	14.29	-36.163	-19.798	5.408
900	7.320	23.34	15.21	-35.920	-17.762	4.313
1000	8.680	24.77	16.09	-35.663	-15.762	3.445
1100	10.120	26.15	16.95	-35.343	-13.792	2.740
1200	11.600	27.43	17.76	-34.992	-11.831	2.155

MELTING POINT DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 1.6970 KCAL MOLAR VOLUME 0.29207 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

COPPER..... M. P. 1357 DEG K.

REFERENCES 74 78 15 COMPILED 2-12-67

CUPRITE GRAM FORMULA WEIGHT 143.079

Cu_2O: Crystals 298.15° to melting point 1509°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	22.40	22.40	-40.400	-35.022	25.672
UNCERTAINTY		0.40	0.40	1.500	1.510	1.107
400	1.720	27.36	23.06	-40.242	-33.209	18.145
500	3.470	31.27	24.33	-40.087	-31.474	13.757
600	5.280	34.66	25.86	-39.915	-29.820	10.862
700	7.150	37.54	27.33	-39.704	-28.151	8.789
800	9.050	40.08	28.77	-39.503	-26.514	7.243
900	11.000	42.38	30.16	-39.300	-24.904	6.047
1000	13.020	44.50	31.48	-39.073	-23.321	5.097
1100	15.120	46.50	32.75	-38.793	-21.752	4.322
1200	17.320	48.42	33.99	-38.427	-20.210	3.681

MELTING POINT 1509 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H KCAL MOLAR VOLUME 0.56016 CAL/BAR
298 0

TRANSITIONS IN REFERENCE STATE ELEMENTS

COPPER..... M. P. 1357 DEG K.

REFERENCES 74 78 22 COMPILED 6-13-66

WUSTITE GRAM FORMULA WEIGHT 68.887

$Fe_{.947}O$: Crystals 298.15° to melting point 1650°K. Liquid 1650° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	13.76	13.76	-63.640	-58.599	42.954
UNCERTAINTY		0.10	0.10	0.200	0.210	0.154
400	1.210	17.24	14.22	-63.393	-56.911	31.095
500	2.440	19.99	15.11	-63.168	-55.318	24.179
600	3.700	22.29	16.13	-62.977	-53.768	19.585
700	4.980	24.26	17.15	-62.834	-52.248	16.312
800	6.280	25.99	18.14	-62.757	-50.738	13.861
900	7.590	27.54	19.11	-62.782	-49.235	11.956
1000	8.920	28.94	20.02	-62.964	-47.721	10.429
1100	10.280	30.23	20.89	-63.330	-46.167	9.173
1200	11.670	31.44	21.72	-63.472	-44.611	8.125
1300	13.080	32.57	22.51	-63.267	-43.057	7.238
1400	14.520	33.64	23.27	-63.055	-41.517	6.481
1500	15.980	34.64	23.99	-62.835	-39.971	5.824
1600	17.460	35.60	24.69	-62.618	-38.463	5.254
1650	18.210	36.06	25.02	-62.511	-37.700	4.994
1650	25.700	40.60	25.02	-55.021	-37.700	4.994
1700	26.510	41.08	25.49	-55.117	-37.171	4.779
1800	28.140	42.02	26.39	-54.869	-36.131	4.387
1900	29.770	42.90	27.24	-58.118	-34.927	4.018
2000	31.400	43.73	28.03	-57.933	-33.697	3.682

MELTING POINT	1650 DEG K	BOILING POINT	DEG K
HEAT OF FUSION	7.490 KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	2.262 KCAL	MOLAR VOLUME	0.28776 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.

REFERENCES	74	78	70	COMPILED
		148	148	4-15-67

FERROUS OXIDE STOICHIOMETRIC GRAM FORMULA WEIGHT 71.846

FeO: Crystals 298.15° to 1650°K. Liquid 1650° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	14.52	14.52	-65.020	-60.101	44.055
UNCERTAINTY		0.40	0.40	0.500	0.520	0.381
400	1.240	18.09	14.99	-64.777	-58.458	31.940
500	2.497	20.90	15.90	-64.560	-56.901	24.871
600	3.792	23.26	16.94	-64.373	-55.386	20.174
700	5.119	25.30	17.99	-64.225	-53.906	16.830
800	6.475	27.11	19.02	-64.138	-52.439	14.326
900	7.857	28.74	20.01	-64.143	-50.971	12.377
1000	9.263	30.22	20.96	-64.310	-49.500	10.818
1100	10.692	31.58	21.86	-64.681	-47.997	9.536
1200	12.142	32.84	22.73	-64.825	-46.482	8.466
1300	13.613	34.02	23.55	-64.602	-44.971	7.560
1400	15.104	35.13	24.34	-64.383	-43.472	6.786
1500	16.611	36.17	25.09	-64.162	-41.982	6.117
1600	18.134	37.15	25.82	-63.947	-40.512	5.534
1650	18.878	37.62	26.18	-63.825	-39.764	5.267
1650	24.628	41.11	26.18	-58.075	-39.764	5.267
1700	25.006	41.60	26.89	-58.686	-39.686	5.102
1800	26.636	42.53	27.73	-58.491	-38.566	4.683
1900	28.266	43.41	28.53	-61.988	-37.289	4.289
2000	29.896	44.25	29.30	-61.858	-35.991	3.933

MELTING POINT 1650 DEG K BOILING POINT DEG K

HEAT OF FUSION 5.750 KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.28681 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.

REFERENCES 148 148 148 COMPILED 4-29-67

HEMATITE GRAM FORMULA WEIGHT 159.692

Fe_2O_3: α crystals 298.15° to 950°K. β crystals 950° to 1050°K.

γ crystals 1050° to melting point 1895°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	20.89	20.89	-197.300	-177.728	130.278
UNCERTAINTY		0.05	0.05	0.300	0.310	0.227
400	2.750	28.80	21.92	-196.906	-171.096	93.482
500	5.770	35.53	23.99	-196.332	-164.701	71.991
600	9.010	41.43	26.41	-195.685	-158.433	57.709
700	12.460	46.74	28.94	-194.982	-152.286	47.546
800	16.130	51.64	31.48	-194.249	-146.241	39.951
900	20.030	56.23	33.97	-193.530	-140.269	34.062
950	22.060	58.43	35.21	-193.176	-137.300	31.586
950	22.220	58.60	35.21	-193.016	-137.300	31.586
1000	24.020	60.44	36.42	-193.100	-134.383	29.369
1050	25.820	62.20	37.61	-193.870	-131.430	27.356
1100	27.500	63.76	38.76	-193.639	-128.480	25.527
1200	30.870	66.69	40.96	-193.881	-122.562	22.322
1300	34.250	69.40	43.05	-193.426	-116.660	19.612
1400	37.650	71.92	45.03	-193.002	-110.778	17.293
1500	41.070	74.28	46.90	-192.589	-104.910	15.285
1600	44.540	76.52	48.68	-192.174	-99.083	13.534
1700	48.100	78.68	50.38	-192.277	-93.262	11.990
1800	51.880	80.84	52.02	-191.811	-87.435	10.616

MELTING POINT	1895 DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	3.7189 KCAL	MOLAR VOLUME	0.72357 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.

REFERENCES 74	51	26	COMPILED
	148	148	4-15-67

MAGNETITE GRAM FORMULA WEIGHT 231.539

Fe_3O_4: α crystals 298.15° to 900°K. β crystals 900° to melting point 1870°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	36.03	36.03	-267.400	-243.094	178.192
UNCERTAINTY		0.10	0.10	0.500	0.510	0.374
400	3.990	47.51	37.53	-266.763	-234.881	128.332
500	8.320	57.15	40.51	-265.920	-226.991	99.217
600	13.060	65.78	44.01	-264.880	-219.298	79.879
700	18.340	73.91	47.71	-263.526	-211.818	66.132
800	24.260	81.80	51.47	-261.812	-204.543	55.878
900	30.550	89.21	55.27	-260.090	-197.473	47.953
900	30.550	89.21	55.27	-260.090	-197.473	47.953
1000	35.350	94.27	58.92	-260.424	-190.506	41.635
1100	40.150	98.84	62.34	-261.442	-183.445	36.447
1200	44.950	103.02	65.56	-261.848	-176.370	32.121
1300	49.750	106.86	68.59	-261.222	-169.294	28.461
1400	54.550	110.42	71.46	-260.670	-162.258	25.330
1500	59.350	113.73	74.16	-260.162	-155.228	22.617
1600	64.150	116.83	76.74	-259.726	-148.257	20.251
1700	68.950	119.74	79.18	-260.200	-141.271	18.162
1800	73.750	122.48	81.51	-260.148	-134.249	16.300

MELTING POINT	1870	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	33.000	KCAL	HEAT OF VAPOR.		KCAL
$H_{298} - H_0$	5.8730	KCAL	MOLAR VOLUME	1.0641	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.

REFERENCES	74	52	70	COMPILED
			148	4-15-67

WATER GRAM FORMULA WEIGHT 18.015

H_2O: Liquid 298.15° to 373.15°K. Ideal gas 373.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	16.71	16.71	-68.315	-56.688	41.554
UNCERTAINTY		0.03	0.03	0.010	0.020	0.015
373.15	1.352	20.76	17.14	-67.747	-53.820	31.522
373.15	11.069	46.80	17.14	-58.030	-53.820	31.522
500	12.173	49.33	24.98	-58.275	-52.359	22.886
600	13.028	50.89	29.18	-58.498	-51.156	18.633
700	13.909	52.25	32.38	-58.708	-49.916	15.585
800	14.819	53.46	34.94	-58.903	-48.644	13.289
900	15.759	54.57	37.06	-59.082	-47.353	11.499
1000	16.728	55.59	38.86	-59.244	-46.040	10.062
1100	17.729	56.54	40.42	-59.389	-44.709	8.883
1200	18.759	57.44	41.81	-59.517	-43.373	7.899
1300	19.817	58.29	43.05	-59.631	-42.028	7.065
1400	20.903	59.09	44.16	-59.731	-40.663	6.348
1500	22.014	59.86	45.18	-59.822	-39.302	5.726
1600	23.149	60.59	46.12	-59.903	-37.929	5.181
1700	24.306	61.29	46.99	-59.974	-36.549	4.699
1800	25.483	61.96	47.80	-60.039	-35.166	4.270
1900	26.679	62.61	48.57	-60.096	-33.788	3.887
2000	27.892	63.23	49.28	-60.148	-32.399	3.540

MELTING POINT 273.15 DEG K BOILING POINT 373.15 DEG K

HEAT OF FUSION 1.436 KCAL HEAT OF VAPOR. 9.717 KCAL

$H_{298}^{0} - H$ KCAL MOLAR VOLUME 0.43186 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 74 158 158 COMPILED 5-11-67

STEAM GRAM FORMULA WEIGHT · 18.015

H_2O: Ideal gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	45.10	45.10	-57.796	-54.635	40.048
UNCERTAINTY		0.01	0.01	0.010	0.020	0.015
400	0.825	47.48	45.42	-58.040	-53.517	29.240
500	1.654	49.33	46.02	-58.275	-52.360	22.886
600	2.509	50.89	46.71	-58.498	-51.155	18.633
700	3.390	52.25	47.40	-58.708	-49.914	15.584
800	4.300	53.46	48.09	-58.903	-48.646	13.289
900	5.240	54.57	48.75	-59.082	-47.351	11.498
1000	6.209	55.59	49.38	-59.244	-46.040	10.062
1100	7.210	56.54	49.99	-59.389	-44.712	8.883
1200	8.240	57.44	50.57	-59.517	-43.372	7.899
1300	9.298	58.29	51.13	-59.631	-42.022	7.065
1400	10.384	59.09	51.67	-59.731	-40.663	6.348
1500	11.495	59.86	52.19	-59.822	-39.298	5.726
1600	12.630	60.59	52.70	-59.903	-37.927	5.181
1700	13.787	61.29	53.18	-59.974	-36.551	4.699
1800	14.964	61.96	53.65	-60.039	-35.171	4.270
1900	16.160	62.61	54.10	-60.096	-33.788	3.887
2000	17.373	63.23	54.55	-60.148	-32.403	3.541

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	2.3670 KCAL	MOLAR VOLUME 584.727	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148	158	158	COMPILED 2-12-67

HAFNIA GRAM FORMULA WEIGHT 210.489

HfO_2: Crystals 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	14.18	14.18	-266.050	-252.566	185.135
UNCERTAINTY		0.10	0.10	0.300	0.310	0.227
400	1.540	18.61	14.76	-265.870	-247.985	135.492
500	3.170	22.24	15.90	-265.613	-243.536	106.449
600	4.900	25.40	17.23	-265.299	-239.157	87.113
700	6.710	28.19	18.60	-264.946	-234.826	73.316
800	8.570	30.67	19.96	-264.582	-230.548	62.983
900	10.450	32.88	21.27	-264.231	-226.312	54.956
1000	12.230	34.88	22.65	-264.012	-222.238	48.570
1100	14.280	36.72	23.74	-263.553	-217.955	43.303
1200	16.230	38.42	24.89	-263.221	-213.828	38.943
1300	18.200	40.00	26.00	-262.897	-209.731	35.259
1400	20.200	41.48	27.05	-262.567	-205.647	32.103
1500	22.220	42.87	28.06	-262.243	-201.586	29.371
1600	24.260	44.19	29.03	-261.923	-197.565	26.986
1700	26.320	45.44	29.96	-261.607	-193.558	24.883
1800	28.400	46.63	30.85	-261.295	-189.552	23.015
1900	30.500	47.76	31.71	-260.988	-185.575	21.346
2000	32.620	48.85	32.54	-260.684	-181.620	19.846

MELTING POINT	3173	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	0.49768	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

HAFNIUM.... ALPHA-BETA 2013 DEG K.

REFERENCES	74	78	22	COMPILED
				6-13-66

MONTROYDITE GRAM FORMULA WEIGHT 216.589

HgO: Crystals 298.15° to 1000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	16.80	16.80	-21.711	-13.998	10.261
UNCERTAINTY		0.08	0.08	0.090	0.100	0.073
400	1.126	20.04	17.23	-21.620	-11.375	6.215
500	2.323	22.71	18.06	-21.440	-8.832	3.860
600	3.587	25.01	19.03	-21.203	-6.333	2.307
700	4.905	27.04	20.04	-34.949	-2.305	0.720
800	6.263	28.86	21.03	-34.487	2.327	-0.636
900	7.652	30.49	21.99	-34.001	6.901	-1.676
1000	9.063	31.98	22.91	-33.500	11.418	-2.496

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	2.1780 KCAL	MOLAR VOLUME	0.46176 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MERCURY.... B. P. 629.73 DEG K.

REFERENCES 74 78 22 COMPILED 4-10-67

POTASSIUM OXIDE — GRAM FORMULA WEIGHT 94.203

K_2O: Crystals 298.15° to 2000°K. K_2O decomposes above 1154°K and tabulated data are a metastable extrapolation.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	22.50	22.50	-86.800	-76.974	56.423
UNCERTAINTY		1.50	1.50	0.500	0.680	0.498
400	2.148	28.68	23.31	-87.668	-73.441	40.126
500	4.367	33.63	24.90	-87.300	-69.926	30.565
600	6.657	37.81	26.71	-86.840	-66.491	24.219
700	9.033	41.47	28.56	-86.285	-63.141	19.714
800	11.504	44.76	30.38	-85.637	-59.880	16.358
900	14.071	47.79	32.15	-84.901	-56.703	13.769
1000	16.735	50.59	33.86	-84.092	-53.614	11.717
1100	19.496	53.22	35.50	-121.025	-48.560	9.648
1200	22.354	55.71	37.08	-119.585	-42.033	7.655
1300	25.309	58.07	38.61	-118.052	-35.634	5.991
1400	28.360	60.33	40.08	-116.427	-29.352	4.582
1500	31.508	62.51	41.50	-114.709	-23.193	3.379
1600	34.754	64.60	42.88	-112.895	-17.150	2.343
1700	38.097	66.63	44.22	-110.989	-11.226	1.443
1800	41.358	68.59	45.62	-109.169	-5.593	0.679
1900	45.076	70.51	46.78	-106.898	0.283	-0.033
2000	48.712	72.37	48.02	-104.712	5.869	-0.641

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	KCAL	MOLAR VOLUME	0.96511 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

POTASSIUM.. M. P. 336.4, B. P. 1043.7 DEG K.

REFERENCES	148	148	148	COMPILED 2-12-67

LITHIUM OXIDE GRAM FORMULA WEIGHT 29.877

Li_2O: Crystals 298.15° to 1200°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	8.98	8.98	-143.100	-134.329	98.466
UNCERTAINTY		0.02	0.02	0.500	0.510	0.374
400	1.445	13.13	9.52	-143.281	-131.300	71.739
500	3.045	16.70	10.61	-144.882	-128.143	56.011
600	4.765	19.83	11.89	-144.966	-124.783	45.452
700	6.580	22.62	13.22	-144.940	-121.417	37.908
800	8.470	25.15	14.56	-144.833	-118.069	32.255
900	10.430	27.46	15.87	-144.662	-114.735	27.861
1000	12.460	29.59	17.13	-144.425	-111.413	24.349
1100	14.540	31.58	18.36	-144.141	-108.134	21.484
1200	16.660	33.42	19.54	-143.821	-104.871	19.100

MELTING POINT 1700 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 2.7250 KCAL MOLAR VOLUME 0.35277 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

LITHIUM.... M. P. 453.69, B. P. 1597 DEG K.

REFERENCES 148 148 148 COMPILED 4-10-67

PERICLASE GRAM FORMULA WEIGHT 40.311

MgO: Crystals 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	6.44	6.44	-143.800	-136.087	99.755
UNCERTAINTY		0.04	0.04	0.100	0.110	0.081
400	0.980	9.26	6.81	-143.803	-133.449	72.913
500	2.036	11.61	7.54	-143.751	-130.869	57.203
600	3.148	13.64	8.39	-143.683	-128.294	46.731
700	4.297	15.41	9.27	-143.617	-125.734	39.256
800	5.474	16.98	10.14	-143.561	-123.187	33.653
900	6.673	18.39	10.98	-143.520	-120.638	29.295
1000	7.891	19.67	11.78	-145.632	-117.924	25.772
1100	9.123	20.85	12.56	-145.600	-115.149	22.878
1200	10.368	21.93	13.29	-145.559	-112.393	20.469
1300	11.620	22.91	13.97	-145.515	-109.592	18.424
1400	12.870	23.84	14.65	-175.822	-106.008	16.549
1500	14.140	24.71	15.28	-175.485	-101.024	14.719
1600	15.420	25.53	15.89	-175.140	-96.062	13.121
1700	16.700	26.31	16.49	-174.798	-91.136	11.716
1800	17.980	27.04	17.05	-174.460	-86.221	10.469
1900	19.270	27.74	17.60	-174.114	-81.335	9.356
2000	20.560	28.40	18.12	-173.771	-76.458	8.355

MELTING POINT 3125 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 1.2346 KCAL MOLAR VOLUME 0.26883 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.

REFERENCES 157 14 120 22 148 COMPILED 4-29-67

BRUCITE GRAM FORMULA WEIGHT 58.327

$Mg(OH)_2$: Crystals 298.15° to 600°K. At approximately 540°K the partial pressure of H_2O in equilibrium with brucite reaches one atmosphere.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	15.09	15.09	-221.200	-199.458	146.206
UNCERTAINTY		0.03	0.03	0.780	0.790	0.579
400	1.890	20.53	15.80	-221.362	-192.002	104.905
500	3.890	24.99	17.21	-221.431	-184.656	80.713
600	6.080	28.98	18.85	-221.362	-177.303	64.582

MELTING POINT DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

$H_{298} - H_0$ 2.7250 KCAL MOLAR VOLUME 0.58867 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.

REFERENCES 74 78 150 63 COMPILED 4-29-67

MANGANOSITE GRAM FORMULA WEIGHT 70.937

MnO: Crystals 298.15° to melting point 2054°K.

TEMP. DEG K	H -H 298 (KCAL)	S (CAL/DEG-GFW)	-(G -H)/T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	14.27	14.27	-92.050	-86.720	63.567
UNCERTAINTY		0.10	0.10	0.110	0.120	0.088
400	1.130	17.53	14.70	-91.972	-84.911	46.393
500	2.280	20.09	15.53	-91.882	-83.154	36.346
600	3.470	22.26	16.48	-91.875	-81.486	29.681
700	4.680	24.13	17.44	-91.759	-79.695	24.882
800	5.900	25.76	18.38	-91.758	-77.977	21.302
900	7.150	27.23	19.29	-91.770	-76.249	18.516
1000	8.430	28.58	20.15	-92.318	-74.526	16.288
1100	9.750	29.83	20.97	-92.323	-72.730	14.450
1200	11.100	31.01	21.76	-92.302	-70.965	12.925
1300	12.470	32.10	22.51	-92.280	-69.175	11.629
1400	13.840	33.12	23.23	-92.847	-67.391	10.520
1500	15.210	34.07	23.93	-93.473	-65.552	9.551
1600	16.590	34.96	24.59	-97.131	-63.392	8.659
1700	17.950	35.79	25.23	-97.312	-61.282	7.878
1800	19.350	36.58	25.83	-97.457	-59.138	7.180
1900	20.740	37.33	26.41	-97.614	-57.011	6.558
2000	22.130	38.05	26.98	-97.774	-54.873	5.996

MELTING POINT 2054 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.31599 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MANGANESE.. ALPHA-BETA 990, BETA-GAMMA 1360, GAMMA-DELTA 1410, M. P. DELTA 1517 DEG K.

REFERENCES 74 78 22 COMPILED 6-13-66

PYROLUSITE GRAM FORMULA WEIGHT 86.937

MnO_2: Crystals 298.15° to 900°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H 298)/T T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	12.68	12.68	-124.450	-111.342	81.615
UNCERTAINTY		0.10	0.10	0.200	0.210	0.154
400	1.445	16.84	13.23	-124.419	-106.866	58.389
500	3.020	20.35	14.31	-124.270	-102.493	44.800
600	4.685	23.38	15.57	-124.165	-98.221	35.777
700	6.415	26.04	16.88	-123.918	-93.840	29.298
800	8.185	28.41	18.18	-123.766	-89.564	24.468
900	9.990	30.56	19.46	-123.630	-85.315	20.717

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.39699 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MANGANESE.. ALPHA-BETA 990, BETA-GAMMA 1360, GAMMA-DELTA 1410, M. P. DELTA 1517 DEG K.

REFERENCES 74 78 22 COMPILED 6-13-66

BIXBYITE GRAM FORMULA WEIGHT 157.874

Mn_2O_3: Crystals 298.15° to 1300°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	26.40	26.40	-228.700	-210.097	154.005
UNCERTAINTY		0.50	0.50	0.500	0.530	0.388
400	2.550	33.73	27.35	-228.616	-203.746	111.321
500	5.220	39.68	29.24	-228.432	-197.547	86.347
600	8.040	44.82	31.42	-228.355	-191.530	69.765
700	10.990	49.37	33.67	-227.982	-185.280	57.847
800	14.040	53.44	35.89	-227.769	-179.201	48.955
900	17.190	57.15	38.05	-227.550	-173.138	42.043
1000	20.420	60.55	40.13	-228.390	-167.104	36.521
1100	23.740	63.71	42.13	-228.139	-160.968	31.981
1200	27.150	66.68	44.05	-227.811	-154.897	28.211
1300	30.650	69.48	45.90	-227.436	-148.825	25.020

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.74976 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MANGANESE.. ALPHA-BETA 990, BETA-GAMMA 1360, GAMMA-DELTA 1410, M. P. DELTA 1517 DEG K.

REFERENCES 74 78 118 22 COMPILED 6-13-66

HAUSMANNITE GRAM FORMULA WEIGHT 228.812

Mn_3O_4: Tetragonal crystals 298.15° to 1445°K. Cubic crystals 1445° to 1800°K.

TEMP. DEG K	H -H 298 (KCAL)	S (CAL/DEG-GFW)	-(G -H)/T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	36.80	36.80	-331.400	-306.313	224.533
UNCERTAINTY		1.00	1.00	0.400	0.500	0.367
400	3.730	47.55	38.22	-331.188	-297.774	162.695
500	7.590	56.16	40.98	-330.875	-289.456	126.521
600	11.590	63.45	44.13	-330.800	-281.408	102.503
700	15.740	69.84	47.35	-330.321	-272.992	85.232
800	19.980	75.50	50.52	-330.137	-264.828	72.347
900	24.250	80.53	53.59	-330.060	-256.661	62.326
1000	28.570	85.08	56.51	-331.639	-248.511	54.312
1100	33.020	89.32	59.30	-331.582	-240.176	47.719
1200	37.650	93.35	61.97	-331.363	-231.905	42.235
1300	42.510	97.23	64.53	-330.977	-223.605	37.591
1400	47.620	101.02	67.01	-332.110	-215.330	33.614
1445	49.960	102.67	68.10	-332.240	-211.560	31.997
1445	54.930	106.11	68.10	-327.270	-211.560	31.997
1500	57.690	107.98	69.52	-328.462	-207.118	30.177
1600	62.710	111.22	72.03	-338.996	-198.151	27.066
1700	67.730	114.26	74.42	-339.040	-189.324	24.339
1800	72.750	117.14	76.72	-339.098	-180.529	21.919

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 1.1221	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MANGANESE.. ALPHA-BETA 990, BETA-GAMMA 1360, GAMMA-DELTA 1410, M. P. DELTA 1517 DEG K.

REFERENCES 74 118 22 COMPILED 6-13-66

MOLYBDITE GRAM FORMULA WEIGHT 143.938

MoO_3: Crystals 298.15° to melting point 1074°K. Liquid 1074° to 1400°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	18.58	18.58	-178.160	-159.745	117.096
UNCERTAINTY		0.10	0.10	0.100	0.110	0.081
400	1.920	24.11	19.31	-177.924	-153.490	83.863
500	3.970	28.68	20.74	-177.577	-147.417	64.436
600	6.130	32.61	22.39	-177.173	-141.422	51.513
700	8.380	36.08	24.11	-176.724	-135.499	42.304
800	10.720	39.20	25.80	-176.223	-129.639	35.416
900	13.150	42.06	27.45	-175.666	-123.855	30.076
1000	15.670	44.72	29.05	-175.052	-118.127	25.816
1074	17.590	46.57	30.19	-174.554	-113.938	23.185
1074	29.280	57.45	30.19	-162.864	-113.938	23.185
1100	30.070	58.18	30.84	-162.591	-112.756	22.402
1200	33.090	60.81	33.23	-161.543	-108.273	19.719
1300	36.110	63.23	35.45	-160.524	-103.883	17.464
1400	39.130	65.47	37.52	-159.535	-99.559	15.542

MELTING POINT 1074 DEG K BOILING POINT DEG K

HEAT OF FUSION 11.690 KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.73040 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MOLYBDENUM. M. P. 2890 DEG K.

REFERENCES 74 78 103 COMPILED 12-10-66

NITROGEN DIOXIDE (ICEAL GAS) GRAM FORMULA WEIGHT 46.005

NO_2: Ideal gas 298.15° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	57.35	57.35	7.930	12.262	-8.989
UNCERTAINTY		0.02	0.02	0.100	0.110	0.081
400	0.944	60.07	57.71	7.795	13.765	-7.521
500	1.948	62.30	58.41	7.716	15.267	-6.673
600	3.021	64.26	59.22	7.678	16.782	-6.113
700	4.151	66.00	60.07	7.666	18.300	-5.714
800	5.327	67.57	60.91	7.673	19.819	-5.414
900	6.539	69.00	61.73	7.691	21.336	-5.181
1000	7.780	70.30	62.52	7.718	22.852	-4.994
1100	9.043	71.51	63.29	7.748	24.363	-4.840
1200	10.324	72.62	64.02	7.781	25.872	-4.712
1300	11.620	73.66	64.72	7.814	27.378	-4.603
1400	12.929	74.63	65.39	7.849	28.881	-4.509
1500	14.247	75.54	66.04	7.881	30.383	-4.427
1600	15.573	76.39	66.66	7.912	31.882	-4.355
1700	16.907	77.20	67.26	7.943	33.379	-4.291
1800	18.247	77.97	67.83	7.969	34.876	-4.235
1900	19.591	78.70	68.38	7.992	36.370	-4.184
2000	20.940	79.39	68.92	8.012	37.862	-4.137

MELTING POINT 261.90 DEG K BOILING POINT 294.25 DEG K

HEAT OF FUSION 3.502 KCAL HEAT OF VAPOR. 9.110 KCAL

H -H 298 0 2.4370 KCAL MOLAR VOLUME 584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148 158 158 COMPILED 2-12-67

SODIUM OXIDE — GRAM FORMULA WEIGHT 61.979

Na_2O: Crystals 298.15° to melting point 1190°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H T 298)/T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	17.99	17.99	-99.400	-90.161	66.090
UNCERTAINTY		0.20	0.20	1.500	1.510	1.107
400	1.789	23.26	18.79	-100.685	-86.950	47.507
500	3.683	27.48	20.11	-100.638	-83.517	36.505
600	5.676	31.11	21.65	-100.465	-80.106	29.179
700	7.768	34.33	23.23	-100.174	-76.735	23.958
800	9.959	37.26	24.81	-99.772	-73.416	20.056
900	12.247	39.95	26.34	-99.271	-70.147	17.034
1000	14.636	42.47	27.83	-98.675	-66.945	14.631
1100	17.122	44.84	29.27	-98.001	-63.809	12.678

MELTING POINT	1193	DEG K	BOILING POINT	DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0		KCAL	MOLAR VOLUME	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SODIUM..... M. P. 370.98, B. P. 1176.9 DEG K.

REFERENCES				
148	50		22	COMPILED 6-13-66

BUNSENITE GRAM FORMULA WEIGHT 74.709

NiO: Crystals 298.15° to melting point 2257°K.

TEMP. DEG K	H -H 298 (KCAL)	S (CAL/DEG-GFW)	-(G -H)/T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	9.08	9.08	-57.300	-50.574	37.072
UNCERTAINTY		0.04	0.04	0.100	0.110	0.081
400	1.165	12.43	9.52	-57.163	-48.294	26.387
500	2.535	15.47	10.40	-56.865	-46.102	20.151
600	3.940	18.05	11.48	-56.620	-43.987	16.022
700	5.220	20.02	12.56	-56.519	-41.879	13.075
800	6.500	21.73	13.60	-56.378	-39.797	10.872
900	7.780	23.24	14.60	-56.259	-37.732	9.162
1000	9.070	24.60	15.53	-56.158	-35.677	7.797
1100	10.370	25.84	16.41	-56.077	-33.635	6.683
1200	11.700	26.99	17.24	-55.993	-31.584	5.752
1300	13.060	28.08	18.03	-55.905	-29.563	4.970
1400	14.450	29.11	18.79	-55.806	-27.536	4.298
1500	15.860	30.08	19.51	-55.697	-25.511	3.717
1600	17.300	31.01	20.20	-55.560	-23.501	3.210
1700	18.770	31.90	20.86	-55.396	-21.508	2.765
1800	20.260	32.76	21.50	-59.513	-19.340	2.348
1900	21.770	33.57	22.11	-59.480	-17.110	1.968
2000	23.300	34.36	22.71	-59.430	-14.889	1.627

MELTING POINT 2257 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.26219 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

NICKEL..... CURIE P. 631, M. P. 1726 DEG K.

REFERENCES 74 78 18 COMPILED 6-13-66

PHOSPHORUS PENTOXIDE (DIMERIC) GRAM FORMULA WEIGHT 283.889

$(P_2O_5)_2$: Crystals 298.15° to 1000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	54.70	54.70	-713.200	-649.968	476.438
UNCERTAINTY		0.10	0.10	0.400	0.410	0.301
400	5.991	71.89	56.91	-712.997	-628.369	343.324
500	13.131	87.77	61.51	-711.796	-607.331	265.463
600	21.431	102.87	67.16	-709.675	-586.625	213.677
700	30.845	117.36	73.30	-706.683	-566.341	176.819
800	41.334	131.35	79.69	-784.516	-567.790	155.113
900	52.856	144.91	86.19	-778.808	-541.030	131.380
1000	65.372	158.09	92.72	-772.183	-514.955	112.543

MELTING POINT	842	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
$H_{298} - H_0$	8.258	KCAL	MOLAR VOLUME	2.8393	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

PHOSPHORUS. SUBLIMES 704 DEG K.

REFERENCES	148	158	158	COMPILED
				2-12-67

LITHARGE (RED) GRAM FORMULA WEIGHT 223.189

PbO: Tetragonal crystals 298.15° to 900°K. Massicot (orthorhombic) is the stable phase above 762°K. See table for lead monoxide (reference state).

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	15.60	15.60	-52.410	-45.121	33.074
UNCERTAINTY		0.20	0.20	0.160	0.180	0.132
400	1.220	19.12	16.07	-52.207	-42.662	23.310
500	2.460	21.88	16.96	-51.997	-40.299	17.615
600	3.740	24.22	17.99	-51.788	-37.985	13.836
700	5.060	26.25	19.02	-52.730	-35.507	11.086
800	6.420	28.06	20.03	-52.493	-33.056	9.030
900	7.820	29.71	21.02	-52.212	-30.643	7.441

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.57146 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

LEAD..... M. P. 600.6, B. P. 2023 DEG K.

REFERENCES 74	78	22	COMPILED
	159	148	5-18-67

MASSICOT (YELLOW) GRAM FORMULA WEIGHT 223.189

PbO: Orthorhombic crystals 298.15° to 2000°K. See table for lead monoxide (reference state).

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	16.10	16.10	-52.180	-45.040	33.015
UNCERTAINTY		0.20	0.20	0.170	0.190	0.139
400	1.152	19.42	16.54	-52.045	-42.620	23.286
500	2.339	22.07	17.39	-51.888	-40.283	17.608
600	3.568	24.30	18.36	-51.730	-37.978	13.833
700	4.832	26.25	19.35	-51.728	-35.507	11.086
800	6.128	27.98	20.32	-52.555	-33.056	9.031
900	7.453	29.54	21.26	-52.349	-30.629	7.438
1000	8.809	30.97	22.16	-52.112	-28.233	6.170
1100	10.194	32.29	23.02	-51.846	-25.865	5.139
1200	11.607	33.52	23.85	-51.547	-23.504	4.281
1300	13.049	34.67	24.64	-51.220	-21.192	3.563
1400	14.518	35.76	25.39	-50.867	-18.892	2.949
1500	16.015	36.80	26.12	-50.490	-16.624	2.422
1600	17.540	37.78	26.82	-50.087	-14.396	1.966
1700	19.092	38.72	27.49	-49.660	-12.153	1.562
1800	20.672	39.62	28.14	-49.209	-9.961	1.209
1900	22.279	40.49	28.77	-48.733	-7.793	0.896
2000	23.914	41.33	29.37	-48.232	-5.655	0.618

MELTING POINT 1170 DEG K BOILING POINT 1789 DEG K

HEAT OF FUSION 6.100 KCAL HEAT OF VAPOR. 49.530 KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.55330 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

LEAD..... M. P. 600.6, B. P. 2023 DEG K.

REFERENCES 148 78 159 22 148 COMPILED 5-18-67

LEAD MONOXIDE (REFERENCE STATE) GRAM FORMULA WEIGHT 223.189

PbO: Litharge (red) 298.15° to 762°K. Massicot (yellow) 762° to 1170°K. Liquid 1170° to 1789°K. Ideal gas 1789° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S (CAL/DEG-GFW)	-(G -H 298)/T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FORMATION FROM THE ELEMENTS FREE ENERGY (KCAL/GFW)	FORMATION FROM THE ELEMENTS LOG K
298.15	0.000	15.60	15.60	-52.410	-45.121	33.074
UNCERTAINTY		0.20	0.20	0.160	0.180	0.132
400	1.220	19.12	16.07	-52.207	-42.662	23.310
500	2.460	21.88	16.96	-51.997	-40.299	17.615
600	3.740	24.22	17.99	-51.788	-37.985	13.836
700	5.060	26.25	19.02	-52.730	-35.507	11.086
762	5.898	27.40	19.66	-52.597	-33.906	9.724
762	5.978	27.50	19.66	-52.517	-33.906	9.724
800	6.474	28.04	19.95	-52.439	-32.986	9.011
900	7.799	29.60	20.93	-52.233	-30.565	7.422
1000	9.155	31.03	21.87	-51.996	-28.174	6.157
1100	10.540	32.35	22.77	-51.730	-25.811	5.128
1170	11.180	33.16	23.60	-51.523	-24.144	4.510
1170	17.280	38.37	23.60	-45.423	-24.144	4.510
1200	18.092	38.82	23.75	-45.292	-23.611	4.300
1300	19.645	40.07	24.95	-44.854	-21.835	3.671
1400	21.119	41.22	26.13	-44.496	-20.155	3.146
1500	22.752	42.29	27.12	-43.983	-18.356	2.674
1600	24.306	43.29	28.10	-43.551	-16.680	2.278
1700	25.859	44.23	29.02	-43.123	-14.988	1.927
1789	27.242	45.03	29.80	-42.745	-13.527	1.652
1789	76.772	72.71	29.80	6.785	-13.527	1.652
1800	76.871	72.77	30.06	6.760	-13.651	1.657
1900	77.774	73.26	32.32	6.531	-14.778	1.700
2000	78.678	73.72	34.38	6.301	-15.897	1.737

MELTING POINT 1170 DEG K BOILING POINT 1789 DEG K

HEAT OF FUSION 6.100 KCAL HEAT OF VAPOR. 49.530 KCAL

$H_{298} - H_0$ KCAL MOLAR VOLUME 0.57146 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

LEAD..... M. P. 600.6, B. P. 2023 DEG K.

REFERENCES 74 78 159 22 148 COMPILED 5-17-67

MINIUM GRAM FORMULA WEIGHT 685.568

Pb_3O_4: Crystals 298.15° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	50.50	50.50	-171.700	-143.632	105.284
UNCERTAINTY		1.50	1.50	2.000	2.060	1.510
400	3.618	60.93	51.89	-171.495	-134.075	73.255
500	7.249	69.03	54.53	-171.321	-124.744	54.525
600	10.958	75.79	57.53	-171.201	-115.445	42.051
700	14.745	81.63	60.56	-174.589	-105.584	32.965
800	18.610	86.79	63.53	-174.492	-95.726	26.151
900	22.553	91.43	66.37	-174.313	-85.886	20.856
1000	26.574	95.67	69.09	-174.064	-76.084	16.628
1100	30.673	99.57	71.69	-173.740	-66.323	13.177
1200	34.850	103.21	74.17	-173.329	-56.540	10.297
1300	39.105	106.61	76.53	-172.849	-46.866	7.879
1400	43.438	109.82	78.80	-172.296	-37.182	5.804
1500	47.849	112.87	80.97	-171.679	-27.561	4.016
1600	52.339	115.76	83.05	-170.995	-18.029	2.463
1700	56.905	118.53	85.06	-170.245	-8.414	1.082
1800	61.550	121.19	86.99	-169.430	1.077	-0.131
1900	66.273	123.74	88.86	-168.549	10.528	-1.211
2000	71.074	126.20	90.67	-167.600	19.922	-2.177

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 1.8358	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

LEAD..... M. P. 600.6, B. P. 2023 DEG K.

REFERENCES 148	78	159	COMPILED
	159		4-15-67

SULFUR DIOXIDE — GRAM FORMULA WEIGHT 64.063

SO_2: Ideal gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	59.30	59.30	-70.944	-71.750	52.594
UNCERTAINTY		0.10	0.10	0.050	0.060	0.044
400	1.015	62.22	59.68	-71.762	-71.959	39.316
500	2.090	64.62	60.44	-72.357	-71.941	31.445
600	3.240	66.71	61.31	-72.818	-71.809	26.156
700	4.440	68.56	62.22	-73.196	-71.610	22.358
800	5.675	70.21	63.12	-86.584	-72.579	19.828
900	6.940	71.70	63.99	-86.571	-70.865	17.208
1000	8.230	73.06	64.83	-86.549	-69.081	15.098
1100	9.545	74.31	65.63	-86.516	-67.334	13.378
1200	10.875	75.47	66.41	-86.478	-65.594	11.946
1300	12.215	76.54	67.14	-86.440	-63.851	10.734
1400	13.565	77.54	67.85	-86.401	-62.115	9.697
1500	14.925	78.54	68.59	-86.360	-60.476	8.811
1600	16.290	79.36	69.18	-86.320	-58.653	8.012
1700	17.660	80.19	69.80	-86.281	-56.924	7.318
1800	19.035	80.98	70.40	-86.245	-55.152	6.696
1900	20.415	81.72	70.98	-86.210	-53.471	6.151
2000	21.800	82.43	71.53	-86.176	-51.748	5.655

MELTING POINT	197.64 DEG K	BOILING POINT	263.08 DEG K
HEAT OF FUSION	1.769 KCAL	HEAT OF VAPOR.	5.960 KCAL
$H_{298} - H_0$	2.5220 KCAL	MOLAR VOLUME	584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36,
B. P. 717.75 DEG K.

REFERENCES	148 158 34	158	COMPILED 5-06-67

SULFUR TRIOXIDE GRAM FORMULA WEIGHT 80.062

SO_3: Ideal gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	61.34	61.34	-94.580	-88.690	65.012
UNCERTAINTY		0.20	0.20	0.170	0.190	0.139
400	1.322	65.14	61.83	-95.453	-86.601	47.317
500	2.768	68.36	62.82	-96.042	-84.318	36.855
600	4.328	71.20	63.99	-96.471	-81.929	29.842
700	5.975	73.74	65.20	-96.791	-79.480	24.815
800	7.687	76.03	66.42	-110.101	-78.211	21.366
900	9.448	78.10	67.60	-109.999	-74.263	18.033
1000	11.248	80.00	68.75	-109.880	-70.260	15.355
1100	13.077	81.74	69.85	-109.753	-66.304	13.173
1200	14.930	83.35	70.91	-109.616	-62.356	11.357
1300	16.802	84.85	71.93	-109.474	-58.424	9.822
1400	18.688	86.25	72.90	-109.331	-54.507	8.509
1500	20.587	87.56	73.84	-109.187	-50.597	7.372
1600	22.497	88.79	74.73	-109.040	-46.690	6.378
1700	24.415	89.95	75.59	-108.894	-42.793	5.501
1800	26.340	91.05	76.42	-108.753	-38.855	4.718
1900	28.272	92.10	77.22	-108.613	-35.043	4.031
2000	30.209	93.09	77.99	-108.477	-31.168	3.406

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	2.7960 KCAL	MOLAR VOLUME 584.727	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36,
B. P. 717.75 DEG K.

REFERENCES 148 158 158 COMPILED 5-06-67

SILICON MONOXIDE GRAM FORMULA WEIGHT 44.085

SiO: Ideal gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	50.55	50.55	-23.800	-30.226	22.156
UNCERTAINTY		0.20	0.20	1.000	1.010	0.740
400	0.742	52.69	50.83	-23.936	-32.403	17.704
500	1.501	54.38	51.38	-24.088	-34.501	15.081
600	2.288	55.82	52.00	-24.251	-36.570	13.320
700	3.096	57.06	52.64	-24.423	-38.610	12.055
800	3.922	58.16	53.26	-24.602	-40.624	11.098
900	4.761	59.15	53.86	-24.790	-42.615	10.348
1000	5.610	60.05	54.44	-24.984	-44.578	9.743
1100	6.468	60.86	54.98	-25.185	-46.528	9.244
1200	7.332	61.62	55.51	-25.391	-48.462	8.826
1300	8.201	62.31	56.00	-25.602	-50.379	8.469
1400	9.076	62.96	56.48	-25.817	-52.271	8.160
1500	9.953	63.56	56.93	-26.040	-54.166	7.892
1600	10.834	64.13	57.36	-26.267	-56.039	7.655
1700	11.718	64.67	57.78	-38.570	-57.790	7.429
1800	12.604	65.18	58.17	-38.739	-58.912	7.153
1900	13.493	65.66	58.55	-38.907	-60.027	6.905
2000	14.383	66.11	58.92	-39.077	-61.141	6.681

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	2.0820 KCAL	MOLAR VOLUME	584.727 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SILICON.... M. P. 1685 DEG K.

REFERENCES 148 158 158 COMPILED 6-13-66

QUARTZ GRAM FORMULA WEIGHT 60.085

SiO_2: α quartz 298.15° to 848°K. β quartz 848° to 2000°K.

β quartz is metastable above 1140°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	9.88	9.88	-217.650	-204.646	150.009
UNCERTAINTY		0.02	0.02	0.400	0.410	0.301
400	1.200	13.33	10.33	-217.690	-200.197	109.382
500	2.560	16.36	11.24	-217.607	-195.830	85.597
600	4.040	19.05	12.32	-217.454	-191.486	69.749
700	5.630	21.50	13.46	-217.233	-187.176	58.439
800	7.320	23.76	14.61	-216.947	-182.905	49.967
848	8.170	24.79	15.16	-216.787	-180.870	46.615
848	8.460	25.13	15.16	-216.497	-180.870	46.615
900	9.300	26.09	15.76	-216.401	-178.680	43.389
1000	10.920	27.80	16.88	-216.238	-174.494	38.136
1100	12.570	29.37	17.94	-216.066	-170.325	33.840
1140	13.247	29.97	18.35	-215.997	-168.662	32.334
1200	14.250	30.83	18.95	-215.880	-166.175	30.264
1300	15.940	32.18	19.92	-215.699	-162.039	27.241
1400	17.640	33.44	20.84	-215.521	-157.915	24.652
1500	19.360	34.63	21.72	-215.336	-153.824	22.412
1600	21.100	35.76	22.57	-215.143	-149.745	20.454
1700	22.860	36.82	23.37	-227.011	-145.549	18.712
1800	24.630	37.84	24.16	-226.740	-140.777	17.093
1900	26.420	38.81	24.90	-226.455	-136.013	15.645
2000	28.220	39.73	25.62	-226.165	-131.261	14.343

MELTING POINT DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

$H_{298} - H_0$ 1.6257 KCAL MOLAR VOLUME 0.54226 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SILICON.... M. P. 1685 DEG K.

REFERENCES 74 178 180 COMPILED
49 6-13-66

CRISTOBALITE GRAM FORMULA WEIGHT 60.085

SiO_2: α cristobalite 298.15° to 523°K. β cristobalite 523° to 2000°K. Cristobalite melts at 1996°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	10.38	10.38	-216.930	-204.075	149.591
UNCERTAINTY		0.02	0.02	0.450	0.460	0.337
400	1.210	13.86	10.83	-216.960	-199.679	109.099
500	2.560	16.86	11.74	-216.887	-195.360	85.392
523	2.910	17.54	11.97	-216.870	-194.367	81.223
523	3.110	17.92	11.97	-216.670	-194.367	81.223
600	4.310	20.06	12.88	-216.464	-191.102	69.609
700	5.850	22.43	14.07	-216.293	-186.887	58.348
800	7.460	24.58	15.25	-216.087	-182.701	49.911
900	9.090	26.50	16.40	-215.891	-178.539	43.355
1000	10.730	28.23	17.50	-215.708	-174.394	38.114
1100	12.390	29.81	18.55	-215.526	-170.269	33.829
1200	14.080	31.28	19.55	-215.330	-166.165	30.263
1300	15.790	32.65	20.50	-215.129	-162.080	27.248
1400	17.510	33.92	21.41	-214.931	-157.997	24.664
1500	19.240	35.12	22.29	-214.736	-153.959	22.432
1600	20.990	36.25	23.13	-214.533	-149.919	20.478
1700	22.750	37.31	23.93	-226.401	-145.772	18.740
1743	23.513	37.75	24.26	-226.280	-143.735	18.022
1800	24.530	38.33	24.70	-226.120	-141.039	17.124
1900	26.320	39.30	25.45	-225.835	-136.324	15.681
1996	28.050	40.19	26.14	-225.557	-131.809	14.432
2000	28.120	40.22	26.16	-225.545	-131.621	14.383

MELTING POINT 1996 DEG K BOILING POINT DEG K

HEAT OF FUSION 1.950 KCAL HEAT OF VAPOR. KCAL

H -H 298 0 1.6825 KCAL MOLAR VOLUME 0.61518 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SILICON.... M. P. 1685 DEG K.

REFERENCES 74 69 178 36 95 COMPILED 4-29-67

TRIDYMITE GRAM FORMULA WEIGHT 60.085

SiO_2: α tridymite 298.15° to 390°K. β tridymite 390° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	10.50	10.50	-216.895	-204.076	149.591
UNCERTAINTY		0.10	0.10	0.570	0.580	0.425
390	1.085	13.66	10.88	-216.920	-200.120	112.143
390	1.125	13.76	10.88	-216.880	-200.120	112.143
400	1.270	14.13	10.95	-216.865	-199.692	109.106
500	2.710	17.34	11.92	-216.702	-195.415	85.416
600	4.170	20.00	13.05	-216.569	-191.171	69.634
700	5.710	22.37	14.21	-216.398	-186.950	58.368
800	7.320	24.52	15.37	-216.192	-182.758	49.927
900	8.950	26.44	16.50	-215.996	-178.590	43.368
1000	10.590	28.17	17.58	-215.813	-174.439	38.124
1100	12.250	29.75	18.61	-215.631	-170.308	33.837
1140	12.928	30.25	19.01	-215.555	-168.662	22.334
1200	13.940	31.22	19.60	-215.435	-166.198	30.269
1300	15.650	32.59	20.55	-215.234	-162.107	27.253
1400	17.370	33.87	21.46	-215.036	-158.032	24.670
1500	19.100	35.06	22.33	-214.841	-153.974	22.434
1600	20.850	36.19	23.16	-214.638	-149.928	20.479
1700	22.610	37.25	23.95	-226.506	-145.775	18.741
1743	23.373	37.69	24.28	-226.386	-143.735	18.022
1800	24.390	38.27	24.72	-226.225	-141.036	17.124
1900	26.180	39.24	25.46	-225.940	-136.315	15.680
2000	27.980	40.16	26.17	-225.650	-131.606	14.381

MELTING POINT DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.63408 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SILICON.... M. P. 1685 DEG K.

REFERENCES 74 131 95 COMPILED 4-29-67

COESITE GRAM FORMULA WEIGHT 60.085

SiO_2: Crystals 298.15° to 1800°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	9.65	9.65	-216.440	-203.367	149.072
UNCERTAINTY		0.10	0.10	0.500	0.510	0.374
400	1.189	13.07	10.10	-216.491	-198.895	108.671
500	2.501	15.99	10.99	-216.456	-194.495	85.013
600	3.918	18.56	12.03	-216.366	-190.106	69.246
700	5.417	20.86	13.12	-216.236	-185.733	57.988
800	6.969	22.92	14.21	-216.088	-181.378	49.550
900	8.588	24.83	15.29	-215.903	-177.050	42.993
1000	10.279	26.61	16.33	-215.669	-172.735	37.751
1100	12.015	28.26	17.34	-215.411	-168.451	33.468
1200	13.779	29.80	18.32	-215.141	-164.201	29.905
1300	15.555	31.24	19.27	-214.874	-159.987	26.896
1400	17.354	32.56	20.16	-214.597	-155.755	24.314
1500	19.142	33.81	21.05	-214.344	-151.597	22.088
1600	20.921	34.95	21.88	-214.112	-147.419	20.136
1700	22.709	36.03	22.67	-225.952	-143.150	18.403
1800	24.510	37.07	23.46	-225.650	-138.307	16.793

MELTING POINT DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H KCAL MOLAR VOLUME 0.49333 CAL/BAR
298 0

TRANSITIONS IN REFERENCE STATE ELEMENTS

SILICON.... M. P. 1685 DEG K.

REFERENCES 163 61 61 COMPILED
131 5-17-67

STISHOVITE GRAM FORMULA WEIGHT 60.085

SiO_2: Crystals 298.15° to 1800°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	6.64	6.64	-205.860	-191.890	140.659
UNCERTAINTY		0.10	0.10	0.500	0.510	0.374
400	1.160	9.98	7.08	-205.940	-187.108	102.231
500	2.444	12.84	7.95	-205.933	-182.395	79.725
600	3.832	15.36	8.98	-205.872	-177.692	64.724
700	5.303	17.62	10.05	-205.770	-172.998	54.012
800	6.826	19.65	11.12	-205.651	-168.321	45.983
900	8.417	21.53	12.18	-205.494	-163.667	39.744
1000	10.079	23.28	13.20	-205.289	-159.021	34.754
1100	11.787	24.90	14.19	-205.059	-154.402	30.677
1200	13.522	26.42	15.15	-204.818	-149.818	27.286
1300	15.270	27.83	16.08	-204.579	-145.264	24.421
1400	17.040	29.14	16.97	-204.331	-140.705	21.965
1500	18.800	30.37	17.84	-204.106	-136.204	19.845
1600	20.550	31.50	18.66	-203.903	-131.689	17.988
1700	22.310	32.56	19.44	-215.771	-127.067	16.335
1800	24.080	33.57	20.19	-215.500	-121.851	14.795

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.33494 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SILICON.... M. P. 1685 DEG K.

REFERENCES 163	61	61	COMPILED 5-17-67

SILICA GLASS GRAM FORMULA WEIGHT 60.085

SiO_2: Glass 298.15° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	11.33	11.33	-215.870	-203.298	149.021
UNCERTAINTY		0.05	0.05	0.500	0.510	0.374
400	1.230	14.87	11.79	-215.880	-199.002	108.730
500	2.550	17.81	12.71	-215.837	-194.784	85.140
600	3.950	20.36	13.78	-215.764	-190.581	69.419
700	5.430	22.64	14.88	-215.653	-186.393	58.194
800	6.990	24.72	15.98	-215.497	-182.222	49.781
900	8.610	26.63	17.06	-215.311	-178.075	43.242
1000	10.280	28.39	18.11	-215.098	-173.943	38.015
1100	11.980	30.01	19.12	-214.876	-169.838	33.744
1200	13.700	31.50	20.08	-214.650	-165.748	30.187
1300	15.450	32.90	21.01	-214.409	-161.684	27.181
1400	17.240	34.23	21.91	-214.141	-157.640	24.609
1500	19.080	35.50	22.78	-213.836	-153.627	22.383
1600	20.980	36.72	23.61	-213.483	-149.619	20.437
1700	22.930	37.90	24.41	-225.161	-145.533	18.709
1800	24.920	39.04	25.19	-224.670	-140.866	17.103
1900	26.950	40.14	25.95	-224.145	-136.228	15.670
2000	29.010	41.20	26.69	-223.595	-131.629	14.384

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.65177 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SILICON.... M. P. 1685 DEG K.

REFERENCES	74	161	95	COMPILED
		178	180	4-15-67

CASSITERITE GRAM FORMULA WEIGHT 150.689

SnO_2: Crystals 298.15° to melting point 1903°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	12.50	12.50	-138.820	-124.266	91.089
UNCERTAINTY		0.30	0.30	0.150	0.180	0.132
400	1.510	16.84	13.06	-138.714	-119.305	65.185
500	3.100	20.38	14.18	-138.565	-114.468	50.034
600	4.780	23.45	15.48	-140.010	-109.356	39.833
700	6.550	26.18	16.82	-139.703	-104.270	32.554
800	8.390	28.63	18.14	-139.346	-99.224	27.107
900	10.280	30.85	19.43	-138.960	-94.237	22.884
1000	12.210	32.88	20.67	-138.537	-89.283	19.513
1100	14.190	34.77	21.87	-138.086	-84.381	16.765
1200	16.210	36.53	23.02	-137.594	-79.525	14.483
1300	18.260	38.17	24.12	-137.091	-74.708	12.560
1400	20.340	39.71	25.18	-136.555	-69.919	10.915
1500	22.440	41.16	26.20	-136.016	-65.189	9.498

MELTING POINT 1903 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.51506 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

TIN..... M. P. 505 DEG K.

REFERENCES 74 78 22 COMPILED 6-13-66

STRONTIUM OXIDE GRAM FORMULA WEIGHT 103.619

SrO: Crystals 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	13.00	13.00	-144.440	-137.285	100.632
UNCERTAINTY		0.20	0.20	0.400	0.440	0.323
400	1.170	16.37	13.44	-144.292	-134.863	73.686
500	2.340	18.98	14.30	-144.167	-132.519	57.924
600	3.550	21.18	15.26	-144.045	-130.194	47.423
700	4.800	23.11	16.25	-143.934	-127.901	39.932
800	6.090	24.83	17.22	-143.823	-125.618	34.317
900	7.410	26.39	18.16	-143.940	-123.343	29.952
1000	8.740	27.79	19.05	-143.933	-121.051	26.456
1100	10.070	29.06	19.91	-146.253	-118.641	23.572
1200	11.400	30.21	20.71	-146.087	-116.122	21.149
1300	12.740	31.28	21.48	-145.915	-113.632	19.103
1400	14.090	32.28	22.22	-145.737	-111.153	17.352
1500	15.450	33.22	22.92	-145.553	-108.692	15.836
1600	16.820	34.11	23.60	-145.361	-106.246	14.513
1700	18.200	34.94	24.23	-178.241	-102.567	13.186
1800	19.590	35.74	24.86	-177.796	-98.131	11.915

MELTING POINT 2693 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.49450 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

STRONTIUM.. ALPHA-GAMMA 862, M. P. GAMMA 1043, B. P. 1648 DEG K.

REFERENCES 74 78 108 COMPILED 6-13-66

THORIANITE GRAM FORMULA WEIGHT 264.037

ThO_2: Crystals 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	15.59	15.59	-293.200	-279.436	204.831
UNCERTAINTY		0.05	0.05	0.400	0.410	0.301
400	1.600	20.20	16.20	-293.004	-274.759	150.121
500	3.210	23.79	17.37	-292.825	-270.218	118.112
600	4.890	26.85	18.70	-292.630	-265.714	96.786
700	6.620	29.51	20.05	-292.438	-261.240	81.562
800	8.390	31.88	21.39	-292.256	-256.798	70.154
900	10.200	34.01	22.68	-292.080	-252.379	61.286
1000	12.050	35.96	23.91	-291.907	-247.973	54.194
1100	13.940	37.76	25.09	-291.746	-243.596	48.398
1200	15.860	39.43	26.21	-291.584	-239.215	43.567
1300	17.800	40.98	27.29	-291.441	-234.856	39.483
1400	19.760	42.43	28.32	-291.315	-230.503	35.983
1500	21.740	43.80	29.31	-291.216	-226.179	32.954
1600	23.740	45.09	30.25	-291.123	-221.837	30.301
1700	25.750	46.31	31.16	-291.735	-217.481	27.959
1800	27.770	47.46	32.03	-291.704	-213.103	25.874
1900	29.800	48.56	32.88	-291.669	-208.732	24.010
2000	31.840	49.61	33.69	-296.129	-204.285	22.323

MELTING POINT	3493	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	2.5244	KCAL	MOLAR VOLUME	0.63033	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

THORIUM.... ALPHA-BETA 1673, M. P. BETA 1968 DEG K.

REFERENCES 156 78 22 COMPILED 6-13-66

RUTILE GRAM FORMULA WEIGHT 79.899

TiO_2: Crystals 298.15° to melting point 2103°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	12.04	12.04	-225.760	-212.559	155.810
UNCERTAINTY		0.04	0.04	0.100	0.110	0.081
400	1.540	16.47	12.62	-225.571	-208.074	113.686
500	3.100	19.95	13.75	-225.385	-203.723	89.047
600	4.735	22.93	15.04	-225.170	-199.412	72.636
700	6.440	25.55	16.35	-224.932	-195.127	60.921
800	8.160	27.85	17.65	-224.723	-190.889	52.148
900	9.900	29.90	18.90	-224.535	-186.670	45.330
1000	11.650	31.74	20.09	-224.373	-182.469	39.878
1100	13.420	33.43	21.23	-224.227	-178.288	35.422
1200	15.200	34.98	22.31	-225.071	-174.082	31.705
1300	17.000	36.42	23.34	-224.851	-169.839	28.552
1400	18.820	37.77	24.33	-224.642	-165.622	25.855
1500	20.660	39.04	25.27	-224.445	-161.418	23.519
1600	22.530	40.24	26.16	-224.249	-157.203	21.473
1700	24.420	41.39	27.03	-224.063	-153.022	19.672
1800	26.340	42.48	27.85	-223.879	-148.842	18.072
1900	28.280	43.53	28.65	-223.705	-144.682	16.642
2000	30.250	44.54	29.41	-227.222	-140.418	15.344

MELTING POINT	2103	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	2.0720	KCAL	MOLAR VOLUME	0.44981	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

TITANIUM... ALPHA-BETA 1155, M. P. 1943 DEG K.

REFERENCES 74 78 111 COMPILED 6-13-66

ANATASE GRAM FORMULA WEIGHT 79.899

TiO_2: Crystals 298.15° to 1300°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	11.93	11.93	-225.860	-212.626	155.859
UNCERTAINTY		0.07	0.07	0.320	0.330	0.242
400	1.540	16.36	12.51	-225.671	-208.130	113.717
500	3.100	19.84	13.64	-225.485	-203.768	89.067
600	4.735	22.82	14.93	-225.270	-199.446	72.648
700	6.440	25.45	16.25	-225.032	-195.157	60.930
800	8.170	27.75	17.54	-224.813	-190.899	52.151
900	9.930	29.82	18.79	-224.605	-186.668	45.329
1000	11.720	31.71	19.99	-224.403	-182.469	39.878
1100	13.530	33.44	21.14	-224.217	-178.289	35.423
1200	15.350	35.02	22.23	-225.021	-174.080	31.704
1300	17.180	36.48	23.26	-224.771	-169.837	28.552

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.49044 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

TITANIUM... ALPHA-BETA 1155, M. P. 1943 DEG K.

REFERENCES 74 78 162 COMPILED 4-29-67

URANINITE GRAM FORMULA WEIGHT 270.029

UO_2: Crystals 298.15° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S (CAL/DEG-GFW)	-(G -H)/T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	18.63	18.63	-259.200	-246.569	180.739
UNCERTAINTY		0.10	0.10	0.600	0.610	0.447
400	1.680	23.47	19.27	-258.944	-242.295	132.383
500	3.470	27.46	20.52	-258.620	-238.168	104.103
600	5.340	30.86	21.96	-258.300	-234.102	85.271
700	7.280	33.85	23.45	-258.008	-230.093	71.838
800	9.250	36.48	24.92	-257.786	-226.120	61.773
900	11.250	38.83	26.33	-257.650	-222.170	53.950
1000	13.280	40.97	27.69	-258.187	-218.193	47.686
1100	15.340	42.94	28.99	-259.066	-214.161	42.550
1200	17.420	44.75	30.23	-258.744	-210.083	38.261
1300	19.510	46.42	31.41	-258.431	-206.045	34.639
1400	21.620	47.98	32.54	-258.095	-202.015	31.536
1500	23.750	49.45	33.62	-260.846	-197.819	28.822
1600	25.900	50.84	34.65	-260.493	-193.607	26.445
1700	28.070	52.16	35.65	-260.120	-189.453	24.356
1800	30.260	53.41	36.60	-259.734	-185.291	22.497
1900	32.470	54.60	37.51	-259.334	-181.166	20.839
2000	34.700	55.75	38.40	-258.919	-177.095	19.352

MELTING POINT 3151 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.58838 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

URANIUM.... ALPHA-BETA 941, BETA-GAMMA 1048, M. P. 1405 DEG K.

REFERENCES 74 78 22 COMPILED 6-13-66

KARELIANITE GRAM FORMULA WEIGHT 149.882

V_2O_3: Crystals 298.15° to 1800°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FORMATION FROM THE ELEMENTS FREE ENERGY (KCAL/GFW)	FORMATION FROM THE ELEMENTS LOG K
298.15	0.000	23.53	23.53	-291.290	-272.273	199.581
UNCERTAINTY		0.30	0.30	0.380	0.400	0.293
400	2.720	31.36	24.56	-290.904	-265.830	145.242
500	5.590	37.76	26.58	-290.402	-259.617	113.478
600	8.600	43.25	28.92	-289.827	-253.524	92.346
700	11.700	48.02	31.31	-289.220	-247.519	77.279
800	14.870	52.25	33.66	-288.601	-241.593	66.000
900	18.100	56.06	35.95	-287.980	-235.755	57.249
1000	21.370	59.50	38.13	-287.380	-229.984	50.263
1100	24.660	62.64	40.22	-286.833	-224.271	44.558
1200	27.960	65.51	42.21	-286.345	-218.603	39.813
1300	31.360	68.23	44.11	-285.824	-212.998	35.808
1400	34.940	70.98	46.02	-285.186	-207.556	32.401
1500	38.670	73.45	47.67	-284.467	-201.874	29.413
1600	42.480	75.91	49.36	-283.746	-196.401	26.827
1700	46.370	78.26	50.98	-283.031	-190.954	24.549
1800	50.350	80.54	52.57	-282.313	-185.535	22.527

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	KCAL	MOLAR VOLUME	0.71343 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

VANADIUM... M. P. 2175 DEG K.

REFERENCES 74 78 110 COMPILED 4-29-67

TUNGSTEN TRIOXIDE GRAM FORMULA WEIGHT 231.848

WO_3: Crystals (monoclinic ?) 298.15° to 1050°K. Tetragonal crystals 1050° to melting point 1745°K. Liquid 1745° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	18.14	18.14	-201.460	-182.631	133.871
UNCERTAINTY		0.12	0.12	0.200	0.210	0.154
400	1.880	23.55	18.85	-201.268	-176.222	96.283
500	3.940	28.14	20.26	-200.910	-170.000	74.307
600	6.130	32.13	21.91	-200.471	-163.862	59.687
700	8.400	35.63	23.63	-199.994	-157.796	49.266
800	10.710	38.71	25.32	-199.514	-151.802	41.470
900	13.050	41.46	26.96	-199.036	-145.857	35.419
1000	15.420	43.96	28.54	-198.553	-139.977	30.592
1050	16.640	45.15	29.30	-198.278	-137.050	28.526
1050	17.050	45.54	29.30	-197.868	-137.050	28.526
1100	18.240	46.65	30.07	-197.647	-134.150	26.653
1200	20.630	48.73	31.54	-197.193	-128.407	23.386
1300	23.060	50.67	32.93	-196.719	-122.684	20.625
1400	25.510	52.49	34.27	-196.245	-117.005	18.265
1500	27.990	54.20	35.54	-195.760	-111.367	16.226
1600	30.500	55.82	36.76	-195.261	-105.756	14.446
1700	33.030	57.36	37.93	-194.758	-100.182	12.879
1745	34.180	58.02	38.44	-194.530	-97.680	12.234
1745	51.730	68.08	38.44	-176.980	-97.680	12.234
1800	53.460	69.06	39.36	-176.374	-95.202	11.559
1900	56.610	70.76	40.97	-175.286	-90.715	10.435
2000	59.760	72.38	42.50	-174.214	-86.289	9.429

MELTING POINT	1745	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	17.550	KCAL	HEAT OF VAPOR.		KCAL
$H_{298} - H_0$	2.949	KCAL	MOLAR VOLUME	0.75550	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

TUNGSTEN... M. P. 3680 DEG K.

REFERENCES	90	90	170	COMPILED
				2-12-67

ZINCITE GRAM FORMULA WEIGHT 81.369

ZnO: Crystals 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	10.43	10.43	-83.250	-76.089	55.775
UNCERTAINTY		0.10	0.10	0.200	0.210	0.154
400	1.070	13.51	10.83	-83.172	-73.655	40.243
500	2.190	16.01	11.63	-83.057	-71.284	31.158
600	3.350	18.12	12.54	-82.945	-68.944	25.113
700	4.530	19.94	13.47	-84.614	-66.600	20.793
800	5.740	21.56	14.38	-84.553	-64.036	17.494
900.	6.970	23.00	15.26	-84.480	-61.462	14.925
1000	8.220	24.32	16.10	-84.393	-58.912	12.875
1100	9.500	25.54	16.90	-84.283	-56.374	11.201
1200	10.800	26.67	17.67	-111.667	-53.394	9.724
1300	12.120	27.72	18.40	-111.272	-48.543	8.161
1400	13.450	28.71	19.10	-110.871	-43.737	6.828
1500	14.800	29.64	19.77	-110.453	-38.957	5.676
1600	16.160	30.52	20.42	-110.028	-34.209	4.673
1700	17.530	31.35	21.04	-109.596	-29.485	3.791
1800	18.910	32.14	21.63	-109.158	-24.795	3.010
1900	20.300	32.89	22.21	-108.712	-20.115	2.314
2000	21.700	33.61	22.76	-108.258	-15.457	1.689

MELTING POINT 2242 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.34269 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ZINC..... M. P. 692.7, B. P. 1184 DEG K.

REFERENCES 74 78 22 COMPILED 6-13-66

BADDELEYITE GRAM FORMULA WEIGHT 123.219

ZrO_2: Monoclinic crystals 298.15° to 1478°K. Tetragonal crystals 1478° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	12.04	12.04	-262.300	-248.505	182.158
UNCERTAINTY		0.08	0.08	0.400	0.410	0.301
400	1.475	16.28	12.59	-262.195	-243.804	133.208
500	3.050	19.79	13.69	-262.022	-239.224	104.565
600	4.690	22.78	14.96	-261.841	-234.683	85.483
700	6.380	25.38	16.26	-261.654	-230.168	71.861
800	8.120	27.72	17.57	-261.450	-225.699	61.658
900	9.910	29.83	18.81	-261.219	-221.245	53.725
1000	11.730	31.74	20.01	-260.980	-216.807	47.383
1100	13.570	33.50	21.16	-260.749	-212.409	42.202
1200	15.420	35.11	22.26	-261.485	-207.977	37.878
1300	17.280	36.59	23.29	-261.256	-203.516	34.214
1400	19.150	37.98	24.30	-261.032	-199.090	31.079
1478	20.620	39.00	25.05	-260.857	-195.638	28.928
1478	22.040	39.96	25.05	-259.437	-195.638	28.928
1500	22.430	40.22	25.26	-259.411	-194.688	28.366
1600	24.210	41.37	26.23	-259.303	-190.377	26.004
1700	25.990	42.45	27.16	-259.208	-186.074	23.921
1800	27.770	43.47	28.04	-259.126	-181.778	22.071
1900	29.550	44.43	28.87	-259.057	-177.479	20.415
2000	31.330	45.34	29.67	-259.001	-173.183	18.925

MELTING POINT	3123	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	20.800	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	2.0900	KCAL	MOLAR VOLUME	0.50550	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ZIRCONIUM.. ALPHA-BETA 1143.2, M. P. BETA 2128.2 DEG K.

REFERENCES	74	148	67	COMPILED
			148	4-15-67

PEROVSKITE GRAM FORMULA WEIGHT 135.978

$CaTiO_3$: α crystals (orthorhombic) 298.15° to 1530°K. β crystals (cubic) 1530° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	22.40	22.40	-396.900	-376.517	275.994
UNCERTAINTY		0.10	0.10	0.410	0.420	0.308
400	2.680	30.11	23.41	-396.583	-369.593	201.936
500	5.430	36.24	25.38	-396.257	-362.887	158.617
600	8.300	41.47	27.64	-395.910	-356.247	129.763
700	11.260	46.03	29.94	-395.571	-349.656	109.167
800	14.270	50.05	32.21	-395.306	-343.122	93.736
900	17.310	53.63	34.40	-395.055	-336.611	81.740
1000	20.380	56.87	36.49	-394.886	-330.130	72.150
1100	23.490	59.84	38.49	-394.780	-323.671	64.307
1200	26.640	62.58	40.38	-397.438	-317.036	57.740
1300	29.820	65.12	42.18	-397.006	-310.335	52.172
1400	33.030	67.50	43.91	-396.579	-303.703	47.410
1500	36.270	69.74	45.56	-396.158	-297.080	43.284
1530	37.260	70.39	46.04	-396.033	-295.096	42.152
1530	37.810	70.75	46.04	-395.483	-295.096	42.152
1600	40.050	72.18	47.15	-395.230	-290.509	39.682
1700	43.250	74.12	48.68	-394.915	-283.968	36.506
1800	46.460	75.96	50.15	-430.905	-276.545	33.577
1900	49.680	77.69	51.54	-430.398	-267.965	30.823
2000	52.910	79.34	52.88	-433.605	-259.320	28.337

MELTING POINT	2188	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	0.80368	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
TITANIUM... ALPHA-BETA 1155, M. P. 1943 DEG K.

REFERENCES	74	78	80	COMPILED
			151	4-29-67

CHROMITE GRAM FORMULA WEIGHT 223.837

$FeCr_2O_4$: Crystals 298.15° to 1900°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	34.90	34.90	---	---	---
UNCERTAINTY		0.40	0.40			
400	3.450	44.83	36.20	---	---	---
500	7.180	53.14	38.78	---	---	---
600	11.130	60.34	41.79	---	---	---
700	15.220	66.64	44.90	---	---	---
800	19.410	72.24	47.98	---	---	---
900	23.680	77.26	50.95	---	---	---
1000	28.030	81.85	53.82	---	---	---
1100	32.450	86.06	56.56	---	---	---
1200	36.920	89.95	59.18	---	---	---
1300	41.430	93.55	61.68	---	---	---
1400	45.990	96.93	64.08	---	---	---
1500	50.590	100.11	66.38	---	---	---
1600	55.230	103.10	68.58	---	---	---
1700	59.910	105.94	70.70	---	---	---
1800	64.630	108.64	72.73	---	---	---
1900	69.390	111.11	74.59	---	---	---

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 1.0518	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CHROMIUM... M. P. 2130 DEG K.
IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.

REFERENCES 74 78 COMPILED 6-13-66

ILMENITE GRAM FORMULA WEIGHT 151.745

$FeTiO_3$: Crystals 298.15° to melting point 1640°K. Liquid 1640° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	25.30	25.30	-295.560	-277.065	203.093
UNCERTAINTY		0.30	0.30	0.380	0.390	0.286
400	2.595	32.77	26.28	-295.313	-270.779	147.946
500	5.330	38.87	28.21	-294.992	-264.682	115.692
600	8.200	44.10	30.43	-294.650	-258.653	94.214
700	11.130	48.61	32.71	-294.366	-252.672	78.887
800	14.150	52.65	34.96	-294.126	-246.742	67.407
900	17.250	56.30	37.13	-293.965	-240.822	58.479
1000	20.430	59.65	39.22	-293.946	-234.920	51.342
1100	23.650	62.72	41.22	-294.150	-229.003	45.499
1200	26.900	65.54	43.12	-295.118	-223.044	40.622
1300	30.200	68.18	44.95	-294.646	-217.062	36.491
1400	33.540	70.66	46.70	-294.189	-211.127	32.958
1500	36.920	72.99	48.38	-293.738	-205.205	29.898
1600	40.360	75.21	49.98	-293.280	-199.311	27.225
1640	41.750	76.07	50.61	-293.095	-196.960	26.247
1640	63.420	89.28	50.61	-271.425	-196.960	26.247
1700	66.280	90.99	52.00	-270.675	-194.238	24.971
1800	71.040	93.72	54.25	-269.086	-189.804	23.045
1900	75.800	96.29	56.40	-271.219	-185.261	21.310
2000	80.560	98.73	58.45	-273.446	-180.661	19.742

MELTING POINT	1640	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	21.670	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	0.75741	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.
TITANIUM... ALPHA-BETA 1155, M. P. 1943 DEG K.

REFERENCES 74 78 80 COMPILED 6-13-66

TITANOMAGNETITE GRAM FORMULA WEIGHT 223.592

Fe_2TiO_4: Crystals 298.15° to 1600°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	40.36	40.36	---	---	---
UNCERTAINTY		0.60	0.60			
400	3.750	51.16	41.78	---	---	---
500	7.610	59.76	44.54	---	---	---
600	11.640	67.10	47.70	---	---	---
700	15.850	73.59	50.95	---	---	---
800	20.220	79.42	54.14	---	---	---
900	24.740	84.74	57.25	---	---	---
1000	29.400	89.65	60.25	---	---	---
1100	34.210	94.23	63.13	---	---	---
1200	39.180	98.56	65.91	---	---	---
1300	44.350	102.70	68.58	---	---	---
1400	49.760	106.71	71.17	---	---	---
1500	55.450	110.93	73.96	---	---	---
1600	61.460	114.51	76.10	---	---	---

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 1.1190	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.
TITANIUM... ALPHA-BETA 1155, M. P. 1943 DEG K.

REFERENCES 74 78 COMPILED 6-13-66

PSEUDOBROOKITE GRAM FORMULA WEIGHT 239.591

Fe_2TiO_5: Crystals 298.15° to 1800°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H T 298)/T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	37.40	37.40	---	---	---
UNCERTAINTY		0.30	0.30			
400	4.330	49.86	39.03	---	---	---
500	8.740	59.69	42.21	---	---	---
600	13.300	68.00	45.83	---	---	---
700	18.010	75.26	49.53	---	---	---
800	22.870	81.75	53.16	---	---	---
900	27.860	87.63	56.67	---	---	---
1000	32.960	93.00	60.04	---	---	---
1100	38.130	97.93	63.27	---	---	---
1200	43.330	102.45	66.34	---	---	---
1300	48.550	106.63	69.28	---	---	---
1400	53.800	110.52	72.09	---	---	---
1500	59.080	114.16	74.77	---	---	---
1600	64.400	117.60	77.35	---	---	---
1700	69.760	120.85	79.81	---	---	---
1800	75.160	123.93	82.17	---	---	---

MELTING POINT	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	KCAL	MOLAR VOLUME	1.3033	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

COPPER..... M. P. 1357 DEG K.
TITANIUM... ALPHA-BETA 1155, M. P. 1943 DEG K.

REFERENCES 74 78 COMPILED 6-13-66

SPINEL GRAM FORMULA WEIGHT 142.273

$MgAl_2O_4$: Crystals 298.15° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	19.26	19.26	-552.800	-522.961	383.339
UNCERTAINTY		0.10	0.10	0.500	0.510	0.374
400	3.140	28.28	20.43	-552.949	-512.948	280.261
500	6.619	36.03	22.79	-552.833	-502.690	219.725
600	10.324	42.78	25.57	-552.622	-492.677	179.457
700	14.188	48.73	28.47	-552.378	-482.703	150.706
800	18.173	54.05	31.34	-552.145	-472.771	129.155
900	22.262	58.87	34.13	-551.959	-462.854	112.396
1000	26.441	63.27	36.83	-559.017	-452.423	98.877
1100	30.704	67.33	39.42	-558.730	-441.772	87.772
1200	35.047	71.11	41.91	-558.381	-431.165	78.526
1300	39.464	74.65	44.29	-557.974	-420.572	70.704
1400	43.954	77.97	46.58	-587.855	-409.191	63.877
1500	48.515	81.12	48.78	-587.051	-396.460	57.764
1600	53.147	84.11	50.89	-586.188	-383.782	52.422
1700	57.847	86.96	52.93	-585.267	-371.157	47.715
1800	62.615	89.68	54.90	-584.290	-358.588	43.538
1900	67.450	92.30	56.80	-583.260	-346.079	39.808
2000	72.352	94.81	58.64	-582.173	-333.629	36.457

MELTING POINT 2408 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 3.6830 KCAL MOLAR VOLUME 0.94909 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.

REFERENCES 148 78 115 151 COMPILED 4-15-67

PICROCHROMITE GRAM FORMULA WEIGHT 192.302

$MgCr_2O_4$: Crystals 298.15° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	25.30	25.30	---	---	---
UNCERTAINTY		0.20	0.20			
400	3.350	34.94	26.56	---	---	---
500	7.040	43.16	29.08	---	---	---
600	10.930	50.25	32.03	---	---	---
700	14.940	56.43	35.09	---	---	---
800	19.060	61.93	38.10	---	---	---
900	23.260	66.87	41.03	---	---	---
1000	27.520	71.36	43.84	---	---	---
1100	31.810	75.45	46.53	---	---	---
1200	36.130	79.21	49.10	---	---	---
1300	40.490	82.69	51.54	---	---	---
1400	44.890	85.96	53.90	---	---	---
1500	49.340	89.03	56.14	---	---	---
1600	53.840	91.93	58.28	---	---	---
1700	58.370	94.67	60.33	---	---	---
1800	62.930	97.28	62.32	---	---	---
1900	67.520	99.76	64.22	---	---	---
2000	72.140	102.13	66.06	---	---	---

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 1.0411	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CHROMIUM... M. P. 2130 DEG K.
MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.

REFERENCES 74 78 COMPILED 6-13-66

MAGNESIOFERRITE GRAM FORMULA WEIGHT 200.004

$MgFe_2O_4$: α crystals 298.15° to 665°K. β crystals 665° to 1230°K.
γ crystals 1230° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	29.60	29.60	-341.720	-315.112	230.983
UNCERTAINTY		0.20	0.20	0.440	0.450	0.330
400	3.860	40.70	31.05	-341.199	-306.093	167.241
500	7.870	49.63	33.89	-340.640	-297.371	129.980
600	12.270	57.64	37.19	-339.876	-288.780	105.188
665	15.600	62.91	39.45	-338.961	-283.284	93.100
665	15.600	62.91	39.45	-338.961	-283.284	93.100
700	17.190	65.24	40.68	-338.786	-280.372	87.536
800	21.730	71.30	44.14	-338.304	-272.067	74.325
900	26.270	76.65	47.46	-338.103	-263.786	64.056
1000	30.810	81.43	50.62	-340.454	-255.346	55.806
1100	35.350	85.76	53.62	-341.132	-246.789	49.032
1200	39.890	89.71	56.47	-341.408	-238.230	43.387
1230	41.250	90.83	57.29	-341.297	-235.637	41.869
1230	41.600	91.11	57.29	-340.947	-235.637	41.869
1300	44.630	93.51	59.18	-340.802	-229.673	38.611
1400	49.000	96.75	61.75	-370.965	-220.314	34.392
1500	53.520	99.87	64.19	-370.384	-209.565	30.533
1600	58.190	102.88	66.51	-369.705	-198.865	27.164
1700	63.000	105.80	68.74	-369.496	-188.196	24.194
1800	67.960	108.63	70.87	-368.791	-177.528	21.555
1900	73.060	111.39	72.94	-375.338	-166.579	19.161
2000	78.300	114.07	74.92	-374.495	-155.595	17.003

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 1.0652	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.
MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.

REFERENCES 74 78 93 COMPILED 5-06-67

GEIKELITE GRAM FORMULA WEIGHT 120.210

$MgTiO_3$: Crystals 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	17.82	17.82	-375.900	-354.790	260.067
UNCERTAINTY		0.10	0.10	0.270	0.280	0.205
400	2.500	25.01	18.76	-375.734	-347.596	189.917
500	5.130	30.87	20.61	-375.482	-340.592	148.872
600	7.900	35.92	22.75	-375.176	-333.641	121.528
700	10.790	40.37	24.96	-374.836	-326.737	102.011
800	13.740	44.31	27.13	-374.518	-319.894	87.391
900	16.750	47.85	29.24	-374.218	-313.074	76.024
1000	19.800	51.07	31.27	-376.086	-306.130	66.905
1100	22.900	54.02	33.20	-375.810	-299.135	59.432
1200	26.030	56.75	35.06	-376.508	-292.158	53.209
1300	29.190	59.27	36.82	-376.136	-285.123	47.933
1400	32.390	61.67	38.53	-406.104	-277.354	43.297
1500	35.660	63.92	40.15	-405.410	-268.177	39.073
1600	39.010	66.08	41.70	-404.669	-259.041	35.383
1700	42.450	68.17	43.20	-403.871	-249.966	32.135
1800	45.980	70.19	44.65	-403.019	-240.950	29.255
1900	49.600	72.15	46.04	-402.109	-231.979	26.684
2000	53.310	74.05	47.39	-404.833	-222.936	24.361

MELTING POINT	1903	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	3.2550	KCAL	MOLAR VOLUME	0.73757	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.
TITANIUM... ALPHA-BETA 1155, M. P. 1943 DEG K.

REFERENCES 74 78 80 COMPILED 4-29-67

BROMARGYRITE GRAM FORMULA WEIGHT 187.779

AgBr: Crystals 298.15° to melting point 703°K. Liquid 703° to 1000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	25.60	25.60	-23.990	-23.158	16.975
UNCERTAINTY		0.10	0.10	0.300	0.310	0.227
400	1.355	29.50	26.11	-27.396	-22.152	12.103
500	2.840	32.81	27.13	-26.973	-20.890	9.131
600	4.480	35.79	28.32	-26.417	-19.724	7.184
700	6.275	38.56	29.60	-25.718	-18.660	5.826
703	6.330	38.64	29.64	-25.697	-18.630	5.792
703	8.520	41.76	29.64	-23.507	-18.630	5.792
800	9.970	43.68	31.22	-23.131	-17.978	4.911
900	11.460	45.43	32.70	-22.775	-17.348	4.213
1000	12.950	47.00	34.05	-22.440	-16.765	3.664

MELTING POINT 703 DEG K BOILING POINT DEG K

HEAT OF FUSION 2.190 KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.69290 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SILVER..... M. P. 1234 DEG K.
BROMINE.... B. P. 332.62 DEG K.

REFERENCES 74 78 158 158 COMPILED 6-13-66

CHLORARGYRITE GRAM FORMULA WEIGHT 143.323

AgCl: Crystals 298.15° to melting point 728°K. Liquid 728° to 1000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	23.00	23.00	-30.370	-26.242	19.236
UNCERTAINTY		0.10	0.10	0.300	0.310	0.227
400	1.320	26.81	23.51	-30.097	-24.873	13.590
500	2.720	29.93	24.49	-29.744	-23.607	10.319
600	4.150	32.54	25.62	-29.388	-22.419	8.166
700	5.660	34.86	26.77	-28.967	-21.280	6.644
728	6.080	35.45	27.10	-28.838	-20.970	6.295
728	9.160	39.68	27.10	-25.758	-20.970	6.295
800	10.310	41.19	28.30	-25.420	-20.522	5.606
900	11.910	43.07	29.84	-24.950	-19.931	4.840
1000	12.510	44.76	32.25	-25.502	-20.404	4.459

MELTING POINT 728 DEG K BOILING POINT DEG K

HEAT OF FUSION 3.080 KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.61489 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SILVER..... M. P. 1234 DEG K.

REFERENCES 74 78 158 158 101 COMPILED 5-06-67

HYDROPHILITE GRAM FORMULA WEIGHT 110.986

$CaCl_2$: Crystals 298.15° to melting point 1055°K. Liquid 1055° to 1700°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	27.20	27.20	-190.000	-179.255	131.397
UNCERTAINTY		0.30	0.30	0.150	0.180	0.132
400	1.850	32.53	27.90	-189.645	-175.636	95.963
500	3.700	36.66	29.26	-189.333	-172.174	75.257
600	5.540	40.02	30.79	-189.087	-168.770	61.474
700	7.400	42.88	32.31	-188.870	-165.396	51.639
800	9.290	45.40	33.79	-188.701	-162.056	44.272
900	11.230	47.69	35.21	-188.481	-158.740	38.547
1000	13.270	49.84	36.57	-188.235	-155.449	33.973
1055	14.420	50.96	37.29	-188.090	-153.650	31.829
1055	21.200	57.38	37.29	-181.310	-153.650	31.829
1100	22.340	58.44	38.13	-181.022	-152.476	30.294
1200	24.840	60.62	39.92	-182.182	-149.777	27.278
1300	27.320	62.60	41.58	-181.344	-147.094	24.729
1400	29.780	64.42	43.15	-180.528	-144.498	22.557
1500	32.210	66.10	44.63	-179.744	-141.943	20.681
1600	34.580	67.63	46.02	-179.022	-139.459	19.049
1700	36.860	69.01	47.33	-178.391	-136.998	17.612

MELTING POINT 1055 DEG K BOILING POINT DEG K

HEAT OF FUSION 6.780 KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 1.21295 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.

REFERENCES 74 78 141 COMPILED 6-13-66

LAWRENCITE GRAM FORMULA WEIGHT 126.753

$FeCl_2$: Crystals 298.15° to melting point 950°K. Liquid 950° to boiling point 1357°K. Ideal gas (monomer) 1347° to 1500°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	28.19	28.19	-81.700	-72.273	52.977
UNCERTAINTY		0.50	0.50	0.120	0.200	0.147
400	1.905	33.68	28.92	-81.275	-69.118	37.764
500	3.834	37.98	30.31	-80.874	-66.120	28.901
600	5.803	41.57	31.90	-80.504	-63.205	23.022
700	7.804	44.66	33.51	-80.171	-60.358	18.845
800	9.835	47.37	35.08	-79.896	-57.547	15.721
900	11.891	49.79	36.58	-79.710	-54.758	13.297
950	12.920	50.94	37.34	-79.640	-54.620	12.566
950	23.200	61.76	37.34	-69.360	-54.620	12.566
1000	24.428	62.98	38.55	-69.227	-52.531	11.481
1100	26.870	65.31	40.88	-69.062	-50.867	10.106
1200	29.312	67.44	43.01	-68.690	-49.245	8.969
1300	31.754	69.39	44.96	-67.970	-47.656	8.012
1347	32.895	70.24	45.82	-67.630	-46.910	7.611
1347	62.725	92.39	45.82	-37.800	-46.910	7.611
1400	63.479	92.99	47.65	-37.989	-47.347	7.391
1500	65.060	94.04	50.67	-38.164	-47.943	6.985

MELTING POINT	950 DEG K	BOILING POINT	1347 DEG K
HEAT OF FUSION	10.280 KCAL	HEAT OF VAPOR.	29.830 KCAL
$H_{298} - H_0$	3.8890 KCAL	MOLAR VOLUME	0.94312 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.

REFERENCES 148	148	94 148	COMPILED 5-06-67

MOLYSITE GRAM FORMULA WEIGHT 162.206

$FeCl_3$: Crystals 298.15° to melting point 577°K. Liquid 577° to boiling point 605°K. Ideal gas (dimer) 605° to 700°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	34.02	34.02	-95.460	-79.827	58.515
UNCERTAINTY		0.60	0.60	0.200	0.270	0.198
400	2.475	41.14	34.95	-94.887	-74.569	40.743
500	5.165	47.13	36.80	-94.152	-69.566	30.407
577	7.373	51.22	38.44	-93.505	-65.850	24.942
577	17.673	69.07	38.44	-83.205	-65.850	24.942
600	18.406	70.34	39.66	-82.944	-65.144	23.729
605	18.566	70.58	39.89	-82.890	-65.040	23.495
605	23.796	79.22	39.89	-77.660	-65.040	23.495
700	25.849	82.36	45.43	-77.608	-62.988	19.666

MELTING POINT	577 DEG K	BOILING POINT	605 DEG K
HEAT OF FUSION	10.300 KCAL	HEAT OF VAPOR.	5.230 KCAL
H -H 298 0	4.7100 KCAL	MOLAR VOLUME	1.3828 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.

REFERENCES 148	148	94	COMPILED
		148	5-06-67

HYDROGEN CHLORIDE (IDEAL GAS) GRAM FORMULA WEIGHT 36.461

HCl: Ideal gas 298.15° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	44.65	44.65	-22.062	-22.777	16.696
UNCERTAINTY		0.01	0.01	0.150	0.160	0.117
400	0.710	46.69	44.92	-22.128	-23.012	12.573
500	1.408	48.25	45.44	-22.206	-23.224	10.151
600	2.112	49.53	46.01	-22.286	-23.420	8.531
700	2.823	50.63	46.60	-22.365	-23.602	7.369
800	3.546	51.60	47.16	-22.438	-23.774	6.495
900	4.281	52.46	47.71	-22.504	-23.937	5.813
1000	5.030	53.25	48.22	-22.561	-24.093	5.266
1100	5.793	53.98	48.71	-22.610	-24.244	4.817
1200	6.569	54.65	49.18	-22.651	-24.390	4.442
1300	7.356	55.28	49.63	-22.687	-24.536	4.125
1400	8.156	55.88	50.05	-22.716	-24.675	3.852
1500	8.965	56.43	50.46	-22.743	-24.814	3.615
1600	9.783	56.96	50.85	-22.768	-24.952	3.408
1700	10.610	57.46	51.22	-22.789	-25.087	3.225
1800	11.445	57.94	51.58	-22.808	-25.223	3.062
1900	12.287	58.40	51.93	-22.825	-25.355	2.916
2000	13.135	58.83	52.26	-22.842	-25.488	2.785

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	2.0650 KCAL	MOLAR VOLUME 584.727	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148	158	158	COMPILED
	148		2-12-67

SYLVITE GRAM FORMULA WEIGHT 74.555

KCl: Crystals 298.15° to melting point 1044°K. Liquid 1044° to fictive boiling point 1750°K. Ideal gas (monomer) 1750° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	19.73	19.73	-104.370	-97.693	71.611
UNCERTAINTY		0.04	0.04	0.200	0.210	0.154
400	1.272	23.40	20.22	-104.847	-95.321	52.081
500	2.561	26.27	21.15	-104.728	-92.950	40.628
600	3.889	28.69	22.21	-104.560	-90.608	33.004
700	5.254	30.80	23.29	-104.350	-88.304	27.570
800	6.664	32.68	24.35	-104.095	-86.027	23.502
900	8.132	34.41	25.37	-103.784	-83.788	20.346
1000	9.681	36.04	26.36	-103.403	-81.585	17.830
1044	10.399	36.74	26.78	-122.242	-80.614	16.876
1044	16.681	42.76	26.78	-115.960	-80.614	16.876
1100	17.665	43.68	27.62	-115.505	-78.742	15.645
1200	19.424	45.21	29.02	-114.693	-75.435	13.739
1300	21.183	46.62	30.33	-113.882	-72.200	12.138
1400	22.942	47.92	31.53	-113.072	-69.018	10.774
1500	24.701	49.13	32.66	-112.263	-65.894	9.601
1600	26.460	50.27	33.73	-111.455	-62.837	8.583
1700	28.219	51.33	34.73	-110.648	-59.813	7.689
1750	29.099	51.85	35.22	-110.245	-58.320	7.283
1750	66.239	73.07	35.22	-73.105	-58.320	7.283
1800	66.703	73.33	36.27	-73.118	-57.911	7.031
1900	67.630	73.83	38.24	-73.147	-57.063	6.564
2000	68.559	74.30	40.02	-73.175	-56.202	6.141

MELTING POINT 1044 DEG K BOILING POINT 1750 DEG K

HEAT OF FUSION 6.282 KCAL HEAT OF VAPOR. 37.140 KCAL

$H_{298} - H_0$ 2.7170 KCAL MOLAR VOLUME 0.89685 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

POTASSIUM.. M. P. 336.4, B. P. 1043.7 DEG K.

REFERENCES 148 78 148 148 COMPILED 5-06-67

CHLOROMAGNESITE GRAM FORMULA WEIGHT 95.218

$MgCl_2$: Crystals 298.15° to melting point 987°K. Liquid 987° to boiling point 1710°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H 298)/T	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	21.42	21.42	-153.350	-141.521	103.737
UNCERTAINTY		0.20	0.20	0.110	0.130	0.095
400	1.800	26.61	22.11	-153.016	-137.532	75.144
500	3.650	30.73	23.43	-152.658	-133.700	58.440
600	5.555	34.21	24.95	-152.288	-129.945	47.332
700	7.480	37.17	26.49	-151.935	-126.244	39.415
800	9.420	39.76	27.99	-151.603	-122.600	33.493
900	11.380	42.07	29.43	-151.284	-118.989	28.894
987	13.160	43.96	30.63	-153.094	-115.748	25.630
987	23.460	54.40	30.63	-142.794	-115.748	25.630
1000	23.750	54.69	30.94	-142.725	-115.391	25.219
1100	25.960	56.80	33.20	-142.192	-112.680	22.387
1200	28.170	58.72	35.25	-141.662	-110.028	20.039
1300	30.380	60.49	37.12	-141.134	-107.407	18.057
1400	32.590	62.12	38.84	-170.953	-103.994	16.234
1500	34.800	63.65	40.45	-170.146	-99.247	14.460
1600	37.010	65.08	41.95	-169.341	-94.554	12.915
1700	39.220	66.42	43.35	-168.537	-89.902	11.558
1710	39.440	66.56	43.50	-168.457	-89.440	11.431
1710	76.780	88.40	43.50	-131.117	-89.440	11.431

MELTING POINT	987 DEG K	BOILING POINT	1710 DEG K
HEAT OF FUSION	10.300 KCAL	HEAT OF VAPOR.	37.340 KCAL
$H_{298} - H_0$	3.2910 KCAL	MOLAR VOLUME	0.97538 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.

REFERENCES	74	78	141	COMPILED
		148	148	4-15-67

SCACCHITE GRAM FORMULA WEIGHT 125.844

$MnCl_2$: Crystals 298.15° to melting point 923°K. Liquid 923° to 1400°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	28.26	28.26	-115.038	-105.295	77.183
UNCERTAINTY		0.05	0.05	0.200	0.210	0.154
400	1.850	33.59	28.96	-114.723	-102.014	55.738
500	3.730	37.78	30.32	-114.391	-98.872	43.217
600	5.640	41.26	31.86	-114.155	-95.866	34.919
700	7.590	44.27	33.43	-113.788	-92.778	28.967
800	9.600	46.95	34.95	-113.484	-89.799	24.532
900	11.680	49.40	36.42	-113.149	-86.856	21.091
923	12.170	49.94	36.76	-113.072	-86.186	20.407
923	21.140	59.66	36.76	-104.102	-86.186	20.407
1000	22.880	61.47	38.59	-104.258	-84.712	18.514
1100	25.140	63.62	40.77	-103.800	-82.767	16.444
1200	27.400	65.59	42.76	-103.345	-80.888	14.732
1300	29.660	67.40	44.58	-102.907	-79.031	13.286
1400	31.920	69.07	46.27	-103.056	-77.190	12.050

MELTING POINT	923	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	8.970	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	3.6020	KCAL	MOLAR VOLUME	1.0064	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MANGANESE.. ALPHA-BETA 990, BETA-GAMMA 1360, GAMMA-DELTA 1410, M. P. DELTA 1517 DEG K.

REFERENCES 74 21 94 COMPILED 2-12-67

SALAMMONIAC GRAM FORMULA WEIGHT 53.491

NH_4Cl: α crystals (CaCl structure) 298.15° to 457.7°K.

β crystals (rock salt structure) 457.7° to 500°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	22.70	22.70	-75.180	-48.572	35.604
UNCERTAINTY		1.00	1.00	0.200	0.360	0.264
400	2.340	29.43	23.58	-75.031	-39.498	21.580
457.7	3.810	32.86	24.53	-74.945	-34.260	16.359
457.7	4.750	34.91	24.53	-74.905	-34.260	16.359
500	5.650	36.79	25.49	-73.897	-30.733	13.433

MELTING POINT		DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
$H_{298} - H_0$	5.425	KCAL	MOLAR VOLUME	0.83795	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES 148	148	148	COMPILED
	158	158	4-15-67

HALITE GRAM FORMULA WEIGHT 58.443

NaCl: Crystals 298.15° to melting point 1073.8°K. Liquid 1073.8° to fictive boiling point 1791°K. Ideal gas (monomer) 1791° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	17.24	17.24	-98.260	-91.807	67.296
UNCERTAINTY		0.05	0.05	0.300	0.310	0.227
400	1.253	20.85	17.72	-98.785	-89.570	48.938
500	2.523	23.68	18.63	-98.683	-87.275	38.148
600	3.831	26.07	19.68	-98.530	-85.010	30.965
700	5.177	28.14	20.74	-98.329	-82.771	25.842
800	6.568	30.00	21.79	-98.076	-80.567	22.010
900	8.015	31.70	22.79	-97.764	-78.392	19.036
1000	9.529	33.29	23.76	-97.387	-76.255	16.666
1073.8	10.695	34.42	24.46	-97.060	-74.710	15.206
1073.8	17.425	40.69	24.46	-90.330	-74.710	15.206
1100	17.854	41.10	24.87	-90.207	-74.354	14.773
1200	19.506	42.53	26.27	-112.945	-72.469	13.198
1300	21.128	43.83	27.58	-112.271	-69.125	11.621
1400	22.735	45.02	28.78	-111.613	-65.830	10.277
1500	24.336	46.13	29.91	-110.962	-62.591	9.119
1600	25.936	47.16	30.95	-110.313	-59.383	8.111
1700	27.536	48.13	31.93	-109.663	-56.218	7.227
1791	28.992	48.96	32.77	-109.075	-53.376	6.513
1791	68.377	70.95	32.77	-69.690	-53.376	6.513
1800	68.460	71.00	32.97	-69.692	-53.290	6.470
1900	69.384	71.49	34.97	-69.721	-52.358	6.023
2000	70.309	71.97	36.82	-69.751	-51.456	5.623

MELTING POINT 1073.8 DEG K BOILING POINT 1791 DEG K

HEAT OF FUSION 6.730 KCAL HEAT OF VAPOR. 39.385 KCAL

H -H 2.5360 KCAL MOLAR VOLUME 0.64567 CAL/BAR
298 0

TRANSITIONS IN REFERENCE STATE ELEMENTS

SODIUM..... M. P. 370.98, B. P. 1176.9 DEG K.

REFERENCES 148 148 148 COMPILED 5-06-67

COTUNNITE GRAM FORMULA WEIGHT 278.096

$PbCl_2$: Crystals 298.15° to melting point 768°K. Liquid 768° to 1000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	32.50	32.50	-86.200	-75.366	55.244
UNCERTAINTY		0.50	0.50	0.070	0.170	0.125
400	1.920	38.04	33.24	-85.780	-71.731	39.192
500	3.830	42.30	34.64	-85.388	-68.264	29.838
600	5.890	46.05	36.23	-84.890	-64.885	23.634
700	8.040	49.36	37.87	-85.491	-61.401	19.170
768	9.505	51.35	38.97	-85.140	-59.060	16.807
768	15.205	58.77	38.97	-79.440	-59.060	16.807
800	16.060	59.85	39.78	-79.081	-58.220	15.905
900	18.780	63.05	42.18	-77.963	-55.675	13.520
1000	21.500	65.91	44.41	-76.843	-53.257	11.639

MELTING POINT	768	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	5.700	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	4.0490	KCAL	MOLAR VOLUME	1.1254	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

LEAD..... M. P. 600.6, B. P. 2023 DEG K.

REFERENCES				COMPILED
	74	78	148	
		159	159	4-15-67

FLUORITE — GRAM FORMULA WEIGHT 78.077

CaF_2: Crystals I 298.15° to transition point 1424°K. Crystals II 1424° to melting point 1691°K. Liquid 1691° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	16.46	16.46	-290.300	-277.799	203.631
UNCERTAINTY		0.08	0.08	0.400	0.410	0.301
400	1.755	21.52	17.13	-289.979	-273.575	149.474
500	3.540	25.50	18.42	-289.686	-269.512	117.803
600	5.400	28.89	19.89	-289.383	-265.506	96.710
700	7.320	31.85	21.39	-289.079	-261.550	81.659
800	9.280	34.47	22.87	-288.820	-257.642	70.384
900	11.300	36.84	24.28	-288.506	-253.753	61.620
1000	13.380	39.04	25.66	-288.211	-249.915	54.619
1100	15.550	41.10	26.96	-287.893	-246.097	48.895
1200	17.850	43.10	28.22	-289.250	-242.178	44.106
1300	20.230	45.01	29.45	-288.513	-238.281	40.059
1400	22.680	46.82	30.62	-287.710	-234.451	36.599
1424	23.280	47.25	30.90	-287.513	-233.542	35.843
1424	24.420	48.05	30.90	-286.373	-233.542	35.843
1500	26.660	49.58	31.81	-285.381	-230.734	33.618
1600	29.620	51.49	32.98	-284.076	-227.146	31.027
1691	32.350	53.15	34.02	-282.900	-223.990	28.949
1691	39.450	57.35	34.02	-275.800	-223.990	28.949
1700	39.670	57.48	34.14	-275.684	-223.667	28.754
1800	42.050	58.84	35.48	-311.245	-219.708	26.676
1900	44.440	60.13	36.74	-310.279	-214.644	24.690
2000	46.830	61.36	37.94	-309.316	-209.656	22.910

MELTING POINT 1691 DEG K — BOILING POINT — DEG K

HEAT OF FUSION 7.100 KCAL — HEAT OF VAPOR. — KCAL

H -H 298 0 — KCAL — MOLAR VOLUME 0.58657 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.

REFERENCES 74 78 141 — COMPILED 6-13-66

SELLAITE GRAM FORMULA WEIGHT 62.309

MgF_2: Crystals 298.15° to melting point 1536°K. Liquid 1536° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	13.68	13.68	-268.700	-256.008	187.658
UNCERTAINTY		0.07	0.07	0.300	0.310	0.227
400	1.645	18.42	14.31	-268.460	-251.708	137.526
500	3.320	22.15	15.51	-268.231	-247.547	108.202
600	5.080	25.36	16.89	-267.969	-243.432	88.670
700	6.890	28.15	18.31	-267.704	-239.363	74.732
800	8.720	30.60	19.70	-267.462	-235.340	64.292
900	10.590	32.80	21.03	-267.219	-231.332	56.175
1000	12.510	34.82	22.31	-269.101	-227.185	49.651
1100	14.450	36.67	23.53	-268.833	-223.000	44.306
1200	16.430	38.39	24.70	-268.530	-218.854	39.859
1300	18.440	40.00	25.82	-268.203	-214.721	36.098
1400	20.460	41.50	26.89	-298.215	-209.797	32.751
1500	22.490	42.90	27.91	-297.593	-203.501	29.650
1536	23.220	43.38	28.26	-297.375	-201.240	28.633
1536	37.120	52.43	28.26	-283.475	-201.240	28.633
1600	38.560	53.34	29.24	-282.935	-197.818	27.021
1700	40.820	54.71	30.70	-282.090	-192.522	24.750
1800	43.080	56.01	32.08	-281.249	-187.294	22.741
1900	45.340	57.23	33.37	-280.410	-182.095	20.946
2000	47.600	58.39	34.59	-279.574	-176.942	19.335

MELTING POINT	1536	DEG K	BOILING POINT	2630	DEG K
HEAT OF FUSION	13.900	KCAL	HEAT OF VAPOR.	57.400	KCAL
$H_{298} - H_0$	2.3860	KCAL	MOLAR VOLUME	0.46869	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.

REFERENCES 74 78 142 148 COMPILED 6-13-66

VILLIAUMITE GRAM FORMULA WEIGHT 41.988

NaF: Crystals 298.15° to melting point 1269°K. Liquid 1269° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	12.26	12.26	-137.027	-129.812	95.154
UNCERTAINTY		0.07	0.07	0.200	0.210	0.154
400	1.181	15.66	12.71	-137.594	-127.307	69.557
500	2.396	18.37	13.58	-137.523	-124.742	54.525
600	3.661	20.68	14.58	-137.395	-122.200	44.511
700	4.976	22.70	15.59	-137.212	-119.678	37.365
800	6.341	24.52	16.59	-136.975	-117.187	32.014
900	7.756	26.19	17.57	-136.688	-114.733	27.861
1000	9.220	27.73	18.51	-136.356	-112.309	24.545
1100	10.733	29.18	19.42	-135.985	-109.933	21.842
1200	12.296	30.54	20.29	-158.811	-107.125	19.510
1269	13.404	31.43	20.87	-158.356	-104.180	17.942
1269	21.324	37.67	20.87	-150.436	-104.180	17.942
1300	21.847	38.10	21.29	-150.208	-103.056	17.325
1400	23.534	39.35	22.54	-149.472	-99.457	15.526
1500	25.220	40.51	23.70	-148.738	-95.905	13.973
1600	26.907	41.60	24.78	-148.006	-92.408	12.622
1700	28.593	42.62	25.80	-147.275	-88.951	11.435
1800	30.280	43.59	26.77	-146.546	-85.553	10.388
1900	31.967	44.50	27.68	-145.818	-82.179	9.453
2000	33.653	45.36	28.53	-145.093	-78.840	8.615

MELTING POINT 1269 DEG K BOILING POINT DEG K

HEAT OF FUSION 7.920 KCAL HEAT OF VAPOR. KCAL

H -H 298 0 2.0280 KCAL MOLAR VOLUME 0.35813 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SODIUM..... M. P. 370.98, B. P. 1176.9 DEG K.

REFERENCES 148 78 23 COMPILED 5-06-67

CRYOLITE GRAM FORMULA WEIGHT 209.941

Na_3AlF_6:Crystals 298.15° to 1500°K. Cryolite dissociates above 1279°K presumably by the reaction $Na_3AlF_6 = NaAlF_4 + 2NaF$.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H 298)/T T	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	56.98	56.98	-790.000	-750.695	550.273
UNCERTAINTY		0.40	0.40	2.000	2.010	1.473
400	5.538	72.92	59.08	-791.492	-737.283	402.832
500	11.454	86.10	63.19	-790.851	-723.663	316.312
600	17.758	97.59	67.99	-789.865	-710.313	258.731
700	24.397	107.81	72.96	-788.582	-697.154	217.661
800	31.338	117.08	77.91	-787.041	-684.196	186.913
900	40.340	127.74	82.92	-783.499	-671.602	163.087
1000	47.237	135.00	87.76	-784.660	-659.057	144.036
1100	54.478	141.90	92.37	-782.942	-646.583	128.464
1200	62.065	148.50	96.78	-850.625	-632.899	115.266
1300	69.996	154.85	101.00	-847.652	-614.873	103.369
1400	78.268	160.97	105.07	-844.351	-597.090	93.210
1500	86.881	166.91	108.99	-840.721	-579.550	84.440

MELTING POINT		DEG K	BOILING POINT		DEG K
HEAT OF FUSION	26.710	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	9.106	KCAL	MOLAR VOLUME	1.6924	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
SODIUM..... M. P. 370.98, B. P. 1176.9 DEG K.

REFERENCES 148	78	23	COMPILED
	148	148	4-15-67

IODARGYRITE GRAM FORMULA WEIGHT 234.774

AgI: Hexagonal crystals 298.15° to 423°K. Cubic crystals 423° to 800°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	27.60	27.60	-14.780	-15.830	11.604
UNCERTAINTY		0.40	0.40	0.400	0.420	0.308
400	1.450	31.77	28.14	-16.553	-16.137	8.817
423	1.810	32.64	28.36	-16.730	-16.080	8.308
423	3.280	36.12	28.36	-15.260	-16.080	8.308
500	4.320	38.37	29.73	-20.064	-15.835	6.922
600	5.670	40.84	31.39	-19.803	-15.024	5.472
700	7.020	42.91	32.88	-19.552	-14.234	4.444
800	8.370	44.71	34.25	-19.313	-13.489	3.685

MELTING POINT 831 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 0.98712 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SILVER..... M. P. 1234 DEG K.
IODINE..... M. P. 386.75, B. P. 458.39 DEG K.

REFERENCES 74 78 158 158 COMPILED 2-12-67

COCCINITE GRAM FORMULA WEIGHT 454.399

HgI_2: Crystals I 298.15° to 403°K. Crystals II 403° to melting point 523°K. Liquid 523° to 600°K.

TEMP. DEG K	H -H 298 (KCAL)	S (CAL/DEG-GFW)	-(G -H)/T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	42.40	42.40	-25.200	-24.148	17.701
UNCERTAINTY		1.50	1.50	0.400	0.610	0.447
400	1.885	47.84	43.13	-29.184	-23.634	12.913
403	1.940	47.98	43.17	-29.207	-23.570	12.782
403	2.590	49.59	43.17	-28.557	-23.570	12.782
500	4.550	53.95	44.85	-38.694	-21.446	9.374
523	5.015	54.86	45.27	-38.587	-20.685	8.644
523	9.515	63.46	45.27	-34.087	-20.685	8.644
600	11.440	66.90	47.83	-33.350	-18.733	6.824

MELTING POINT	523	DEG K	BOILING POINT	627	DEG K
HEAT OF FUSION	4.500	KCAL	HEAT OF VAPOR.	14.141	KCAL
H -H 298 0		KCAL	MOLAR VOLUME	1.7170	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MERCURY.... B. P. 629.73 DEG K.
IODINE..... M. P. 386.75, B. P. 458.39 DEG K.

REFERENCES 74 78 141 148 COMPILED 4-10-67

WITHERITE GRAM FORMULA WEIGHT 197.349

$BaCO_3$: Orthorhombic crystals 298.15° to 1079°K. Tetragonal crystals 1079° to 1241°K. Cubic crystals 1241° to 1600°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	26.80	26.80	-297.460	-278.359	204.042
UNCERTAINTY		0.50	0.50	0.870	0.930	0.682
400	2.300	33.41	27.66	-297.152	-271.871	148.543
500	4.730	38.83	29.37	-296.815	-265.591	116.090
600	7.330	43.56	31.34	-296.438	-259.377	94.478
700	10.080	47.80	33.40	-296.155	-253.215	79.057
800	12.980	51.67	35.44	-295.684	-247.115	67.508
900	16.020	55.25	37.45	-295.195	-241.076	58.541
1000	19.190	58.59	39.40	-296.481	-235.058	51.372
1079	21.790	61.09	40.90	-295.873	-230.213	46.629
1079	26.280	65.25	40.90	-291.383	-230.213	46.629
1100	27.060	65.97	41.37	-291.143	-229.038	45.505
1200	30.760	69.19	43.56	-290.001	-223.445	40.695
1241	32.270	70.42	44.42	-289.552	-221.200	38.953
1241	33.000	71.01	44.42	-288.822	-221.200	38.953
1300	35.240	72.78	45.67	-288.105	-217.982	36.646
1400	39.040	75.59	47.70	-286.907	-212.617	33.191
1500	42.840	78.21	49.65	-285.728	-207.361	30.212
1600	46.640	80.66	51.51	-284.563	-202.162	27.614

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 1.0948	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

BARIUM..... ALPHA-BETA 643, M. P. BETA 983, B. P. 1895 DEG K.

REFERENCES				
74	78	4		COMPILED
		98		1-12-67

ARAGONITE GRAM FORMULA WEIGHT 100.089

$CaCO_3$: Crystals 298.15° to 1000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	21.18	21.18	-288.651	-269.678	197.679
UNCERTAINTY		0.30	0.30	0.340	0.350	0.257
400	2.130	27.31	21.98	-288.507	-263.214	143.813
500	4.440	32.45	23.57	-288.297	-256.913	112.296
600	6.900	36.93	25.43	-288.073	-250.658	91.302
700	9.500	40.94	27.37	-287.830	-244.442	76.318
800	12.220	44.57	29.29	-287.601	-238.264	65.090
900	15.060	47.91	31.18	-287.299	-232.109	56.364
1000	18.000	51.01	33.01	-287.005	-225.992	49.390

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.81620 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.

REFERENCES 74 78 43 100 COMPILED 8- 9-66

CALCITE GRAM FORMULA WEIGHT 100.089

$CaCO_3$: Crystals 298.15° to 1400°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	22.15	22.15	-288.592	-269.908	197.847
UNCERTAINTY		0.20	0.20	0.320	0.330	0.242
400	2.220	28.53	22.98	-288.358	-263.553	143.998
500	4.610	33.86	24.64	-288.068	-257.389	112.505
600	7.200	38.58	26.58	-287.714	-251.289	91.532
700	9.890	42.72	28.59	-287.381	-245.239	76.567
800	12.660	46.42	30.59	-287.102	-239.245	65.358
900	15.500	49.76	32.54	-286.800	-233.275	56.647
1000	18.430	52.85	34.42	-286.516	-227.343	49.686
1100	21.450	55.73	36.23	-286.238	-221.449	43.998
1200	24.550	58.42	37.96	-287.706	-215.426	39.234
1300	27.619	60.87	39.63	-287.211	-209.411	35.205
1400	30.790	63.22	41.23	-286.632	-203.456	31.761

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.88274 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.

REFERENCES	74	78	43 100	COMPILED 8- 9-66

DOLOMITE GRAM FORMULA WEIGHT 184.411

$CaMg(CO_3)_2$: Crystals 298.15° to 1000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	37.09	37.09	-557.613	-518.734	380.241
UNCERTAINTY		0.07	0.07	0.520	0.530	0.388
400	4.150	49.01	38.63	-557.406	-505.468	276.174
500	8.743	59.24	41.75	-556.968	-492.535	215.286
600	13.752	68.37	45.45	-556.371	-479.704	174.732
700	19.121	76.63	49.31	-555.645	-466.972	145.795
800	24.797	84.21	53.21	-554.838	-454.372	124.128
900	30.709	91.17	57.05	-553.923	-441.860	107.298
1000	36.760	97.53	60.77	-555.182	-429.266	93.816

MELTING POINT		DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	6.210	KCAL	MOLAR VOLUME	1.53776	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.

REFERENCES 144 144 144 COMPILED 4-29-67

MAGNESITE GRAM FORMULA WEIGHT 84.321

$MgCO_3$: Crystals 298.15° to 1100°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	15.70	15.70	-266.081	-246.112	180.405
UNCERTAINTY		0.20	0.20	0.320	0.330	0.242
400	2.028	21.52	16.45	-266.010	-239.293	130.743
500	4.301	26.58	17.98	-265.791	-232.637	101.685
600	6.786	31.11	19.80	-265.483	-226.034	82.332
700	9.449	35.21	21.71	-265.106	-219.485	68.526
800	12.269	38.97	23.63	-264.664	-212.999	58.188
900	15.217	42.44	25.53	-264.175	-206.564	50.160
1000	18.243	45.63	27.39	-265.812	-200.020	43.714
1100	21.308	48.55	29.18	-265.309	-193.458	38.436

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.66965 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.

REFERENCES				
74	78	133		COMPILED
		99		4-15-67

RHODOCHROSITE GRAM FORMULA WEIGHT 114.947

$MnCO_3$: Crystals 298.15° to 700°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	23.90	23.90	-212.521	-195.045	142.971
UNCERTAINTY		0.50	0.50	0.290	0.330	0.242
400	2.160	30.12	24.72	-212.387	-189.094	103.316
500	4.550	35.44	26.34	-212.107	-183.298	80.119
600	7.095	40.07	28.24	-211.878	-177.631	64.702
700	9.800	44.24	30.24	-211.470	-171.883	53.664

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.74266 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MANGANESE.. ALPHA-BETA 990, BETA-GAMMA 1360, GAMMA-DELTA 1410, M. P. DELTA 1517 DEG K.

REFERENCES 74 122 133 COMPILED 12-20-66

STRONTIANITE GRAM FORMULA WEIGHT 147.629

$SrCO_3$: Orthorhombic crystals 298.15° to 1197°K. Hexagonal crystals 1197° to 1500°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	23.20	23.20	-294.581	-275.450	201.910
UNCERTAINTY		0.40	0.40	0.650	0.670	0.491
400	2.270	29.72	24.04	-294.307	-268.950	146.947
500	4.620	34.96	25.72	-294.052	-262.638	114.799
600	7.100	39.48	27.65	-293.793	-256.378	93.385
700	9.700	43.49	29.63	-293.535	-250.168	78.106
800	12.420	47.12	31.59	-293.251	-243.994	66.656
900	15.250	50.45	33.51	-293.159	-237.843	57.756
1000	18.170	53.52	35.35	-292.895	-231.702	50.638
1100	21.160	56.37	37.13	-294.917	-225.475	44.798
1197	24.110	58.94	38.80	-294.432	-219.364	40.052
1197	28.810	62.87	38.80	-289.732	-219.364	40.052
1200	28.920	62.96	38.86	-289.705	-219.189	39.920
1300	32.380	65.73	40.82	-288.819	-213.353	35.868
1400	35.840	68.29	42.69	-287.951	-207.571	32.403
1500	39.300	70.68	44.48	-287.102	-201.865	29.412

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.93236 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

STRONTIUM.. ALPHA-GAMMA 862, M. P. GAMMA 1043, B. P. 1648 DEG K.

REFERENCES 74 78 4 98 COMPILED 1-12-67

NITROBARITE GRAM FORMULA WEIGHT 261.350

$Ba(NO_3)_2$: Crystals 298.15° to melting point 865°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	51.14	51.14	-237.060	-190.066	139.322
UNCERTAINTY		0.20	0.20	0.500	0.590	0.432
400	3.960	62.53	52.63	-236.638	-174.063	95.103
500	8.410	72.44	55.62	-235.762	-158.513	69.286
600	13.240	81.24	59.17	-234.621	-143.166	52.148
700	18.460	89.28	62.91	-233.338	-128.014	39.968
800	24.070	96.76	66.67	-231.638	-113.080	30.892

MELTING POINT	865	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	1.9259	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

BARIUM..... ALPHA-BETA 643, M. P. BETA 983, B. P. 1895 DEG K.

REFERENCES 74 78 141 COMPILED 2-12-67

NITER GRAM FORMULA WEIGHT 101.107

KNO_3: Orthorhombic crystals 298.15° to 401°K. Rhombohedral crystals 401° to melting point 610°K. Liquid 610° to 700°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	31.81	31.81	-117.760	-93.893	68.826
UNCERTAINTY		0.15	0.15	0.300	0.310	0.227
400	2.490	38.98	32.75	-118.038	-85.675	46.810
401	2.520	39.05	32.76	-118.030	-85.600	46.654
401	3.920	42.54	32.76	-116.630	-85.600	46.654
500	6.780	48.92	35.36	-115.939	-78.011	34.098
600	9.660	54.17	38.07	-115.273	-70.486	25.675
610	9.970	54.68	38.36	-115.210	-69.730	24.983
610	12.770	59.26	38.36	-112.797	-69.730	24.983
700	15.013	62.64	41.19	-112.167	-63.421	19.801

MELTING POINT	610	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	2.413	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	1.1481	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

POTASSIUM.. M. P. 336.4, B. P. 1043.7 DEG K.

REFERENCES 74 78 141 COMPILED 6-13-66

AMMONIA-NITER GRAM FORMULA WEIGHT 80.043

NH_4NO_3: Ammonia-niter undergoes phase changes at 305.3°, 357.4°, 398.4°K. It melts at 442.8°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FORMATION FROM THE ELEMENTS FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	36.11	36.11	-87.373	-43.971	32.232
UNCERTAINTY		0.05	0.05	0.200	0.210	0.154
400	4.900	49.94	37.69	-85.683	-29.284	16.000
500	10.360	62.20	41.48	-83.420	-15.486	6.769

MELTING POINT	442.8	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	1.300	KCAL	HEAT OF VAPOR.		KCAL
$H_{298} - H_0$		KCAL	MOLAR VOLUME	1.1111	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

REFERENCES	74	158	158	COMPILED
				6-13-66

SODANITER — GRAM FORMULA WEIGHT 84.995

$NaNO_3$: α crystals 298.15° to 549.2°K. β crystals 549.2° to 579.2°K. Liquid 579.2° to 700°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	27.85	27.85	-111.540	-87.459	64.109
UNCERTAINTY		0.10	0.10	0.300	0.310	0.227
400	2.495	35.01	28.77	-111.842	-79.221	43.284
500	5.575	41.86	30.71	-110.951	-71.158	31.103
549.2	7.260	45.07	31.86	-111.830	-67.000	26.624
549.2	8.070	46.55	31.86	-111.020	-67.000	26.624
579.2	9.140	48.44	32.66	-109.132	-64.920	24.496
579.2	12.832	54.81	32.66	-105.440	-64.920	24.496
600	13.598	56.08	33.42	-105.137	-63.500	23.130
700	17.298	61.78	37.07	-103.674	-56.675	17.695

MELTING POINT	579.2	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	3.692	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	0.89866	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SODIUM..... M. P. 370.98, B. P. 1176.9 DEG K.

REFERENCES 74 78 141 COMPILED 6-13-66

BARITE GRAM FORMULA WEIGHT 233.402

$BaSO_4$: Crystals 298.15° to 1300°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	31.60	31.60	-352.131	-325.300	238.451
UNCERTAINTY		0.20	0.20	2.030	2.000	1.466
400	2.700	39.37	32.62	-352.644	-316.108	172.713
500	5.700	46.06	34.66	-352.723	-306.965	134.174
600	8.800	51.71	37.04	-352.701	-297.812	108.478
700	12.000	56.63	39.49	-352.732	-288.644	90.119
800	15.200	60.91	41.91	-365.726	-280.719	76.689
900	18.400	64.67	44.23	-365.435	-270.104	65.590
1000	21.600	68.05	46.45	-367.040	-259.498	56.713
1100	24.900	71.19	48.55	-366.611	-248.756	49.423
1200	28.300	74.15	50.57	-366.101	-238.068	43.358
1300	31.800	76.95	52.49	-365.510	-227.420	38.233

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 1.2452	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

BARIUM..... ALPHA-BETA 643, M. P. BETA 983, B. P. 1895 DEG K.
SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36,
B. P. 717.75 DEG K.

REFERENCES 74 78 73 135 COMPILED 4-10-67

ANHYDRITE GRAM FORMULA WEIGHT 136.142

$CaSO_4$: Crystals 298.15° to 1400°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	25.50	25.50	-343.321	-316.475	231.982
UNCERTAINTY		0.40	0.40	1.010	1.000	0.733
400	2.600	32.99	26.49	-343.928	-307.268	167.883
500	5.200	38.78	28.38	-344.414	-298.046	130.275
600	8.050	43.97	30.55	-344.655	-288.746	105.175
700	11.250	48.90	32.83	-344.576	-279.431	87.242
800	14.850	53.70	35.14	-357.232	-271.369	74.134
900	18.800	58.35	37.46	-356.178	-260.694	63.305
1000	22.850	62.61	39.76	-355.123	-250.131	54.666
1100	27.000	66.57	42.02	-354.054	-239.697	47.623
1200	31.300	70.31	44.23	-354.654	-229.213	41.745
1300	35.800	73.91	46.37	-353.053	-218.811	36.785
1400	40.500	77.39	48.46	-351.268	-208.560	32.558

MELTING POINT	1723	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	6.700	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	1.0979	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36,
B. P. 717.75 DEG K.

REFERENCES	74	78	135	COMPILED
			29	4-15-67

ARCANITE GRAM FORMULA WEIGHT 174.266

K_2SO_4: Orthorhombic crystals (α) 298.15° to 856°K. Hexagonal crystals (β) 856° to melting point 1342°K. Liquid 1342° to 1700°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	42.00	42.00	-343.481	-315.290	231.113
UNCERTAINTY		0.40	0.40	0.620	0.600	0.440
400	3.410	51.82	43.29	-345.282	-305.402	166.863
500	7.150	60.15	45.85	-345.429	-295.408	129.122
600	11.120	67.38	48.85	-345.277	-285.410	103.960
700	15.390	73.95	51.96	-344.795	-275.461	86.003
800	20.100	80.24	55.11	-356.930	-266.840	72.897
856	22.780	83.48	56.87	-356.250	-260.540	66.520
856	24.920	85.98	56.87	-354.110	-260.540	66.520
900	26.920	88.25	58.34	-353.600	-255.757	62.106
1000	31.600	93.18	61.58	-352.457	-244.945	53.533
1100	36.320	97.77	64.75	-389.132	-232.304	46.154
1200	41.220	102.04	67.69	-387.366	-218.130	39.727
1300	46.260	106.06	70.48	-385.479	-204.086	34.310
1342	48.410	107.70	71.63	-384.660	-198.260	32.287
1342	57.470	114.45	71.63	-375.600	-198.260	32.287
1400	60.240	116.46	73.43	-374.668	-190.593	29.753
1500	65.020	119.77	76.42	-373.072	-177.520	25.865
1600	69.800	122.85	79.22	-371.488	-164.525	22.473
1700	74.580	125.74	81.87	-369.917	-151.627	19.493

MELTING POINT	1342	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	9.060	KCAL	HEAT OF VAPOR.		KCAL
$H_{298} - H_0$		KCAL	MOLAR VOLUME	1.5654	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

POTASSIUM.. M. P. 336.4, B. P. 1043.7 DEG K.
SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36, B. P. 717.75 DEG K.

REFERENCES 74 78 73 135 COMPILED 2-12-67

ALUNITE GRAM FORMULA WEIGHT 828.440

$K_2Al_6(OH)_{12}(SO_4)_4$: Crystals 298.15° to 700°K.

TEMP.	H -H T 298	S T	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY	FREE ENERGY	LOG K
298.15	0.000	156.80	156.80	---	---	---
UNCERTAINTY		0.90	0.90			
400	22.050	219.99	164.86	---	---	---
500	47.500	276.70	181.70	---	---	---
600	74.100	325.19	201.69	---	---	---
700	101.100	366.64	222.21	---	---	---

MELTING POINT	DEG K		BOILING POINT		DEG K
HEAT OF FUSION	KCAL		HEAT OF VAPOR.		KCAL
H -H 298 0	KCAL		MOLAR VOLUME	7.0172	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
POTASSIUM.. M. P. 336.4, B. P. 1043.7 DEG K.
SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36,
B. P. 717.75 DEG K.

REFERENCES 74 78 COMPILED 4-15-67

MASCAGNITE GRAM FORMULA WEIGHT 132.139

$(NH_4)_2SO_4$: Crystals 298.15° to 600°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	52.60	52.60	-282.230	-215.565	158.013
UNCERTAINTY		0.30	0.30	0.300	0.320	0.235
400	4.970	66.92	54.49	-283.355	-192.676	105.273
500	10.340	78.88	58.20	-283.885	-169.937	74.279
600	16.590	90.25	62.60	-283.513	-147.166	53.605

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 1.7848	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36,
B. P. 717.75 DEG K.

REFERENCES 74 78 158 158 COMPILED 6-13-66

THENARDITE GRAM FORMULA WEIGHT 142.041

Na_2SO_4: Orthorhombic crystals (V) 298.15° to 450°K. Orthorhombic crystals (III) 450° to 514°K. Hexagonal crystals (I) 514° to 1157°K. Liquid 1157° to 1800°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	35.73	35.73	-331.528	-303.400	222.398
UNCERTAINTY		0.07	0.07	0.410	0.400	0.293
400	3.520	45.86	37.06	-333.277	-293.674	160.456
450	5.370	50.22	38.29	-333.280	-288.760	140.241
450	6.110	51.86	38.29	-332.540	-288.760	140.241
500	8.130	56.12	39.86	-332.550	-283.844	124.068
514	8.720	57.28	40.32	-332.500	-282.440	120.092
514	10.400	60.55	40.32	-330.820	-282.440	120.092
600	13.820	66.70	43.67	-330.668	-274.401	99.950
700	18.000	73.14	47.43	-330.256	-265.055	82.754
800	22.340	78.93	51.00	-342.727	-256.993	70.207
900	26.860	84.25	54.41	-341.653	-246.337	59.819
1000	31.590	89.23	57.64	-340.398	-235.808	51.536
1100	36.570	93.98	60.73	-338.931	-225.430	44.789
1157	39.470	96.55	62.44	-338.000	-219.480	41.458
1157	45.140	101.45	62.44	-332.330	-219.480	41.458
1200	47.170	103.17	63.86	-378.351	-214.467	39.060
1300	51.880	106.94	67.03	-376.794	-200.872	33.769
1400	56.600	110.44	70.01	-375.243	-187.402	29.255
1500	61.320	113.70	72.82	-373.707	-174.045	25.358
1600	66.040	116.74	75.46	-372.183	-160.772	21.960
1700	70.760	119.60	77.98	-370.668	-147.601	18.975
1800	75.470	122.29	80.36	-369.180	-134.519	16.333

MELTING POINT 1157 DEG K BOILING POINT DEG K

HEAT OF FUSION 5.670 KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 1.2746 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SODIUM..... M. P. 370.98, B. P. 1176.9 DEG K.
SULFUR..... ORTHO-MCNO 368.54, M. P. MONO 388.36, B. P. 717.75 DEG K.

REFERENCES 74 78 73 135 COMPILED 4-15-67

ANGLESITE GRAM FORMULA WEIGHT 303.252

$PbSO_4$: Crystals 298.15° to 1100°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H 298)/T T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	35.51	35.51	-219.891	-194.360	142.469
UNCERTAINTY		0.07	0.07	0.260	0.250	0.183
400	2.580	42.95	36.50	-220.523	-185.603	101.408
500	5.300	49.01	38.41	-220.869	-176.831	77.293
600	8.220	54.33	40.63	-221.008	-168.009	61.197
700	11.360	59.16	42.93	-222.097	-158.982	49.636
800	14.870	63.84	45.25	-234.732	-151.205	41.307
900	18.700	68.35	47.57	-233.680	-140.824	34.197
1000	22.800	72.67	49.87	-232.381	-130.579	28.538
1100	27.050	76.72	52.13	-230.951	-120.477	23.936

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	4.7950 KCAL	MOLAR VOLUME	1.1460 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

LEAD..... M. P. 600.6, B. P. 2023 DEG K.
SULFUR..... ORTHO-MCNO 368.54, M. P. MONO 388.36,
B. P. 717.75 DEG K.

REFERENCES 74 41 159 COMPILED 2-12-67

ZINKOSITE GRAM FORMULA WEIGHT 161.432

$ZnSO_4$: Crystals 298.15° to 1000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	26.40	26.40	-233.600	-207.022	151.751
UNCERTAINTY		0.30	0.30	0.200	0.230	0.169
400	2.520	33.66	27.36	-234.267	-197.903	108.129
500	5.120	39.45	29.21	-234.708	-188.750	82.502
600	7.870	44.46	31.34	-234.994	-179.535	65.395
700	10.920	49.16	33.56	-236.760	-170.271	53.161
800	14.220	53.56	35.78	-249.631	-162.000	44.256
900	17.770	57.74	38.00	-248.897	-151.082	36.688
1000	21.620	61.79	40.17	-247.892	-140.260	30.654

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.99355 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SULFUR..... ORTHO-MONO 368.54, M. P. MONO 388.36, B. P. 717.75 DEG K.
ZINC..... M. P. 692.7, B. P. 1184 DEG K.

REFERENCES 74 170 3 135 COMPILED 4-15-67

WHITLOCKITE GRAM FORMULA WEIGHT 310.183

$Ca_3(PO_4)_2$: Rhombohedral crystals 298.15° to 1373°K. Monoclinic crystals 1373° to 1600°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	57.58	57.58	-986.200	-932.785	683.748
UNCERTAINTY		0.20	0.20	0.500	0.520	0.381
400	6.000	74.85	59.85	-986.130	-914.532	499.676
500	12.300	88.89	64.29	-985.951	-896.660	391.929
600	19.100	101.28	69.45	-985.548	-878.842	320.117
700	26.400	112.52	74.81	-984.921	-861.098	268.846
800	34.050	122.73	80.17	-1025.134	-854.086	233.325
900	42.050	132.14	85.42	-1023.752	-832.768	202.223
1000	50.600	141.15	90.55	-1022.088	-811.632	177.382
1100	59.600	149.72	95.54	-1020.206	-790.689	157.095
1200	69.000	157.90	100.40	-1023.364	-769.511	140.147
1300	78.800	165.74	105.12	-1020.100	-748.452	125.826
1373	86.200	171.28	108.50	-1017.520	-733.320	116.728
1373	89.900	173.97	108.50	-1013.820	-733.320	116.728
1400	92.000	175.48	109.77	-1013.466	-727.782	113.612
1500	99.900	180.93	114.33	-1012.162	-707.377	103.064
1600	107.800	186.03	118.65	-1010.884	-687.140	93.859

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 2.3331	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
PHOSPHORUS. SUBLIMES 704 DEG K.

REFERENCES 74 78 141 COMPILED 4-10-67

HYDROXYLAPATITE GRAM FORMULA WEIGHT 502.322

$Ca_5(PO_4)_3OH$: Crystals 298.15° to 1500°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	93.30	93.30	-3215.000	-3123.504	2289.584
UNCERTAINTY		0.40	0.40	3.000	3.010	2.206
400	10.170	121.20	95.77	-3214.765	-3091.707	1689.226
500	21.345	147.30	104.61	-3213.829	-3061.658	1338.246
600	33.000	168.60	113.60	-3212.860	-3031.356	1104.167
700	45.005	187.00	122.71	-3211.987	-3001.100	936.983
800	57.355	203.60	131.91	-3272.601	-2987.065	816.026
900	70.045	218.40	140.57	-3271.016	-2951.322	716.677
1000	83.065	232.20	149.13	-3269.547	-2915.950	637.279
1100	96.390	249.40	161.77	-3268.162	-2885.641	573.322
1200	110.025	256.80	165.11	-3275.535	-2844.893	518.124
1300	123.945	267.90	172.56	-3272.589	-2809.019	472.238
1400	138.140	278.40	179.73	-3269.422	-2773.512	432.963
1500	152.590	288.40	186.67	-3266.055	-2738.179	398.951

MELTING POINT		DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	15.355	KCAL	MOLAR VOLUME	3.8145	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
PHOSPHORUS. SUBLIMES 704 DEG K.

REFERENCES 74 78 97 COMPILED 11-29-66

FLUORAPATITE GRAM FORMULA WEIGHT 504.313

$Ca_5(PO_4)_3F$: Crystals 298.15° to 1600°K.

TEMP. DEG K	H -H 298 (KCAL)	S (CAL/DEG-GFW)	-(G -H 298)/T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	92.70	92.70	---	---	---
UNCERTAINTY		0.40	0.40			
400	10.050	121.45	96.32	---	---	---
500	20.850	150.15	108.45	---	---	---
600	32.030	165.65	112.27	---	---	---
700	43.245	183.35	121.57	---	---	---
800	55.395	199.80	130.56	---	---	---
900	67.825	214.05	138.69	---	---	---
1000	79.855	227.00	147.14	---	---	---
1100	92.860	239.20	154.78	---	---	---
1200	105.570	200.20	112.22	---	---	---
1300	118.655	260.65	169.38	---	---	---
1400	131.905	270.35	176.13	---	---	---
1500	145.065	279.40	182.69	---	---	---
1600	157.500	287.50	189.06	---	---	---

MELTING POINT	DEG K		BOILING POINT		DEG K
HEAT OF FUSION	KCAL		HEAT OF VAPOR.		KCAL
H -H 298 0	15.170	KCAL	MOLAR VOLUME	3.7657	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
PHOSPHORUS. SUBLIMES 704 DEG K.

REFERENCES 74 78 COMPILED 6-13-66

KYANITE GRAM FORMULA WEIGHT 162.046

Al_2SiO_5: Crystals 298.15° to 1800°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	20.02	20.02	-619.930	-584.000	428.082
UNCERTAINTY		0.08	0.08	0.540	0.550	0.403
400	3.320	29.55	21.25	-620.156	-571.894	312.467
500	7.080	37.93	23.77	-620.031	-559.569	244.587
600	11.170	45.38	26.76	-619.719	-547.506	199.428
700	15.460	51.99	29.90	-619.335	-535.500	167.190
800	19.900	57.91	33.03	-618.930	-523.547	143.026
900	24.450	63.27	36.10	-618.559	-511.648	124.245
1000	29.090	68.16	39.07	-623.282	-499.414	109.147
1100	33.810	72.66	41.92	-622.817	-487.053	96.768
1200	38.620	76.84	44.66	-622.291	-474.731	86.460
1300	43.510	80.76	47.29	-621.711	-462.467	77.748
1400	48.480	84.44	49.81	-621.077	-450.233	70.284
1500	53.530	87.92	52.23	-620.387	-438.062	63.825
1600	58.660	91.23	54.57	-619.637	-425.934	58.180
1700	63.870	94.39	56.82	-630.896	-413.751	53.191
1800	69.160	97.41	58.99	-629.955	-400.994	48.687

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	3.8340 KCAL	MOLAR VOLUME	1.0537 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 121 78 59 60 COMPILED 4-29-67

ANDALUSITE GRAM FORMULA WEIGHT 162.046

Al_2SiO_5: Crystals 298.15° to 1800°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	22.28	22.28	-619.390	-384.134	428.180
UNCERTAINTY		0.10	0.10	0.710	0.720	0.528
400	3.340	31.87	23.52	-619.596	-572.262	312.668
500	7.120	40.29	26.05	-619.451	-560.169	244.849
600	11.170	47.67	29.05	-619.179	-548.340	199.732
700	15.420	54.22	32.19	-618.835	-536.561	167.521
800	19.810	60.08	35.32	-618.480	-524.833	143.377
900	24.320	65.39	38.37	-618.149	-513.146	124.609
1000	28.920	70.23	41.31	-622.912	-501.114	109.518
1100	33.600	74.69	44.14	-622.487	-488.956	97.146
1200	38.350	78.82	46.86	-622.021	-476.837	86.844
1300	43.170	82.68	49.47	-621.511	-464.763	78.134
1400	48.060	86.31	51.98	-620.957	-452.731	70.674
1500	53.020	89.73	54.38	-620.357	-440.747	64.217
1600	58.040	92.97	56.69	-619.717	-428.798	58.571
1700	63.120	96.05	58.92	-631.106	-416.783	53.581
1800	68.260	98.89	60.97	-630.315	-404.018	49.054

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	4.0860 KCAL	MOLAR VOLUME	1.2316 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 121 78 164 60 COMPILED 4-29-67

SILLIMANITE GRAM FORMULA WEIGHT 162.046

Al_2SiO_5: Crystals 298.15° to 1800°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	22.97	22.97	-618.650	-583.599	427.789
UNCERTAINTY		0.10	0.10	0.710	0.720	0.528
400	3.350	32.59	24.21	-618.846	-571.800	312.416
500	7.090	40.92	26.74	-618.741	-559.774	244.676
600	11.100	48.23	29.73	-618.509	-548.006	199.610
700	15.300	54.70	32.84	-618.215	-536.277	167.433
800	19.630	60.48	35.94	-617.920	-524.593	143.312
900	24.080	65.72	38.96	-617.649	-512.943	124.559
1000	28.640	70.52	41.88	-622.452	-500.944	109.481
1100	33.310	74.97	44.69	-622.037	-488.814	97.118
1200	38.080	79.12	47.39	-621.551	-476.727	86.824
1300	42.950	83.02	49.98	-620.991	-464.685	78.120
1400	47.910	86.70	52.48	-620.367	-452.687	70.667
1500	52.960	90.18	54.87	-619.677	-440.742	64.216
1600	58.090	93.49	57.18	-618.927	-428.840	58.577
1700	63.300	96.65	59.41	-630.186	-416.883	53.594
1800	68.590	99.67	61.56	-629.245	-404.352	49.095

MELTING POINT DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 4.1620 KCAL MOLAR VOLUME 1.1926 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 121 78 164 60 COMPILED 4-29-67

MULLITE (3-2) GRAM FORMULA WEIGHT 426.053

$3Al_2O_3 \cdot 2SiO_2$: Crystals 298.15° to melting point 2123°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	64.43	64.43	-1629.543	-1539.006	1128.118
UNCERTAINTY		1.00	1.00	1.700	1.730	1.268
400	8.930	90.07	67.74	-1630.011	-1508.618	824.268
500	18.810	112.08	74.46	-1629.760	-1477.475	645.802
600	29.420	131.41	82.38	-1629.156	-1447.077	527.096
700	40.580	148.61	90.64	-1628.345	-1416.795	442.342
800	52.170	164.08	98.87	-1627.456	-1386.638	378.811
900	64.090	178.11	106.90	-1626.639	-1356.578	329.421
1000	76.260	190.93	114.67	-1641.102	-1325.492	289.685
1100	88.630	202.72	122.15	-1640.018	-1293.989	257.091
1200	101.170	213.63	129.32	-1638.836	-1262.590	229.948
1300	113.850	223.78	136.20	-1637.578	-1231.290	206.998
1400	126.640	233.26	142.80	-1636.274	-1200.080	187.340
1500	139.520	242.15	149.14	-1634.938	-1169.005	170.323
1600	152.460	250.50	155.21	-1633.592	-1137.991	155.442
1700	165.440	258.37	161.05	-1656.391	-1106.852	142.295
1800	178.450	265.80	166.66	-1654.928	-1074.546	130.467
1900	191.480	272.84	172.06	-1653.489	-1042.335	119.895
2000	204.520	279.53	177.27	-1652.073	-1010.232	110.393

MELTING POINT	2133	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	3.2158	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 124	60	164	COMPILED
	124	60	4-29-67

LARNITE GRAM FORMULA WEIGHT 172.244

Ca_2SiO_4: Crystals 298.15° to 970°K. α' crystals (bredigite) 970° to 1710°K. α crystals 1710° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H T 298)/T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	30.50	30.50	-551.420	-524.022	384.118
UNCERTAINTY		0.20	0.20	0.770	0.780	0.572
400	3.335	40.09	31.75	-551.349	-514.663	281.198
500	6.940	48.13	34.25	-551.122	-505.523	220.963
600	10.790	55.14	37.16	-550.804	-496.432	180.825
700	14.810	61.34	40.18	-550.461	-487.399	152.173
800	18.940	66.85	43.17	-550.203	-478.414	130.696
900	23.140	71.79	46.08	-549.911	-469.447	113.997
970	26.120	74.98	48.06	-549.760	-463.185	104.358
970	26.560	75.44	48.06	-549.320	-463.185	104.358
1000	27.860	76.76	48.90	-549.275	-460.527	100.648
1100	32.250	80.94	51.62	-549.122	-451.666	89.738
1120	33.140	81.74	52.15	-549.091	-449.900	87.790
1200	36.720	84.83	54.23	-552.514	-442.544	80.598
1300	41.290	88.49	56.73	-551.790	-433.394	72.860
1400	45.970	91.95	59.11	-550.976	-424.326	66.240
1500	50.780	95.27	61.42	-550.052	-415.298	60.509
1600	55.710	98.45	63.63	-549.026	-406.373	55.508
1700	60.780	101.53	65.78	-559.946	-397.395	51.089
1710	61.290	101.83	65.99	-548.030	-396.495	50.675
1710	64.680	103.81	65.99	-544.640	-396.495	50.675
1800	69.090	106.32	67.94	-628.062	-386.189	46.890
1900	73.990	108.97	70.03	-626.562	-372.794	42.881
2000	78.890	111.48	72.03	-625.072	-359.504	39.285

MELTING POINT	2403 DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 1.2332	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 74 78 81 COMPILED 4-29-67

CALCIUM OLIVINE GRAM FORMULA WEIGHT 172.244

Ca_2SiO_4: Crystals 298.15° to 1120°K. Calcium olivine is the stable form of dicalcium silicate below 1120°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	28.80	28.80	-553.973	-526.069	385.618
UNCERTAINTY		0.20	0.20	0.940	0.950	0.696
400	3.270	38.21	30.03	-553.967	-516.529	282.217
500	6.760	45.99	32.47	-553.855	-507.186	221.690
600	10.480	52.76	35.29	-553.667	-497.867	181.347
700	14.380	58.77	38.23	-553.444	-488.583	152.542
800	18.420	64.17	41.14	-553.276	-479.343	130.950
900	22.590	69.08	43.98	-553.014	-470.111	114.158
1000	26.890	73.61	46.72	-552.798	-460.900	100.729
1100	31.320	77.83	49.36	-552.605	-451.728	89.750
1120	32.220	78.64	49.87	-552.567	-449.900	87.790

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 1.4127	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 74 78 81 129 COMPILED 4-29-67

GEHLENITE GRAM FORMULA WEIGHT 274.205

$Ca_2Al_2SiO_7$: Crystals 298.15° to melting point 1863°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	47.40	47.40	-952.740	-904.432	662.965
UNCERTAINTY		0.40	0.40	0.960	0.970	0.711
400	5.430	63.01	49.43	-952.880	-888.105	485.236
500	11.340	76.18	53.50	-952.706	-871.662	381.002
600	17.630	87.64	58.26	-952.399	-855.484	311.609
700	24.170	97.72	63.19	-952.073	-839.357	262.058
800	30.910	106.72	68.08	-951.836	-823.283	224.910
900	37.800	114.83	72.83	-951.599	-807.219	196.019
1000	44.820	122.23	77.41	-956.569	-790.807	172.830
1100	51.950	129.02	81.79	-956.453	-774.244	153.828
1200	59.180	135.31	85.99	-959.875	-757.414	137.944
1300	66.500	141.17	90.02	-959.202	-740.552	124.498
1400	73.900	146.65	93.86	-958.482	-723.775	112.986
1500	81.370	151.80	97.55	-957.723	-707.016	103.012
1600	88.900	156.66	101.10	-956.930	-690.356	94.298
1700	96.480	161.26	104.51	-968.181	-673.620	86.599
1800	104.100	165.61	107.78	-1039.837	-654.462	79.462

MELTING POINT	1863	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	2.1567	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 122 172 8 COMPILED 5-08-67

GROSSULAR GRAM FORMULA WEIGHT 450.454

$Ca_3Al_2Si_3O_{12}$: Crystals 298.15° to 1700°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	57.70	57.70	-1588.393	-1500.986	1100.249
UNCERTAINTY		1.30	1.30	1.830	1.880	1.378
400	9.017	83.63	61.09	-1588.438	-1471.314	803.886
500	18.707	105.22	67.80	-1588.089	-1441.796	630.207
600	29.183	124.32	75.68	-1587.352	-1412.622	514.546
700	40.060	141.06	83.84	-1586.581	-1383.545	431.961
800	51.298	156.07	91.95	-1585.888	-1354.607	370.060
900	62.815	169.61	99.81	-1585.129	-1325.708	321.925
1000	74.534	180.67	106.14	-1589.628	-1295.240	283.074
1100	86.414	193.28	114.73	-1589.097	-1267.261	251.781
1200	98.417	203.75	121.74	-1593.918	-1237.652	225.407
1300	110.565	213.46	128.41	-1592.604	-1207.973	203.078
1400	122.884	222.58	134.81	-1591.181	-1178.455	183.965
1500	135.340	231.20	140.97	-1589.681	-1149.056	167.417
1600	147.930	239.29	146.84	-1588.101	-1119.733	152.948
1700	160.650	247.01	152.51	-1622.649	-1090.195	140.154

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 2.9947	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 163	57	57	COMPILED 4-29-67

MERWINITE GRAM FORMULA WEIGHT 328.719

$Ca_3Mg(SiO_4)_2$: Crystals 298.15° to incongruent melting point 1848°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	60.50	60.50	-1091.490	-1037.184	760.274
UNCERTAINTY		0.50	0.50	1.270	1.290	0.946
400	6.590	79.45	62.97	-1091.399	-1018.626	556.550
500	13.690	95.28	67.90	-1091.009	-1000.486	437.311
600	21.170	108.91	73.63	-1090.534	-982.426	357.847
700	28.940	120.88	79.54	-1090.047	-964.442	301.111
800	36.930	131.55	85.39	-1089.688	-946.542	258.583
900	45.080	141.15	91.06	-1089.275	-928.663	225.509
1000	53.350	149.86	96.51	-1091.190	-910.634	199.018
1100	61.730	157.85	101.73	-1091.104	-892.596	177.342
1200	70.230	165.24	106.72	-1096.348	-874.151	159.204
1300	78.870	172.16	111.49	-1095.440	-855.645	143.847
1400	87.670	178.68	116.06	-1124.757	-836.438	130.574
1500	96.650	184.87	120.44	-1123.306	-815.868	118.871
1600	105.830	190.79	124.65	-1121.691	-795.462	108.655
1700	115.230	196.49	128.71	-1144.028	-774.916	99.622

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 2.4952	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 122 172 117 75 COMPILED 4-29-67

AKERMANITE GRAM FORMULA WEIGHT 272.640

$Ca_2MgSi_2O_7$: Crystals 298.15° to melting point 1727°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H 298)/T T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	50.03	50.03	-926.510	-879.353	644.581
UNCERTAINTY		0.50	0.50	1.070	1.090	0.799
400	5.560	66.02	52.12	-926.437	-863.241	471.652
500	11.420	79.08	56.24	-926.236	-847.467	370.427
600	17.670	90.47	61.02	-925.889	-831.746	302.962
700	24.200	100.53	65.96	-925.488	-816.084	254.792
800	30.900	109.48	70.85	-925.185	-800.493	218.684
900	37.740	117.53	75.60	-924.845	-784.911	190.602
1000	44.720	124.88	80.16	-926.736	-769.182	168.104
1100	51.830	131.66	84.54	-926.541	-753.444	149.695
1200	59.070	137.96	88.73	-929.861	-737.461	134.310
1300	66.430	143.85	92.75	-929.064	-721.436	121.284
1400	73.910	149.39	96.60	-958.529	-704.684	110.006
1500	81.500	154.63	100.30	-957.293	-686.596	100.037
1600	89.200	159.60	103.85	-955.979	-668.626	91.330
1700	97.010	164.33	107.27	-978.725	-650.489	83.626

MELTING POINT	1727	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	2.2182	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 122	172	116	COMPILED
		75	4-29-67

SPHENE GRAM FORMULA WEIGHT 196.063

$CaTiSiO_5$: Crystals 298.15° to melting point 1670°K. Liquid 1670° to 2000°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	30.88	30.88	-622.050	-588.246	431.195
UNCERTAINTY		0.20	0.20	0.570	0.580	0.425
400	3.750	41.66	32.28	-621.903	-576.708	315.098
500	7.690	50.44	35.06	-621.664	-565.437	247.152
600	11.860	58.04	38.27	-621.344	-554.225	201.876
700	16.230	64.77	41.58	-620.964	-543.059	169.550
800	20.750	70.81	44.87	-620.593	-531.967	145.326
900	25.380	76.26	48.06	-620.186	-520.907	126.493
1000	30.070	81.20	51.13	-619.854	-509.885	111.435
1100	34.800	85.71	54.07	-619.606	-498.906	99.123
1200	39.580	89.87	56.89	-622.128	-487.773	88.835
1300	44.430	93.75	59.57	-621.535	-476.589	80.122
1400	49.350	97.39	62.14	-620.920	-465.468	72.663
1500	54.340	100.84	64.61	-620.284	-454.399	66.206
1600	59.400	104.10	66.97	-619.623	-443.360	60.560
1670	62.980	106.29	68.58	-619.140	-435.134	56.945
1670	92.570	124.01	68.58	-589.550	-435.134	56.945
1700	94.570	125.20	69.57	-600.966	-432.798	55.640
1800	101.250	129.02	72.77	-634.985	-422.059	51.245
1900	107.930	132.63	75.82	-632.523	-410.295	47.195
2000	114.610	136.06	78.75	-633.790	-398.581	43.555

MELTING POINT 1670.00 DEG K BOILING POINT DEG K

HEAT OF FUSION 29.590 KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 1.33007 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
SILICON.... M. P. 1685 DEG K.
TITANIUM... ALPHA-BETA 1155, M. P. 1943 DEG K.

REFERENCES 74 78 152 COMPILED 4-29-67

FAYALITE GRAM FORMULA WEIGHT 203.778

Fe_2SiO_4: Crystals 298.15° to melting point 1490°K. Liquid 1490° to 2000°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	35.45	35.45	-353.544	-329.668	241.652
UNCERTAINTY		0.40	0.40	0.700	0.720	0.528
400	3.440	45.35	36.75	-353.338	-321.540	175.681
500	7.210	53.75	39.33	-352.926	-313.627	137.086
600	11.190	61.00	42.35	-352.488	-305.808	111.390
700	15.320	67.36	45.47	-352.085	-298.067	93.061
800	19.560	73.02	48.57	-351.787	-290.374	79.326
900	23.890	78.12	51.58	-351.665	-282.694	68.647
1000	28.310	82.78	54.47	-351.849	-275.021	60.106
1100	32.850	87.10	57.24	-352.386	-267.294	53.106
1200	37.510	91.16	59.90	-352.408	-259.586	47.277
1300	42.290	94.98	62.45	-351.634	-251.893	42.347
1400	47.190	98.62	64.91	-350.800	-244.268	38.132
1490	51.690	100.98	66.29	-349.985	-236.310	34.661
1490	73.720	115.76	66.29	-327.955	-236.310	34.661
1500	74.300	116.90	67.37	-327.796	-236.827	34.506
1600	80.050	120.61	70.58	-326.210	-230.821	31.529
1700	85.800	124.10	73.63	-337.310	-224.790	28.899
1800	91.550	127.39	76.53	-335.928	-218.201	26.493
1900	97.300	130.49	79.28	-341.938	-211.328	24.308
2000	103.050	133.44	81.91	-340.698	-204.490	22.346

MELTING POINT	1490	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	22.030	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	1.1087	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

IRON..... CURIE P. 1033, ALPHA-GAMMA 1184, GAMMA-DELTA 1665, M. P. DELTA 1809 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES	74	151 78	82	COMPILED 5-06-67

FORSTERITE GRAM FORMULA WEIGHT 140.708

Mg_2SiO_4: Crystals 298.15° to melting point 2163°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	22.75	22.75	-520.370	-491.938	360.599
UNCERTAINTY		0.20	0.20	0.520	0.530	0.388
400	3.100	31.66	23.91	-520.476	-482.202	263.462
500	6.520	39.38	26.34	-520.342	-472.698	206.616
600	10.180	45.95	28.98	-520.096	-463.126	168.693
700	14.010	51.85	31.84	-519.801	-453.652	141.636
800	17.960	57.12	34.67	-519.497	-444.228	121.357
900	22.000	61.88	37.44	-519.207	-434.828	105.590
1000	26.130	66.23	40.10	-523.195	-425.117	92.909
1100	30.340	70.24	42.66	-522.862	-415.308	82.514
1200	34.630	73.97	45.11	-522.474	-405.568	73.864
1300	39.000	77.47	47.47	-522.030	-395.834	66.546
1400	43.450	80.77	49.73	-582.216	-384.491	60.022
1500	47.950	83.87	51.90	-581.116	-370.411	53.969
1600	52.470	86.79	54.00	-580.014	-356.411	48.683
1700	57.000	89.55	56.02	-590.988	-342.387	44.017
1800	61.540	92.14	57.95	-589.830	-327.786	39.799
1900	66.090	94.60	59.82	-588.674	-313.261	36.033
2000	70.650	96.94	61.61	-587.518	-298.806	32.652

MELTING POINT	2163	DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	4.129	KCAL	MOLAR VOLUME	1.0466	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 74 78 153 COMPILED 4-29-67

CORDIERITE GRAM FORMULA WEIGHT 584.969

$Mg_2Al_3(AlSi_5O_{18})$: Crystals 298.15° to 1700°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	97.33	97.33	---	---	---
UNCERTAINTY		0.90	0.90			
400	12.030	131.89	101.81	---	---	---
500	25.440	161.77	110.89	---	---	---
600	39.950	188.20	121.62	---	---	---
700	55.220	211.73	132.84	---	---	---
800	71.020	232.82	144.05	---	---	---
900	87.210	251.88	154.98	---	---	---
1000	103.720	269.28	165.56	---	---	---
1100	120.520	285.29	175.73	---	---	---
1200	137.600	300.15	185.48	---	---	---
1300	154.960	314.04	194.84	---	---	---
1400	172.590	327.11	203.83	---	---	---
1500	190.490	339.45	212.46	---	---	---
1600	208.660	351.18	220.77	---	---	---
1700	227.090	362.35	228.77	---	---	---

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 5.5740	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 122 172 COMPILED 8- 9-66

TEPHROITE GRAM FORMULA WEIGHT 201.960

Mn_2SiO_4: Crystals 298.15° to melting point 1620°K. Liquid 1620° to 1800°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	39.00	39.00	-413.520	-390.028	285.898
UNCERTAINTY		1.00	1.00	0.760	0.820	0.601
400	3.340	48.61	40.26	-413.524	-381.998	208.713
500	6.940	56.63	42.75	-413.322	-374.133	163.533
600	10.750	63.57	45.65	-413.204	-366.458	133.482
700	14.720	69.69	48.66	-412.791	-358.556	111.946
800	18.800	75.14	51.64	-412.553	-350.836	95.844
900	22.950	80.03	54.53	-412.361	-343.129	83.323
1000	27.140	84.44	57.30	-413.285	-335.437	73.309
1100	31.370	88.47	59.95	-413.182	-327.639	65.096
1200	35.640	92.19	62.49	-413.064	-319.894	58.260
1300	39.960	95.64	64.90	-412.950	-312.117	52.471
1400	44.330	98.88	67.22	-413.976	-304.336	47.509
1500	48.750	101.93	69.43	-415.082	-296.468	43.195
1600	53.230	104.82	71.55	-422.226	-287.973	39.335
1620	54.130	105.38	71.97	-422.253	-286.480	38.648
1620	75.550	118.61	71.97	-400.823	-286.480	38.648
1700	80.200	121.41	74.23	-411.966	-280.559	36.068
1800	86.010	124.73	76.95	-410.744	-272.857	33.129

MELTING POINT	1620	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	21.430	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	1.1618	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MANGANESE.. ALPHA-BETA 990, BETA-GAMMA 1360, GAMMA-DELTA 1410, M. P. DELTA 1517 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 104 78 71 COMPILED 4-29-67

ZIRCON GRAM FORMULA WEIGHT 183.304

$ZrSiO_4$: Tetragonal crystals 298.15° to 2000°K. Note zircon decomposes to ZrO_2 and SiO_2 at approximately 1949°K.

TEMP. DEG K	H -H 298 T (KCAL)	S T (CAL/DEG-GFW)	-(G -H 298)/T T	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	20.08	20.08	---	---	---
UNCERTAINTY		0.30	0.30			
400	2.620	27.61	21.06	---	---	---
500	5.460	33.94	23.02	---	---	---
600	8.550	39.56	25.31	---	---	---
700	11.800	44.58	27.73	---	---	---
800	15.180	49.09	30.12	---	---	---
900	18.640	53.16	32.45	---	---	---
1000	22.140	56.85	34.71	---	---	---
1100	25.670	60.21	36.88	---	---	---
1200	29.220	63.30	38.95	---	---	---
1300	32.790	66.16	40.94	---	---	---
1400	36.380	68.82	42.84	---	---	---
1500	39.990	71.31	44.65	---	---	---
1600	43.630	73.66	46.39	---	---	---
1700	47.290	75.88	48.07	---	---	---
1800	50.980	77.99	49.67	---	---	---
1900	54.690	79.99	51.21	---	---	---
2000	58.420	81.90	52.69	---	---	---

MELTING POINT DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 3.562 KCAL MOLAR VOLUME 0.93834 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

SILICON.... M. P. 1685 DEG K.
ZIRCONIUM.. ALPHA-BETA 1143.2, M. P. BETA 2128.2 DEG K.

REFERENCES 74 78 148

COMPILED 4-15-67

WOLLASTONITE GRAM FORMULA WEIGHT 116.164

$CaSiO_3$: Crystals 298.15° to 1400°K. Pseudowollastonite is the stable phase above 1398°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	19.60	19.60	-390.640	-370.263	271.410
UNCERTAINTY		0.20	0.20	0.870	0.880	0.645
400	2.300	26.21	20.46	-390.592	-363.302	198.499
500	4.780	31.74	22.18	-390.439	-356.499	155.825
600	7.390	36.49	24.17	-390.259	-349.726	127.387
700	10.140	40.72	26.23	-390.032	-342.983	107.084
800	13.000	44.54	28.29	-389.810	-336.282	91.868
900	15.890	47.94	30.28	-389.591	-329.599	80.037
1000	18.810	51.02	32.21	-389.441	-322.935	70.577
1100	21.770	53.84	34.05	-389.339	-316.294	62.842
1200	24.800	56.48	35.81	-390.987	-309.529	56.373
1300	27.880	58.94	37.49	-390.584	-302.743	50.896
1400	31.000	61.25	39.11	-390.158	-296.008	46.209

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.95435 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 74 78 152 16 COMPILED 4-29-67

PSEUDOWOLLASTONITE GRAM FORMULA WEIGHT 116.164

$CaSiO_3$: Crystals 298.15° to melting point 1817°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	20.90	20.90	-389.070	-369.081	270.543
UNCERTAINTY		0.20	0.20	0.620	0.630	0.462
400	2.290	27.49	21.76	-389.032	-362.254	197.926
500	4.710	32.88	23.46	-388.939	-355.569	155.419
600	7.330	37.66	25.44	-388.749	-348.918	127.093
700	10.040	41.83	27.49	-388.562	-342.290	106.867
800	12.840	45.57	29.52	-388.400	-335.696	91.708
900	15.710	48.94	31.48	-388.201	-329.109	79.918
1000	18.630	52.02	33.39	-388.051	-322.545	70.492
1100	21.590	54.84	35.21	-387.949	-316.004	62.784
1200	24.580	57.45	36.97	-389.637	-309.343	56.339
1300	27.610	59.87	38.63	-389.284	-302.652	50.880
1400	30.690	62.15	40.23	-388.898	-296.008	46.209
1500	33.810	64.31	41.77	-388.489	-289.396	42.165
1600	36.970	66.34	43.23	-388.054	-282.805	38.629
1700	40.170	68.28	44.65	-399.663	-276.136	35.500

MELTING POINT	1817 DEG K	BOILING POINT	DEG K
HEAT OF FUSION	6.550 KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.95794 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES	74	78	75	COMPILED 4-29-67

CALCIUM-ALUMINUM PYROXENE GRAM FORMULA WEIGHT 218.125

$CaAl_2SiO_6$: Crystals 298.15° to 1700°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	34.60	34.60	-786.984	-745.130	546.194
UNCERTAINTY		0.80	0.80	0.660	0.710	0.520
400	4.437	47.35	36.26	-787.105	-731.016	399.408
500	9.287	58.16	39.58	-786.941	-716.739	313.286
600	14.523	67.70	43.50	-786.585	-702.737	255.971
700	19.980	76.10	47.56	-786.188	-688.787	215.048
800	25.618	83.63	51.61	-785.819	-674.905	184.375
900	31.395	90.43	55.54	-785.458	-661.052	160.525
1000	37.274	96.19	58.92	-790.256	-646.440	141.279
1100	43.234	102.30	63.00	-789.930	-632.554	125.677
1200	49.257	107.55	66.50	-791.375	-618.137	112.578
1300	55.345	112.42	69.85	-790.766	-603.710	101.493
1400	61.504	116.98	73.05	-790.115	-589.351	92.002
1500	67.720	121.28	76.13	-789.434	-575.045	83.784
1600	73.990	125.31	79.07	-788.723	-560.774	76.598
1700	80.310	129.15	81.90	-800.053	-546.445	70.250

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	KCAL	MOLAR VOLUME 1.5176	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 163	57	57	COMPILED 4-29-67

DIOPSIDE GRAM FORMULA WEIGHT 216.560

$CaMg(SiO_3)_2$: Crystals 298.15° to melting point 1664°K

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H T 298)/T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	34.20	34.20	-767.390	-725.784	532.012
UNCERTAINTY		0.20	0.20	2.180	2.190	1.605
400	4.320	46.61	35.81	-767.545	-711.533	388.763
500	8.940	56.90	39.02	-767.534	-697.528	304.888
600	14.060	66.24	42.81	-767.214	-683.562	248.987
700	19.540	74.66	46.75	-766.709	-669.642	209.071
800	25.420	82.52	50.74	-765.992	-655.841	179.167
900	31.340	89.48	54.66	-765.335	-642.093	155.921
1000	37.280	95.74	58.46	-766.953	-628.241	137.302
1100	43.250	101.43	62.11	-766.518	-614.389	122.068
1200	49.250	106.65	65.61	-767.894	-600.454	109.357
1300	55.300	111.49	68.95	-767.239	-586.512	98.601
1400	61.440	116.04	72.15	-796.872	-571.815	89.264
1500	67.660	120.34	75.23	-795.830	-555.799	80.980
1600	73.980	124.41	78.17	-794.718	-539.840	73.738

MELTING POINT	1664	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	18.500	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	1.5795	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 74 78 95 116 COMPILED 4-29-67

CLINOENSTATITE GRAM FORMULA WEIGHT 100.396

$MgSiO_3$: Crystals 298.15° to melting point 1830°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	16.22	16.22	-370.140	-349.394	256.112
UNCERTAINTY		0.10	0.10	0.440	0.450	0.330
400	2.140	22.38	17.03	-370.223	-342.293	187.020
500	4.480	27.59	18.63	-370.164	-335.314	146.565
600	6.980	32.14	20.51	-370.035	-328.350	119.601
700	9.600	36.17	22.46	-369.867	-321.411	100.349
800	12.300	39.77	24.39	-369.692	-314.500	85.917
900	15.090	43.06	26.29	-369.494	-307.612	74.698
1000	17.970	46.09	28.12	-371.401	-300.565	65.688
1100	20.910	48.89	29.88	-371.139	-293.485	58.310
1200	23.890	51.49	31.58	-370.857	-286.459	52.171
1300	26.890	53.88	33.20	-370.574	-279.418	46.974
1400	29.910	56.12	34.76	-400.633	-271.589	42.397
1500	32.940	58.22	36.26	-400.071	-262.418	38.234
1600	35.970	60.17	37.69	-399.523	-253.255	34.593
1700	39.010	62.01	39.06	-411.049	-244.020	31.371
1800	42.060	63.75	40.38	-410.440	-234.205	28.436

MELTING POINT	1830 DEG K		BOILING POINT		DEG K
HEAT OF FUSION	14.700 KCAL		HEAT OF VAPOR.		KCAL
H -H 298 0	2.895 KCAL		MOLAR VOLUME	0.75215	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 74 78 153 COMPILED 4-29-67

RHODONITE GRAM FORMULA WEIGHT 131.022

$MnSiO_3$: Crystals 298.15° to melting point 1564°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	24.50	24.50	-315.620	-297.390	217.992
UNCERTAINTY		0.50	0.50	0.470	0.500	0.367
400	2.300	31.12	25.37	-315.612	-291.162	159.083
500	4.800	36.69	27.09	-315.449	-285.064	124.601
600	7.430	41.48	29.10	-315.329	-279.074	101.652
700	10.200	45.75	31.18	-315.022	-272.985	85.229
800	13.070	49.58	33.24	-314.775	-266.999	72.941
900	15.970	52.99	35.25	-314.571	-261.032	63.387
1000	18.890	56.07	37.18	-314.936	-255.090	55.750
1100	21.850	58.90	39.04	-314.779	-249.115	49.494
1200	24.870	61.52	40.80	-314.582	-243.156	44.285
1300	27.950	63.98	42.48	-314.359	-237.204	39.877
1400	31.090	66.31	44.10	-314.678	-231.266	36.102
1500	34.300	68.53	45.66	-314.999	-225.311	32.828

MELTING POINT	1564 DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME	0.84034 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MANGANESE.. ALPHA-BETA 990, BETA-GAMMA 1360, GAMMA-DELTA 1410, M. P. DELTA 1517 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 74 132 82 COMPILED 4-29-67

JADEITE GRAM FORMULA WEIGHT 202.140

$NaAl(SiO_3)_2$: Crystals 298.15° to 1200°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	31.90	31.90	-719.871	-677.206	496.404
UNCERTAINTY		0.30	0.30	1.000	1.010	0.740
400	4.250	44.10	33.47	-720.791	-662.633	362.045
500	8.970	54.62	36.68	-720.728	-647.958	283.221
600	14.040	63.86	40.46	-720.447	-633.433	230.727
700	19.360	72.05	44.39	-720.034	-618.959	193.247
800	24.860	79.39	48.31	-719.552	-604.551	165.155
900	30.490	86.02	52.14	-719.056	-590.205	143.321
1000	36.240	92.08	55.84	-721.070	-575.720	125.823
1100	42.120	97.68	59.39	-720.440	-561.213	111.502
1200	48.160	102.94	62.81	-742.935	-546.323	99.499

MELTING POINT	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	KCAL	MOLAR VOLUME	1.4435	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
SODIUM..... M. P. 370.98, B. P. 1176.9 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES	74	78	165 96	COMPILED 4-29-67

TREMOLITE GRAM FORMULA WEIGHT 812.409

$Ca_2Mg_5Si_8O_{22}(OH)_2$: Crystals 298.15° to 1100°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H T 298)/T (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	131.19	131.19	-2952.935	-2779.137	2037.157
UNCERTAINTY		0.30	0.30	4.140	4.150	3.042
400	17.375	181.14	137.70	-2953.488	-2719.647	1485.942
500	36.516	223.75	150.72	-2952.751	-2661.239	1163.223
600	57.054	261.13	166.04	-2951.329	-2603.034	948.152
700	78.638	294.44	182.10	-2949.511	-2545.161	794.633
800	101.089	324.43	198.07	-2947.470	-2487.580	679.573
900	124.309	351.74	213.62	-2945.105	-2430.170	590.124
1000	148.241	376.93	228.69	-2953.240	-2372.150	518.432
1100	172.847	400.35	243.22	-2950.360	-2314.120	459.772

MELTING POINT		DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	23.338	KCAL	MOLAR VOLUME	6.5229	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 132 137 169 COMPILED 4-29-67

ANORTHITE GRAM FORMULA WEIGHT 278.210

$CaAl_2Si_2O_8$: Crystals 298.15° to melting point 1825°K.

TEMP. DEG K	H -H 298 (KCAL)	S (CAL/DEG-GFW)	-(G -H)/T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	48.45	48.45	-1009.300	-955.626	700.491
UNCERTAINTY		0.30	0.30	1.150	1.160	0.850
400	5.570	64.47	50.54	-1009.528	-937.460	512.203
500	11.750	78.23	54.73	-1009.311	-919.188	401.776
600	18.450	90.44	59.69	-1008.818	-901.214	328.266
700	25.410	101.16	64.86	-1008.287	-883.317	275.783
800	32.570	110.72	70.01	-1007.800	-865.506	236.444
900	39.910	119.35	75.01	-1007.310	-847.733	205.857
1000	47.430	127.28	79.85	-1011.924	-829.650	181.319
1100	55.130	134.62	84.50	-1011.336	-811.459	161.222
1200	62.970	141.44	88.96	-1012.458	-793.184	144.458
1300	70.930	147.80	93.24	-1011.486	-774.930	130.277
1400	79.050	153.82	97.36	-1010.396	-756.783	118.139
1500	87.450	159.62	101.32	-1009.066	-738.733	107.633
1600	96.170	165.24	105.13	-1007.452	-720.770	98.452
1700	105.230	170.73	108.83	-1029.670	-702.699	90.338

MELTING POINT 1825 DEG K BOILING POINT DEG K

HEAT OF FUSION KCAL HEAT OF VAPOR. KCAL

H -H 298 0 KCAL MOLAR VOLUME 2.4089 CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
CALCIUM.... ALPHA-BETA 737, M. P. BETA 1123, B. P. 1756 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 74 78 6 72 COMPILED 4-29-67

MICROCLINE GRAM FORMULA WEIGHT 278.337

$KAlSi_3O_8$: Crystals 298.15° to 1400°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	52.47	52.47	-946.265	-892.817	654.451
UNCERTAINTY		0.80	0.80	0.930	0.970	0.711
400	5.500	68.28	54.53	-947.146	-874.504	477.805
500	11.550	81.76	58.66	-947.032	-856.210	374.248
600	17.950	93.42	63.50	-946.753	-838.073	305.267
700	24.800	103.97	68.54	-946.189	-820.001	256.015
800	32.000	113.58	73.58	-945.428	-802.026	219.103
900	39.400	122.29	78.51	-944.618	-784.144	190.416
1000	46.900	130.19	83.29	-946.370	-766.150	167.441
1100	54.500	137.44	87.89	-964.439	-747.152	148.445
1200	62.200	144.14	92.31	-963.325	-727.454	132.487
1300	70.000	150.37	96.52	-962.164	-707.836	118.998
1400	77.900	156.23	100.59	-960.950	-688.315	107.451

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	KCAL	MOLAR VOLUME 2.5984	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
POTASSIUM.. M. P. 336.4, B. P. 1043.7 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 167 187 166 COMPILED
79 168 5-18-67

HIGH-SANIDINE GRAM FORMULA WEIGHT 278.337

$KAlSi_3O_8$: Crystals 298.15° to melting point 1473°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	56.94	56.94	-944.378	-892.263	654.045
UNCERTAINTY		1.00	1.00	0.930	0.980	0.718
400	5.500	72.75	59.00	-945.259	-874.405	477.751
500	11.550	86.23	63.13	-945.145	-856.558	374.400
600	17.950	97.89	67.97	-944.866	-838.868	305.557
700	24.800	108.44	73.01	-944.302	-821.243	256.403
800	32.000	118.05	78.05	-943.541	-803.715	219.564
900	39.400	126.76	82.98	-942.731	-786.280	190.934
1000	46.900	134.66	87.76	-944.483	-768.733	168.006
1100	54.500	141.91	92.36	-962.552	-750.182	149.047
1200	62.200	148.61	96.78	-961.438	-730.931	133.120
1300	70.000	154.84	100.99	-960.277	-711.760	119.657
1400	77.900	160.70	105.06	-959.063	-692.686	108.133

MELTING POINT	1473	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	14.702	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	2.6063	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
POTASSIUM.. M. P. 336.4, B. P. 1043.7 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 167	148	166	COMPILED
	167		4-15-67

ADULARIA GRAM FORMULA WEIGHT 278.337

$KAlSi_3O_8$: Crystals 298.15° to 1400°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	55.99	55.99	-945.000	-892.602	654.293
UNCERTAINTY		1.00	1.00	1.200	1.240	0.909
400	5.500	71.80	58.05	-945.881	-874.647	477.883
500	11.550	85.28	62.18	-945.767	-856.705	374.464
600	17.950	96.94	67.02	-945.488	-838.920	305.576
700	24.800	107.49	72.06	-944.924	-821.200	256.389
800	32.000	117.10	77.10	-944.163	-803.577	219.527
900	39.400	125.81	82.03	-943.353	-786.047	190.878
1000	46.900	133.71	86.81	-945.105	-768.405	167.934
1100	54.500	140.96	91.41	-963.174	-749.759	148.963
1200	62.200	147.66	95.83	-962.060	-730.413	133.026
1300	70.000	153.89	100.04	-960.899	-711.147	119.554
1400	77.900	159.75	104.11	-959.685	-691.978	108.022

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 2.5881	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
POTASSIUM.. M. P. 336.4, B. P. 1043.7 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 74 167 79 44 COMPILED 4-15-67

KALSI3O8 GLASS GRAM FORMULA WEIGHT 278.337

$KAlSi_3O_8$: Glass 298.15° to 1400°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	63.28	63.28	-933.276	-883.051	647.292
UNCERTAINTY		1.00	1.00	0.910	0.960	0.704
400	5.542	79.20	65.35	-934.115	-865.841	473.072
500	11.743	93.01	69.53	-933.850	-848.655	370.946
600	18.341	105.03	74.47	-933.373	-831.662	302.932
700	25.391	115.89	79.62	-932.609	-814.767	254.381
800	32.772	125.74	84.78	-931.667	-797.997	218.002
900	40.331	134.64	89.83	-930.698	-781.342	189.735
1000	47.988	142.71	94.72	-932.293	-764.591	167.101
1100	55.783	150.14	99.43	-950.167	-746.854	148.386
1200	63.777	157.10	103.95	-948.759	-728.438	132.666
1300	72.049	163.70	108.28	-947.126	-710.133	119.384
1400	80.702	170.12	112.48	-945.159	-691.972	108.021

MELTING POINT	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	KCAL	MOLAR VOLUME	2.7844	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
POTASSIUM.. M. P. 336.4, B. P. 1043.7 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 166	166	166	COMPILED
	167		4-15-67

LOW-ALBITE GRAM FORMULA WEIGHT 262.224

$NaAlSi_3O_8$: Crystals 298.15° to 1400°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	50.20	50.20	-937.146	-883.988	647.979
UNCERTAINTY		0.40	0.40	0.740	0.760	0.557
400	5.410	65.75	52.22	-938.146	-865.822	473.062
500	11.390	79.07	56.29	-938.100	-847.598	370.484
600	17.900	90.93	61.10	-937.706	-829.536	302.158
700	24.690	101.40	66.13	-937.192	-811.555	253.378
800	31.690	110.74	71.13	-936.614	-793.643	216.813
900	38.870	119.19	76.00	-936.002	-775.802	188.390
1000	46.220	126.94	80.72	-937.873	-757.839	165.625
1100	53.720	134.08	85.24	-937.101	-739.866	146.997
1200	61.340	140.71	89.59	-959.510	-721.521	131.407
1300	69.060	146.89	93.77	-958.429	-701.740	117.973
1400	76.860	152.67	97.77	-957.315	-682.027	106.469

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 2.3917	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
SODIUM..... M. P. 370.98, B. P. 1176.9 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 74 79 166 COMPILED 4-15-67

HIGH-ALBITE GRAM FORMULA WEIGHT 262.224

$NaAlSi_3O_8$: Crystals 298.15° to 1400°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	54.67	54.67	-934.513	-882.687	647.025
UNCERTAINTY		0.45	0.45	0.770	0.790	0.579
400	5.530	70.56	56.74	-935.393	-864.995	472.610
500	11.627	84.14	60.89	-935.230	-847.263	370.338
600	18.254	96.21	65.78	-934.719	-829.715	302.223
700	25.162	106.85	70.90	-934.087	-812.264	253.600
800	32.279	116.33	75.99	-933.392	-794.897	217.155
900	39.576	124.91	80.94	-932.663	-777.614	188.830
1000	47.044	132.78	85.73	-934.416	-760.220	166.145
1100	54.661	140.02	90.33	-933.527	-742.824	147.585
1200	62.398	146.74	94.74	-955.819	-725.067	132.052
1300	70.236	153.01	98.98	-954.620	-705.882	118.669
1400	78.153	158.86	103.04	-953.389	-686.773	107.210

MELTING POINT	1391	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	13.560	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	2.4003	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
SODIUM..... M. P. 370.98, B. P. 1176.9 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 62	168	166	COMPILED
	167		4-15-67

NAALSI3O8 GLASS GRAM FORMULA WEIGHT 262.224

$NaAlSi_3O_8$: Glass 298.15° to 1400°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	62.95	62.95	-922.609	-873.252	640.109
UNCERTAINTY		0.60	0.60	0.760	0.790	0.579
400	5.468	78.66	64.99	-923.551	-856.393	467.910
500	11.536	92.08	69.01	-923.417	-839.419	366.909
600	18.167	104.26	73.98	-922.902	-822.730	299.678
700	25.118	114.98	79.09	-922.227	-806.093	251.673
800	32.321	124.59	84.19	-921.446	-789.552	215.695
900	39.751	133.33	89.16	-920.584	-773.110	187.736
1000	47.400	141.40	94.00	-922.156	-756.578	165.350
1100	55.254	148.87	98.64	-921.030	-740.066	147.037
1200	63.286	155.86	103.12	-943.027	-723.219	131.716
1300	71.480	162.42	107.44	-941.472	-704.972	118.516
1400	79.820	168.60	111.59	-939.818	-686.832	107.219

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 2.6311	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
SODIUM..... M. P. 370.98, B. P. 1176.9 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 166 168 166 COMPILED 4-29-67

NEPHELINE GRAM FORMULA WEIGHT 142.055

$NaAlSiO_4$: Crystals 298.15° to 1521°K. Carnegieite is the stable phase above 1521°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	29.72	29.72	-497.029	-469.664	344.272
UNCERTAINTY		0.30	0.30	1.000	1.010	0.740
400	3.095	38.62	30.88	-497.864	-460.339	251.517
500	6.280	46.93	34.37	-498.059	-451.401	197.307
600	10.420	53.49	36.12	-497.381	-441.543	160.832
700	14.150	59.23	39.02	-497.189	-432.247	134.953
800	18.000	64.37	41.87	-496.953	-422.987	115.554
900	21.970	69.05	44.64	-496.683	-413.761	100.475
1000	26.050	73.34	47.29	-498.910	-404.364	88.373
1100	30.370	77.46	49.85	-498.362	-394.941	78.467
1200	35.050	81.53	52.32	-520.723	-385.121	70.140
1300	39.330	84.96	54.71	-520.064	-373.854	62.850
1400	43.620	88.14	56.98	-519.416	-362.630	56.609
1500	47.920	91.11	59.16	-518.778	-351.471	51.209

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
$H_{298} - H_0$	KCAL	MOLAR VOLUME 1.2944	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
SODIUM..... M. P. 370.98, B. P. 1176.9 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 74 78 165 COMPILED 4-15-67

MUSCOVITE GRAM FORMULA WEIGHT 398.313

$KAl_2[AlSi_3O_{10}](OH)_2$: Crystals 298.15° to 1500°K.

TEMP. DEG K	H -H 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H 298)/T	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	69.00	69.00	-1421.180	-1330.103	974.989
UNCERTAINTY		0.70	0.70	1.300	1.320	0.968
400	8.670	93.91	72.23	-1422.266	-1299.103	709.795
500	18.340	115.44	78.76	-1421.955	-1267.921	554.206
600	28.770	134.45	86.50	-1421.174	-1237.193	450.646
700	39.660	151.23	94.57	-1420.198	-1206.604	376.718
800	50.910	166.24	102.60	-1419.123	-1176.162	321.312
900	62.520	179.91	110.44	-1417.967	-1145.857	278.251
1000	74.490	192.52	118.03	-1424.287	-1115.119	243.708
1100	86.785	204.23	125.34	-1441.583	-1083.255	215.222
1200	99.382	215.19	132.37	-1439.520	-1050.773	191.371
1300	112.272	225.51	139.14	-1437.243	-1018.475	171.221
1400	125.449	235.27	145.66	-1434.752	-986.342	153.974
1500	138.909	244.55	151.95	-1432.050	-954.438	139.061

MELTING POINT	DEG K	BOILING POINT	DEG K
HEAT OF FUSION	KCAL	HEAT OF VAPOR.	KCAL
H -H 298 0	KCAL	MOLAR VOLUME 3.3630	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
POTASSIUM.. M. P. 336.4, B. P. 1043.7 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 119 177 9 125 COMPILED 2-12-67

FLUORPHLOGOPITE GRAM FORMULA WEIGHT 421.268

$KMg_3[AlSi_3O_{10}]F_2$: Crystals 298.15° to melting point 1670°K.

Liquid 1670° to 1800°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY	LOG K
298.15	0.000	75.90	75.90	-1522.020	-1439.522	1055.195
UNCERTAINTY		0.50	0.50	1.200	1.210	0.887
400	8.930	101.58	79.25	-1522.842	-1411.286	771.089
500	18.680	123.31	85.95	-1522.483	-1383.300	604.638
600	29.030	142.17	93.79	-1521.839	-1355.514	493.744
700	39.810	158.78	101.91	-1521.056	-1327.852	414.573
800	50.870	173.54	109.95	-1520.265	-1300.315	355.229
900	62.150	186.83	117.77	-1519.518	-1272.855	309.091
1000	73.630	198.92	125.29	-1527.753	-1244.763	272.042
1100	85.300	210.04	132.49	-1545.823	-1215.457	241.488
1200	97.170	220.37	139.39	-1544.624	-1185.516	215.911
1300	109.240	230.03	146.00	-1543.293	-1155.628	194.278
1400	121.510	239.12	152.33	-1632.855	-1123.367	175.365
1500	133.980	247.72	158.40	-1630.390	-1087.092	158.389
1600	146.650	255.90	164.24	-1627.777	-1050.977	143.556
1670	155.620	261.39	168.20	-1625.844	-1025.809	134.245
1670	229.420	305.58	168.20	-1552.044	-1025.809	134.245
1700	234.350	308.50	170.65	-1586.391	-1016.026	130.619
1800	250.740	317.87	178.57	-1579.945	-982.658	119.311

MELTING POINT	1670	DEG K	BOILING POINT		DEG K
HEAT OF FUSION	73.800	KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0		KCAL	MOLAR VOLUME	3.4983	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

ALUMINUM... M. P. 933 DEG K.
POTASSIUM.. M. P. 336.4, B. P. 1043.7 DEG K.
MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.
SILICON.... M. P. 1685 DEG K.

REFERENCES 74 78 77 COMPILED 3-31-67

TALC GRAM FORMULA WEIGHT 379.289

$Mg_3Si_4O_{10}(OH)_2$: Crystals 298.15° to 1100°K.

TEMP. DEG K	H -H T 298 (KCAL)	S T (CAL/DEG-GFW)	-(G -H)/T T 298 (CAL/DEG-GFW)	FORMATION FROM THE ELEMENTS ENTHALPY (KCAL/GFW)	FREE ENERGY (KCAL/GFW)	LOG K
298.15	0.000	62.34	62.34	-1415.205	-1324.486	970.871
UNCERTAINTY		0.15	0.15	1.710	1.720	1.261
400	8.561	86.94	65.54	-1415.622	-1293.412	706.686
500	17.997	107.97	71.98	-1415.372	-1262.882	552.004
600	28.148	126.46	79.55	-1414.737	-1232.432	448.912
700	38.889	143.01	87.45	-1413.812	-1202.119	375.317
800	50.152	158.03	95.34	-1412.633	-1171.957	320.163
900	61.903	171.87	103.09	-1411.211	-1141.942	277.301
1000	74.121	184.75	110.63	-1415.944	-1111.578	242.935
1100	86.793	195.81	116.91	-1413.928	-1080.098	214.595

MELTING POINT		DEG K	BOILING POINT		DEG K
HEAT OF FUSION		KCAL	HEAT OF VAPOR.		KCAL
H -H 298 0	11.206	KCAL	MOLAR VOLUME	3.2564	CAL/BAR

TRANSITIONS IN REFERENCE STATE ELEMENTS

MAGNESIUM.. M. P. 922, B. P. 1363 DEG K.
SILICON.... M. P. 1685 DEG K.

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