THERMODYNAMIC PROPERTIES OF THE ELEMENTS

Tabulated values of the heat capacity, heat content, entropy, and free energy function of the solid, liquid, and gas states of the first 92 elements are given for the temperature range 298° to 3000°K. Auxiliary data include temperatures and heats of transition, melting, and vaporization and vapor pres-Literature sources are listed. The published sures. values have been analyzed and are supplemented by estimates when experimental data are lacking. With the aim of providing the basic data for the elements needed in the calculation of the thermodynamic properties of chemical compounds, the tables were compiled by D. R. Stull and G. C. Sinke at the Thermal Laboratory of the Dow Chemical Co. These up to date tables especially fill the need for data in the increasingly important high temperature region.



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Preface

Preparation of consistent tabulations of thermodynamic data is a difficult task because of the complex interrelations of the data. One new set of data can require changes in numerous related values. For inorganic thermodynamic compilations, the logical starting point is a reliable tabulation of data for the elements. If data for compounds are to be compared, they must be based on the same elemental data. Once the thermodynamic data for the elements have been fixed, then equilibria involving the elements and compounds can be treated to fix the stability of the compounds. When the heats of sublimation and ionization of the elements are available, Born-Haber cycle calculations can be carried out for ionic compounds to check the reliability of data for the compounds.

The present tables are thus an important step in the preparation of complete thermodynamic tables for inorganic compounds at high temperatures. Because of recognition of the importance of data for the elements, there has been a great upsurge in experimental work on the elements during the last decade. The availability of large calculating machines has made the calculation of gaseous thermodynamic data from spectroscopic data almost routine. In particular, there has been a great deal of work on the determination of vapor pressures and heats of sublimation of the elements. In view of these recent developments, the present compilation is greatly improved over similar previous work, and is the first complete compilation for the elements at closely spaced temperature intervals.

The authors have chosen 298.15° K. instead of the conventional 0° K. as the standard reference temperature for preparation of free energy function tables. 0° K. is the most logical reference temperature for calculating thermodynamic functions from spectroscopic data. However, most heats of formation of condensed phases are given at 25° C. or 298.15° K. and data are often lacking for converting to 0° K. Whenever data are available for calculating thermodynamic functions using the 0° K. reference temperature, data are also available for converting to the 298.15° K., but the reverse is not always true. Thus, for high temperature thermodynamic calculations, 298.15° K. is a more convenient reference temperature. Inasmuch as it will be necessary to combine the $(F^{\circ} - H_{298}^{\circ})/T$ functions given here for the elements with $(F^{\circ} - H_{0}^{\circ})/T$ functions given elsewhere for compounds, the authors have provided the $(H_{298}^{\circ} - H_{0}^{\circ})$ values that will allow conversion from one reference temperature to the other.

It is perhaps regrettable that the authors have not elected to attempt the difficult task of assigning uncertainties to the data, particularly the heats of sublimation. Often, differences between thermodynamic quantities are known with much higher accuracy than the absolute values are known. Thus, it is frequently necessary to retain many figures beyond the last significant figure to retain the accuracy of the relative values. However, when no indication of the absolute accuracy is given, the person using the tables can be deceived by the number of figures presented. It is important to know the limitations of the calculations that one is making. Some of the heats of sublimation given in the tabulations are uncertain enough to cause uncertainties in the calculated vapor

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pressures by as much as a factor of 2, and in some instances by a factor of 10. It is difficult to assign uncertainties because the uncertainty is usually not due to random error in the determinations but often to unknown systematic errors. The compiler must, from his experience with the technique used, his appraisal of the experimenters, and possible checks with theoretical or empirical rules, try to guess the odds by which the values he listed may be off by a given amount. Although difficult, it is important to try to do this.

Because of the recent change in the temperature scale, as well as changes in the best values for the fundamental constants, thermodynamic tabulations from different sources are not quite consistent. These differences are usually negligible from the practical point of view, but they can be annoying when thermodynamic calculations are being checked for arithmetic errors, because different ways of carrying out the calculations will give slightly different answers. The change due to the change in the temperature scale and the resulting change in R is 1 in 27,000, and should be kept in mind when the values in this tabulation are combined with values from earlier tabulations based on the old temperature scale. Also, the values used for h, k, and N have fluctuated in recent years and the values used in this compilation are probably not the ones that will be generally accepted in the future. Here again, the corrections are nuisance corrections rather than significant ones, but it appears likely that the data tabulated in these tables for gaseous elements will have to be recalculated for complete consistency with future tabulations when general agreement has been reached on the values of h, k, and N, as well as the ratio of the physical and chemical atomic weight scales. Fortunately, the modern calculating machines make this chore relatively easy.

A word should be said about the use of these tables in evaluating vapor pressure data or in calculating vapor pressures from the heats of sublimation. Because of the difficulty in obtaining accurate temperature coefficients, the calculation of heats of sublimation or vaporization from the temperature coefficient of the vapor pressure is often not reliable. When entropies are known and free energy functions are available, the preferred method of treating the data is to calculate the heat of vaporization or sublimation from each vapor pressure by means of the relationship, $\Delta H_{298}^o = T [\Delta F^o/T - (\Delta F^o - \Delta H_{298}^o)/T]$, where the function $(\Delta F^o - \Delta H_{298}^o)/T$ is tabulated in the tables and $\Delta F^o/T$ is obtained from the equation $\Delta F^o/T = -RT \ln P$. If the data have no serious temperature-dependent errors, the values of ΔH_{298}^o derived from data at different temperatures will show no trend with temperature. However, a reasonably good value can still be obtained from the average ΔH_{298}^o , whereas the temperature coefficient of the vapor pressure would yield a heat greatly in error.

Because the heats of sublimation and vapor pressures are related through the free energy functions, it is important that they be used consistently. Heats of sublimation derived through the use of free energy functions in other tabulations should not be used with the tables given here. Comparison of the data in this compilation with those in other compilations will show differences in the tabulated values, even though the same original data were treated, because of different methods of preparation of the free energy functions. In spite of the differences between tabulated heats of sublimation and free energy functions in different tables, the original data can be reproduced from either set if the heat of sublimation is used together with the free energy function that was used to obtain it.

Likewise, the heat capacity values tabulated in the present compilation may appear different from those of other compilations, even when the original data are the same. This is due to the fact that the original measurements are usually heat content measurements at high temperatures and the accuracy of the heat content measurements is not sufficient to allow the temperature dependence to be fixed explicitly. Different people assume different functions to represent the temperature variation of the heat content or heat capacity. For example, some prefer to take an average constant heat capacity to represent data for a limited liquid range. Others will assume a linear variation with temperature with some relationship between the two coefficients of the heat capacity equation.

Clearly, the user of any thermodynamic tables must become familiar with the tables and the interrelationships of the data if he plans to make extensive use of the values. Moreover, he must not use them blindly. The actual numbers tabulated for the different thermodynamic functions are not so significant as the final equilibrium constants that are to be calculated from them. These tables are designed to yield equilibrium constants of as high an accuracy as can be obtained from the available data. Thus, the uncertainty of a given heat of sublimation may be considerably smaller in regard to its use for calculation of vapor pressures than in regard to its use for heat balance calculations.

The above considerations point out the importance of having all thermodynamic tables prepared in a consistent way, preferably by a single group. New data are being obtained at a rapid rate and it is important to have some permanent staff of experienced people providing continuous revisions, either through use of loose-leaf additions or through lists of revised values. The National Bureau of Standards has made a start in this direction with the publication of Series I and II of their thermodynamic compilations in Circular Since the publication of Circular 500, however, the NBS group appears **500**. to have lost its momentum; work on Series III, the high temperature compilation, seems to have come to a halt except for some tabulations published in the Journal of Research of the National Bureau of Standards. The job of obtaining a complete tabulation of all available data is such an enormous one that no single group could hope to do it adequately. It is to be hoped that many groups will contribute by tabulating data in their fields of interest so that the first stage of a complete compilation can be achieved. Then it might be possible for the National Bureau of Standards to keep these tables up to date, but even this would require much more adequate staffing and support.

In many instances, estimates were necessary to carry out the calculations. Even for the elements a surprising amount of experimental data are necessary to put the tables on a firmer basis. It is hoped that research workers will take note of these gaps and endeavor to fill them when they have the equipment and materials on hand. Thermodynamics can be an extremely powerful tool, but its edge is severely blunted when the fundamental starting data are lacking. Berkeley, California LEO BREWER August, 1956

Introduction

RECENT YEARS have seen a considerable widening of the scope of chemical technology. Elements previously neglected or unavailable have become important as fission products in atomic reactors. The search for materials possessing the unusual properties needed for applications in atomic energy, aircraft, electronics, and many other industries has raised laboratory curiosities to quantity production status. Higher and higher temperatures are being used in routine chemical operations, with the prospect of high temperature process heat from atomic energy increasing the attractiveness of this field. Along with the broadened horizon of technology has come a growing recognition of chemical thermodynamics as a useful research and engineering tool. When accurate data are available, a screening program based on thermodynamic calculations frequently points out the most favorable approach to the production of the elements and their compounds. Even estimates can sometimes indicate the most promising of the available routes or the most suitable material for a particular purpose.

Examples of thermodynamic calculations are discussed by Kelley (181, 183, 184) (italic numbers in parentheses refer to the bibliography on page 227) in his pioneer bulletins on practical applications of thermodynamics. Other examples are detailed by Brewer and coworkers (36). More recently, Margrave (222) has presented the advantages of the free energy function in thermodynamic calculations. In the hydrocarbon field, representative papers by Rossini and coworkers (103, 189, 339) demonstrate the value of thermodynamics for the petroleum industry.

In order to make thermodynamic data for chemical compounds consistent and directly comparable, values for the heats and free energies of formation must all refer to a single set of data for each element. It was to provide such a set of data for the temperature range from 298° to 3000° K. that this project was undertaken. The choice of a reference state for any particular element is somewhat arbitrary, but we believe the most practical choice is that of the condensed state up to the temperature at which the vapor pressure of the element reaches one atmosphere and the ideal gas state above this temperature. We have therefore elected to use the crystalline solid from room temperature to the melting point at one atmosphere, the liquid from the melting point to the normal boiling point, and the most representative ideal gaseous species in the temperature range from the normal boiling point to 3000° K. In two cases, arsenic and phosphorus, the vapor pressure of the solid reaches one atmosphere at a temperature below the melting point and the liquid is not used as a reference state for these elements.

Tables for this defined reference state, including the heat capacity, the heat content relative to 298.15° K., the absolute entropy, and the free energy function at even 100° intervals from 298.15° to 3000° K. have been assembled for the first 92 elements. These tables are arranged alphabetically beginning on page 36. The choice of 298.15° K. as the reference temperature is made because the low temperature heat capacities of many elements and compounds are not known. Most of the thermodynamic data now reported in the literature refer to 25° C., which, when combined with the recent international agreement on 273.15° K. for the ice point (319) gives a reference temperature of

appropriate temperature interval, while the nature of the phase change is easily deter-

298.15° K. The figure 298° K. quoted in the tables and text should be understood to be the reference temperature, 298.15° K. For those who prefer to use 0° K. as the reference temperature, we have included, for cases in which it is known, the heat content at 298.15° K. relative to 0° K. Changes in phase in the tables are indicated by lines drawn across the tables in the mined from the description of the reference state at the top of each table. The tables are based on 1 gram atomic weight of the element, except for hydrogen, oxygen, nitrogen, and the halogens, for which the more familiar diatomic form is used.

In addition to these reference state tables, we have tabulated the thermodynamic properties of all but a few of the ideal gaseous species over the entire range from 298.15° K. to 3000° K. These values can be readily calculated from molecular constant and spectroscopic data by methods described in standard texts (153, 225, 271). Pertinent data were mainly taken from the compilations of Moore (241), Herzberg (152), and Landolt-Bornstein Tabellen (208). Estimates were made for a few molecules for which spectroscopic data were not available.

At temperatures below the normal boiling point of an element, the heat and free energy of formation of these gaseous species refer to the process

$xE \text{ (condensed)} \rightarrow E_x \text{ (gas)}$

The equilibrium constant of this reaction is equal to the equilibrium pressure of the gaseous species E_x over the condensed state. The logarithm of the equilibrium constant of formation, given in the last column of these tables, is, therefore, identical with the logarithm of the partial pressure in atmospheres of the gaseous species E_x in the saturated vapor of the element E. The total vapor pressure of the element E is obtained by adding together the partial pressures of the various species which make up the vapor. In the frequent cases in which only the monatomic form is present, the vapor pressure is directly determined from the logarithm of the equilibrium constant of formation of the monatomic gas.

Above the normal boiling point, the heat and free energy of formation refer to the process

$$\frac{x}{y} E_y (\text{gas}) \to E_z (\text{gas})$$

in which E_{ν} is the gas species selected as the reference state and E_{x} is any other form of interest. The equilibrium constant in this case can be used to calculate the amount of each form present in the vapor, provided the saturation pressure of the element is not exceeded. The vapor density can be readily calculated from these data by considering the equilibria among the various gaseous species.

Upon examination of the tables, it will become evident that the gaseous reference state selected may not be the most stable state over the entire temperature range in which it is used. For example, our selection of ideal diatomic gas for the reference state of phosphorus is based on the fact that this form predominates in most of the temperature range from 704° to 3000° K. For a short range just above 704° K., however, the equilibrium constant of formation of the tetratomic form indicates that this form is more stable than the diatomic form. Similarly, monatomic chlorine is more stable than the reference state of diatomic chlorine at temperatures above 2100° K. Since the transition from one gaseous species to another takes place over a considerable temperature range, it is not possible to select a single species for these elements which is always the most stable. In order to keep an unambiguous expression for the equilibrium constant, however, it is necessary to use a single form for the reference state. When considering the equilibrium point of a reaction involving the reference state of an element, therefore, it may be necessary also to take into account the equilibrium between the reference state and other elemental gas species.

Sources and discussion of the data presented for each element begin on page 10. The elements are arranged alphabetically according to their names. In many cases, the tables for the condensed states represent an assemblage of information from previous exhaustive compilations, particularly those of Kelley (180, 182, 185, 186), Rossini and coworkers (274), and Brewer (35). We have searched the literature through 1955 in order to bring these compilations up to date. A considerable mass of new thermodynamic data is now available and it is believed that in many cases the present tables are an improvement. For some of the gaseous species, earlier calculations by Brewer (35) and by Katz and Margrave (173) agree in general with our values. Since our data are given at smaller temperature intervals, interpolation should be simplified. Several investigators have made their experimental information available to us in advance of publication and we express our gratitude to them. Comments and suggestions by readers of an earlier limited edition have been very helpful.

In spite of the diligent efforts of many able scientists, there are still many gaps in our knowledge of the thermodynamic properties of the elements. In cases where other workers have made reasonable estimates needed to fill these gaps we have used them, while in numerous instances we have made our own estimates. It is difficult to assess the reliability of these estimates and we have operated on the principle that an "educated guess" may be of some value. When experimental data are available we will be among the first to abandon our estimates.

We wish to thank the many coworkers who assisted in the assembling, computation, and printing of this report.

D. R. STULL AND G. C. SINKE

The Dow Chemical Co. Midland, Michigan July 1956

Physical Constants and Terminology

ATOMIC WEIGHTS

The values used are the 1953 international atomic weights published by Wichers (345) except for the 12 elements revised on recommendation of the Commission on Atomic Weights of the International Union of Pure and Applied Chemistry (101).

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Element	Symbol	Atomic Number	Atomic Weight ^a
	•	89	227.
Actinium	Ac Al	89 13	227. 26.98
Aluminum		13 51	20.98 121.76
Antimony	\mathbf{Sb}		39.944
Argon	A	18	59.944 74.91
Arsenic	As	33	
Astatine	At	85	(210)
Barium	Ba	56	137.36
Beryllium	Be	4	9.013
Bismuth	Bi	83	209.00
Boron	B	5	10.82
Bromine	Br	35	79.916
Cadmium	Cd	48	112.41
Calcium	Ca	20	40.08
Carbon	\mathbf{C}	6	12.011
Cerium	Се	58	140.13
Cesium	Cs	55	132.91
Chlorine	Cl	17	35.457
Chromium	\mathbf{Cr}	24	52.01
Cobalt	Co	27	58.94
Copper	Cu	29	63.54
Dysprosium	Dy	66	162.51
Erbium	Er	68	167 . 27
Europium	$\mathbf{E}\mathbf{u}$	63	152.0
Fluorine	\mathbf{F}	9	19.00
Francium	Fr	87	(223)
Gadolinium	Gd	64	157.26
Gallium	Ga	31	69.72
Germanium	Ge	32	72.60
Gold	Au	79	197.0
Hafnium	Hf	72	178.50
Helium	He	2	4.003
Holmium	Ho	67	164.94
Hydrogen	Н	1	1.0080
Indium	In	49	114.82
Iodine	I	53	126.91
Iridium	Īr	77	192.2
Iron	Fe	26	55.85
Krypton	Kr	36	83.80
Lanthanum	La	57	138.92
Lead	Pb	82	207.21
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In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

THERMODYNAMIC PROPERTIES OF THE ELEMENTS

ElementSymbolNumberAtomic WeightLithiumLi3 6.940 LutetiumLu71 174.99 MagnesiumMg12 24.32 ManganeseMn25 54.94 MercuryHg80200.61MolybdenumMo4295.95NeodymiumNd60 144.27 NeonNe1020.183NickelNi28 58.71 NiobiumNb4192.91NitrogenN714.008OsmiumOs76190.2OxygenO816 (definedPalladiumPd46106.4	
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OsmiumOs76190.2OxygenO816 (defined)	
Osmium Os 76 190.2 Oxygen O 8 16 (defined)	
Palladium Pd 46 106 Å)
Phosphorus P 15 30.975	
Platinum Pt 78 195.09	
Polonium Po 84 210.	
Potassium K 19 39.100	
Praseodymium Pr 59 140.92	
Promethium Pm 61 (145)	
Protactinium Pa 91 231	
Radium Ra 88 226.05	
Radon Rn 86 222	
Rhenium Re 75 186.22	
Rhodium Rh 45 102.91	
Rubidium Rb 37 85.48	
Ruthenium Ru 44 101.1	
Samarium Sm 62 150.35	
Scandium Sc 21 44.96	
Selenium Se 34 78.96	
Silicon Si 14 28.09	
Silver Ag 47 107.880	
Sodium Na 11 22.991	
Strontium Sr 38 87.63	
Sulfur S 16 32.066 ^b	
Tantalum Ta 73 180.95 (00) (00) (00) (00)	
TechnetiumTc43(99)TelluriumTe52127.61	
Terbium Tb 65 158.93 Thallium Tl 81 204.39	
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Tungsten W 74 183.86	
Uranium U 92 238.07	
$\begin{array}{ccc} Vanadium & V & 23 & 50.95 \end{array}$	
$\begin{array}{ccc} Xenon & Xe & 54 & 131.30 \end{array}$	
Ytterbium Yb 70 173.04	
Yttrium Y 39 88.92	
Zinc Zn 30 65.38	
Zirconium Zr 40 91.22	

^a A value given in parentheses denotes the mass number of the isotope of longest known half life.

^b Because of natural variations in relative abundance of the sulfur isotopes, its atomic weight has a range of ± 0.003 .

PHYSICAL CONSTANTS

Rossini and coworkers (272) give values for the necessary physical constants. The new value of the ice point has been used (319), necessitating changes in some of the derived constants. Although some calculations were made using older constants, the difference does not affect the thermodynamic functions in the second decimal place.

Name and Symbol

Velocity of light, c

Planck constant, h

Avogadro constant, N

Faraday constant, F

- Absolute temperature of ice point T (0° C.)
- Pressure-volume product for 1 mole of gas at 0° C. and zero pressure $(PV)_T^P = \underset{0}{\overset{0}{}} _{\circ C.}$

Electronic charge e = F/N

Gas constant $R = \frac{(PV)_T^P = 0}{T(0^\circ \text{ C.})}$

Boltzmann constant k = R/N

Constant relating wave number and energy Z = Nhc

Standard atmosphere (atm.) Thermochemical calorie Value and Units

 2.997902×10^{10} cm./sec. 6.62377×10^{-27} erg sec./molecule 6.02380×10^{23} molecules/mole 96,493.1 coulombs/equivalent

273.15 ° K.

2271.16 joules/mole

 1.601864×10^{-19} coulomb

8.31469 joules/deg. mole

1.98726 cal./deg. mole

 1.38031×10^{-16} erg/deg. molecule

11.96171 joule cm./mole 2.858917 cal. cm./mole 1,013,250 dynes/cm.² 4.1840 (exact) joules 4.18331 int. joules 41.2929 cm.³ atm.

TERMINOLOGY

g.f.w. = Gram formula weight

 $H_{298\cdot15} - H_0 =$ Enthalpy at 298.15° K. relative to 0° K. in cal./g.f.w.

 C_p = Heat capacity at constant pressure in cal./deg./g.f.w.

 $H_T - H_{298.15} =$ Enthalpy or heat content at temperature T° K. relative to 298.15° K. in cal./g.f.w.

$$S_T$$
 = Absolute entropy at temperature T° K. in cal./deg./g.f.w.

 $\frac{F - H_{298\cdot 15}}{T} = \text{Free energy function in cal./deg./g.f.w.} = \frac{(H_T - H_{298\cdot 15})}{T} - S_T$

- ΔH_f = Heat of formation from reference state in cal./g.f.w.
- ΔF_f = Free energy of formation from reference state in cal./g.f.w.
- $Log_{10}K_p = Logarithm$ to the base 10 of the equilibrium constant of formation from reference state.
- M. P. = Melting point in ° K. at 1 atmosphere pressure.
- B. P. = Boiling point in $^{\circ}$ K. at 1 atmosphere pressure.
- ΔH_m = Heat of melting in cal./g.f.w. at the melting point.
- ΔH_{t} = Heat of vaporization in cal./g.f.w. at 1 atmosphere total pressure.

- S. P. = Sublimation point in ° K. at 1 atmosphere pressure.
- T. P. = Transition point in ° K. at 1 atmosphere pressure.
- ΔH_{*} = Heat of sublimation in cal./g.f.w. at S. P.
- ΔH_t = Heat of transition in cal./g.f.w. at T. P.
- T_c = Critical temperature in ° K.
- P_c = Critical pressure in atmospheres.
- T = Absolute temperature in ° K.
- K = Kelvin scale of temperatures where 273.15° K. represents the ice point.
- e. u. = entropy unit = cal./deg. mole.

Circular superscript, °, denotes the thermodynamic standard reference state of unit activity.

Sources and Discussion of the Data

ACTINIUM

Foster (115) has made a preliminary report that indicates the melting point is about 1470° K. and the normal boiling point is about 3600° K. The rest of the data are all estimated and are intended to serve only until measured data are available.

ALUMINUM

Giauque and Meads (123) have measured the low temperature heat capacity from 15° to 302° K. and calculate at 298° K. an entropy of 6.769 ± 0.02 e. u. and an enthalpy of 1094 cal./gram atom. The heat capacity and heat content data for the solid state are taken from the work of Kelley (185). The melting point appears well established at 932° \pm 1° K. (185, 206, 274). A value of 2550 cal./gram atom has been selected as the heat of melting on the basis of Kelley's heat content data, since the recent determinations of Oelsen, Oelsen, and Thiel (254) and Wittig (348) are not in good agreement. The liquid heat capacity value given by Kelley (185) has been extrapolated to the boiling point.

Huff, Gordon, and Morrell (163) have calculated the thermodynamic properties of the ideal monatomic gas using spectroscopic data given by Moore (241). Vapor pressure measurements have been made by Brewer and Searcy (39), Baur and Brunner (23), and Farkas (108). Giving Brewer and Searcy's data the most weight, we derive a heat of sublimation at 298° K. of 77,500 cal./gram atom, a boiling point of 2720° K., and a heat of vaporization at the normal boiling point of 70,200 cal./gram atom.

ANTIMONY

The low temperature heat capacity has been measured by Anderson (9) and by DeSorbo (83), who calculates the entropy at 298°K. to be 10.92 ± 0.05 e. u. From these data we calculate the enthalpy at 298°K. to be 1410 cal./gram atom. Kelley (185) lists the heat capacity of the solid above 298°K. and the liquid as well as the melting point of 903°K., with an associated heat of melting of 4740 cal./gram atom. These values agree well with those of Kubaschewski and coworkers (206), and the heat of melting is about the average of the heat measured by Oelsen, Oelsen, and Thiel (254) and by Wittig (347). The thermodynamic functions of the monatomic gas were calculated from the spectroscopic values given by Meggers and Humphreys (233). The thermodynamic functions of the data given by Kelley (185, 186) and were extended to 3000°K.

In addition to the vapor pressure data listed by Kelley (180) and Brewer (35), measurements have been made by Nesmeyanov and Iofa (247) and by Richards (267). Considering all these data, the best fit is obtained by combining the thermodynamic functions of the monatomic and diatomic species with the following values: (1) an entropy of 83.65 e. u. at 298° K. and a heat of sublimation at 298° K. of 49,000 cal./mole for the gaseous species Sb₄; (2) a heat of sublimation at 298° K. of 56,400 cal./mole for the gaseous species Sb₂; and (3) a heat of sublimation at 298° K. of 62,700 cal./mole for the monatomic gas. The last value is consistent with the value of 69,000 cal./mole given by Gaydon (118) for the dissociation energy of the diatomic gas. These values lead to a total vapor pressure of all species of one atmosphere at 1910° K., in good agreement with the measured value of von Leitgebel (211). The heat of vaporization of 1 gram atomic weight at 1910° K. to the equilibrium vapor is 16,230 cal. The reference state selected is the condensed state below 1910° and the ideal diatomic gas state above 1910° K. Note that the reference state table is based on 1 gram atomic weight (121.76 grams) for all phases.

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ARGON

Clusius and Frank (61) find 83.78° K. for the melting point with 280.8 cal./gram atom for the heat of melting as well as 87.29° K. for the normal boiling point and 1558 cal./gram atom for the associated heat of vaporization. These vapor pressure data are substantiated by the more recent work of Clark, Din, Robb, Michels, Wassenaar, and Zwietering (57). Thermodynamic properties of the ideal gas have been calculated at the National Bureau of Standards (295). Kobe and Lynn (193) select 151° K. for the critical temperature and 48.0 atmospheres for the critical pressure.

ARSENIC

From the heat capacity measurements of Anderson (7) from 57° to 291° K., Kelley (186) calculates the entropy at 298° K. to be 8.4 ± 0.2 e. u., and we calculate the enthalpy at 298° K. to be 1226 cal./gram atom. Kelley (185) gives the heat capacity of the solid from 298° K. to the melting point of 1090° K. where he estimates the heat of melting (182) as 6620 cal./gram atom. Our data indicate a vapor pressure of about 28 atmospheres at this temperature. Thermodynamic functions for the monatomic gas were calculated using the spectroscopic data listed by Moore (241). Kelley (185, 186) lists heat content and entropy for the diatomic gas, while Gaydon (118) adopts 90,800 cal./mole for the dissociation energy of the diatomic gas at 0° K.

Vapor pressure data, as reviewed by Brewer and Kane (37), can be represented by assuming the tetratomic molecule to be the gaseous species, with a heat of sublimation at 298° K. of 34,500 cal./mole, an entropy at 298° K. of 75.00 e. u., and a reasonable estimate of the heat capacity. According to this view, there is no appreciable concentration of the diatomic species in the vapor at saturation pressure below 1000° K., which sets a lower limit of about 48,000 cal./mole for the heat of sublimation at 298° K. for the diatomic gas. Comparison with the bond energies of P_4 and Sb_4 gives support to this value.

The data of Preuner and Brockmöller (262) lead to an unreasonably low figure and are somewhat discredited by comparison of their values for phosphorus, antimony, and sulfur with those of other workers. The heat of sublimation at 298° K. to the monatomic species was calculated to be 69,400 cal./mole using Gaydon's value (118) for the dissociation energy of the diatomic gas. This treatment leads to a total pressure of one atmosphere at 886° K. and a heat of sublimation of 7630 cal./gram atom. For the reference state we have selected the solid below 886° K. and the ideal diatomic gas above the sublimation point. Note that the reference state table is based on 1 gram atomic weight (74.91 grams) for all phases.

ASTATINE

These data are entirely estimated by comparison with the other halogens and are intended to serve only until measured data become available.

BARIUM

Kelley (181) estimates the entropy at 298° K. as 16.0 e. u. while Latimer (210) estimates 15.1 e. u. We adopt 15.5 e. u. Kubaschewski (205) has reported solid and liquid heat capacity data, a heat of transition of 140 ± 80 cal./gram atom at 643° K., and a heat of melting of $1830' \pm 70$ cal./gram atom at 983° K. The heat capacity of the solid beta phase and the liquid phase appear to be extraordinarily high, and when combined with vapor pressure data lead to a very unusual Trouton's constant of about 14. Consequently, we have estimated a lower heat capacity of the condensed phases by comparison with calcium.

Thermodynamic functions of the ideal monatomic gas were calculated using spectroscopic data from Bacher and Goudsmit (19). Vapor pressures have been measured by Hartmann and Schneider (146) and by Rudberg and Lempert (278). We consider the data of the former workers to be more reliable. Their data give a heat of sublimation at 298°K. of 41,740 cal./gram atom, a normal boiling point of 1910°K., and a heat of vaporization at the normal boiling point of 36,070 cal./gram atom.

BERYLLIUM

Hill and Smith (156) have measured the heat capacity from 4° to 300° K. Their results lead to an entropy of 2.28 e.u. at 298° K. and an enthalpy of 468 cal./gram atom. The recent measurements of solid heat capacity of Ginnings, Douglas, and Ball (127) have been adopted and extrapolated to the melting point. The melting point accepted by several sources is $1556^{\circ} \pm 1^{\circ}$ K. (206, 207, 274), while the recent review of Kubaschewski and coworkers (206) gives 2800 ± 500 cal./gram atom for the heat of melting. In the absence of any liquid heat capacity data, we have used the value of 7.50 cal./degree/-gram atom estimated by Kelley (187).

Thermodynamic functions for the ideal monatomic gas have been calculated using the energy levels given by Moore (241). The vapor pressure data of Gulbransen and Andrew (138) and of Holden, Speiser, and Johnston (160) are in good agreement, while the results of Schuman and Garrett (288) are too low and the values given by Baur and Brunner (23) have a wrong temperature dependence. We calculate a heat of sublimation at 298° K. of 77,900 cal./gram atom, a normal boiling point of 2750° K., and a heat of vaporization of 70,400 cal./gram atom at the normal boiling point.

BISMUTH

Low temperature heat capacity measurements by Anderson (10), Bronson and MacHattie (42), Keesom and van den Ende (176), and Armstrong and Grayson-Smith (16) were used to calculate an entropy and enthalpy at 298° K. of 13.58 e. u. and 1536 cal./gram atom, respectively. From many sources, Kelley (185) derives an equation for the solid heat capacity above 298° K. Kubaschewski and coworkers (206) select 544.5° K. as the melting point and 2600 \pm 50 cal./gram atom for the heat of melting. Data on the liquid heat capacity are discordant and the average value for liquid metals of 7.50 cal./degree/gram atom has been used.

Thermodynamic properties of the ideal monatomic gas were calculated using the energy levels listed in Landolt-Bornstein Tabellen (208). Kelley (185, 186) gives data for the diatomic gas. The dissociation energy given by Gaydon (118), 39,200 cal./mole, indicates the saturated vapor must be largely monatomic. Of the vapor pressure measurements, those of O'Donnell (252) are about an average of the low pressure region while in the normal boiling point range the determination of von Leitgebel (211) is considered most reliable. When corrected for the actual composition of the gas, the results of O'Donnell and von Leitgebel are in excellent agreement and lead to a value of 47,500 cal./gram atom for the heat of sublimation at 298° K. of the monatomic species. Combining this value with the dissociation energy given by Gaydon yields a heat of sublimation at 298° K. of the diatomic form of 55,300 cal./mole. From these data we calculate a normal boiling point of 1832° K. and a heat of vaporization to equilibrium gas at 1832° K. of 36,200 cal./gram atom.

BORON

Johnston, Hersh, and Kerr (168) have measured the heat capacity of the crystalline form from 13° to 305° K., and calculate the entropy at 298° K. to be 1.403 ± 0.005 e. u. and the enthalpy at 298° K. to be 292 cal./gram atom. In the absence of definite information, we have estimated that the solid heat capacity will reach a value of 7.5 cal./degree/gram atom at the melting point and have extrapolated the low temperature measurements in a reasonable manner to obtain this value. Cueilleron (77) has measured the melting point of the crystalline variety and reports a range of 2273° to 2348° K., which we have rounded to 2300° K. Elements with a hexagonal close-packed structure have an average entropy of melting of 2.3 e. u. Using this estimate gives 5300 cal./gram atom for the heat of melting. We estimate the liquid heat capacity to be 7.5 cal./degree/gram atom. Huff, Gordon, and Morrell (163) have calculated the thermodynamic properties of the ideal monatomic gas using the spectroscopic data given by Moore (241). The vapor pressure has been measured by Myers (243) from which we calculate the heat of sublimation at 298° K. to be 141,000 cal./gram atom, a normal boiling point of 4200° K., and a heat of vaporization of 128,800 cal./gram atom at 4200° K.

BROMINE

McDonald (227) has measured the melting point to be 265.95° K., while Rossini and coworkers (274) list 2520 cal./mole (2 gram atomic weights) for the heat of melting. McDonald (227) has also measured the heat of vaporization in the temperature range from 298° to 308° K., from which we derive 7450 cal./mole for the heat of vaporization at 298° K. Evans, Munson, and Wagman (106) have calculated the thermodynamic properties of the ideal diatomic and monatomic gases, while Gaydon (118) gives 45,440 cal./mole for the heat of dissociation at 0° K. Combining the statistical entropy of diatomic bromine gas at 298° K. with McDonald's heat of vaporization and the vapor pressure data selected by Stull (322) gives the entropy of liquid bromine at 298° K. as 36.25 e. u. This value is lower than that of 36.7 e. u. given by Kelley (186) based on low temperature heat capacity data. Since the liquid heat capacity and heat of melting are based on very old measurements, we consider the entropy derived from spectroscopic data to be the more reliable.

The normal boiling point has been selected by Stull (322) to be 331.4° K., although the recent measurements of Fischer and Bingle (112) give a somewhat higher value. The heat of vaporization at the normal boiling point is calculated to be 7170 cal./gram mole. Kobe and Lynn (193) list the critical temperature as 584° K. and the critical pressure as 102 atmospheres.

CADMIUM

Craig and coworkers (75) have recently measured the heat capacity from 12° to 320° K. and have reported the entropy at 298° K. as 12.37 ± 0.01 e.u. These heat capacity data lead to an enthalpy at 298° K. of 1491 cal./gram atom. Kelley's values (185) for the neat capacity of the solid and liquid, the melting point of 594° K., and heat of melting of 1450 cal./gram atom have been used. The last value is in good agreement with the recent measurements of Oelsen and coworkers (253, 254).

The thermodynamic properties of the monatomic gas have been calculated from spectroscopic data given by Landolt-Bornstein (208). Kelley (180) has selected 1038°K. for the boiling point and 23,870 cal./gram atom for the heat of vaporization. This leads to a heat of sublimation at 298°K. of 26,750 cal./gram atom. Recent measurements of O'Donnell (251) and Kotov (202) are in good agreement with Kelley's selected value, giving heats of sublimation of 26,620 and 26,910 cal./gram atom, respectively.

CALCIÚM

Kelley (186) selects the entropy at 298° K. as 9.95 ± 0.10 e. u., relying almost entirely on the low temperature data of Clusius and Vaughen (70). From these data we calculate an enthalpy at 298° K. of 1380 cal./gram atom. The solid and liquid heat capacity data given by Kubaschewski (205) have been used. He lists 713° K. for the solid state transition with a heat of transition of 270 ± 40 cal./gram atom and 1123° K. as the melting point, with a heat of melting of 2070 ± 80 cal./gram atom.

Thermodynamic properties of the ideal monatomic gas have been calculated from the spectroscopic information reported by Moore (241). Vapor pressure measurements have been made by Douglas (88), Hartmann and Schneider (146), Pilling (261), Priselkov and

Nesmeianov (263), Rudberg (277), Tomlin (329), and Ruff and Hartmann (280). The pressures reported by Rudberg appear to be too low, while those of Ruff and Hartmann seem to increase too rapidly with increase of temperature. The remaining measurements are in good agreement. We calculate a heat of sublimation at 298° K. of 42,200 cal./ gram atom, a boiling point of 1765° K., and a heat of vaporization at 1765° K. of 35,840 cal./gram atom.

CARBON

DeSorbo and Tyler (85) have recently measured the heat capacity from 13° to 300° K., and calculate the entropy at 298° K. to be 1.372 ± 0.005 e. u., and an enthalpy at 298° K. of 251 cal./gram atom. Thermodynamic properties of the solid and the ideal monatomic gas have been taken from the compilation of Rossini and coworkers (273). Thermodynamic properties of the ideal diatomic gas have been calculated from the spectroscopic data of Herzberg (152). Our calculated entropy at 298° K. agrees with that calculated by Kelley (186), but is R ln 3 less than the value calculated by Gordon (129). According to Brewer (34) additional low lying electronic states are to be expected, so that the present treatment must be considered approximate. Thermodynamic properties for the ideal triatomic gas have been calculated from the estimated molecular constants listed by Glockler (128).

The heat of sublimation of graphite to ideal monatomic gas has been the subject of numerous investigations. Recent work (55, 56, 87, 158) has given increasing support to a value in the vicinity of 170 kcal./gram atom. According to Brewer and Kane (37) and Thorn and Winslow (326) the experimental conditions sometimes prevent reaching a true equilibrium between graphite and all the gaseous species. This may be responsible for the divergence of the values found by the various experimental methods. Thus, experiments to date probably yield a reliable value for the heat of sublimation of the ideal monatomic species only. The only values for the heats of sublimation of higher species at the present time have come from the mass spectrometer measurements of Chupka and Inghram. We have used rounded values of 200,000 cal./gram mole for the diatomic and triatomic species.

The best value for the heat of sublimation of graphite to ideal monatomic gas can be obtained from a consideration of the following reactions:

$$C(gr) + \frac{1}{2}O_2(g) \rightarrow CO(g)$$
⁽¹⁾

$$CO(g) \rightarrow C(g) + O(g)$$
 (2)

$$O(g) \rightarrow \frac{1}{2}O_2(g) \tag{3}$$

$$C(gr) \rightarrow C(g) \tag{4}$$

The heat of Reaction 1 is from Rossini and coworkers (274), that of Reaction 2 is from Douglas (87), and that of Reaction 3 is from Brix and Herzberg (41). This gives for Reaction 4 at 298° K. a value of $170,890 \pm 500$ cal./gram atom. In view of the uncertainties that have been mentioned, we estimate the total vapor pressure reaches 1 atmosphere at a temperature of about 4000° K.

CERIUM

Parkinson, Simon, and Spedding (257) have measured the heat capacity from 2° to 180° K. and report the entropy at 298° K. to be 16.64 e. u. and an enthalpy at 298° K. of 1742 cal./gram atom. We have adjusted Kelley's (185) solid heat capacity equation so that it joins smoothly with the low temperature data. Spedding and Daane (314) report a transition at 1027° K. and a melting point of 1077° K. We have estimated the heats accompanying these phase changes, as well as the liquid heat capacity. Ahmann (4) and Brewer (35) have measured the vapor pressure, and differ by nearly one order of magnitude. Taking an average of their data and estimating the gaseous spectroscopic contribution, we find a normal boiling point of 3200° K., with an associated heat of vaporization of 75,000 cal./gram atom.

CESIUM

Based on the low temperature measurements of Dauphinee, Martin, and Preston-Thomas (82), we calculate an entropy at 298° K. of 20.16 e. u. and an enthalpy at 298° K. of 1859 cal./gram atom. Clusius and Stern (69) have measured the melting point as 301.8° K. We have averaged the values for heat of melting reported by Kelley (185), Dauphinee, Martin, and Preston-Thomas (82), and Clusius and Stern (69) to obtain 510 cal./gram atom. The liquid heat capacity measurements of Dauphinee, Martin, and Preston-Thomas (82) have been extrapolated to the boiling point.

Evans, Jacobson, Munson, and Wagman (105) have calculated the thermodynamic properties of the ideal monatomic and diatomic gases and list 10,380 cal./mole for the heat of dissociation of the diatomic gas. Vapor pressure measurements have been made by Scott (290), Ruff and Johannsen (281), Taylor and Langmuir (324), Fuchtbauer and Bartels (116), Kroner (204), and by Hackspill (141). The data of the last four sets of workers are in excellent agreement, and lead to a heat of sublimation at 298° K. of 18,670 cal./gram atcm for the ideal monatomic species, 26,630 cal./mole for the ideal diatomic species, a norn al boiling point of 958° K., and a heat of vaporization to equilibrium vapor at 958° K. of 15,750 cal./gram atom.

CHLORINE

Based on the measurements of Giauque and Powell (124), Rossini and coworkers (274) give the melting point, 172.16° K.; heat of melting, 1531 cal /mole; normal boiling point, 239.10° K.; and heat of vaporization, 4878 cal./mole. The critical temperature, 417° K., and critical pressure, 76.1 atmospheres, listed by Kobe and Lynn (193) have been adopted. Evans, Munson, and Wagman (106) have calculated the thermodynamic properties of ideal monatomic and diatomic gases. They select 57,880 cal./gram mole for the dissociation energy at 298° K. Note that the reference state table is based on 2 gram atomic weights.

CHROMIUM

Low temperature measurements by Weertman, Burk, and Goldman (342) and by Anderson (12) are in fair agreement and give an entropy at 298° K. of 5.70 e. u. and an enthalpy of 973 cal./gram atom. Recent heat capacity work by Armstrong and Grayson-Smith (17) on a very pure sample has been adopted and has been extended to join Kelley's (185) equation smoothly at about 1300° K. Kelley's equation has been extrapolated to the transition. In working with multicomponent systems as well as very pure chromium, Bloom, Putnam, and Grant (28) have found evidence of a transition at 2113° \pm 15° K. and a melting point of 2176° \pm 10° K. The data of Grube and Knabe (137) on the palladium-chromium system lead to a calculated heat of melting of 3300 \pm 200 cal./gram atom atom. However, the directly measured value of Umino (332) is 3650 cal./gram atom and probably includes the heat of the transition, so we have selected the difference, 350 cal./ gram atom for the heat of the transition, leaving 3300 \pm 200 cal./gram atom for the heat of melting. The heat capacity of the solid above the transition has been assumed to have the same value as the liquid, which Kelley (179) reports as 9.70 cal./degree/gram atom based on Umino's data.

Thermodynamic properties for the ideal monatomic gas state have been calculated using the spectroscopic energy levels listed by Moore (241). The vapor pressure has been reported by Speiser, Johnston, and Blackburn (317), Gulbransen and Andrew (139), and Baur and Brunner (23). The data of Baur and Brunner appear to be too high, since there is good agreement in the data of the first two sources. We calculate the heat of sublimation at 298° K. to be 95,000 cal./gram atom, the normal boiling point of 2915° K., and a heat of vaporization at the normal boiling point of 83,360 cal./gram atom.

COBALT

From the data of Duyckaerts (92) as well as their own low temperature measurements from 15° to 270° K., Clusius and Schachinger (68) calculate an entropy at 298° K. of 7.18 e. u. We calculate from these same data an enthalpy at 298° K. of 1146 cal./gram atom. Since the latest compilation of Kelley (185), Armstrong and Grayson-Smith (17) have measured the heat capacity of a very pure sample up to 1073° K. They report a peak in the heat capacity curve from 720° to 755° K. which we interpret as a sluggish phase change. We select 720° K. as the ideal transformation temperature which would be obtained with infinitely slow heating. Armstrong and Grayson-Smith obtain 60 cal./ gram atom as the heat of this transition by direct integration of the peak. The heat capacity data of Armstrong and Grayson-Smith have been used and extrapolated to the Curie point. The Curie point is given by the "Metals Handbock" (216) as 1388° K. and by Meyer and Taglang (235) as 1404° K. We interpret these data as a lambda point at 1395° K. of undefined shape and add 130 cal./gram atom at this temperature, the value selected by Kelley (185) for this discontinuity. The melting point was determined as 1768° ± 1° K. by Van Dusen and Dahl (336). Kelley (185) lists 3640 cal./gram atom for the heat of melting and also gives the liquid heat capacity.

We have calculated the thermodynamic properties of the ideal monatomic gas from the spectroscopic data of Moore (241). Vapor pressure has been measured by Dancy (80), Ruff and Keilig (282), Kornev and Golubkin (199), and by Edwards, Johnston, and Ditmars (98). We have the most confidence in the measurements of Edwards, Johnston, and Ditmars, although the data from the other three sources form a different consistent pattern. Combining the measurements of Edwards, Johnston, and Ditmars with the other thermodynamic data, we find the heat of sublimation at 298° K. to be 101,600 cal./gram atom, a normal boiling point of 3150° K., and a heat of vaporization at the normal boiling point of 91,400 cal./gram atom.

COPPER

Kelley (186) has calculated the entropy as 7.97 ± 0.02 e. u. based on heat capacities from several sources including measurements to 1° K. Giauque and Meads (123) give the enthalpy at 298° K. as 1201 cal./gram atom. Solid and liquid heat capacity and heat of melting of 3120 cal./gram atom have been taken from Kelley's (185) compilation. Rossini and coworkers (274) give 1356° K. as the melting point.

Thermodynamic functions for the ideal monatomic gas have been calculated from spectroscopic data given by Moore (241). Older vapor pressure measurements of Harteck (145) and of Marshall, Dornte, and Norton (223) agree with the more recent measurements of Hersh (151) and of Edwards, Johnston, and Ditmars (99). From these data we find the heat of sublimation at 298° K. to be 81,100 cal./gram atom, a normal boiling point of 2855° K., and a heat of vaporization at 2855° K. of 72,800 cal./gram atom.

DYSPROSIUM

Griffel, Skochdopole, and Spedding (136) have measured the heat capacity from 15° to 300° K., and report an entropy at 298° K. of 17.78 e. u. and an enthalpy at 298° K. of 2116 cal./gram atom. Spedding and Daane (314) indicate 1773° K. as the approximate melting point and have measured the vapor pressure at 1390° K. as 0.01 mm. of mercury (313). They calculate a heat of vaporization at 1390° K. of 66,700 cal./gram atom. From these data we estimate the boiling point as 2600° K. and the heat of vaporization at the boiling point as 60,000 cal./gram atom. The solid, liquid, and gas heat capacity and heat of melting are all estimated and are intended for use only until measured values become available.

ERBIUM

Skochdopole, Griffel, and Spedding (310) have measured the heat capacity from 15° to 320° K., and calculate an entropy at 298° K. of 17.48 e. u. and an enthalpy at 298° K. of 1763 cal./gram atom. Spedding and Daane (314) indicate a melting point of about 1800° K. and from their suggested volatility we estimate a normal boiling point of 2900° K. The remaining data have been estimated by comparison with related metals and should be used only until measured values are available.

EUROPIUM

Skochdopole, Griffel, and Spedding (310) have compared measured entropies for the rare earths with theoretically predicted values. Although they do not predict a value for europium, they believe it is somewhat higher than its immediate periodic table neighbors. On this basis, we adopt a value of 17 e. u. for the entropy of europium at 298° K. Spedding and Daane (314) remark that europium is the most volatile of the rare earths. Landolt-Bornstein (208) report available spectroscopic terms from which we have calculated the thermodynamic properties of the ideal monatomic gas. The remaining data listed for this element are estimated and are consistent with the above known facts. These data are intended for use only until measured values become available.

FLUORINE

Hu, White, and Johnston (162) have determined the low temperature thermal data for fluorine and report a solid state transition at 45.55° K. with a heat of 173.90 cal./mole, the melting point at 53.54° K. with a heat of melting of 121.98 ± 0.5 cal./mole, the boiling point at 85.02° K., and a heat of vaporization at 84.71° K. of 1563.98 ± 3 cal./mole. The resulting calorimetric entropy of the gas at 85.02° K. is in excellent agreement with that calculated by statistical methods. Correcting the heat of vaporization to 760 mm. and 85.02° K. gives 1562 ± 4 cal./mole. The critical temperature, 144.2° K., and pressure, 55 atmospheres, have been taken from Cady and Hildebrand (50). Thermodynamic functions for the ideal monatomic and diatomic gases as well as the dissociation energy are from the work of Evans, Munson, and Wagman (106). Note that the reference state represents 2 gram atomic weights for this element.

FRANCIUM

These data are completely estimated by comparison with the other alkali metals and are intended to serve only until measured data become available.

GADOLINIUM

Griffel, Skochdopole, and Spedding (135) have measured the heat capacity from 15° to 355° K., and report an entropy at 298° K. of 15.77 e. u. and an enthalpy of 2172 cal./ gram atom. We have estimated the solid and liquid heat capacities as well as the heat of melting. Spedding and Daane (314) report approximately 1600° K. for the melting point and a volatility which places the normal boiling point in the vicinity of 3000° K. Gaseous spectroscopic data from Russell (284) permit calculation of the thermodynamic properties of the ideal monatomic gas. Based on these data, we calculate a heat of sublimation at 298° K. of 82,500 cal./gram atom and a heat of vaporization at the normal boiling point of 74,500 cal./gram atom.

GALLIUM

An entropy of 9.82 ± 0.05 e. u. and an enthalpy of 1331 cal./gram atom at 298° K., based on measurements from 15° to 323° K., have been calculated by Adams, Johnston, and Kerr (1). Their values for the heat of melting, 1335 cal./gram atom, melting point 303° K., and liquid heat capacity are also employed. Speiser and Johnston (316) have estimated the liquid heat capacity to be 6.65 cal./degree/gram atom in the high temperature region.

Thermodynamic properties for the ideal monatomic gas have been computed from the spectroscopic energy levels reported by Moore (241). Vapor pressures reported by Harteck (145) are somewhat lower than the more recent measurements of Speiser and Johnston. Giving the latter workers the most weight we calculate a heat of sublimation at 298° K. of 65,000 cal./gram atom, a normal boiling point of 2510° K., and a heat of vaporization at the normal boiling point of 61,200 cal./gram atom.

GERMANIUM

Estermann and Weertman (104) and Hill and Parkinson (155) have recently measured low temperature heat capacities of very pure samples, covering the temperature range from 0° to 200° K. with good agreement. The extension of the heat capacity curve to the melting point was accomplished by direct analogy with similar measured data for silicon and gray tin. This results in a smooth curve reaching a value of 7.0 cal./ degree/gram atom at the melting point. Integration leads to an entropy at 298° K. of 7.43 \pm 0.10 e. u., in good agreement with the value of 7.40 e. u. derived by Coughlin (73), and an enthalpy at 298° K. of 1105 cal./gram atom. Hassion, Thurmond, and Trumbore (147) have measured the melting point under a variety of conditions and report 1210.4° K. Wittig (348) and Greiner (133) have measured the heat of melting as 7100 and 8100 cal./gram atom, respectively. An average of 7600 cal./gram atom has been adopted. We have estimated the heat capacity of the liquid to be 7.0 cal./degree/gram atom.

We have assumed that the gas is ideal and monatomic and have calculated the thermodynamic properties based on the energy levels of Moore (241). Searcy (291) and Searcy and Freeman (293) have measured the vapor pressure, while Honig (161) has studied the vapor species in a mass spectrometer. These data are consistent with a heat of sublimation at 298° K. of 90,000 cal./gram atom, a normal boiling point of 3100° K., and a heat of vaporization at 3100° K. of 79,900 cal./gram atom.

GOLD

Geballe and Giauque (119) have recently measured the heat capacity from 15° to 300° K., and report the entropy and enthalpy at 298° K. to be 11.32 ± 0.02 e. u. and 1434 cal./gram atom, respectively. The solid and liquid heat capacity and the heat of melting have been taken from the compilation of Kelley (185). Stimson (319) has listed 1336.15° K., the defined melting point, as a primary calibration point on the International Temperature Scale. From spectroscopic data listed by Landolt-Bornstein (208), we have calculated the thermodynamic properties of the ideal monatomic gas. Vapor pressure data given by Hall (142) lead to a heat of sublimation at 298° K. of 84,700 cal./gram atom, a normal boiling point of 2980° K., and a heat of vaporization at the normal boiling point of 77,540 cal./gram atom.

HAFNIUM

Low temperature heat capacities have been measured by Cristescu and Simon (76) from 13° to 210° K., and by Weertman, Burk, and Goldman (342) from 50° to 200° K. Since the latter workers have not substantiated the anomaly reported by the former workers, we have adopted the values of the latter group and have extrapolated them to absolute zero with a Debye function. From this information, we calculate the entropy at 298° K. to be 10.91 e. u. and the enthalpy at 298° K. to be 1448 cal./gram atom. We have estimated the heat capacity of the solid above 298° K. and of the liquid. A transition point has been reported by Duwez (91) and by Fast (110). The melting point has been reported by Adenstedt (2), Litton (213), and Zwikker (352). Considerable disagreement is evidenced by these values. There is probably a transition in the vicinity of the melting point, but in view of the uncertainty existing, we have elected to minimize the necessary

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estimations by considering a single phase change at the melting point and combining any transitional heat with the heat of melting. It seems to us that the most reasonable melting point is that given by Adenstedt, 2250° K. Estimating the entropy of melting at 2.3 e. u., we calculate the heat of melting to be 5200 cal./gram atom.

From data given in the Landolt-Bornstein Tabellen (208), we have calculated the thermodynamic functions for the ideal monatomic gas. Richardson (268) has roughly measured the normal boiling point to be 5400° K., which is in good agreement with the estimate by Brewer (35) of 5500° K., which we have used. From these data we calculate a heat of sublimation at 298° K. of 168,000 cal./gram atom, and at the normal boiling point a heat of vaporization of 158,000 cal./gram atom.

HELIUM

The solid is not stable at one atmosphere, and can only be obtained at elevated pressures. In the range from 0° to 1° K., the required pressure is reported by Simon and Swenson (304) as 25 atmospheres. At a pressure of 103 atmospheres, Keesom (174) reports the melting point to be 3.5° K., with an associated heat of 5 cal./gram atom. Keesom also reports the second order transition (lambda point) at 2.186° K., and the normal boiling point at 4.216° K. with the associated heat of vaporization of 20 cal./gram atom. Thermodynamic properties for the ideal monatomic gas have been calculated at the National Bureau of Standards (295). Kobe and Lynn (193) report the critical temperature as 5.3° K. and the critical pressure as 2.26 atmospheres.

HOLMIUM

Skochdopole, Griffel, and Spedding (310) have estimated the entropy at 300° K. to be 17.81 e. u., very close to the entropy of dysprosium. Spedding and Daane (314) give the approximate melting point of 1773° K., and place its volatility similar to that of dysprosium. This element appears to be very similar to dysprosium. The values listed are, therefore, based on dysprosium and are to be used only until measured data are available.

HYDROGEN

Woolley, Scott, and Brickwedde (350) have compiled the thermodynamic properties for normal hydrogen. They list the melting point as 13.95_7° K. and give the heat of melting measured by Simon and Lange (302) as 28.0 ± 0.15 cal./mole. Unpublished vapor pressure measurements by Brickwedde and Scott cited in the compilation lead to a normal boiling point of 20.390° K., the presently accepted value. A new determination of the temperature scale using gas thermometry by Moessen, Aston, and Ascah (238) will, if adopted in 1960 by the International Committee of Weights and Measures, lead to a value of 20.365° K. The value measured by Simon and Lange for the heat of vaporization is 215.8 ± 1.1 cal./mole.

White, Friedman, and Johnston (343) have measured the critical constants for normal hydrogen and have found 33.24_4° K. and 12.797 atmospheres. Woolley, Scott, and Brickwedde have presented data on the dissociation energy and the thermodynamic properties for the ideal diatomic gas, including contributions from nuclear spin. We have omitted the spin entropy in compiling our tables. Thermodynamic properties for the ideal monatomic gas have been computed at the National Bureau of Standards (295). Note that the reference state represents 2 gram atomic weights for this element.

INDIUM

Clusius and Schachinger (66) have measured the heat capacity from 12° to 273° K., and Clement and Quinnell (58) from 1.7° to 21.3° K., from which can be derived the entropy at 298° K. of 13.82 e. u. and an enthalpy at 298° K. of 1578 cal./gram atom. Roth, Meyer, and Zeumer (275) have reported data for the solid heat capacity, melting point, heat of melting, and liquid heat capacity. Oelsen (253) has measured the heat of melting and liquid heat capacity and Oelsen, Oelsen, and Thiel (254) give a value for the heat of melting. From these sources we have selected our heat capacity data and the heat of melting of 780 cal./gram atom. Valentiner (333) has accurately measured the melting point as 429.32° K.

Thermodynamic properties for the ideal monatomic gas have been calculated from energy levels listed in the Landolt-Bornstein Tabellen (208). Kohlmeyer and Spandau (194) have measured the normal boiling point directly and report $2273^{\circ} \pm 10^{\circ}$ K. Anderson (14) has measured the vapor pressure from 1000° to 1348° K. His results extrapolate to a normal boiling point of 2364° K. We have selected the heat of sublimation at 298° K. to be 57,000 cal./gram atom, which leads to an average normal boiling point of 2320° K. and an associated heat of vaporization of 54,100 cal./gram atom.

IODINE

On the basis of literature values of low temperature heat capacities, Kelley (186) calculates an entropy at 298° K. of 27.9 e. u., in good agreement with calculations of Giauque (120). Giauque also reports an enthalpy of 3178 cal./gram mole and a heat of sublimation of 14,877 cal./gram mole, both at 298° K. Kelley (185) gives an equation for the heat capacity of the solid to the melting point of 386.8° K., the heat of melting as 3770 cal./mole, the heat capacity of the liquid to the normal boiling point at 456° K., and the heat of vaporization at the boiling point of 9970 cal./mole. Thermodynamic properties of the ideal monatomic and diatomic species as well as the dissociation energy are given by Evans, Munson, and Wagman (106). Note that the reference state represents 2 gram atomic weights for this element.

IRIDIUM

The entropy at 298° K. has been estimated by Lewis and Gibson (212) to be 8.7 \pm 0.5 e. u. Kelley (185) has given an equation for the solid heat capacity from 298° to 1800° K., which we have extrapolated to the melting point and have assumed that the heat capacity of the liquid is the same as that of the solid at the melting point. Based on the work of Henning and Wensel (150) and of Morris and Scholes (242), Vines (338) selects a melting point of 2727° K. For a face-centered cubic lattice, we adopt an entropy of melting of 2.3 e. u., which leads to a heat of melting of 6300 cal./gram atom.

Thermodynamic functions for the ideal monatomic gas have been calculated from spectroscopic data listed in the Landolt-Bornstein Tabellen (208). Brewer (33) believes a former estimate of 4800° K. for the normal boiling point is somewhat high, and we have selected 4400° K. This results in a heat of sublimation at 298° K. of 150,000 cal./gram atom and a heat of vaporization at 4400° K. of 134,700 cal./gram atom.

IRON

Kelley (186) gives the entropy at 298° K. as 6.49 ± 0.03 e. u., based on measurements from 1° K. upward. From these data an enthalpy at 298° K. of 1070 cal./gram atom can be derived. An excellent review on the high temperature thermal properties of iron is given by Darken and Smith (81) and we have used their data exclusively. We prefer their treatment of the heat capacity in the vicinity of the Curie point. According to this view, there is no change in phase in this temperature region and hence no heat of transition. There is a very sharp peak or lambda point in the heat capacity curve at 1033° K. and the measured data have been integrated directly to obtain the derived values. Bona fide transitions occur at 1183° and 1673° K., with associated heats of 215 and 165 cal./ gram atom, respectively. The melting point is listed as 1812° K. with a heat of melting of 3670 cal./gram atom. Liquid heat capacity data of Darken and Smith have been extrapolated to the boiling point.

Thermodynamic functions for the ideal monatomic gas have been calculated from spectroscopic data reported by Moore (241). The vapor pressure of iron has been measured by Jones, Langmuir, and Mackay (170), Marshall, Dornte, and Norton (223) and

Edwards, Johnston, and Ditmars (98). While agreement between the first two sets of observations is good, truly pure iron has only been produced within the last few years. Thus, we believe the slightly lower pressures reported by Edwards, Johnston, and Ditmars are more nearly correct. Their data yield a heat of sublimation at 298° K. of 99,830 cal./gram atom, a normal boiling point of 3160° K., and a heat of vaporization of 83,900 cal./gram atom.

KRYPTON

Clusius (60) reports 115.9° K. for the melting point and 391 cal./gram atom for the heat of melting. Michels, Wassenaar, and Zwietering (237) have measured the vapor pressure and find 119.75° K. for the normal boiling point. Clusius, Kruis, and Konnertz (64) have measured the heat of vaporization at the normal boiling point as 2158 cal./gram atom. Kobe and Lynn (193) give 209.4° K. as the critical temperature and 54.3 atmospheres for the critical pressure. Thermodynamic functions for the ideal monatomic gas have been calculated at the National Bureau of Standards (295).

LANTHANUM

Parkinson, Simon, and Spedding (257) have measured the heat capacity from 2° to 180° K., and calculate the entropy at 298° K. as 13.60 e.u. and the enthalpy at 298° K. as 1569 cal./gram atom. Kelley (185) reports the heat capacity of the solid above room temperature. Spedding and Daane (314) have reported the melting point at 1193° K. We estimate the heat of melting to be 2700 cal./gram atom. Kelley (187) has estimated the liquid heat capacity. Thermodynamic functions for the ideal monatomic gas have been calculated from the spectroscopic data reported in the Landolt-Bornstein Tabellen (208). Daane (78) has measured the vapor pressure from 1600° to 1900° K. By selecting a smoothed value in the middle of this range, we derive a heat of sublimation at 298° K. of 99,600 cal./gram atom. These data extrapolate to a normal boiling point of 3640° K. and a heat of vaporization at the normal boiling point of 95,500 cal./gram atom.

LEAD

Based on seven sets of measurements covering the range from 2° to 303° K., Kelley (186) computes the entropy at 298° K. to be 15.49 ± 0.05 e.u., while Meads, Forsythe, and Giauque (230) report the enthalpy at 298° K. to be 1644 cal./gram atom. Data for the solid and liquid heat capacity, melting point, and heat of melting have been adopted from the work of Douglas and Dever (90). Thermodynamic functions of the ideal monatomic gas have been computed from the energy levels listed in the Landolt-Bornstein Tabellen (208).

Vapor pressures have been measured by Baur and Brunner (23), Harteck (145), Rodebush and Dixon (269, 270), Fischer (111), von Leitgebel (211), Egerton (100), von Wartenberg (341), Ingold (164), Greenwood (130–132), and Ruff and Bergdahl (279). Measurements reported in the last six references are high in comparison with the remaining measurements and, in agreement with Kelley (180), we believe these high results are unreliable. Of the first seven references, we have given the most weight to the results of Rodebush and Dixon in calculating a heat of sublimation at 298° K. of 46,800 cal./gram atom. Extrapolation gives a normal boiling point of 2024° K. and a heat of vaporization at the normal boiling point of 42,880 cal./gram atom.

LITHIUM

Evans, Jacobson, Munson, and Wagman (105) have critically reviewed the literature and have selected a consistent set of values. They find the entropy at 298° K. to be 6.753 e. u., the enthalpy at 298° K. as 1092.2 cal./gram atom, the melting point as 453.70° K., and the heat of melting to be 722.8 cal./gram atom. They present the solid and liquid heat capacities as well as the thermodynamic properties of the ideal monatomic and diatomic gases. They have also summarized the vapor pressure data and derive heats of sublimation at 298° K. of 38,440 cal./gram atom and 50,470 cal./gram mole for the monatomic and diatomic gases, respectively. From these data we calculate that this system reaches a total pressure of one atmosphere at 1604° K., at which temperature the heat of vaporization to equilibrium gas is 32,190 cal./gram atom.

LUTETIUM

Skochdopole, Griffel, and Spedding (310) have estimated the entropy at 300° K. as 11.79 e. u. Spedding and Daane (314) report the melting point in the range from 1923° to 2023° K. and place the volatility between samarium and thulium. Klinkenberg (192) gives the available spectroscopic data from which we calculate the thermodynamic properties of the ideal monatomic gas. The remaining data are estimated, are consistent with the above facts and are intended for use only until measured information is available.

MAGNESIUM

The third law entropy based on measurements from 12° to 320° K. by Craig and coworkers (75) is 7.81 e. u. at 298° K. Using their heat capacities we calculate an enthalpy at 298° K. of 1195 cal./gram atom. In addition to the heat capacity data reviewed by Kelley (185), we have considered the values given by Kubaschewski (205, 206) and the measurements of McDonald and Stull (228). The heat of melting is 2140 cal./ gram atom from McDonald and Stull. Rossini and coworkers (274) have selected a melting point of 923° K.

Thermodynamic functions for the ideal monatomic gas have been calculated from the energy levels reported by Moore (241). Vapor pressure data measured by Baur and Brunner (23), Hartmann and Schneider (146), Greenwood (130), von Leitgebel (211), Schneider and Esch (285), Vetter and Kubaschewski (337), Ruff and Hartmann (280), and Coleman and Egerton (72) are in reasonably good agreement, except for Coleman and Egerton who are somewhat high. Giving the most weight to the results of Hartmann and Schneider, we calculate a heat of sublimation at 298° K. of 35,600 cal./gram atom, a normal boiling point of 1390° K., and a heat of vaporization at the normal boiling point of 30,750 cal./gram atom.

MANGANESE

Shomate (300), Kelley (177), Armstrong and Grayson-Smith (16), Elson, Smith, and Wilhelm (102), and Booth, Hoare, and Murphy (29) have reported low temperature heat capacity data. From these data we calculate an entropy and enthalpy at 298° K. of 7.65 e. u. and 1194 cal./gram atom, respectively. Above 298° K. Armstrong and Grayson-Smith (17) and Naylor (244) have reported heat capacity measurements which we regard as equally reliable. We adopt an average of these data to the first transition. Naylor finds transitions at 1000°, 1374°, and 1410° K., with accompanying transitional heats of 535, 545, and 430 cal./gram atom, respectively. The heat capacity between 1000° K. and the melting point has been adjusted to give the enthalpy found by Naylor. The melting point, heat of melting, and the liquid heat capacity have been given by Kelley (185) as 1517° K., 3500 cal./gram atom, and 11.00 cal./degree/gram atom, respectively.

Thermodynamic functions for the ideal monatomic gas have been calculated from the energy levels listed by Moore (241). Brewer (33) has reported the heat of sublimation at 298° K. as 66,730 cal./gram atom, which leads to a normal boiling point of 2314° K. and a heat of vaporization at 2314° K. of 52,520 cal./gram atom.

MERCURY

Busey and Giauque (48) have measured the heat capacities and transitional heats from about 15° to 300° K. Their melting point of 234.29° K. is in good agreement with that of Wilhelm (346) who found 234.287° K. and proposed this transition as a secondary

thermometric calibration point. Busey and Giauque (48) find 548.6 cal./gram atom for the heat of melting, 18.19 e.u. for the entropy of the liquid state at 298° K., and an enthalpy at 298° K. of 2232 cal./gram atom. Liquid heat capacities of Busey and Giauque have been adopted. They have extended their measurements by adjusting the values of Douglas, Ball, and Ginnings (89) to join smoothly with their own.

Thermodynamic functions for the ideal monatomic gas were calculated. Energy levels listed by Landolt-Bornstein Tabellen (208) indicate that below 3000° K. there is no electronic contribution. Busey and Giauque have reviewed the vapor pressure data and find the normal boiling point at 629.88° K., the heat of vaporization to the ideal monatomic gas at the normal boiling point of 14,137 cal./gram atom, while the heat of vaporization at 298° K. is 14,652 cal./gram atom. Beale (25) has recently measured the heat of vaporization as 13,595 \pm 23 cal./gram atom. Beale (24) points out that this heat of vaporization can only be made consistent with the other thermodynamic properties by assuming a much larger gas imperfection than that derived by Busey and Giauque from vapor pressure data. Experimental data on mercury vapor are needed to resolve the question.

MOLYBDENUM

Simon and Zeidler (305) have measured the low temperature heat capacity, which leads to an entropy and enthalpy at 298° K. of 6.83 ± 0.05 e.u. and 1092 cal./gram atom, respectively. Using the Shomate method (301), enthalpy measurements of Kothen (200) and Redfield and Hill (265) have been combined with the values selected by Kelley (185) to give the heat capacity of the solid to the melting point. We have adopted a melting point of 2890° \pm 10° K., which is an average of the values selected by Rossini and coworkers (274) and by Kelley (182). Brewer (35) estimates the heat of melting to be 6600 cal./gram atom. We estimate the liquid heat capacity to be 10.00 cal./degree/mole.

Thermodynamic properties of the ideal monatomic gas have been calculated from energy levels given in the Landolt-Bornstein Tabellen (208) and by Trees and Harvey (330). The vapor pressure has been measured by Jones, Langmuir, and Mackay (170) and by Edwards, Johnston, and Blackburn (97). These data have been averaged to obtain a heat of sublimation at 298° K. of 157,500 cal./gram atom, a normal boiling point of 5100° K., and a heat of vaporization at the normal boiling point of 142,000 cal./gram atom.

NEODYMIUM

Parkinson, Simon, and Spedding (257) have measured the heat capacity from 2° to 180° K., and report an entropy at 298° K. of 17.50 e.u. and an enthalpy of 1804 cal./gram atom. Spedding and Miller (315) have measured the heat capacity from 273° to 673° K. and support the equation given by Kelley (185). Spedding and Daane (314) report a transition point at 1141° K. and the melting point at 1297° K., and also give vapor pressure data. We have estimated the heats of transition and melting and the heat capacities of the solid above the transition and of the liquid. Using spectroscopic data from Klinkenberg (190) and Schuurmans (289) we have calculated the thermodynamic functions of the ideal monatomic gas. From these data we calculate a heat of sublimation at 298° K. of 76,800 cal./gram atom, a normal boiling point of 3360° K., and a heat of vaporization at the normal boiling point of 67,800 cal./gram atom.

NEON

Clusius (60) reports 24.55° K. as the melting point, with 80.1 cal./gram atom as the heat of melting. Henning and Otto (149) have measured the vapor pressure and find the normal boiling point at 27.07° K. From the heat of sublimation calculated by Clusius (59), we calculate the heat of vaporization at the normal boiling point to be 422 cal./gram atom. Thermodynamic functions for the ideal monatomic gas have been calculated at the National Bureau of Standards (295). Kobe and Lynn (193) report 45.5° K. for the critical temperature and 26.9 atmospheres for the critical pressure.

NICKEL

Busey and Giauque (47) have measured the third law entropy and enthalpy at 298° K. to be 7.137 e. u. and 1144 cal./gram atom, respectively. The heat capacity data selected by Sykes and Wilkinson (323) are in good agreement with the results of Neel (245) and Krauss and Warncke (203) up to the lambda point at 630° K. Above the lambda point, both Neel and Persoz (259) are from 6 to 7% above the coincident data of Sykes and Wilkinson, Kelley (185), and Krauss and Warncke. We have adopted the heat capacity data of Sykes and Wilkinson up to about 850° K., where it joins smoothly with Kelley's equation. Van Dusen and Dahl (336) have determined the melting point at 1728° \pm 1° K., while Kelley lists the heat of melting as 4210 cal./gram atom. Kelley's value of 9.20 cal./degree/gram atom has been used for the heat capacity throughout the liquid range.

Thermodynamic functions for the ideal monatomic gas have been calculated from the energy levels listed by Moore (241). Our calculations based on the vapor pressure data of Johnston and Marshall (169) give a heat of sublimation at 298° K. of 101,260 cal./gram atom, a normal boiling point of 3110° K., and a heat of vaporization of 88,870 cal./gram atom.

NIOBIUM

Brown, Zemansky, and Boorse (45) have measured the heat capacity up to 12° K. and also in the range from 65° to 75° K. We have used these meager data with a Debye function to calculate the entropy and enthalpy at 298° K. as 8.73 e.u. and 1264 cal./gram atom, respectively. Kelley (185) lists the heat capacity for the solid above 298° K. Reimann and Grant (266) have determined the melting point as 2770° K. We estimate the heat of melting of 6400 cal./gram atom and the liquid heat capacity.

Thermodynamic properties of the ideal monatomic gas have been calculated using energy levels listed by Moore (241). From the rate of evaporation measurements of Reimann and Grant (266), we calculate a heat of sublimation at 298° K. of 177,500 cal./ gram atom. Estimating the gaseous heat capacity to be 1 cal./degree/gram atom less than the liquid heat capacity in the range from 3000° to 5000° K., we calculate a normal boiling point of 5200° K. and a heat of vaporization at the normal boiling point of 166,500 cal./gram atom.

NITROGEN

Giauque and Clayton (121) have measured the low temperature heat capacity and give 55 cal./mole for the heat of transition and 172 cal./mole for the heat of melting. Corrected for changes in temperature scale, the transition temperature is 35.62° K. Furukawa and McCoskey (117) give the triple point as 63.18° K. Armstrong (15) has measured the vapor pressure and finds a normal boiling point of 77.36° K. Giauque and Clayton and Furukawa and McCoskey have measured the heat of vaporization. We have adopted an average value of 1335 cal./mole. The critical temperature of 126.26° K., and the critical pressure of 33.54 atmospheres have been measured by White, Friedman, and Johnston (344).

Wagman and coworkers (339) report the thermodynamic properties for the ideal diatomic gas, while the National Bureau of Standards (295) has published calculations of the thermodynamic functions for the ideal monatomic gas. The value of 225,100 cal./gram mole selected by Gaydon (118) for the dissociation energy at 0° K. is supported by the recent work of Douglas (87), Hendrie (148), Burns (46), Toennies and Greene (328), and Altshuller (6). This appears to conclude a voluminous literature on this subject. Note that the reference state represents 2 gram atomic weights for this element.

OSMIUM

The entropy at 298° K. has been estimated by Lewis and Gibson (212) to be 7.8 ± 0.5 e. u. Kelley (185) has given an equation for the solid heat capacity from 298° to 1800° K. which we have extrapolated to the melting point. We have assumed that the heat capacity of the liquid is the same as that of the solid at the melting point. We have

adopted the value of 3000° K. for the melting point based on the estimate of Vines (338). For a hexagonal close-packed lattice we adopt 2.3 e. u. for the entropy of melting, which leads to a heat of melting of 7000 cal./gram atom. Thermodynamic functions for the ideal monatomic gas have been calculated from energy levels listed in the Landolt-Bornstein Tabellen (208). At the suggestion of Brewer (33) we have lowered previous estimates of the boiling point to 4500° K., and have calculated a heat of sublimation at 298° K. of 160,000 cal./gram atom and a heat of vaporization at 4500° K. of 150,000 cal./gram atom.

OXYGEN

Hoge (159) has reviewed the literature and has assigned the transition points, 23.886° and 43.800° K., and the melting point, 54.363° K., as well as the critical temperature, 154.78° K., and the critical pressure, 50.14 atmospheres. Giauque and Johnston (122) have measured the heats of these transitions: 22.42 cal./mole at 23.886° K., 177.6 cal./mole at 43.800° K., and 106.3 cal./mole for the heat of melting. The presently accepted International Temperature Scale defines 90.190° K. (-182.97° C.) as the normal boiling point (319). A new absolute determination of 90.154° K. (using 0° C. = 273.16° K.) by Aston and Moessen (18) will be subject to review by the International Committee of Weights and Measures in 1960. Furukawa and McCoskey (117) have measured the heat of vaporization and have reviewed previous data. We have adopted an average value of 1630 cal./mole. Thermodynamic properties for the ideal diatomic gas have been calculated from spectroscopic data by Woolley (349). The National Bureau of Standards (295) has published calculations of the thermodynamic properties of the ideal monatomic gas. The dissociation energy of the ideal diatomic gas at 0° K. is given by Brix and Herzberg (41) as $117,960 \pm 40$ cal./gram mole. Note that the reference state represents 2 gram atomic weights for this element.

PALLADIUM

Based on the measurements of Clusius and Schachinger (68) as well as their own measurements, Pickard and Simon (260) calculate the entropy at 298° K. to be 9.05 e. u. and the enthalpy as 1308 cal./gram atom. We have adopted the solid heat capacity values above 298° K. of Kelley (185). Rossini and coworkers (274) have selected 1823° K. for the melting point and 4000 cal./gram atom for the heat of melting. We have estimated the heat capacity of the liquid to be the same as the solid at the melting point, 8.30 cal./degree/gram atom. Thermodynamic properties of the ideal monatomic gas have been computed from the spectroscopic data of Shenstone (298). From Brewer's (35) estimate of the vapor pressure, we calculate a heat of sublimation at 298° K. of 94,000 cal./gram atom, a normal boiling point of 3400° K., and a heat of vaporization at the normal boiling point of 90,000 cal./gram atom.

PHOSPHORUS

Farr (109), of the Tennessee Valley Authority, has compiled a resume of the physical and thermodynamic properties of the allotropic forms of phosphorus. Based on entropy calculations from low temperature heat capacity measurements, Stephenson (318) believes that red crystalline triclinic phosphorus (T.V.A. designation V) is the most stable form at room temperature. This point of view is buttressed by the x-ray work of Roth, DeWitt, and Smith (276). Consequently we have selected red phosphorus V as the reference state up to its sublimation point at 704° K.

Stephenson reports the entropy of the red triclinic crystals at 298° K. as 5.46 e. u.Farr has reported the heat capacity of this form to the sublimation point as well as a melting point of about 870° K. Spectroscopic data by Moore (241) on the monatomic species and by Herzberg (152, 153) for the diatomic and tetratomic species have been used to compute the thermodynamic functions of the ideal monatomic, diatomic, and tetratomic gases. From vapor pressure measurements reported by Farr, we calculate the heat of sublimation of red phosphorus V to the tetratomic ideal gas at 298° K. to be $30,820 \text{ cal./mole of } P_4$. The heat of sublimation of red phosphorus V to the ideal diatomic gas at 298° K. is calculated to be 42,725 cal./mole P_2 , based on the heat of the dissociation of P_4 to P_2 of 54,630 cal./mole of P_4 , derived from the measurements of Stock, Gibson, and Stamm (320). From Gaydon's (118) dissociation energy of 116,000 cal./mole of P_2 at 0° K. to ideal monatomic gas, we calculate a heat of sublimation of red phosphorus V at 298° K. to ideal monatomic gas of 79,800 cal./gram atom. At the normal sublimation point, 704° K., the vapor is completely composed of the tetratomic species. We calculate a heat of sublimation at 704° K. of 7200 cal./gram atom. Since in most of the temperature range from 704° to 3000° K. the diatomic form is predominant, we have selected the ideal diatomic gas as the reference state in this region. Note that the table for the reference state is for 1 gram atomic weight.

Stephenson reports the entropy of the white α (cubic)-form at 298° K. as 9.80 e. u. Kelley (185) lists the heat capacity of the solid and liquid forms and the heat of melting of 150 cal./gram atom at the melting point of 317.4° K. The heat of sublimation of the white α -form at 298° K. to ideal tetratomic gas is 14,100 cal./mole of P₄, based on the measurements of MacRae and Van Voorhis (218), Centnerszwer (52), and Fishbeck and Eich (113). A slightly higher value is obtained from the vapor pressure data listed by Farr (109) and may be due to nonideal behavior at high pressures. Farr lists the normal boiling point of liquid white phosphorus as 554° K., and we calculate a heat of vaporization to P₄ vapor at this temperature of 2960 cal./gram atom. In the temperature range from 600° to 800° K. liquid white phosphorus is rapidly converted to red phosphorus. The heat of formation at 298° K. of white α from red V derived from the data presented here is 4180 cal./gram atom, in good agreement with the value of 4200 cal./gram atom selected by Yost and Russell (351) from calorimetric measurements.

PLATINUM

From low temperature measurements by Kok and Keesom (195) and by Simon and Zeidler (305), Kelley (186) calculates the entropy at 298° K. as 10.00 ± 0.05 e. u. and we calculate an enthalpy at 298° K. of 1384 cal./gram atom. Kelley (185) also gives an equation for the solid heat capacity from 298° to 1800° K., which we have extrapolated to the melting point. We assume the heat capacity of the liquid to be the same as that of the solid at the melting point. Kelley (182) and Rossini and coworkers (274) are in substantial agreement on a melting point of 2043° K. and a heat of melting of 4700 cal./ gram atom.

Thermodynamic properties of the ideal monatomic gas have been calculated from energy levels listed in the Landolt-Bornstein Tabellen (208). Jones, Langmuir, and Mackay (170) have measured the vapor pressure. We calculate a heat of sublimation at 298° K. of 134,800 cal./gram atom, a normal boiling point of 4100° K., and a heat of vaporization at the normal boiling point of 122,000 cal./gram atom.

POLONIUM

Maxwell (224) and Beamer and Maxwell (26) have measured the melting point as 527° K. and find a transition at about 370° K. The sluggish nature of the transition suggests a small heat of transition which can be neglected. Brooks (44) has measured the vapor pressure from 711° to 1018° K., which can best be fit by assuming both diatomic and monatomic species to be present in the vapor. This view finds support in that the diatomic form is important in bismuth and tellurium, neighboring elements in the periodic table. The thermodynamic functions of the ideal gases as well as the entropy, heat capacity, and heat of melting of the solid and the heat capacity of the liquid are all estimated. These estimates were used in calculating the heats of sublimation at 298° K. of the monatomic and diatomic species as 34,450 and 32,900 cal./mole, respectively. The boiling point is 1235° K. and the heat of vaporization to equilibrium gas at 1235° K. is 14,400 cal./ gram atom.

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POTASSIUM

The low temperature measurements of Dauphinee, Martin, and Preston-Thomas (82) and of Wallace, Craig, and Krier (340) are in excellent agreement and lead to an entropy and enthalpy at 298° K. of 15.39 e.u. and 1695 cal./gram atom, respectively. Evans, Jacobson, Munson, and Wagman (105) have critically reviewed the literature and have selected a consistent set of values. We have used their values for the heat capacities of the condensed states. They report 336.4° K. for the melting point and 554 cal./gram atom for the heat of fusion. They present complete thermodynamic functions for the ideal monatomic and diatomic gases as well as the dissociation energy. Employing their evaluation of the vapor pressure data and adjusting for the above new entropy value, we calculate the heats of sublimation at 298° K. to be 21,420 cal./gram atom and 30,580 cal./gram mole to the ideal monatomic and diatomic gases, respectively. We calculate a normal boiling point of 1039° K. and an associated heat of vaporization of 18,530 cal./gram atom of equilibrium gas. This boiling point is higher than the 1027° K. recently reported by Makansi, Madsen, Selke, and Bonilla (221).

PRASEODYMIUM

Parkinson, Simon, and Spedding (257) have measured the heat capacity from 2° to 180° K., and report the entropy at 298° K. to be 17.45 e. u., and the enthalpy as 1697 cal./ gram atom. We have extrapolated the solid heat capacity to the transition point at 1071° K. and the melting point at 1208° K., both of which are reported by Spedding and Daane (314). We estimate the heat of this transition to be 320 cal./gram atom and the heat of melting to be 2400 cal./gram atom. We have estimated the heat capacity of the liquid. Daane (78) has measured the vapor pressure from 1425° to 1692° K. and, reports 3290° ± 90° K. for the normal boiling point and 79,500 ± 1100 cal./gram atom for the heat of vaporization by a second law extrapolation. Spectroscopic data are not available to make a third law check of these values.

PROMETHIUM

Skochdopole, Griffel, and Spedding (310) estimate the entropy at 300° K. to be 17.25 e. u. All other values are estimated and are intended to serve only until measured values are available.

PROTACTINIUM

All data are estimated and are intended to serve only until measured values are available.

RADIUM

Rossini and coworkers (274) list 973° K. for the melting point. Landolt-Bornstein Tabellen (208) present spectroscopic data for the ideal monatomic gas. The remainder of these data are estimated and are intended to serve only until measured values are available.

RADON

Rossini and coworkers (274) estimate 202° K. as the melting point, 693 cal./gram atom as the heat of melting, 211° K. as the normal boiling point, and 3920 cal./gram atom as the associated heat of vaporization. Thermodynamic properties of the ideal monatomic gas have been calculated at the National Bureau of Standards (295).

RHENIUM

Smith, Oliver, and Cobble (312) have measured the low temperature heat capacity and report 8.887 e. u. and 1307 cal./gram atom for the entropy and enthalpy at 298° K., respectively. Kelley's (185) solid heat capacity equation, based on data to 1500° K., has been extrapolated to 3000° K. Sims, Craighead, and Jaffee (306) have measured the melting point and report $3453^{\circ} \pm 20^{\circ}$ K. Estimating the entropy of melting to be 2.3 e.u., which is reasonable for a hexagonal close-packed structure, we calculate 7900 cal./ gram atom for the heat of melting. Thermodynamic functions for the ideal monatomic gas have been calculated using spectroscopic data given by Klinkenberg (191). Sherwood, Rosenbaum, Blocher, and Campbell (299) have measured the vapor pressure and estimate the liquid heat capacity at 10.8 cal./degree/gram atom. We have calculated a heat of sublimation at 298° K. of 185,650 cal./gram atom, a normal boiling point of 5900° K., and an associated heat of vaporization of 169,000 cal./gram atom.

RHODIUM

Lewis and Gibson (212) have estimated the entropy at 298° K. to be 7.6 \pm 0.5 e. u. Kelley (185) gives an equation for the heat capacity of the solid which we have extrapolated to the melting point. We have assumed the heat capacity of the liquid to have the same constant value as the solid at the melting point. The melting point selected by Vines (338) is confirmed by the recent work of Oriani and Jones (255) at 2239° \pm 3° K. For a face-centered cubic lattice we employ an entropy of melting of 2.3 e. u., which leads to a heat of melting of 5200 cal./gram atom. Thermodynamic functions for the ideal monatomic gas have been calculated from the spectroscopic data of Molnar and Hitchcock (239). We estimate the normal boiling point as 4000° K., leading to a heat of sublimation at 298° K. of 133,000 cal./gram atom and a heat of vaporization at the normal boiling point of 118,400 cal./gram atom.

RUBIDIUM

From the low temperature measurements of Dauphinee, Martin, and Preston-Thomas (32), we calculate an entropy and enthalpy at 298° K. of 18.22 e. u. and 1790 cal./ gram atom, respectively. These workers report 560 cal./gram atom for the heat of melting. Rossini and coworkers (274) select 312.0° K. for the melting point. We have estimated an average heat capacity for the liquid range. Evans, Jacobson, Munson, and Wagman (105) present the thermodynamic properties of the ideal monatomic and diatomic gases, as well as the dissociation energy of the diatomic gas. Vapor pressure has been measured by Scott (290), Hackspill (141), Ruff and Johannsen (281), and Killian (188). At 298° K. we calculate the heat of sublimation to the ideal diatomic gas as 27,550 cal./gram mole and the heat of sublimation to the ideal monatomic gas as 19,600 cal./gram atom. The total pressure in the gas phase reaches one atmosphere at 974° K., at which temperature the heat of vaporization to equilibrium gas is 16,540 cal./gram atom.

RUTHENIUM

Lewis and Gibson (212) have estimated the entropy at 298° K. to be 6.9 ± 0.5 e. u. We adopt Kelley's (185) values for the solid heat capacity and the heats and temperatures of the transitions: at 1308° K. a heat of 60 cal./gram atom; at 1473° K. a second order transition (no heat change); and at 1773° K. a heat of 320 cal./gram atom. Brewer (35) estimates the melting point as 2700° K. and the heat of melting as 6100 cal./gram atom. We estimate a boiling point of 4000° K., which leads to a heat of sublimation at 298° K. of 144,000 cal./gram atom and a heat of vaporization at the normal boiling point of 135,700 cal./gram atom. The heat capacity of the liquid and the gas are assumed to be equal in the range from 3000° to 4000° K.

SAMARIUM

Skochdopole, Griffel, and Spedding (310) estimate the entropy at 300° K. to be 16.32 e. u. We have estimated the heat capacities of the solid and liquid states. Spedding and Daane (314) report a transition at 1190° K. and the melting point at 1325° K. We have estimated the heats of these phase changes. Spectroscopic data from Brix (40) and Albertson (5) have been used to calculate the thermodynamic functions of the ideal monatomic gas. Spedding (313) indicates that the vapor pressure reaches 0.01 mm. of mercury at a temperature less than 1073° K. Assuming it to be 0.01 mm. at 1000° K., we calculate a heat of sublimation at 298° K. of 50,000 cal./gram atom, a normal boiling point of 1860° K., and a heat of vaporization at the normal boiling point of 45,800 cal./gram atom.

SCANDIUM

The entropy at 298° K. has been estimated to be 9.0 e. u. by Brewer (35). Kelley (187) has estimated the heat capacity of the solid and the liquid as well as the melting point, 1673° K., and the heat of melting, 3850 cal./gram atom. We estimate the normal boiling point to be 2750° K., which may be in error by several hundred degrees. Assuming the gas to be ideal and monatomic, we have calculated the thermodynamic functions from the energy levels given by Moore (241). From these data, we calculate the heat of sublimation at 298° K. to be 82,000 cal./gram atom and the heat of vaporization at the normal boiling point as 72,850 cal./gram atom.

SELENIUM

DeSorbo (84) has recently measured the heat capacity from 15° to 300° K., and calculates an entropy and enthalpy at 298° K. of 10.15 ± 0.05 e. u. and 1319.2 cal./gram atom, respectively. The low temperature heat capacity has been extended linearly to the melting point using the measured data of Monval (240) and Borelius and Paulson (30). We adopt the values of Kelley (185) for the melting point, 490° K., the heat of melting, 1300 cal./gram atom, and the heat capacity of the liquid. Thermodynamic functions for the ideal monatomic gas have been calculated from the energy levels listed by Moore (241), while those for the ideal diatomic gas are based on the spectroscopic data given by Herzberg (152). The heat capacity of the ideal hexatomic gas has been estimated.

Vapor pressures have been measured by Brooks (43), deSelincourt (296), Niwa and Sibata (249), Neumann and Lichtberger (248), and Preuner and Brockmöller (262). An entropy of 110 e. u. at 298° K. for the hexatomic gas and heats of sublimation at 298° K. of 35,380 and 34,120 cal./mole for the hexatomic and diatomic species, respectively, were selected to give the best fit with the vapor pressure data. Gaydon (118) gives the dissociation energy of the diatomic gas as 64,600 cal./mole, from which we calculate the heat of sublimation at 298° K. of the ideal monatomic gas to be 49,400 cal./gram atom. At the normal boiling point, 958° K., we calculate a heat of vaporization of 1 gram atom of selenium to equilibrium gas to be 6290 cal. Note that the values given for the reference state are based on 1 gram atom of selenium and that the diatomic gas is selected as the reference state above the boiling point.

SILICON

Using the low temperature heat capacity data of Pearlman and Keesom (258), Nernst and Schwers (246), Magnus (219), and Anderson (8), we calculate a third law entropy at 298° K. of 4.53 ± 0.05 e. u. and an enthalpy of 769 cal./gram atom. Since the measured data for the solid heat capacity of Serebrennikov and Gel'd (297) and Magnus (219) are in agreement, we have chosen the equation given by the former. Hansen and coworkers (144) have measured the melting point to be 1683° \pm 5° K., while Korber and Oelsen (198) give the value 11,100 cal./gram atom for the heat of melting. We estimate the heat capacity of the liquid state to be equal to that of the solid state at the melting point and obtain the value 7.0 cal./degree/gram atom. Thermodynamic properties of the ideal monatomic gas were calculated using energy levels listed by Moore (241). Although Honig (161) has detected polyatomic species in silicon vapor, there is not sufficient information available to calculate the thermodynamic functions of these species. Honig gives the heat of sublimation of the monatomic species as 105,000 cal./gram atom and calculates a boiling point of about 2950° K., considerably higher than earlier determinations of Ruff and Konschak (283) and Baur and Brunner (23). This high value is supported by the spectroscopic work of Barrow and Rowlinson (21). Without more spectroscopic data on the polyatomic species we cannot check the boiling point or calculate the heat of vaporization to equilibrium gas by third law methods.

SILVER

Based on five different sets of measurements from 1° to 303° K., Kelley (186) calculates the entropy at 298° K. as 10.20 ± 0.05 e.u., while Meads, Forsythe, and Giauque (230) calculate an enthalpy at 298° K. of 1373 cal./gram atom. The measurements of Lyashenko (215) have been considered along with sources listed by Kelley (185) in selecting the solid heat capacity from 298° K. to the melting point. The defined melting point on the International Temperature Scale as described by Stimson (319) is 1233.95° K. The heat of melting, 2,700 cal./gram atom, is a rounded value reached by considering those reported by Kubaschewski and coworkers (206), by Wittig (347), and by Kelley (179, 182, 185). The liquid heat capacity has been estimated as 7.5 cal./degree/gram atom.

Thermodynamic functions of the ideal monatomic gas have been calculated from the spectroscopic data listed in Landolt-Bornstein Tabellen (208). Kelley (180) selects the vapor pressure data of Harteck (145) as being the most reliable of the older data. Harteck is in fair agreement with the measurements of Fischer (111) and McCabe and Birchenall (2265b), while Lyubimov and Granovskaya (217) are too low and Baur and Brunner (23) are too high. We find a heat of sublimation at 298°K. of 68,400 cal./gram atom, a normal boiling point of 2450°K., and a heat of vaporization at the normal boiling point of 60,960 cal./gram atom. Searcy, Freeman, and Michel (294) have recently indicated that polyatomic species may be important in silver vapor.

SODIUM

Low temperature measurements of Dauphinee, Martin, and Preston-Thomas (82), Simon and Zeidler (305) and Parkinson and Quarrington (256) were used to calculate an entropy and enthalpy at 298° K. of 12.21 e. u. and 1532 cal./gram atom, respectively. Published values of other thermodynamic properties have been reviewed by Evans, Jacobson, Munson, and Wagman (106). They select the melting point to be 370.97° K. and the heat of melting as 621.8 cal./gram atom. They present data on the solid and liquid heat capacity, thermodynamic functions of the ideal monatomic and diatomic gases, and the dissociation energy. Consistent with this information we find the heats of sublimation at 298° K. to ideal monatomic and diatomic gases as 25,900 and 33,800 cal./ mole, respectively. The total pressure reaches one atmosphere at 1163° K. and the heat of vaporization to equilibrium gas at this temperature is 21,280 cal./gram atom. A more comprehensive review of the physical and thermodynamic properties of sodium has been compiled by Thomson and Garelis (325).

STRONTIUM

Kelley (186) estimates the entropy at 298° K. as 12.5 ± 0.5 e. u. The solid heat capacity above room temperature was estimated by comparison with calcium. Eastman, Cubicciotti, and Thurmond (93) have reported a transition point at 862° K. and a melting point of 1043° K., in good agreement with the review of Kubaschewski, Brizgys, Huchler, Jauch, and Reinartz (206). Kubaschewski and coworkers (206) have estimated

the heat of melting to be 2200 cal./gram atom. We estimate the heat of the transition to be 200 cal./gram atom by comparison with calcium. Thermodynamic functions of the ideal monatomic gas have been calculated from the energy levels listed by Moore (241). Vapor pressures measured by Hartmann and Schneider (146) and by Priselkov and Nesmeianov (263) are in fair agreement, and lead to a heat of sublimation at 298° K. of 39,100 cal./gram atom, a normal boiling point of 1640° K., and a heat of vaporization of 33,200 cal./gram atom.

SULFUR

Eastman and McGavock (94) have measured the heat capacity of the solid from 12° to 366° K., from which can be derived for the rhombic form at 298° K. an entropy and enthalpy of 7.62 e. u. and 1053 cal./gram atom, respectively. Braune and Moller (31) have measured the heat capacity of the liquid and have reviewed previous work. They list a heat of transition from rhombic to monoclinic of 90 cal./gram atom at 368.6° K. and the heat of melting as 337 cal./gram atom at 392° K. The boiling point of sulfur is defined on the International Temperature Scale as 717.75° K. (444.60° C.) as described by Stimson (319).

Guthrie, Scott, and Waddington (140) have calculated thermodynamic functions of the octatomic gas as well as the heat of sublimation of this form to be 24,350 cal./mole at 298° K., while Evans and Wagman (107) present data for the diatomic form, including the heat of sublimation of 30,840 cal./mole at 298° K. As noted by Guthrie, Scott, and Waddington, these data cannot be reconciled with the vapor density data for sulfur recently determined by Braune, Peter, and Neveling (32). Luft (214) has attempted to correlate the data by postulating several gaseous species between the octatomic and the diatomic forms, but does not appear to give enough weight to the heat of sublimation of the diatomic gas derived by Evans and Wagman. We believe additional data are needed to define completely the sulfur vapor phase and have, therefore, presented only the data for octatomic, diatomic, and monatomic forms. Evans and Wagman give the thermodynamic functions of the monatomic gas, while the dissociation energy of the diatomic form was taken from the work of St. Pierre and Chipman (321). An approximate value of the heat of vaporization can be derived using the equilibrium constants derived by Braune, Peter, and Neveling. At the normal boiling point the value calculated is 2300 cal./gram atom.

TANTALUM

Low temperature data have been given by Kelley (178) Keesom and Desirant (175), Simon and Ruhemann (303), and Clusius and Gutierrez Losa (62), from which we calculate an entropy and enthalpy at 298° of 9.90 e. u. and 1358 cal./gram atom, respectively. Hoch (157), Jaeger and Veenstra (167), and Magnus and Holzmann (220) have measured the heat capacity of the solid to 2939°, 1828° and 1173° K., respectively. We have smoothed these data by the method of Shomate (301) and have extrapolated them to 3000° K. Brewer (35) lists the melting point as 3270° K. and the heat of melting as 7500 cal./gram atom.

Thermal properties of the ideal monatomic gas have been calculated from the spectroscopic data of Van Den Berg, Klinkenberg, and Van Den Bosch (334). Edwards, Johnston, and Blackburn (95), Langmuir and Malter (209), and Fiske (114) have measured the vapor pressure. Data reported by the first two sources are in good agreement but lower than that of Fiske. Using the data of the first two sources, we calculate a heat of sublimation to ideal monatomic gas at 298° K. of 186,800 cal./gram atom. Assuming the heat capacity of the liquid and the gas above 3000° K. to be equal, we compute a normal boiling point of 5700° K. and an accompanying heat of vaporization of 180,000 cal./gram atom.

TECHNETIUM

Brewer (35) has estimated the entropy at 298° K. to be 8.0 e. u., the heat capacity of the solid, the melting point as 2400° K., and the heat of melting as 5500 cal./gram atom. The spectroscopic data of Meggers (232) have been employed to calculate the thermodynamic functions of the ideal monatomic gas. Using Brewer's estimate of the vapor pressure at 3000° K. and estimating ΔC_p to be 3.5 cal./degree/gram atom, we calculate a heat of sublimation at 298° K. of 155,000 cal./gram atom, a normal boiling point of 4900° K., and an accompanying heat of vaporization of 138,000 cal./gram atom.

TELLURIUM

Based on the low temperature measurements of Slansky and Coulter (311) and of Anderson (13), Kelley (186) calculates the entropy at 298° K. as 11.88 ± 0.10 e. u., and we compute the enthalpy at 298° K. as 1463 cal./gram atom. Kubaschewski (205) has given the heat capacity of the solid and liquid states and lists 723° K. as the melting point and 4180 \pm 130 cal./gram atom as the heat of melting. Spectroscopic energy levels listed in Landolt-Bornstein Tabellen (208) have been employed to calculate the thermodynamic properties of the ideal monatomic gas. The computations of Kelley (185, 186) on the thermodynamic properties of the ideal diatomic gas have been extended to 3000° K. Gaydon (118) gives the dissociation energy of the diatomic gas at 0° K. as 53,000 cal./ gram mole.

The vapor pressures measured by Brooks (43) fall between those of Schneider and Schupp (286) and Doolan and Partington (86), and extrapolate nicely to those of Niwa and Sibata (250), who show the gas to be diatomic in the temperature range from 593° to 683° K. From the foregoing information we calculate the heat of sublimation at 298° K. to ideal monatomic and diatomic gases as 46,500 and 39,600 cal./gram mole, respectively. The total vapor pressure reaches one atmosphere at 1260° K. and the accompanying heat of vaporization to equilibrium gas is 12,100 cal./gram atom.

TERBIUM

Skochdopole, Griffel, and Spedding (310) estimate the entropy at 300° K. as 17.5 e. u. Spedding and Daane (314) indicate the melting point is between 1673° and 1773° K. The remainder of the values are estimated by analogy with neighboring elements and should be used only until measured data are available.

THALLIUM

The entropy at 298° K. is 15.35 ± 0.06 e. u. as given by Kelley (186). From the measurements of Hicks (154) we calculate the enthalpy at 298° K. as 1632 cal./gram atom. Recent measurements of the solid and liquid heat capacities and heats of transitions have been made by Kubaschewski and coworkers (205, 206) and by Oelsen and coworkers (253, 254). Considering also the review of Kelley (185), we have selected the heat capacities, the transition point of 507° K. with associated heat of transition of 90 cal./gram atom, as well as a melting point of 577° K. and a heat of melting of 1020 cal./gram atom. Meggers and Murphy (234) have reported spectroscopic data which we have used to calculate the thermodynamic functions of the ideal monatomic gas. Vapor pressures have been reported by Gibson (125), von Leitgebel (211), and Coleman and Egerton (72). We calculate a heat of sublimation at 298° K. of 43,000 cal./gram atom, a normal boiling point of 1740° K., and an accompanying heat of vaporization of 38,740 cal./gram atom.

THORIUM

Griffel and Skochdopole (134) have measured the heat capacity from 20° to 300° K., and report an entropy and enthalpy at 298° K. of 12.760 e. u. and 1556 cal./gram atom, respectively. Kelley (185) has reported an equation for the solid heat capacity which we have adjusted to fit the low temperature data and extrapolated to the melting point. Chiotti (53, 54) has recently shown the presence of a solid state transition from a facecentered to a body-centered lattice at 1673° K. and has determined the melting point as 1968° K. We have estimated the heat of transition and heat of melting as 670 and 3740 cal./gram atom, respectively. The liquid heat capacity is also estimated. Based on the work of Zwikker (352), Brewer (35) has calculated the normal boiling point at 4500° K. and a heat of vaporization of 130,000 cal./gram atom. The term values of thorium gas have not yet been determined and no thermodynamic functions for the gas can be calculated.

THULIUM

Skochdopole, Griffel, and Spedding (310) estimate the entropy at 300° K. as 17.10 e. u. Spedding and Daane (314) place the melting point between 1823° and 1923° K. and believe the volatility is between that of dysprosium and lutetium. Meggers (231) lists the available spectroscopic data. The information listed has been estimated and is consistent with the above known facts. These values are intended for use only until measured data are available.

TIN

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On the basis of five sets of low temperature data covering the range from 1° to 287° K., Kelley (186) calculates an entropy value of 12.29 e. u. at 298° K. for white tin, and we calculate the enthalpy as 1507 cal./gram atom. Jovanovic (172) has measured the heat of transition of gray to white tin at 292° K. and gives 535 ± 8 cal./gram atom. The heat capacity of the solid and liquid have been adopted from the compilation of Kelley (185), who also gives the heat of melting as 1720 cal./gram atom at 505° K. Thermodynamic functions of the ideal monatomic gas have been calculated from the energy levels listed in Landolt-Bornstein Tabellen (208).

Of the vapor pressure measurements reviewed by Baughan (22), only those of Harteck (145) are in agreement with the recent measurements of Brewer and Porter (38) and Searcy and Freeman (292). Searcy and Freeman have demonstrated that tin vapor is monatomic. We adopt a rounded value of 72,000 cal./gram atom for the heat of sublimation at 298° K., and further calculate a normal boiling point of 2960° K. with an accompanying heat of vaporization of 69,400 cal./gram atom.

TITANIUM

Kothen and Johnston (201) have measured the heat capacity of a high purity sample from 15° to 305° K., and report an entropy and enthalpy at 298° K. of 7.33 ± 0.02 e. u. and 1150 cal./gram atom, respectively. Kothen (200) and Jaeger, Rosenbohm, and Fonteyne (166) have measured the heat content, from which we derive the heat capacity of the solid and the heat of transition of 950 cal./gram atom. Edwards, Johnston, and Ditmars (99) have confirmed McQuillan's (229) value of 1155° K. for the transition temperature. Of the recent values listed for the melting point (3, 143, 226a, 255, 287), we have taken an average value of $1950^{\circ} \pm 20^{\circ}$ K. No direct measurement of the heat of melting has been made, but the average entropy of melting for body-centered cubic elements is about 1.9 e. u. On this basis we have used a heat of melting of 3700 cal./gram atom. The heat capacity of the liquid has been estimated.

Thermodynamic functions of the ideal monatomic gas have been calculated from the energy levels of Moore (241), and are in good agreement with those of Kolsky and Gilles (196). Vapor pressure measurements have been made by Edwards, Johnston, and Ditmars (99), who have corrected the results of Blocher and Campbell (27) and Carpenter and Mair (51). From these data we calculate a heat of sublimation at 298° K. of 112,600 cal./gram atom, a normal boiling point of 3550° K., and an associated heat of vaporization of 102,500 cal./gram atom.

TUNGSTEN

Kelley (186) reports the entropy at 298° K. as 8.04 ± 0.10 e. u. From the same data we calculate the enthalpy at 298° K. as 1216 cal./gram atom. Solid heat content measurements of Magnus and Holzmann (220), Jaeger and Rosenbohm (165), and Hoch (157) are in good agreement and have been smoothed by the method of Shomate (301) and extrapolated to 3000° K. Brewer (35) lists the melting point as 3650° K. and the heat of melting as 8420 cal./gram atom. Thermodynamic functions for the ideal monatomic gas have been calculated from energy levels listed in Landolt-Bornstein Tabellen (208). From the vapor pressure measurements of Jones, Langmuir, and Mackay (170) we calculate a heat of sublimation at 298° K. of 200,000 cal./gram atom. By estimating the heat capacity of liquid and gas from 3000° to 6000° K. at 8.5 and 7.5 cal./degree/gram atom, respectively, we find a normal boiling point of 5800° K. and an accompanying heat of vaporization of 191,000 cal./gram atom.

URANIUM

Jones, Gordon, and Long (171) have measured the heat capacity from 15° to 300° K., and report an entropy of 12.03 ± 0.03 e. u. at 298° K. We calculate the enthalpy at 298° K. to be 1559 cal./gram atom. We have adopted the heat capacity of the solid and the heats and temperatures of transition as measured by Ginnings and Corruccini (126). The melting point of $1406^{\circ} \pm 2^{\circ}$ K. seems well established from the measurements of Dahl and Cleaves (79), Udy and Boulger (331), and Buzzard, Liss, and Fickle (49). We have estimated the heat capacity of the liquid to be the same as the solid at the melting point.

Van Den Bosch and Van Den Berg (335) have reported spectroscopic energy levels from which we have calculated the thermodynamic functions of the ideal monatomic gas. From the vapor pressure measurements of Rauh and Thorn (264), we calculate the heat of sublimation at 298° K. to be 117,160 cal./gram atom, the heat of fusion at the melting point to be 3700 cal./gram atom, the normal boiling point as 4200° K., and the heat of vaporization at the normal boiling point as 101,000 cal./gram atom.

VANADIUM

Anderson (11) has measured the heat capacity from about 50° to 300° K. and computes an entropy at 298° K. of 7.01 \pm 0.10 e. u. We calculate a heat content of 1122 cal./gram atom from his data. The heat capacity of the solid has been derived from the data of Jaeger and Veenstra (167). Recent measurements of the melting point by Oriani and Jones (255) and by Adenstedt, Pequignot, and Raymer (3) are in reasonable agreement and we adopt the value 2190° \pm 10° K. In the absence of a measured value for the heat of melting, we have used 1.9 e. u., the average entropy of melting for body-centered cubic elements, and calculate a heat of melting of 4200 cal./gram atom. By comparison with chromium and titanium, the heat capacity of the liquid has been estimated to be 9.50 cal./degree/gram atom.

Thermodynamic functions for the ideal monatomic gas state have been calculated from the spectroscopic energy levels of Moore (241). From the vapor pressure measurements of Edwards, Johnston, and Blackburn (96), we calculate a heat of sublimation at 298° K. of 122,750 cal./gram atom, a normal boiling point of 3650° K., with an accompanying heat of vaporization of 109,600 cal./gram atom.

XENON

A melting point of 161.3° K. and heat of melting of 549 cal./gram atom have been reported by Clusius and Riccoboni (65). Michels and Wassenaar (236) have measured the vapor pressure and find the normal boiling point at 165.04° K. in good agreement with the measurements of Clusius and Wiegand (71), who also report 3021 cal./gram atom

for the heat of vaporization at this temperature. Kobe and Lynn (193) adopt 256.57° K. as the critical temperature and 58.0 atmospheres as the critical pressure. Thermodynamic functions of the ideal gas have been calculated at the National Bureau of Standards (295).

YTTERBIUM

Spedding and Daane (314) report a transition at 1071° K. and the melting point at 1097° K. They indicate the volatility to be between europium and samarium. Thermodynamic functions of the ideal monatomic gas have been calculated from energy levels given in Landolt-Bornstein Tabellen (208). The information listed for the reference state is consistent with the above facts and has been estimated. It is intended that this information will serve only until measured data are available.

YTTRIUM

Brewer (35) estimates the entropy at 298° K. as 11.0 e. u. Kelley (187) has estimated the heat capacities of the solid and liquid, as well as the melting point of 1773° K. and the heat of melting of 4100 cal./gram atom. Brewer (35) has estimated the normal boiling point of 3500° K. The energy levels listed by Moore (241) have been used to calculate the thermodynamic functions of the ideal monatomic gas. Consistent with these estimates, we have computed the heat of sublimation at 298° K. to be 102,000 cal./gram atom, and a heat of vaporization at the normal boiling point of 94,000 cal./gram atom.

ZINC

Kelley (186) lists the entropy at 298° K. as 9.95 ± 0.05 e. u. Barrow and coworkers (20) have calculated the enthalpy at 298° K. to be 1349 cal./gram atom. Kelley (185) also reports the heat capacity of the solid and the liquid states, based on numerous sources. His value of the melting point, 692.7° K., and his heat of melting, 1765 cal./ gram atom, have been recently confirmed by Kubaschewski and coworkers (206). Thermodynamic functions for the ideal monatomic gas have been calculated from the energy levels of Moore (241). Barrow and coworkers (20) have reviewed the vapor pressure information and find the heat of sublimation at 298° K. to be 31,180 cal./gram atom. We calculate a normal boiling point of 1181° K. with an accompanying heat of vaporization of 27,560 cal./gram atom.

ZIRCONIUM

Skinner and Johnston (309) have measured the heat capacity from 14° to 300° K. and Todd (327) has measured the range from 51° to 298° K. The entropies at 298° K. are in good agreement and we adopt the value 9.29 ± 0.04 e. u. Skinner and Johnston (309) report an enthalpy at 298° K. of 1313 cal./gram atom. Skinner (307) has used his own measurements and those of Coughlin and King (74) to calculate the thermodynamic functions for the solid state. Skinner finds a transition at 1143° K. with an associated heat change of 1040 cal./gram atom. Adenstedt (2) and Oriani and Jones (255) are in good agreement that the melting point is 2125° K. No direct measurement of the heat of melting has been made, but the average entropy of melting for bodycentered cubic elements is about 1.9 e. u. On this basis, we have used a heat of melting of 4000 cal./gram atom. The heat capacity of the liquid has been estimated.

Thermodynamic functions of the ideal monatomic gas state have been calculated from the spectroscopic data of Moore (241). Values recently reported by Kolsky and Gilles (197) are in agreement. Skinner, Edwards, and Johnston (308) have reported the only vapor pressure data measured from 1949° to 2054° K. Their data lead to a heat of sublimation at 298° K. of 146,000 cal./gram atom, a normal boiling point of 4650° K., and an accompanying heat of vaporization of 139,000 cal./gram atom.

ACTINIUM	Ac		Solid	Solid from 298°	• to 1470	to 1470°, Liquid from 1470° to 3000°.	from 147	0° to 300	•••
REFERENCE STATE	ATE								
_{64w} 227.	GRAMS	-	e	9H - 9H	2	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
(H ^o _{296,15} H ^o) =	CAL/GFW.	TEMPERATURE °K	P HEAT CAPACITY CAL./DEG./ GFW.	T 298.15 HEAT CONTENT CAL./ GPV.	T ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H ^e cal/gfw.	FREE ENERCY & F	л н 1 м 1 м
		298	6.50	0	15.00	15.00			
(1,470)	*	300	6.50	12	15.04	15.00			
		400	6.70	670	16.94	15.27			
△Hm (5,400,	CAL. /GFW.	500	6.90	1350	18.45	15.75			
		600	7.10	2050	19.73	16.32			
		700	7.30	2770	20.84	16.89			
B.P. (5,600)	*	800	7.50	3510	21.83	17.45			
		006	7.70	4270	22.72	17.98			
(000, c ^k) ₁ , M∆	CAL /GFW.	1000	7.90	5050	23.54	18.45			
		1100	8.10	5850	24.30	18,99			
		1200	8.30	6670	25•02	19.47			
S.P.	¥	1300	8.50	7510	25.69	19. 92			
		1400	8.70	8370	26.33	20.36			
ΔHs	CAL. /GFW.	1500	8 • 00	12650	29•24	20.81			
		1600	8.00	13450	29.76	21.36			
		1700	8 • 00	14250	30.25	21.87			
T.P.	*	1800	8 • 00	15050	30.70	22.34			
:		1900	000	15850	31.14	22.80			
∆H,	CAL. /GFW.	2100		17450	40-16	23.65			
		2200	8.00	18250	32.31	24.02			
1.6		2300	8 • 00	19050	32.66	24.38			
	4	2400	8.00	19850	33.00	24.73			
ΔH.	CAL /GFW.	2500	8.00	20650	33 •3 3	25.07			
-		2600	8.00	21450	33.64	25.39			
		2700	8 • 00	22250	33 • 95	25.71			
	or.	2800	8 • 00	23050	34 • 24	26.01			
-	2	2900	8 •0 0	23850	34.52	26.30			
Pc =	ATM.	3000	8 •0 0	24650	34.79	26.58			
		_							

Tabulated Values of Thermodynamic Properties

36

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

ACTINIUM

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: January
Date
Publication

ALUM	ALUMINUM	TA			Solid fro	m 298° to	Solid from 298° to 932°, Liquid from 932°	quid from	1 932° to		
REFE	REFERENCE STATE	ATE			2720°, Id	eal Monat	2720°, Ideal Monatomic Gas from	from 2720°	° to 3000°	•	-
*5 5	26.98	GRAMS	-	ۍ ه	H ^o - H ^o 7 24615	°.'	-(10-10 -210.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE	
(H ⁰ 298. 13	(H [°] _{214 . 15} H°) =] , 094	CAL./GPW.	TEMPERATURE •K	HEAT CAPACITY CAL./DEG/ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CALL/ GFW.	LOG K	
			298	5.82	0	6•77	6.77				
ж. Р.	932	×	300	5.83	11	6.80	6.77				
₽₩₽	2,550	CAL. / GFW.	400	0.12 6.43	000	8•49 0-01	0.99 7.45				
			009	6.72	1890	11.11	96.2				-
			700	7.02	2580	12.17	8.49				
<u>م</u> . م	2,720	¥	800	7.31	3310	13.15	9.02				
∆н,	70,200	CAL /GFW.	1000	7.00	1330	14.03	10.20				
			1100	7.00	8030	18.19	10.89				
			1200	7.00	8730	18.80	11.53				
с. С.		¥	1300	7.00	9430	19.36	12.11				
H <		CAL /GFW	1400	7.00	10130	19.88	12.65				
•			1500	1.00	10830	20.36	13.14				
			1600	2•00 -	11530	20.81	13.61				
Ţ₽		¥	00/1	00.	06221	21.64	C0+1				
			1900	00.7	13630	22.02	14.85				
₩ 2		CAL / GPW.	2000	7.00	14330	22.38	15.22				
			2100	7.00	15030	22.72	15.57				
4		3	2200	7.00	15730	23.04	15.89				
<u></u>		4	2300	7.00	16430	23.35	16.21				
N <		CAL CEW	2400	7.00	17130	23.65	16.52				
r 1			2500	7.00	17830	23.94	16.81				
			2600	1.00	18530	24.21	17.09				L
		3	2700	7.00	19230	24.48	17.36				JN
*			2800	4.97	89970	50.50	10.49				
" "		ATA	857	- 7	00+05	10.00	0				U
,			3000	4.97	90960	50 . 84	20.52				-

THERMODYNAMIC PROPERTIES OF THE ELEMENTS

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January
Date:
Publication

ALUMINUM	AT		Re	eference (State for	Reference State for Calculating AH, AP, and	ng AH,	∆P°, and	
IDEAL MONATOMIC GAS	C GAS		ភ្ន	Log ₁₀ Kpt 5	Solid from 298°	n 298° to	to 932°, L10	, Liquid from 932°	932°
			ដ	2720°,	Ideal Mon	Monatomic Gas	from	2720° to 3000°	
64 26.98	GRAMS		٢.	ы ⁰ — н ⁰	૧	-(P°-H° 208.15)	FORMATI	FORMATION FROM REFERENCE STATE	NCE STATE
		TEMPERATURE		T 294.15	ب	FREE ENERGY	HEAT A H ^e	FREE ENERGY & F	
(H ^{2,246, 15} H ²) = 1,654	CAL./GFW.	א <mark>ہ</mark>	HEAT CAPACITY CAL./DEG./ GPV.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	f CAL./GPW.	f CAL./GFW.	Ч. Сос ГОС К. К. С.
		20R	11.2	c	VE UE	06 06	11600	10022	
A.P.	×	300	5.11	ათ	39.33	06.96	77498	62139	- 49.351
		400	5.05	517	40.79	39.50	77417	64497	- 35.242
ΔHm	CAL. / GFW.	500	5.02	1020	41.92	39 ° 88	77290	61285	- 26.789
		600	5.00	1521	42 . 83	40.30	77131	58099	- 21.164
		700	66 •7	2021	43.60	40.72	76941	54940	- 17.154
B.P.	*	800	4. 99	2520	44.27	41.12	76710	51814	- 14.156
		006	4 . 98	3018	44 • 85	41.50	76458	48720	- 11.831
2H ,	CAL. /GFW.	1000	4 • 98	3516	45 • 38	41.87	73686	45836	- 10.018
		1100	4°68	4014	45 . 85	42•21	73484	43058	- 8,555
		1200	4 • 98	4512	46.29	42.53	73282	40294	- 7.339
S.P.	×	1300	4•98	500 3	46.68	42.83	73079	37563	- 6.315
		1400	4.97	5507	47.05	43.12	72877	34839	- 5.439
∆ H₅	CAL. /GFW.	1500	4.97	6004	47.40	43.40	72674	32114	- 4.679
		1600	4.97	6501	47.72	43.66	72471	29415	- 4.017
		1700	4.97	6669	48.02	43.91	7,2269	26743	- 3.438
T.P.	×	1800	4.97	7496	48.30	44.14	72066	24078	- 2,923
:		1900	4.97	1993	48•57	44.37	71863	21418	- 2.463
₽ 4	CAL. /GFW.	2 000	4.97	8490	48.83	44.59	71660	18760	- 2.049
		2100	4.97	8987	49•07	44.80	71457	16122	- 1.677
		2200	4.97	9484	49.30	44.99	71254	13482	- 1.339
1.P.	×	2300	4.97	1866	49 . 52	45.19	71051	10860	- 1.031
:		2400	4.97	10478	49.73	45.37	70848	8256	751
	CAL. /GFW.	2500	4•97	10975	40°04	45.55	70645	5645	- 493
		2600	4•97	11472	50.13	45.72	70442	3050	256
		2700	4.97	11969	50.32	45.89	70239	471	- •038
Tc =	×	2800	4.97	12466	50.50	46.05	0	0	с Г
		2900	- n • t	6067T	10.00	40.20	0	•	0
		3000	4.97	13460	50.84	46.36	0	0	•

ALUMINUM

ANTIMONY	Sb			Soli	d from 29	38° to 90 3	Solid from 298° to 903°, Liquid from 903° to	l from 90	3° to	
REFERENCE STATE	STATE	M		0161	°, Ideal	Distomic	1910°, Ideal Diatomic Gas from 1910° to 3000°	1910° to	3000°.	
6t* 121.76	.76	GRAMS	F	ۍ ۲	H ⁰ - H ⁰ T 274.15	°.	-(F°-H° 228.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
(H ⁰ _{298 · 15} H ⁰) =	1,410	CAL/GFW.	TEMPERATURE °K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL. /DEG./ GFW.	CAL./GFW.	CAL./ GFW.	х•
			298	£0°9	0	10.92	10-92			
H .P.	903	×	300	6.03	11	10.96	10.93			
∆H- 4	4 740	CAL /GFW.	400	6.21	625	12.72	11.16			
				0.00	0021	14.11	10.11			
			002	6.73	2550	16.30	12.66			
B.P. 1,	1,910	×	800	6.90	3240	17.22	13.17			
			000	7.08	3950	18.05	13.68			
\ ∆H, 16,	16,230	CAL. /GFW.	1000	7.50	0440	24.10	14.66			
			1100	7.50	10190	24.81	15.55			
			1200	7.50	10940	25.46	16.35			
S.P.		*	1300	7.50	11690	26.06	17.07			
1		CAL /GEW	1400	7.50	12440	26.52	17.74			
9 1			1500	7.50	13190	27.13	1g.34			
			1600	7.50	13940	27.62	18.91			
			1700	7.50	14690	28.07	19.43			
<u>.</u>		4	1900	0.00	15100	00 90	19.93			
۵H		CAL. /GFW.	2000	4.47	35775	38.89	21.01			
			2100	4.47	36220	39.11	21.87			
			2200	4.47	36670	39.32	22.66			
T.P.		*	2300	4 • 4 J	37115	39.52	23.34			
3		11 / CEM	2400	4.47	37560	39.71	24.06			
6 1 10			2500	4 • 47	38010	30.80	24 69 25 23			
		ſ	2700				20.02			
1 ,=		*	2800	4.47	39350	40.40	26.35			
•			2900	4.47	39800	40.55	25.83			
ہ =		ATA.	3000	4.47	40240	40.71	27.30			

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

ANTIMONY

ANTIMONY	Sbe		Reference	ice State	for Calcu	State for Calculating AH, AF, AF, and	1°, 2P°, 1	and	
TDEAT DIAMONTO	2 0		Log ₁₀ Kp:		from 298°	Solid from 298° to 903°, Liquid from 903°	Liquid 1	from 903°	
THRAL ULATOMIC	SAU		to 1910°	, Ideal	Diatomic Gas	Gas from	from 1910° to	to 3000°.	
243.52						(FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
C.Fr	GRAMS		૨ -	H ^o H ^o T 296.15	₽ +	FREE ENERGY	HEAT △ H ^o	FREE ENERGY \$ F	
$(H^{\circ}_{210,15} - H^{\circ}_{0}) = 2,363$	CAL/GFW.	¥	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GPW.	FUNCTION CAL./DEG./ GFW.	CAL./GPW.		л 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
	,	298	8.69	0	06 • 09	06-09	56400	44753	- 32,806
A.P.	¥	300	8.69	16	60.96	60.91	56394	44682	- 32,553
:		40 0	8.79	890	63.47	61.25	56040	40828	- 22.309
∆ 11.	CAL /GPW.	500	8.85	1775	65.44	61.89	55675	37065	- 16.202
		600	8.87	2660	67.05	62.62	55280	33386	- 12.161
	1	200	8.89	3545	68•42	63•36	54845	29771	- 9.295
а	f	800	8•90	4435	69•60	64.06	54355	26227	- 7.165
:		906	8.91	5325	70.65	64.74	53825	22748	- 5.524
2H ~	CAL. /GFW.	1000	8•92	6220	71.60	65.38	43740	20340	- 4.445
		1100	8.92	7112	72.45	65.99	43132	18019	- 3.580
		1200	8.93	8005	73.23	66.56	42525	15753	- 2.869
S.P.	¥	1300	8°93	8897	73.94	67.10	41917		- 2.278
:		1400	8•93	0626	74.60	67.61	41310	11406	- 1.780
₽ H ²	CAL /GFW.	1500	8.93	10683	75.22	68.10	40703	9263	- 1.349
		1600	8.93	11575	75.79	68.56	40095	7215	- •985
		1700	8.93	12468	76.33	69°00	39488	5165	664
1.P.	¥	1800	8•93	13361	76.84	69.42	38881	3169	384
		1900	8.94	14255	77.32	69 . 82	38275	1187	136
		2 000	8.94	15149	77.78	70.21	0	c	
		2100	8.94	16042	78.22	70.59	0	c	0
		2200	8 • 94	16936	78.63	70.94	0	0	0
T.P.	¥	2300	8.94	17830	79.03	71.28	0	0	0
-		2400	8.94	18723	79.41	71.61	0	c	0
ΔH	CAL. /GFW.	2500	8•94	19617	79.78	71.94	0	0	0
		2600	8•94	20510	80.13	72.25	0	0	0
		2700	8.94	21404	80.46	72.54	0	0	0
Tc=	¥	2800	8.94	22298	80.79	72.83	0	0	0
-		2900	8•94	23192	81.10	73.11	0	0	0
_c =	AIA.	3000	8.94	24086	81.41	73.39	0	0	0

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ANT_LITION I D.4 IDEAL TETRATOMIC GAS T 6iv 487.04 GRAMS 700 CAL/GFW. 0K °K Ahn CAL/GFW. 298 °K M.P. °K 0C °K 0B.P. °K 0Nu °K 0Nu °K 1100 2.0 °K		Log _{1 O} Kp :				- -	200 1010 1	•	
487.04 GRAMS 4.1 ⁻ H ⁰) = CAL/GFW. CAL/GFW. CAL/GFW. CAL/GFW.		to 191		Log ₁₀ Kp: Solid From 298° to 903°, Liquid from 903° to 1910°, Ideal Diatomic Gas from 1910° to 3000°.	8° to 903 c Gas fro	5°, Liquid m 1910° 1	1 11.000 3000°.	, 	
e, ij - H ⁰ ₀) = CAL / GFW. K CAL / GFW. CAL / GFW. CAL / GFW.	F	ۍ ۳	H° – H° 	<u>ه</u> .	-(F°-H°298.15)	FORMAT	FORMATION FROM REFERENCE STATE	ENCE S	ATE
۲ ۲ ۲ ۲ ۲ ۲ ۲ ۲ ۲ ۲		HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL. /DEG./ GFW.	FREE EMERGY FUNCTION CAL./DEG./ GFW.	HEAT A H	FREE ENERGY & F		۲oc × °
۰ ۸ ۲ - ۲ - ۲ - ۲ - ۲ - ۲ - ۲ - ۲ - ۲ - ۲ -	86	19.35	C	83•65	83•65	0006*	37079	1	27.180
CAL /GFW.	8	19.35	36	83.79	83.67	48992	37007	1	26.961
	8	19•55	1980	89.38	84.43	48480	33080	1	18.075
«K CAL/GFW	8	19.65	3940	93.75	85.87	47940	29285		12.801
C.A.L./GFW	88	19.72	5910	97.34	87.49	47350	25618	1	9.332
C.AL. /GFW.	38	19.79	0800	103-05	90.13	45900	18564	1	5.071
CAL/GFW	88	19.81	11840	105.35	92.20	45040	15241	1	3.701
8	00	19.82	13830	107.45	93.62	25070	14020	1	3.064
2	8	19.83	15810	109.35	94•98	24050	12929	1	2.568
*	8	19.83	17790	111.05	96.23	23030	11978	1	2.181
-	8	19.84	19770	112.65	97.45	22010	11077	1	1.862
	8	19.84	21760	114.15	98.61	21000	10262	1	1.602
	8	19.84	23745	112.45	20.66	GR66T	0866	•	166.1
1600	8	19.84	25730	116.75	100.67	18970	85.58	1	1.220
	8	19.85	27715	117.95	101.65	17955	8316	1	1.069
T.P. %K 1800	88	19.85	29700	119.15	102•65	16940	7670	1 1	-931
ΔH, CAL. /GFW. 2000	38	19.85	33670	121.25	104.42	- 60430	8190	•	.894
T.P. oK									
ΔH ₁ CAL. /GFW.									
T _c = %									
P _c = ATM.									

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INATOMIC GAS Log Log Kor Solid from 280° to 903°, Liquid from 1910° to 300 76 Gtaus T Color 1910°, Lagua Tenens Forum 1910° to 300 7. T C Prime Prime Prime Prime Prime 1.94B1 CuL/GFN Prime Prim Prim Prim <th>ANTTROUT</th> <th>ť</th> <th></th> <th>Refer</th> <th>ence Stat</th> <th>e for Cal</th> <th>Reference State for Calculating Af, AF, and</th> <th>QH°, QP°,</th> <th>and</th> <th></th> <th></th>	ANTTROUT	ť		Refer	ence Stat	e for Cal	Reference State for Calculating Af, AF, and	QH°, QP°,	and		
GAS To 1910° Ideal Diatomic Cas from 19 GRAMS T C 1910° Ideal Diatomic das from 19 GRAMS T CLU-/GRW KAT CONTENT Reference ALMAL HEAT CLU-/GRW KAT CONTENT Reference ALMAL HEAT ALMAL HEAT CLU-/GRW KAT CONTENT Reference ALMAL HEAT ALMAL HEAT W ZOB 4-97 1500 4-97 9 43.006 65 VK CLU-/GRW KAT CONTENT MAL CONTENT MAL CONTENT ALMAL HEAT VK 2000 4-97 15003 45.52 43.65 65 65 VK 10003 4-97 1996 47.905 44.455 65 65 VK 11000 4-99 50.01 47.905 47.905 65 65 VK 11000 4-99 51.020 44.95 <td< td=""><td>T MOUT T MU</td><td>2</td><td></td><td>Log, J</td><td>Kp: Soli</td><td>d from 29</td><td>6° to 903</td><td>, Liquid</td><td>1 from 903°</td><td>ໍ</td><td></td></td<>	T MOUT T MU	2		Log, J	Kp: Soli	d from 29	6° to 903	, Liquid	1 from 903°	ໍ	
121.<76 GRMS T	IDEAL MONATOMIC	C GAS		to 19	•	l Distomi	c Gas fro	m 1910°1	to 3000°.		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $						•	()	FORMAT	ION FROM REFERE	INCE S	IATE
m.i.=1e) L.M. Curr. J. Matt. Total Contrant L.M. Curr. Total Contrent L.M. Curr.		GRAMS	1	ე. ი	H ⁰ -H ⁰ T 298.15	չ-	FREE ENERGY	HEAT △ H ^e	FREE ENERGY & F		
X 298 4.97 0 43.06 43.00 62700 57 X 300 4.97 500 4.97 500 43.05 52453 44.05 X 500 4.97 1500 45.53 44.05 52453 44.05 X 500 4.97 1500 45.53 44.05 627453 44.05 X 500 4.97 1500 45.53 44.05 627453 44.05 Y 1000 4.97 1500 45.53 44.05 62146 47.33 Y 1000 4.97 1500 47.30 44.05 62146 47.33 Y 1000 4.97 3984 49.05 44.05 5749 50149 Y 1100 4.99 50.03 47.11 5749 50149 11 Y 1100 4.99 50.03 54.45.03 55491 11 2740 Y 11200 5.03 54.04 55242 55242 11 21.04 46.55 559491 11	211. 15 H ⁰) =	CAL_/GFW.	er earlore	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	t CAL./ GFW.		LOG K
% %			298	4.97	U	43.06	90~64	62700	53117	•	38.037
C.M. / GFN, 400 4.97 500 4.97 500 4.97 500 4.97 500 4.97 500 4.97 500 4.97 500 4.97 500 4.97 500 4.97 500 4.97 500 4.97 500 4.97 500 4.97 500 4.97 501 4.96 62340 4.46 62340 4.46 62340 4.46 62340 4.46 62340 4.46 62340 4.46 62340 4.46 62340 4.46 62340 4.46 62340 4.46 62340 4.46 62340 4.46 62340 4.46 62340 4.46 62340 4.46 62340 4.46 62340	A.P.	×	300	4.97	0	43.09	43.06	62698	53059	1	38.656
· Cut./GFW 500 4-97 1003 45-63 4-3.63 62453 4-4 'K 'K 'K 600 4-97 1500 4-653 4-4.65 62453 4-4 50 4-4 50 4-4 50 4-4 50 4-4 50 4-4 50 4-4 50 52453 52310 4-4 50 52310 4-4 50 52310 4-4 50 52310 4-4 50 52310 4-4 50 52310 52310 50 53310 52310 52310 52310 52310 52310 52310 52310 52310 52310 52310 52310 52311 111 55249 51140 77011 552491 111 552491 111 552491 111 552491 111 552491 111 552491 111 552491 111 552491 111 552491 51140 77011 552491 111 11 552491 5101	:		400 4	4.97	506	44.52	43.26	62581	49861	1	27.245
% %	D H.	CAL. /GFW.	500	4.97	1003	45.63	43.63	62453	46693	1	20.410
% 700 4-97 1996 47.30 44.45 62146 4 % 800 4-97 2493 47.906 44.45 611953 3 % 1000 4-97 3487 496.55 45.23 56146 4 % 1100 4-97 3487 496.55 45.23 56146 3 % 1100 4-97 3487 496.55 45.93 56494 2 % 11200 4-97 3486 496.55 45.93 56747 3 % 11200 4-98 4482 496.65 47.11 55245 1 1 % 1500 5-09 5480 51.03 47.61 55245 1 1 % 1500 5-019 5993 51.42 47.11 55245 1 1 % 1500 5-019 5993 51.42 47.61 55245 1 1 1 1 <td< td=""><td></td><td></td><td>600</td><td>4.97</td><td>1500</td><td>46.53</td><td>44•03</td><td>62310</td><td>43560</td><td>1</td><td>15.868</td></td<>			600	4.97	1500	46.53	44•03	62310	43560	1	15.868
T 800 4-97 2493 47.96 44.85 61953 3 CAL/GFW 1000 4-97 2990 48.55 45.559 51747 3 "K 11000 4-97 3984 499.65 45.93 56494 3 "K 11000 4-97 3984 495.55 45.93 56494 3 "K 11000 4-99 5480 50.38 46.55 55990 2 "K 11000 5-00 5480 50.38 46.55 55990 2 "K 12000 5-00 5480 50.38 46.55 55990 2 "K 11000 5-00 5480 50.282 55245 1 1 "K 11600 5-19 8021 51.42 4764 1 1 55245 1 1 1 55245 1 1 55245 1 1 2 2 2 2 2 2 </td <td></td> <td></td> <td>700</td> <td>4.97</td> <td>1996</td> <td>47.30</td> <td>44.45</td> <td>62146</td> <td>40446</td> <td>1</td> <td>12.628</td>			700	4.97	1996	47.30	44.45	62146	40446	1	12.628
Cut. /GFW. 900 4.97 2990 48.55 45.23 61740 3 "K 11000 4.97 3487 49.07 45.59 56747 3 "K 11200 4.997 3487 49.077 45.59 56747 3 "K 11300 4.997 3487 49.07 45.55 552493 56747 3 "K 1300 4.99 500 5003 5480 500.75 46.655 552491 1 "K 1400 5.00 5480 50.75 47.62 57740 2 "K 1600 5.03 6485 51.42 47.317 55491 1 "K 1900 5.04 7504 52.03 478.66 54776 1 1 35545 1 1 35545 1 1 35545 1 1 35545 1 1 35451 1 1 1 355451 1 1 35451 <td>B.P.</td> <td>×</td> <td>800</td> <td>4.97</td> <td>2493</td> <td>47.96</td> <td>44.85</td> <td>61953</td> <td>37361</td> <td>1</td> <td>10.207</td>	B.P.	×	800	4.97	2493	47.96	44.85	61953	37361	1	10.207
C.M. /GFN. 1000 4.97 3487 49.07 45.59 56747 3 "K 1100 4.97 3984 49.55 45.93 56494 2 "K 11200 4.99 5984 49.655 55990 22 "K 1200 4.99 5981 51.09 46.84 55740 2 "K 1300 5.00 5480 50.75 46.84 55740 2 "K 1500 5.00 5481 51.42 47.11 55245 1 "K 1600 5.01 6485 51.42 47.61 55245 1 "K 1700 5.02 6485 51.42 47.61 55245 1 "K 1700 5.04 6993 51.42 47.62 5503 34764 "K 1700 5.01 6495 51.42 47.62 55245 1 "K 1700 5.01 6485 51.42 47.62 55245 1 "K 2000 5.14 7504 <	:		006	4.97	2990	48 •55	45°23	61740	34299	I	8.329
"K 1100 4.97 3984 49.55 45.93 56494 2 "K "K 11200 4.980 50.38 46.25 55242 2 "K 11300 5.00 5.00 5480 50.78 46.65 55242 2 "K 1500 5.00 5.00 5480 50.78 46.84 55740 2 "K 1600 5.00 5.01 6485 51.42 47.31 55245 1 "K 1700 5.00 5.01 6485 51.42 47.61 55245 "K 1800 5.01 6485 51.42 47.61 55245 "K 1800 5.14 7504 52.02 47.62 55245 "K 1900 5.14 7504 52.02 47.62 55451 "K 1900 5.14 7504 52.02 47.62 55003 "K 1900 5.14 7504 52.02 47.62 5503 "K 2100 5.219 88021 52.67 48.60 "K 22000 5.246 10162 53.32 48.91 "K 22000 5.48 10152 <	. ∆H,	CAL. /GFW.	1000	4.97	3487	49.07	45.59	56747	31777	1	6.945
vk 1200 4.98 4.482 49.98 46.25 56242 2 vk 1300 4.99 4980 50.38 46.55 55740 2 vk 1500 5.00 5.03 5981 51.09 47.65 55990 2 vk 1500 5.00 5.03 6485 51.42 47.11 55491 2 vk 1600 5.03 6485 51.73 47.65 55990 2 vk 1700 5.09 6993 51.73 47.65 55991 1 vk 1800 5.14 7504 52.02 48.69 54764 1 vk 1900 5.19 8021 52.30 48.69 35453 1 vk 22000 5.26 8543 52.67 48.69 35456 vk 22000 5.48 10152 53.67 48.71 35552 vk 22000 5.48 10152 53.67 48.91 35552 vk 22000 5.48 10152 53.67 48.91 35552 vk 2300 5.48 10152 53.67 48.91 35737 vk 23			1100	4.97	3984	49.55	45 • 93	56494	29280	1	5.817
"K 1300 4.99 4980 50.38 46.55 55990 2 C.M. /GFW 1500 5.00 5480 50.38 46.55 55990 2 K 1400 5.00 5480 51.00 47.65 55740 2 % 1700 5.00 5480 51.42 47.65 55749 2 % 1700 5.00 5.09 6993 51.72 47.65 55749 1 % 1800 5.14 7504 52.02 47.66 54764 1 % 1900 5.19 80.21 52.30 48.08 54531 1 % 1900 5.126 8543 52.82 48.91 35455 1 % 22000 5.265 100705 53.65 5303 35552 35737 % 22000 5.48 10152 53.378 48.91 35552 35737 % 23000 5.48			1200	4 • 98	4482	49.98	46.25	56242	26818	1	4.884
Cut. / GFW. 1400 5.00 5480 50.75 46.84 55740 2 "K 1500 5.03 5981 51.09 47.11 55491 1 "K 1700 5.03 5981 51.03 47.62 5503 1 "K 1700 5.04 6485 51.42 47.62 55045 1 "K 1800 5.14 87.03 591.73 47.62 5503 1 "K 1900 5.14 8543 52.57 48.08 54531 1 "K 22000 5.246 9072 52.827 48.01 35451 1 "K 22000 5.46 9072 52.827 48.01 35451 1 "K 22000 5.46 10152 53.32 48.01 35451 1 "K 22000 5.48 10152 53.32 48.01 35737 "K 22000 5.48 101052 53.49	S.P.	×	1300	4.99	4980	50.38	46.55	55990	24374	1	4 •098
CAL./GFW 1500 5-03 5981 51-09 47.11 55491 1 "K 1600 5-06 6485 51-42 47.37 55245 1 "K 11700 5-09 6993 51-72 47.62 55003 1 "K 11800 5-14 8543 52-30 48.08 54534 1 "K 1900 5-19 8543 52-37 48.08 54534 1 "K 22000 5-12 8543 52-37 48.08 54534 1 "K 22000 5-12 8543 52-37 48.08 54534 1 "K 22000 5-32 9072 52-82 48.61 35533 35737 "K 22000 5-48 10152 53-32 48.91 35737 35845 "K 22000 5-65 11265 53-378 48.91 35737 36079 1 "K 22000 5-65 11265 53-78 48.91 35737 48.91 35737	:		1400	5.00	5480	50.75	46. 84	55740	21958	•	3 . 428
% 1600 5.06 6485 51.42 47.37 55245 1 % 1700 5.09 6993 51.73 47.62 55003 1 % 1800 5.14 7504 52.30 48.08 54531 1 % 1900 5.19 8543 52.57 48.08 54531 1 % 2000 5.32 9072 52.87 48.08 54531 1 % 2200 5.48 10152 53.37 49.69 35552 % 2200 5.48 10152 53.37 48.71 35539 % 2200 5.48 10152 53.37 48.91 35737 % 2200 5.48 10152 53.37 48.91 35737 % 2200 5.48 10152 53.37 49.90 35845 % 2200 5.48 10152 53.37 48.91 35737 % 2200 5.48 10152 53.37 48.91 35737 % 2200 5.48 10152 53.37 48.91 35737 % 2200 5.48 101705 54.48 49.90 3605	₽ ₩⊃	CAL. /GFW.	1500	5.03	5981	51.09	47.11	55491	19551	I	2 .84 8
"K 1700 5.09 6993 51.73 47.62 55003 1 "K 1800 5.14 7504 52.02 48.06 54764 1 "K 1900 5.14 7504 52.02 48.08 54764 1 "K 1900 5.14 7504 52.02 48.03 35458 1 "K 22000 5.26 8543 52.57 48.03 35458 1 "K 2200 5.48 10152 53.307 48.71 35552 "K 2200 5.48 10152 53.355 49.91 35737 "K 2200 5.48 10152 53.378 49.90 35855 "K 2200 5.48 10152 53.378 49.90 35639 "K 2500 5.65 11265 53.378 49.90 36079 "K 2500 5.93 13000 54.44 499.63 36213 1 "K 2700 5.92 13000 54.46 49.90 36350 1 "K 2800 5.92 13000 54.46 49.90 36350 1 "K 3000 54.46			1600	5.06	6485	51.42	47.37	55245	17165	I	2.344
°K 1800 5-14 7504 52.02 47.86 54764 1 CAL/GFW 1900 5-19 8021 52.30 48.08 54531 1 CAL/GFW 22000 5-26 8543 52.30 48.08 54531 1 °K 22000 5-26 8543 52.30 48.50 35552 °K 22000 5-48 10152 53.87 48.50 35552 °K 2200 5-48 10152 53.32 48.91 35552 °K 2300 5-48 10152 53.37 48.91 35552 °K 22600 5-65 11265 53.378 49.903 35635 °K 22600 5-744 11834 54.000 49.49.53 36079 1 °K 22000 5-823 11265 53.378 49.963 35555 °K 22000 5-823 13040 54.964 1 35555 °			1700	5 • 09	6993	51.73	47.62	55003	14781	1	1.900
Cut. /GFW. 1900 5-19 8021 52-30 48.08 54531 1 r 2000 5-19 8021 52-30 48.08 54531 1 r 2000 5-26 8543 52-30 48.08 54531 1 r 2200 5-42 9609 52-82 48.91 35552 r r 2200 5-48 10152 53-32 48.91 35552 r r 2200 5-565 10705 53-55 49.09 35639 r 2400 5-655 11265 53-78 48-91 35737 r 2400 5-655 11265 53-778 49-28 35635 r r 2700 5-83 12413 54-422 49-79 36079 1 r r r 2800 5-92 12413 54-422 49-79 36079 1 r r r 2800 5-9	T.P.	×	1800	5.14	7504	52.02	47.86	54764	12428	1	1.508
CAL_/GFW 2000 5.26 8543 52.57 48.30 35468 °K 2100 5.32 9072 52.87 48.50 35552 °K 2200 5.46 9072 53.07 48.71 35552 °K 2200 5.46 10152 53.07 48.71 35539 °K 2200 5.46 10152 53.07 48.71 35539 °K 2200 5.46 10152 53.55 48.01 35737 °K 2200 5.65 11265 53.78 49.09 35955 °K 2200 5.74 11834 54.00 49.45 36079 °K 2200 5.83 12413 54.22 49.65 36213 °K 2200 5.92 13000 54.44 49.79 36516 °K 2000 6.01 13596 54.464 49.79 36661 AMM 3000 6.09 14201 54.85 50.12 36661	:		1900	5.19	8021	52.30	48 . 08	54531	10071	1	1.158
2100 5-32 9072 52.82 48.50 35552 % 2200 5.40 9609 53.07 48.71 35532 % 2200 5.46 9609 53.07 48.71 35533 2200 5.46 10152 53.32 4991 35737 2200 5.46 10152 53.55 490.09 35845 2200 5.46 11265 53.55 490.09 35845 2200 5.745 11834 54.00 49.49 35079 % 2200 5.83 12413 54.22 49.63 36079 % 2200 5.83 12413 54.22 49.69 36350 % 2200 5.92 13000 54.44 49.79 36350 % 2900 6.01 13596 54.64 49.79 36661 % 3000 6.09 14201 54.85 50.12 36661	¢H,	CAL. /GFW.	2000	5.26	8543	52.57	48.30	35468	8108	1	•885
"K 2200 5.40 9609 53.07 48.71 35639 "K 2300 5.48 10152 53.55 48.91 35737 CAL./GFN 2300 5.65 10705 53.55 49.09 35845 CAL./GFN 2500 5.65 11265 53.55 49.09 35845 CAL./GFN 2200 5.65 11265 53.55 49.09 35845 "K 2200 5.74 11834 54.00 49.45 36079 "K 2200 5.92 13000 54.44 49.63 36213 "K 2200 5.92 13000 54.46 49.79 36350 "K 2000 6.01 13596 54.64 49.96 36496 "M 3000 6.09 14201 54.85 50.12 36661			2100	5•32	9072	52.82	48.50	35552	6761	1	• 703
°K 2300 5.48 10152 53.32 48.91 35737 CAL./GFW 2400 5.56 10705 53.55 49.09 35845 CAL./GFW 2400 5.56 10705 53.55 49.09 35845 CAL./GFW 2500 5.65 11265 53.55 49.09 35955 2500 5.67 11834 54.00 49.45 36079 - 2200 5.92 13000 54.44 49.063 365213 - * 2200 5.92 13000 54.464 49.963 365213 - * 3000 6.01 13596 54.64 49.966 - - * 3000 6.09 14201 54.85 50.12 36661 -			2200	5.40	6096	53.07	48.71	35639	5389	•	• 535
CAL./GFW 22400 5-56 10705 53-55 49.09 35845 CAL./GFW 25600 5-65 11265 53-78 49-28 35955 2500 5-74 11834 54-00 49-28 35955 10709 2700 5-823 11265 53-78 49-28 35079 1 * * 2200 5-823 12413 54-22 49063 365713 1 * * 2800 5-92 13000 54-44 49-79 36350 1 * * 3000 6-01 13596 54-64 49-96 36661 1	T.P.	Å	2300	5.48	10152	53.32	48.91	35737	3997	1	•379
C.AL. /GFN. 2500 5.65 11265 53.78 49.28 35955 2600 5.74 11834 54.00 49.45 36079 - 2700 5.83 12413 54.22 49.63 36213 - 2700 5.92 13000 54.443 49.79 36350 - . 22000 6.01 13596 54.464 49.79 36496 -			2400	5.56	10705	53.55	40°03	35845	2629	I	•239
= 2600 5.74 11834 54.00 49.45 36079 - = °K 2700 5.83 12413 54.22 49.63 36213 - 1 = °K 2800 5.92 13000 54.43 49.79 36350 - 2 = ^N 22900 6.01 13596 54.64 49.96 36496 - 2 = ATM 30000 6.09 14201 54.85 50.12 36661 - 5	₽ ₩	CAL. /GFW.	2500	5.65	11265	53.78	49•28	35955	1230	I	•107
= • 2700 5.83 12413 54.22 49.63 36213 - = • X 2800 5.92 13000 54.43 49.79 36350 - = ATM 3000 6.01 13596 54.64 49.96 36496 -			2600	5.74	11834	54.00	49.45	36079			•011
= • K 2800 5.92 13000 54.43 49.79 36350 - 2900 6.01 13596 54.64 49.96 36496 - 36496 - 36496 1 - 3000 6.09 14201 54.85 50.12 36661 -			2700	5.83	12413	54.22	49.63	36213			•126
= ATM 22900 6.01 13596 54.64 49.96 36496 - 36496 - 3000 6.09 14201 54.85 50.12 36661 -	Tc=	×	2800	5.92	13000	54.43	49.79	36350			•228
= ATM. 3000 6.09 14201 54.85 50.12 36661 -			2900	6.01	13596	54.64	49.96	36496			• 328
		ATM.	3000	6 0 •9	14201	54.85	50.12	36661	- 5759		•419

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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ARGON		A ,		Ideal M	lona tom 1 c	Gas from	Ideal Monatomic Gas from 298° to 3000°.	.000	-		
REFE	REFERENCE STATE	ы									
45 G	39.944	GRAMS	-	ບ	ен – он	Se	-(F°-H° 228.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE	ТТ
(H [°] 298. 1	(H [°] _{298.15} H [°] ₆) = 1,481		TEMPERATURE 9K	HEAT CAL./D	T 298.15 HEAT CONTENT CAL./ GFW.	T ENTROPY CAL. /DEG./GFW.	FREE ENERGY FUNCTION CAL. DEG. / GFW.	HEAT A H ^e cal/GFw.	FREE ENERGY & F ⁶ cal/ gfw.	х ° 001	
			298	4.97	C	36•98	36.98				<u> </u>
¥.P.	83.78	×	300	4.97	0	37.01	36.98				
:	LAC		400	4.97	506	38 • 44	37.18				
∆H	• 107	CAL. / GFW.	500	4.97	1003	39°55	37.55				
			600	4.97	1500	40.46	37.96				
4	87.29	3	200	4.97	1996	41.22	38.37				
10 1		¥	800	4.97	2493	41•89	38.78				
∆н∿	1,558.	CAL. /GFW.	006	4.97	2990	43.00	30.15 30.52				
			1100	4.97	3984	43.47	39.85				
			1200	4.97	4480	43.90	40.17				
5.P.		×	1300	4.97	4977	44 • 30	40.48				
:			1400	4.97	5474	44.67	40.76				
∆ H₅		CAL. /GFW.	1500	4.97	5971	45.01	41.03				
			1600	4•97	6468	45.33	41.29				
			1700	4.97	6964	45.63	41.54				
T.P.		*	1800	4.97	7461	45.92	41.78				
1		141 /CEW	1900	4.97	7958	46.18	42.00				
			0012	-0.4	8952	40 • 44	42.42				
			2200	4.97	9448	46.91	42.62				
T.P.		×	2300	4.97	9945	47.13	42.81				
			2400	4 • 97	10442	47.34	42.99				
ΔH		CAL. / GFW.	2500	4.97	10939	47.55	43.18				
			2600	4.97	11436	47.74	43.35				
			2700	4.97	11932	47.93	43.52				A
Tc=	151.	Å	2800	4.97	12429	48.11	43.68				
	0 01		2900	4.97	12926	48 • 28	43 . 83				GC
Pc ≖	40.0	ATM.	3000	4.97	13423	48 • 45	43.98				DN

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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	EMIC																																٦
		ACE STATE		х 100 к																													
		FORMATION FROM REFERENCE STATE	PREF ENERGY A P	CAL./ GFW.																													
, Ideal	to 3000°	FORMAT	HEAT A H ^o																														
Solid from 298° to 886°, Ideal	Diatomic Gas from 886° to 3000°.	-(F0_16 ***)	CALL AND	FUNCTION CAL./DEG./ GFW.	8-40	8.40	8.64	9°08	9•60	10.13	10.65	3.81	6•19	9.27	11.37	13.18	14.76	16.14	17.37	18.47	19•46	20.37	21.19	21.95	22.64	23.28	23.89	24.44	24.97	25.46	25.92	06.02	26.77
from 296	mic Gas f	•	۶ <u>-</u>	ENTROPY CAL./DEQ./ GFW.	8-40	8.43	10.16	11.56	12.73	13.75	14.68	33 • 39	33.86	34.28	34.67	35.03	35.36	35.67	35.95	36.22	36.48	36.72	36.95	37.17	37.37	37.57	37.76	37.94	38.12	38•29	38.45	10.00	38 • 76
Solld	Diato	!	H ^o -H ^o T 298.15	HEAT CONTENT CAL./ GFW.	0	10	610	1240	1880	2540	3230	26630	27070	27520	27960	28410	28850	29300	29740	30190	30640	31080	31530	31970	32420	32870	33310	33760	34210	34650	35100	06666	35990
		1	<u>ئ</u>	HEAT CAPACITY CAL:/DEG./ GPW.	2.90	5.90	6.12	6.34	6.56	6.78	7.01	4 • 44	4044	4.45	4.45	40	4.46	4.46	4.46	4.46	4.46	4.46	4.46	4.47	4.47	4.47	4.47	4.47	4.47	4.47	4 • 4 7	- t • t	4.47
		_	-	TEMPERATURE OK	298	300	400	500	600	700	800	006	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500	2600	2700	2800	0062	3000
As	TE		GRAMS	CAL./GFW.		×		CAL. /GFW.			×		CAL. /GFW.			×		CAL. /GFW.			×		CAL. / GFW.			¥		CAL. / OF 11.			×	ATM.	
	REFERENCE STATE	10 11	TCOL	°211, 15 H°) = 1 , 226		1,090	1000 0	(020,0)								886	7 630																
ARSENIC	REFE		25	(H ^o 298.15		M.P.		Am			8.P.		₽ H			.Ч.		¶ ₽			T.P.	:	₩			a.: 	H V	1			Tc =	اا م	•

ARSENIC

ARSENIC	As ₂		Reference	e State f	or Calcul	ating AH [®]	, M°, ai	Reference State for Calculating Aff, Aff, and Log ₁₀ Kp:	80
IDEAL DIATOMIC	GAS		Solid from 298°		to 886°, I	Ideal Diat	Diatomic Gas	from 298°	to 3000°.
6iw 149.82	GRAMS	-	ບ	H° - H°	es,	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	INCE STATE
		TEMPERATURE OV	HEAT C	T 298-15 HEAT CONTENT	ENTROPY	FREE ENERGY FUNCTION	HEAT \triangle H ^e	FREE ENERGY Δ F ⁰	K LOG
548.15 u ⁰ / -		e	CAL./DEG/ GFW.	CALLY GFW.	CAL. /DEG./ GFW.	CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	2
		298	8.36	0	57.19	57.19	48000	35957	- 26.358
M. P.	¥	300	8.37	15	57.24	57.24	47980	35866	- 26.130
ΔHm	CAL. / GFW.	400	8.59	865	59.68	57.52	47645	31901	- 17.431
		200	8.71	1730	01.02	58•10 58•10	47250	26105	
		0002	8.82	3485	64•57	59.60	46405	20456	- 6.387
8.P.	¥	800	8,85	4365	65.74	60.29	45905	16801	- 4.590
H	CAL /GEW	. 006	8.87	5255	66.78	56°09	0	0	
Aut	CAL: /01	1000	8•88	6140	67.72	61.58	0	0	0
		1100	8.89	7030	68.56	62.17	0	0	0
	à	1200	8.90	7920	69.34	62.74	0	0	0
	4	1300	8.91	8810	70.05	63•28	o	C	С
- H <	CAL /GFW	1400	R_91	0010	70.71	63.79	0	••	¢C
. 1		1500	8.91	10590	71.33	64.27	•	0	0
		1600	8.92	11480	71.90	64.73	•	0	•
1		1700	8.92	12370	72.44	65.17	0	0	c
T.P.	×	1800	8 . 92	13270	72.95	65 . 58	0	•	0
дн,	CAL. /GFW.	1900	8.02	14160	73.43	65 . 98	00	0	00
		2100		15940	74.33	66.74	0	00	00
		2200	8.93	16840	74.74	61.09	0	0	0
T.P.	×	2300	8.93	17730	75.14	67.44	•	0	0
		2400	8.93	18620	75.52	67.77	•	o	0
₽	CAL. /GFW.	2500	8 . 93	19520	75.88	68 •08	•	•	c
		2600	8.93	20410	76.24	68.39	0	c	c
		2700	8.93	21300	76.57	68.69	•	0	0
Tc =	×	2800	8.93	22200	16.90	68 . 98	•	0	0
,	ATM	2900	8.93	23090	77.21	69.25	c	C	0
		3000	8.93	23980	77.51	69.52	0	0	с

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10.1021/ba-
.956 doi:
: January 1, 1
Publication Date

ARSENIC	A84		Reference	e State f	or Calcul	ating AH	, ∆P°, ai	Reference State for Calculating $\Delta H_{f}^{\circ}, \ \Delta F_{f}^{\circ}, \ and \ Log_{10}^{Kpt}$		
IDEAL TETRATOMIC	IC GAS		Solid from 298°		to 886°, I	deal Diat	comic Gas	Ideal Diatomic Gas from 886°		to 3000°.
		•	2	9	ę	-(F°H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	ENCE STATI	
299.64		TEMPERATURE		T 294.15	a⁺	FREE ENERGY	HEAT A H ^e	FREE ENERGY & F		
$(H^{0}_{296, 15} - H^{0}_{0}) =$	CAL./GFW.	¥•	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GPV.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GPW.	ğ	ж г
A.	¥	298	18.48	340	75.00	75.00	34500	22154	10	16.239
		60 60 60 70	19.10	1920	80.54	75.74	33980	18020		840
		500	19,35	3840	84.83	77.15	33380	14085	0 1	6.156
		600	19.49	5790	88.37	78.72	32770	10300	- - -	3.752
6	20	700	19•58	7740	91.39	80.34	32080	6607	- 5	2.062
	4	800	19.64	9700	94.00	81•88	31280	3056	•	•834
H	CAI /CEW	006	19•69	11670	96•30	83 . 34	- 60350	- 26816	9	6.512
4117		1000	19.72	13640	98.40	84.76	- 60140	- 23100	ۍ •	5.048
		1100	19.74	15610	100.30	86.11	- 59970	- 19468	m.	3.868
0	3	1200	19.76	17590	102.00	87.35	- 59750	- 15734	5	2.865
	4	1300	19.78	19560	103.60	88.56	- 59580	- 12104	5	2.035
Δ H.	CAL. /GFW.	1400	19.80	21540	105.00	89 . 62	- 59360	- 8344	-	1.302
•		1500	19•81	23520	106.40	90.72	- 59180	- 4760	•	• 693
		1600	19.82	25500	107.70	91.77	- 58960	- 1200	•	•163
¢,		1700	19.82	27490	108.90	92 . 73	- 58770	2396	•	• 308
<u></u>	<u>+</u>	1800	19•83	29470	110.00	93.63	- 58590	6066		•736
ΔHr	CAL. /GFW.	1900	19.83 19.84	31450	111.10	94•55 95•39	- 58370 - 58190	9612	<u> </u>	•105
								1		
T.P.	×									
ΔH.	CAL /GFW.							-		
-								-		
T _c =	×									
<mark>ہ</mark> =	ATM.									

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Publication

ARSENIC	As		Referenc	e State f	or Calcul	ating AH	, ∆P°, ar	Reference State for Calculating $\Delta H_{r}^{\circ}, \ \Delta F_{r}^{\circ}$, and $Log_{1,0}Kp_{1,0}$		
IDEAL MONATOMIC GAS	MIC GAS		Solid fr	om 298°t	0 886°, 1	- deal Diat	omic Gas	Solid from 298° to 886°, Ideal Diatomic Gas from 298°	to 3000°	0
ciw 74.91	GRAMS	-	ຍ	H0 H0	°.	-(F°H° 228.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE	
(H ^o _{298.15} H ₀) = 1 , 481	-	TEMPERATURE ⁰ K	P HEAT CAPACITY CAL. (DEG./ GFW.	T 298-15 HEAT CONTENT CAL./ GFW.	T ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL. /DEG./ GFW.	HEAT A H	FREE ENERGY & F	° CC	× °
		906	4 7 7	c	13 14	13 14		0000		;
A.P.	*	300	16.4) တ	41-64	19-14	00089	59036	- 43.011	
		400	4.97	506	43.07	41.81	68896	55732		101
⊐ H=	CAL. / GFW.	500	4.97	1003	44.18	42.18	68763	52453	- 22.928	28
		600	4.97	1500	45.09	42.59	68620	49204	- 17.924	24
		700	4.97	1996	45 . 85	43.00	68456	45986	- 14.358	58
8.P.	*	800	4.97	2493	46.52	43.41	68263	42791	- 11.690	06
		006	10.4	2990	47.10	43.78	45360	33021	- 8.019	19
7H 7	CAL /GFW.	1000	4.97	3487	47.62	44.14	45417	31657	- 6.919	19
		1100	4.97	3984	48.10	44.48	45464	30262	- 6.013	13
		1200	4.97	4481	48.53	44.80	45521	28889	- 5.261	61
. 7 .	Y,	1300	4.97	4978	48.93	45.11	45568	27498	- 4.623	23
H	CAL /GFW	1400	4.98	5475	49.30	45 . 39	45625	26109	- 4.076	76
s :-]	÷ 5	1500	4 . 99	5973	49-64	45.66	45673	24718	- 3.601	01
		1600	5.00	6472	49•96	45.92	45732	23316	- 3.184	84
		1700	5.01	6973	50.27	46.17	45783	21898	- 2.815	15
7.P.	ж	1800	5.04	7475	50.55	46.40	45835	20509	- 2.4	•489
3	M30/ 170	1900	5.06	7980	50.83	46.63	45900	16061	- 2.195	95
1 13		2000	5.10	8488	51.09	46.85	45958	17678	- 1.031	31
		2100	5.14	0006	51.34	47.06	46030	16273	- 1.6	• 693
6	à	2200	5.18	9516	51.58	47.26	46096	14834	- 1.4	•473
<u>s</u> ;	¥	2300	5.24	10037	51.81	47.45	46167	13415	- 1.274	74
3		2400	5.30	10563	52 • 03	47.63	46253	12005	- 1.0	•093
		2500	5.36	11096	52.25	47.82	46336	10561	6 1	•923
		2600	5 4 3	11635	52.46	4.7.99	46425	9141	-	• 768
		2700	5.50	12181	52.67	48.16	46531	7705	9 1	•623
T _c =	×	2800	5.57	12735	52.87	48.33	46635	6259	4• -	88
		2900	5.65	13296	53.06	48.48	45746	4841	۱ ۳	364
re =	AIM.	3000	5.73	13866	53•26	48.64	46876	3376	- 2	.245

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THERMODYNAMIC PROPERTIES OF THE ELEMENTS

REFERENCE STATE G50°, Ideal Intermit G50°, Ideal Intermit From 650° to 3000°. transit t^{2} (aux	ASTATINE At	At ₂		0	olid from	1 298° to	Solid from 298° to 575°, Liquid from 575° to	uid from	575° to		ASTA
420.* GMM T C H ⁺ – H ⁺ Follower	REFERENCE STAT	TE		9	50°, Idea	1 Diatomi	c Gas fro	m 650° to	3000°.		TINE
Table State Cut / GFR Mail of the cut control Mail of the cut control <th< th=""><th>-</th><th>GRAMS</th><th>-</th><th>ەئ</th><th>H⁰ - H⁰ T - YML1</th><th>°.</th><th>-(5-46 228.15) -</th><th>FORMAT</th><th>ION FROM REFEREN</th><th>ICE STATE</th><th></th></th<>	-	GRAMS	-	ە ئ	H ⁰ - H ⁰ T - YML1	°.	-(5-46 228.15) -	FORMAT	ION FROM REFEREN	ICE STATE	
(575) % (575) % (5,700) cut./cFW (5,700) cut./cFW (5,700) cut./cFW (600 20000 1426 (650) % (650) % (650) % (650) % (1000) 9003 (650) % (1000) 9003 (650) % (1000) 9003 (650) % (1100) 9003 (650) % (1100) 9003 (610) 2011 (611) 9 (611) 9 (611) 9 (611) 9 (611) 9 (611) 9 (71,6% 9 (71,6% 9 (71,6% 9 (71,6% 9 (71,6% 9 (71,6% 9 (71,6% 9 (71,6% (71,6%	(H ⁰ _{218.15} H ₀) =	CAL./GFW.	TEMPERATURE •K		HEAT CONTENT CAL./ GPV.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ OFW.	HEAT A H	FREE ENERGY & F cal./ gfw.	¥ 2	
(5,700) cut./GFW 400 14.000 2826 33.12 (650) vk 900 9.03 25210 73.66 700 9.03 25210 73.66 36.24 700 9.05 27020 74.87 800 9.06 27020 75.94 11000 9.09 28840 77.76 900 9.06 27020 75.94 1200 9.09 28840 77.76 9100 9.09 28840 77.76 91100 9.09 28840 77.76 92 0.41 31570 78.55 92 9.11 30660 79.28 93 31570 79.28 78.55 94 9.11 33400 81.18 1700 9.11 30660 79.28 94 9.15 34400 81.28 94 11000 9.13 31570 79.95 94 94.13 34400 81.28 2520 94 94.20 94.28 3707			300 3008	14.00 14.00	26 26	29 • 09	29 . 09				
600 20.00 10080 48.96 700 9.05 25210 73.66 700 9.05 25120 74.87 900 9.06 27020 75.94 % 1000 9.06 276.89 % 1100 9.09 2916 77.76 % 1100 9.09 2913 31570 75.94 % 1100 9.09 29745 76.89 % 11200 9.11 30660 79.25 % 1200 9.11 30560 79.25 % 1200 9.11 30560 79.25 % 1200 9.11 30560 79.25 % 1200 9.14 32480 81.73 % 1500 9.14 32480 81.73 % 1500 9.17 34310 81.73 % 1700 9.17 34310 81.73 % 1700 9.21 35230 82.26 % 1900 9.27 34910 81.73 % 1900 9.23 37070 84.91 % 2200 9.28 34170 84.91 % <	໌ 2	CAL /GFW.	400 500	14•00 14•00	1426 2826	33•12 36•24	29•56 30•59				
(650) % 700 9.03 25210 73.66 (650) cut./drw. 900 9.06 27020 75.94 % 1000 9.06 27020 75.94 % 1000 9.06 27020 75.94 % 11000 9.09 2910 276.89 % 11000 9.09 29745 76.89 % 1300 9.11 30660 77.76 % 1300 9.11 30560 79.28 % 1400 9.11 30560 79.26 % 1200 9.11 30560 79.26 % 1200 9.11 30560 79.26 % 1700 9.17 34310 81.73 % 1700 9.17 34310 81.73 % 1700 9.21 34400 82.25 % 1700 9.23 37070 83.23 % 1700 9.23 37070 84.91 % 22000 9.23 37070 <t< th=""><th></th><th></th><th>600</th><th>20.00</th><th>10080</th><th>48.96</th><th>32.16</th><th></th><th></th><th></th><th></th></t<>			600	20.00	10080	48.96	32.16				
(550) % (21,600) cut./crr. 11000 9.005 27020 % 11000 9.005 27930 % 11000 9.005 27930 75.94 % 11000 9.008 27930 75.94 % 11000 9.010 29745 78.55 % 1300 9.111 30660 79.28 % 1400 9.111 30660 79.28 % 1400 9.111 30660 79.28 % 1600 9.111 30660 79.28 % 1600 9.117 30660 79.28 % 1600 9.117 30660 79.28 % 1600 9.173 34310 81.73 % 18000 9.20 36150 82.75 % 1900 9.23 37070 83.23 % 2200 9.22 37070 84.91 % 2200 9.22 37070 84.95 % 22000 9.28<			200	9•03	25210	73.66	37.65				
(21,600) cut./GFW 1000 9.08 27930 76.89 % 11000 9.09 28840 77.76 % 1200 9.10 29745 78.55 % 1200 9.11 30660 79.95 % 1200 9.13 31570 79.95 % 1400 9.13 31570 79.95 % 1500 9.14 32480 81.03 % 1600 9.13 31570 79.95 % 1500 9.14 32480 81.03 % 1600 9.17 34310 81.03 % 1800 9.17 34310 81.03 % 1900 9.23 36150 82.26 % 2200 9.23 38000 83.68 % 2200 9.23 36150 84.91 % 2200 9.22 37070 84.92 % 2200 9.23 44490 86.01 % 2200 9.33 45420 86.05 </td <td></td> <th>×</th> <td>008</td> <td>9•05 9•06</td> <td>26120 27020</td> <td>74.87 75.94</td> <td>42°22 45°92</td> <td></td> <td></td> <td></td> <td></td>		×	008	9•05 9•06	26120 27020	74.87 75.94	42°22 45°92				
1100 9.09 28840 77.76 x 1200 9.10 29745 78.55 x 1400 9.11 30560 79.28 x 1400 9.11 30560 79.28 x 1500 9.11 30560 79.28 x 1500 9.11 30560 79.28 x 1500 9.11 32480 81.18 x 1600 9.16 33400 81.28 x 1700 9.19 35230 82.75 x 1900 9.22 37070 81.73 x 22000 9.23 38000 82.26 x 22000 9.22 38920 84.61 x 22000 9.26 39840 84.61 x 22000 9.28 41770 85.29 x 22000 9.28 41770 85.65 x 22000 9.28 41770 85.65 x 22000 9.23 44490 86.94 x 22000 9.33 45420 86.95 x 22000 9.35 45420 86.95 x 22000 9.33 454490<		CAL. /GFW.	1000	9.08	27930	76.89	48.96				
• K 1200 9-10 29745 78-55 • K 1300 9-11 30660 79-28 • K 1500 9-11 30560 79-28 • K 1500 9-14 32480 81-18 • K 1600 9-16 33400 81-18 • K 1700 9-17 34310 81-73 • K 1700 9-17 34310 81-73 • K 1700 9-19 35230 82-26 • K 1900 9-22 37070 83-23 • K 21000 9-23 38000 82-75 • K 22000 9-24 38920 84-91 • K 2200 9-26 39840 84-52 • K 2200 9-26 39840 84-52 • K 2200 9-26 39840 85-65 • K 2200 9-28 41770 85-65 • K 2200 9-28 41700 85-65 • K 2200 9-31 42630 86-34 • K 2200 9-33 45420 86-34 • K 2200 9-33 45420 86-34 • K			1100	60°6	28840	77.76	51.55				
x 1300 9-11 50000 Cut./GFN 1400 9-11 50000 x 1500 9-13 31570 x 16000 9-16 334400 810-19 x 17000 9-17 34310 810-73 x 17000 9-17 34310 810-73 x 17000 9-17 34310 810-73 x 18000 9-20 36150 82.26 x 22000 9-23 38000 83.23 x 22000 9-24 38920 84.01 x 22000 9-28 41700 84.61 x 22000 9-28 41700 84.65 x 22000 9-28 41700 85.65 x 22000 9-31 42630 86.01 x 22000 9-33 424490 86.01 x 22000 9-33 454420 86.05 x 22000 9-33 454420 86.05 x 22000 9-33 454420 86.05 x 22000 9-35 454490 86.05			1200	9.10	29745	78.55	53.77				
Cut. /GFW 1500 9.14 32480 80.59 * 1700 9.14 32480 81.18 * 1700 9.14 32480 81.18 * 1700 9.19 35230 81.73 * 1900 9.22 34310 81.73 * 1900 9.22 37070 82.75 * 22000 9.22 38000 82.75 * 22000 9.22 38920 84.01 * 22000 9.26 39840 84.61 * 22000 9.28 40770 85.29 * 22000 9.28 417700 85.29 * 22000 9.28 417700 85.29 * 22000 9.28 417700 85.29 * 22000 9.301 43560 86.34 * 22000 9.33 454490 86.65 * 22000 9.33 45420 86.99 * 22000 9.35 45420 86.99	.e.s	¥	1400	11.0	30000	70.05	0/ • 6 6				
1600 9.16 33400 81.18 % 1700 9.17 34310 81.73 % 1800 9.17 34310 81.73 % 1900 9.19 35230 82.75 CAL/GFW 2000 9.22 37070 83.623 % 2000 9.22 37070 83.23 % 22000 9.22 37070 82.75 % 22000 9.22 38920 84.61 % 22000 9.26 39840 84.61 % 22000 9.27 40770 85.29 % 22000 9.28 41700 85.29 % 2200 9.28 41700 85.29 % 2200 9.28 41700 85.65 % 2200 9.31 43560 86.34 % 2200 9.33 45420 86.65 % 23000 9.33 45420 86.99 % 23000 9.35 45420 86.99	ΔHs	CAL /GFW.	1500	9.14	32480	80.59	58.94				
*K 1700 9.17 34310 81.73 *K 1800 9.19 35230 82.26 *K 1900 9.22 37070 83.23 *K 22000 9.22 37070 83.23 *K 22000 9.22 37070 83.23 *K 22000 9.24 38920 84.11 *K 22000 9.27 40770 84.61 *K 22000 9.27 40770 84.65 *K 22000 9.27 40770 84.65 *K 22000 9.27 40770 85.65 *K 22000 9.30 42630 86.01 *K 22000 9.31 42630 86.01 *K 22000 9.33 45420 86.01 *K 22000 9.33 45420 86.67			1600	9.16	33400	81.18	60.31				
•K 1800 9.19 35230 82.26 C.M. /GFN 1900 9.20 36150 82.75 C.M. /GFN 22000 9.22 37070 83.23 *K 22000 9.24 38920 84.61 *K 22000 9.27 40770 84.61 *K 22000 9.27 40770 84.62 *K 22000 9.28 41700 84.65 *K 22000 9.28 41700 85.65 *K 22000 9.33 42630 86.01 *K 28000 9.33 45420 86.67 *X 28000 9.33 45420 86.67 *X 28000 9.33 45420 86.67			1700	9.17	34310	81.73	61.55				
Cut. /GFNL 1900 9-20 36150 82.75 Cut. /GFNL 2000 9-22 37070 82.75 % 22000 9-24 38920 84.61 % 22000 9-26 38920 84.61 % 22000 9-26 38920 84.61 % 22000 9-26 38940 84.65 22000 9-26 38940 84.65 % 22400 9-26 38940 84.65 22000 9-26 38940 84.65 % 22000 9-28 41700 85.65 % 22000 9-30 42630 86.01 % 28000 9-33 426490 86.61 % 28000 9-33 454490 86.67 % 29000 9-35 46350 86.67	T.P.	¥	1800	9.19	35230	82.26	62.69				
x 2200 9-23 38000 84-11 x 2200 9-24 38920 84-11 x 2300 9-26 39840 84-52 x 2300 9-28 41700 84-91 x 22600 9-28 41700 85-29 x 27 40770 85-29 x 2700 9-31 43560 x 2700 9-31 43560 x 2800 9-32 44490 x 2900 9-35 45420 x 2900 9-35 45420	AH.	CAL /GFW	0007	9.20	04105	82°58	64.70				
*K 2200 9.24 38920 84.11 *K 2300 9.26 39840 84.52 CAL./GFN. 22600 9.27 40770 84.621 CAL./GFN. 2500 9.28 41700 85.29 X 2500 9.31 43560 85.65 *K 2700 9.31 43560 85.65 *K 2800 9.33 45420 86.65 *X 2900 9.33 45420 86.67			2100	9.23	38000	83•68	65.59				
"K 2300 9.26 39840 84.52 C.M. /GFN. 2400 9.27 40770 84.91 2500 9.28 41700 85.29 2600 9.30 42630 85.65 *K 2700 9.31 43560 85.65 *K 2800 9.31 43560 86.01 *K 2800 9.33 45420 86.65 *TM. 3000 9.35 45420 86.67			2200	9.24	38920	84.11	66.42				
CAL./GFW. 2500 9.28 41700 85.29 2500 9.28 41700 85.29 2500 9.30 42530 85.65 2700 9.31 43560 86.05 74490 86.34 2800 9.33 45420 86.67 ATM. 3000 9.35 45320 86.91	T.P.	¥	2300	9•26	39840	84.52	67.20				
•K 2600 9-30 42630 85.65 •K 2700 9-31 43560 86.01 •K 2800 9-32 44490 86.34 •K 2900 9-33 45420 86.67 •N 3000 9-35 46350 86.99	Δ H ,	CAL /GFW.	2500	9.28	41700	84•91 85•29	68.61 68.61				
•K 2700 9•31 43560 86•01 •K 2800 9•32 44490 86•34 •K 2900 9•33 45420 86•67 •Till 3000 9•35 45420 86•99	-		2600	9.30	42630	85.65	69.26				
•K 2800 9-32 44490 86-34 * 2900 9-33 45420 86-67 ATM 3000 9-35 45420 86-99			2700	9.31	43560	86.01	69.88				
ATM. 2900 9.33 45420 86.67 ATM. 3000 9.35 46350 86.99	T c =	*	2800	9.32	06744	86.34	70.46				
= ATM. 3000 9.35 46350 86.99 .			2900	9 • 33	45420	86.67	10.17				
	- -	ATM.	3000	9•35	46350	86•99	71.54	•			.

*Isotope of Longest Known Half Life.

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matrix Transmission			و	H0 - H0	e	-(F°-H° 200.15)	FORMAT	ION FROM REFERE	NCE STATE	
Light of the first of the second of	= #			T 296.15 HEAT CONTENT	T FNTBOPY	FREE ENERGY	HEAT △ H [°]		50	
% 298 8-90 0 66.00 21500 10505 1 % 300 8-90 906 66.00 21500 10505 1 % 4 46.00 66.00 66.00 21500 10555 1 % 500 9.00 1807 70.653 67023 2083 36874 1 % 500 9.003 72.573 67.025 20581 36874 1 % 900 9.003 72.573 67.057 0 </th <th></th> <th></th> <th></th> <th>CAL./ GFW.</th> <th>CAL./DEG./ GFW.</th> <th>CAL./DEG./ GFW.</th> <th>CAL./GFW.</th> <th>CAL./ GFW.</th> <th>3</th> <th><u>د</u> م</th>				CAL./ GFW.	CAL./DEG./ GFW.	CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	3	<u>د</u> م
K 300 8-90 16 66.00 51590 10507 1 K 400 9-00 1001 66.01 71590 10507 1 K 500 9-00 1007 66.05 66.01 71597 10507 1 K 500 9-02 2708 77.02 2428 2428 1 K 900 9-03 3611 73.65 68.51 10.20 2428 1 Y 900 9-03 3611 73.65 68.51 10.20 2428 1 X 900 9-03 54215 74.87 0 </th <th></th> <td>298</td> <td>8 • 90</td> <td>0</td> <td>66.00</td> <td>66.00</td> <td>21600</td> <td>10568</td> <td>2</td> <td>146</td>		298	8 • 90	0	66.00	66.00	21600	10568	2	146
Cut./GFN 500 9.905 909 68.63 51.083 66.36 21083 6874 - % % 700 9.002 21807 77.65 67.76 14278 24.2 - % 800 9.005 54515 74.87 69.23 0		300	8.90	16	66.06	66.01	21590	10502	- 1-	22
Mar. Var. 500 9.00 1807 70.63 67.602 20581 3386 - x x 700 9.02 3615 74.87 69.23 0 <td< th=""><th></th><td></td><td>8.96</td><td>606</td><td>68•63</td><td>66.36</td><td>21083</td><td>6819</td><td></td><td>58</td></td<>			8.96	606	68•63	66.36	21083	6819		58
Nime Cut. /defin. 0000 9-022 2708 772-27 673-76 14228 242 - R 900 9-03 3511 773-66 68-51 0			00 •6	1807	70.63	67.02	20581	3386		80
% 700 9.03 3611 73.665 68.51 0 0 0 Cut. /GFW 1000 9.005 4515 74.867 69.23 0 </th <th></th> <td>000</td> <td>9•02</td> <td>2708</td> <td>72.27</td> <td>67.76</td> <td>14228</td> <td>242</td> <td></td> <td>88</td>		000	9•02	2708	72.27	67.76	14228	242		88
N 800 9-05 4-15 74-87 69-23 0 0 0 Cut. Gen 900 9-05 5420 77-76 71-19 0		700	9•03	3611	73.66	68.51	0	0	0	
Cut. /GFW 900 9-00 54.20 75-94 69-92 0 "K "K "K 11000 9-008 6327 76.89 70.57 0 0 "K 11000 9-011 9056 79.28 71.171 0 0 0 "K 11200 9-11 9056 79.28 72.37 0 <t< th=""><th></th><td>800</td><td>60•6</td><td>4515</td><td>74.87</td><td>69.23</td><td>0</td><td>C</td><td>0</td><td></td></t<>		800	60 • 6	4515	74.87	69.23	0	C	0	
Marrier 11000 9.08 6327 76.89 70.57 0 % 11000 9.014 77.76 71.119 0 0 % 1300 9.111 9056 79.55 71.177 0 0 % 1300 9.111 9056 79.55 71.177 0 0 % 1400 9.111 9056 79.55 71.177 0 0 % 1500 9.111 9056 79.95 72.83 0 0 % 1500 9.14 10881 80.59 73.34 0 0 % 17000 9.16 11796 81.18 73.81 0 0 % 18000 9.17 12713 81.25 74.26 0 0 % 1900 9.20 14551 82.75 74.26 0 0 % 22000 9.22 14451 82.75 77.26 0 0 % 22000 9.22 14451 82.75 77.26 0 0 % 22000 9.23 16491 76.94 0 0 % % 22000 9.26 144.91 <th></th> <td></td> <td>9•00</td> <td>5420</td> <td>75.94</td> <td>69•92</td> <td>0</td> <td>0</td> <td>0</td> <td></td>			9 • 00	5420	75.94	69 • 92	0	0	0	
"K 11000 9-09 7736 771-19 0 0 "K 11200 9-10 8145 78-55 71-77 0 0 "K 11300 9-11 9056 79-28 72-32 0 0 0 "K 11300 9-14 10881 80-59 71-77 0 0 0 "K 11300 9-14 10881 80-59 71-77 0 0 0 "K 11300 9-14 10881 81-38 72-83 0 0 0 "K 1500 9-14 10781 81-73 74-26 0 0 0 "K 1700 9-19 13631 82-26 74-69 0			9°08	6327	76.89	70.57	0	0	0	
% 1200 9-10 8145 78-55 71-77 0 m 11200 9-11 9056 79-28 72-32 0 0 m 1400 9-11 9056 79-28 72-32 0 0 m 1400 9-14 10881 80.59 72-32 0 0 m 1500 9-14 10881 80.59 72-32 0 0 m 1600 9-16 11796 81.18 73-81 0 0 m m 1700 9-17 12713 81.73 74-26 0 0 m m 11700 9-16 11796 81.18 73-81 0 0 m m 11700 9-17 12713 81.73 74-26 0 0 m 11700 9-17 12713 81.73 74-26 0 0 m 22000 9-22 14551 82.26 74.69 0 0 m 22000 9-26 182.75 75.50 0 0 0 m m 22000 9-28 125.61 0 0 0 m 2		1100	60°6	7236	77.76	71.19	0	0	0	
"K 1300 9-11 9056 79-28 72-32 0 CuL/GFN 1400 9-11 9056 79-28 72-32 0 0 % 1500 9-14 10881 80-59 72-83 0 0 0 % 1500 9-14 10705 9-14 10705 9-14 0		1200	9.10	8145	78.55	71.77	0	0	0	
CAL./GFW. 14400 99-13 99668 79-95 72-83 0 *K 1500 9-14 10881 80-59 73-34 0 0 *K 1500 9-14 10881 80-59 73-34 0 0 *K 1600 9-17 12713 81-73 74-26 0 0 *K 1800 9-19 13631 82-25 74-69 0 0 0 *K 1800 9-20 14571 82-75 74-69 0	-	1300	9.11	9056	79.28	72.32	0	0	0	
-w./wr 1500 9.14 10881 80.559 73.34 0 -w 1600 9.16 11796 81.18 73.81 0 0 -w 1600 9.17 12713 81.73 74.26 0 0 -w 1800 9.19 13631 82.26 74.69 0 0 -w 1800 9.20 14551 82.75 75.50 0 0 -w 2200 9.22 14551 82.75 75.50 0 0 -w 2200 9.22 14551 82.75 75.68 0 0 -w 2200 9.22 14551 82.75 75.69 0 0 -w 2200 9.22 14551 82.75 75.56 0 0 -w 2200 9.22 14551 82.63 77.659 0 0 -w 2200 9.28 182.43 84.61 76.93 0 0 -w 2200 9.28 182.43 84.61 76.93 0 0 -w 2200 9.28 186.65 77.659 0 0 0 -w 25600 9			-	9968	79.95	72.83	0	0	0	
* 11700 9.16 11796 81.18 73.81 0 * 1700 9.17 12713 81.73 74.26 0 0 * 1800 9.19 13631 82.26 74.69 0 0 CAL/GFW 1900 9.22 14551 82.75 75.50 0 0 * 1900 9.22 14551 82.75 75.50 0 0 * 22000 9.22 14551 82.75 75.50 0 0 * 22000 9.22 14551 82.75 75.50 0 0 * 22000 9.24 17318 84.01 76.24 0 0 * 22000 9.26 18243 84.91 76.93 0 0 * 22000 9.28 19270 85.65 77.57 0 0 * 22000 9.33 21026 85.65 77.57 0 0 * * 22000 9.32 21026 85.65 77.57 0 0 * * 28000 9.32 21026 85.65 77.57 0 0 *			-	10881	80.59	73.34	0	0	0	
% 11700 9.17 12713 81.73 74.26 0 0 % 1800 9.17 12713 81.73 74.26 0 0 0 CAL/GFW. 1800 9.20 14551 82.75 75.50 0 0 0 % 1900 9.22 15472 83.23 75.50 0 0 0 0 % 22000 9.22 15472 83.68 75.58 0 0 0 0 % 22000 9.24 17318 84.011 76.24 0 <th< th=""><th></th><td>1600</td><td>9.16</td><td>11796</td><td>81.18</td><td>73.81</td><td>0</td><td>0</td><td>0</td><td></td></th<>		1600	9.16	11796	81.18	73.81	0	0	0	
"K 1800 9-19 13631 82.26 74.69 0 0 CAL /GFW. 1900 9-20 14551 82.26 74.69 0 0 0 CAL /GFW. 2000 9-22 15472 83.23 75.610 0 0 0 % 22000 9-22 15472 83.23 75.610 0 0 0 % 22000 9-22 16472 83.23 75.610 0		1700	9.17	12713	81.73	74.26	0	0	0	
CAL./GFW. 1900 9.20 14551 82.75 75.10 0 0 r/s 22000 9.22 15472 83.23 75.50 0 0 0 r/s 22000 9.22 15472 83.23 75.50 0 0 0 r/s 22000 9.22 17318 84.01 75.88 0 0 0 0 r/s 22000 9.24 17318 84.01 76.93 0	-	1800	9•19	13631	82•26	74.69	0	0	0	
-ML./WT. 2000 9.22 15472 83.23 75.50 0 -K 2100 9.23 16395 83.68 75.68 0 0 -K 2200 9.24 17318 84.11 76.24 0 0 -K 2200 9.26 18243 84.52 76.59 0 0 -K 2300 9.26 18243 84.61 76.93 0 0 -K 2300 9.26 18243 84.61 76.93 0 0 2400 9.28 19170 84.91 76.93 0 0 0 2700 9.30 21026 85.29 77.57 0 0 0 2700 9.31 21027 86.01 77.57 0 0 0 -K 2800 9.32 22088 86.34 78.17 0 0 -K 2900 9.33 23821 86.67 78.46 0 0 -K 3000 9.35 24754 86.99 78.74 0 0			9•20	14551	82.75	75.10	0	0	0	
2100 9.23 16395 83.68 75.88 0 % 2200 9.24 17318 84.11 76.24 0 0 % 2200 9.24 17318 84.11 76.24 0 0 2200 9.24 17318 84.91 76.93 0 0 2200 9.27 19170 84.91 76.93 0 0 2400 9.27 19170 84.91 76.93 0 0 2500 9.28 20097 85.29 77.57 0 0 2700 9.31 21026 85.65 77.57 0 0 2700 9.31 21026 86.61 77.57 0 0 % 2800 9.32 22888 86.34 78.17 0 0 % 2900 9.33 23821 86.67 78.46 0 0 % 3000 9.35 24754 86.99 78.74 0 0	_		9.22	15472	83•23	75.50	С	0	0	
% 2200 9.24 17318 84.11 76.24 0 0 % 2300 9.26 18243 84.52 76.59 0 0 0 CAL/GFW 2300 9.26 18243 84.52 76.59 0 0 0 CAL/GFW 2400 9.27 19170 84.91 76.93 0 0 0 ZAL 2500 9.28 20097 85.29 77.57 0 0 0 0 ZAD0 9.31 21026 85.65 77.577 0 0 0 0 0 ZO0 9.32 221036 86.61 77.88 0 0 0 0 X 28000 9.32 221858 86.34 78.17 0 0 0 0 X 29000 9.33 23821 86.67 78.46 0 0 0 0 0 0 0 0 0		2100	9•23	16395	83•68	75.88	0	0	0	
Tk 2300 9.20 18243 84.52 76.59 0 0 0 CAL/GFW 2400 9.27 19170 84.91 76.93 0 <th></th> <td>2200</td> <td>9•24</td> <td>17318</td> <td>84.11</td> <td>76.24</td> <td>0</td> <td>0</td> <td>0</td> <td></td>		2200	9•24	17318	84.11	76.24	0	0	0	
CAL/GFW 2400 9-27 19170 84-91 76-93 0 0 0 CAL/GFW 2500 9-28 20097 85-29 77-26 0 <td< th=""><th></th><td>2300</td><td>9.50</td><td>18243</td><td>84•52</td><td>66.01</td><td>0</td><td>0</td><td>0</td><td></td></td<>		2300	9.50	18243	84•52	66.01	0	0	0	
vm./vm. 2500 9.28 20097 85.29 77.26 0 0 2600 9.30 21026 85.65 77.57 0 0 0 2700 9.31 21957 86.01 77.88 0 0 0 * 2800 9.32 21957 86.01 77.88 0 0 0 * 2800 9.32 22888 86.61 78.17 0 0 0 * 2900 9.33 22818 86.67 78.47 0 0 0 * 3000 9.35 24754 86.69 78.74 0 0 0			9•27	19170	84.91	76.93	0	0	0	
= % 2600 9.30 21026 85.65 77.57 0 0 = % 2700 9.31 21957 86.01 77.88 0 0 = % 2800 9.32 22888 86.34 78.17 0 0 = A1M 2900 9.33 23821 86.67 78.46 0 0 = A1M 3000 9.35 24754 86.99 78.74 0 0	-		9•28	20097	85•29	77.26	0	0	0	
= "K 2700 9.31 21957 86.01 77.88 0 0 0 0 0 = 0 = 0 = 0 = 0 = 0 = 0 = 0		5600	6 •30	21026	85.65	77.57	0	0	0	
= °K 2800 9.32 22888 86.34 78.17 0 0 2900 9.33 23821 86.67 78.46 0 0 = ATM 3000 9.35 24754 86.99 78.74 0 0		2700	9.31	21957	86.01	77.88	0	0	0	
= ATM. 2900 9.33 23821 86.67 78.46 0 0 0 = 0		2800	9.32	22888	86.34	78.17	0	0	0	
= AlM. 3000 9•35 24754 86•99 78•74 0 0		2900	9 • 33	23821	86.67	78.46	0	0	0	
		3000	9.35	24754	86.99	78.74	0	0	0	

ASTATINE

ICE STATE LOG K			• • • • • • • • • • • • • • • • • • •	1•205 1•289 1•433 1•496 1•551	1.603 1.652 1.652 1.736 1.772 1.881 1.881 1.882 1.8872
ION FROM REFEREN FREE ENERCY A P	13002 12948 9961 7025 4258			- 9375 - 10619 - 11868 - 13120 - 14377 - 15615	- 16878 - 19387 - 19387 - 20657 - 20657 - 21904 - 23206 - 24456
FORMAT HEAT A H ^o cal./gfw.	22000 21996 21793 21590 18460	11390 11433 11480 11523	11607 11607 11649 11730 11770	11807 11845 11882 11920 11957 11957	12033 12073 12113 12155 12155 12197 12242 12242 12287 12335
-(F- H 21911) FREE ENEROY FUNCTION CAL./DEG./ GFW.	44•68 44•68 44•88 44•88 45•25 45•65	46.07 46.47 46.85 47.21 47.21	47.87 48.17 48.17 48.45 48.45 48.45 48.72	49.24 49.47 49.47 49.92 49.92 50.12 50.32	50.51 50.70 51.04 51.04 51.53 51.53 51.53
S ⁰ T ENTROPY CAL./DEG./GFW.	44.68 44.71 46.14 47.25 48.15	48.92 49.58 50.17 50.69	51.60 51.99 52.36 53.03 53.03	53.53 53.61 53.61 54.14 54.38 54.38 54.61	54 55 55 55 55 55 55 55 55 55 55 55 55 5
H ⁰ - H ⁰ T 291.15 HEAT CONTENT CAL./ GPV.	0 9 506 1003 1500	1996 2493 2493 3487 3487	5477 5477 5474 5474 5474 5474	6964 7461 7958 8455 8455 9455	9955 10458 10458 11468 11976 12486 12486 12998 13512
C ^O F HEAT CAPACITY CAL./DEG./ GPW.	4°97 4°97 4°97 4°97 4°97	4.07 4.07 4.07 4.07 4.07		00000000000000000000000000000000000000	5.02 5.03 5.03 5.04 5.04 5.04 5.11 5.11
T TEMPERATURI øK	29H 300 5000 600	700 800 900 1000	12000	1 700 1 800 1 900 2 000 2 2 000 2 2 000	2300 2400 2500 2500 2500 2500 2900 29000 3000
GRAMS CAL./GFW.	°K CAL. /GFW.	°K CAL. /GFW.	°K CAL. /GFW.	°K CAL./GFW.	°K CAL/GFW. °K ATA.
iw 210° * M° _{298.15} H\$)= 1,481	.e.,	LP. JH,	а; ⁸ #,	e: <u>-</u>	
	$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	IO.* GRAMS T C H ^O - H ^O T = 2413 C H ^O - H ^O = 2413 C H ^O - H ^O = 2413 C H ^O - H ^O = 2413 C Heat I = 10000 FORMATION FROM REFERENCE ST 1, 48] CAL/GFW. °K CULOREC/GFW. HEAT CONTENT EAT CONTENT </td <td>210.* GRMX T C PHP 1 24.1 CHM FIGUA REFERENCE ST PREFERENCE ST PARTE DELECY OF T PART A PHP FIGUA REFERENCE ST PART A PHP FIGU</td> <td>ZIO.* GRMATION FORMATION FORMATION FORMATION FEERENCE ST. T. Mails T. Mails T. Mean FORMATION FFEERENCE ST. T. Mean MEAT & Me FREE ENERGY & M Lu * * * * * * * * * Lu * Lu * Lu * Lu Mean * Lu Mean Mean Lu Lu<</td> <td>Z10.* GAMS T C H⁰ – H⁰ Mills T PP – H⁰ Mills TORMATION FROM REFERENCE 31 * 1.5 – H⁰ = 1.3 + 31 Tweetexine HC HC</td>	210.* GRMX T C PHP 1 24.1 CHM FIGUA REFERENCE ST PREFERENCE ST PARTE DELECY OF T PART A PHP FIGUA REFERENCE ST PART A PHP FIGU	ZIO.* GRMATION FORMATION FORMATION FORMATION FEERENCE ST. T. Mails T. Mails T. Mean FORMATION FFEERENCE ST. T. Mean MEAT & Me FREE ENERGY & M Lu * * * * * * * * * Lu * Lu * Lu * Lu Mean * Lu Mean Mean Lu Lu<	Z10.* GAMS T C H ⁰ – H ⁰ Mills T PP – H ⁰ Mills TORMATION FROM REFERENCE 31 * 1.5 – H ⁰ = 1.3 + 31 Tweetexine HC HC

ASTATINE

*Isotope of Longest Known Half Life.

BARIUM	Ba		Sol	Solid I from 298°	n 298° to	643°, So	to 643°, Solid II from 643°	om 643° t	to 983°, Liquid	1qu1d
REFERENCE STATE	STATE		from	983°	o 1910°,	Ideal Mon	atomic Ga	s from 19	to 1910°, Ideal Monatomic Gas from 1910° to 3000°	00°.
Głw 137.36	SG GRAMS		-	υ	H° H°	°2	-(F°-H° 228.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
'		-	TEMPERATURE 9K	HEAT CAPACITY	T 204.15 HEAT CONTENT	T ENTROPY	FREE ENERGY FUNCTION	HEAT A H	FREE ENERGY A F	×
10 15			2				CALL/DEG/ GFR.		CALL/ UPN.	2
			298	6.30	0	15.50	15.50			
	985 %		300	6.31	11	15•54	15•51			
		3	400	6.64	656	17.40	15.76			
o(T mn∆		į	500	7.00	1334	18•91	16.25			
			600	7.30	2046	20•21	16.80			
			100	7.40	2921	21.57	17.40			
B.P. 1. J.	Y- 072		800	8.10	3694	22.60	17.99			
			006	8.80	4537	23.59	18•55			
010,00 MD		Ę	1000	7.50	7247	26.38	19.14			
			1100	7.50	1997	27.10	19,83			
			1200	7.50	8747	27.75	20.47			
. 9 .2	¥		1300	7.50	6497	28.35	21.05			
	2	-	1400	7.50	10247	28•91	21.60			
₽ µ 2		,	1500	7.50	10997	29•42	22.09			
]	1600	7.50	11747	29.91	22.57			
			1700	7.50	12497	30.36	23.01			
о́ 	04 .0 %		1800	7.50	13247	30.79	23.44			
		2	1900	7.50	13997	31.20	23.84			
		i	2000	6. 81	50721	50.43	25.07			
			2100	7.30	51438	50.78	26.29			
0 +	3		2200	7.81 8.34	52191	51.13	27•41 28.45			
÷	4				10000					
		ļ	2400	9 • 87	53871	51.86	24.42			
1		, Maria	2500	9•36	54753	52•22	30.32			
			2600	9•92	55747	52.61	31.17			
			2700	10.40	56754	52.99	31.97			
T _c =	*		2800	10.84	57826	53•38	32.73			
1	ATA		2900	11.22	58909	53.75	33°45			
	ľ		3000	11.56	60050	54.15	34.13			

BARIUM	Ba	Ref	erence S	tate for	Calculati	Reference State for Calculating $\Delta H_{\mathbf{f}}^{\circ}$, $\Delta F_{\mathbf{f}}^{\circ}$, and Log $_{10}\mathrm{Kp}$;	P [°] , and]	Log 10Kp:	
		Sol	1d I fro	m 298° to	, 643°, So	lid II fr	om 643° 1	Solid I from 298° to 643°, Solid II from 643° to 983°, Liquid	lquid
TDEAL MONATUMLC	UAS	from	983 °	to 1910°,	Ideal Mon	Ideal Monatomic Gas	s from 1910°	910° to 3000	00°.
61 127 2C	GRAMS	-4	و	0- H0	ę	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
·		TEMPERATURE	• •ر	1 296.15	^ +	FREE ENERGY	HEAT A H ^e	FREE ENERCY & F	
(H ^e _{200,15} H ₆) = 1,481	CAL./GFW.	7	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ OFW.	CAL./GFW.	CAL./GPW.	۲06 ۲
		a00	10.4	C	23 07	10 67	35713	16076	
K.P.	*	300	10.4))	40.70	40.67	41734	34186	- 24.906
	-	400	4.97	506	42.12	40.86	41586	31698	- 17.320
ΔH _m	CAL. /GFW.	500	4.97	1003	43.23	41.23	41405	29245	- 12.783
		600	4.97	1500	44.14	41.64	41190	26832	- 9.774
		700	4.97	1996	44.91	42.06	40811	24473	- 7.641
B.P.	×	800	4.97	2493	45.57	42.46	40535	22159	- 6.054
		006	4.97	2990	46.15	42 . 83	40189	19885	- 4.829
∆ H v	CAL. /GFW.	1000	86°†	3488	46.68	43•20	37977	17677	- 3.863
		1100	5.00	3987	47.15	43.53	37726	15671	- 3,113
		1200	5.03	4488	47.59	43.85	37477	13669	- 2.489
S.P.	*	1300	5.03	4991	47.99	44.15	37230	11698	- 1,966
3	110, 110	1400	5.17	5503	48.37	44.44	36992	9748	- 1.521
2 11		1500	5.31	6026	48.73	44.72	36765	7800	- 1.136
		1600	5.50	6567	49.08	44.98	36556	5884	- •803
		1700	5.74	7128	49.42	45.23	36367	3965	- 509
T.P.	*	1800	6.08	7724	49.76	45.47	36213	2067	- •250
1		1900	6.41	8340	50.09	45.71	36079	188	- •021
с п _р		2000	6.81	6668	50.43	45.94	•	0	0
		2100	7.30	9710	50.78	46.16	0	0	•
1		2200	7.81	10465	51.13	46.38	•	•	0
ġ.	×.	2300	8.34	11272	51.49	46.59	0	0	0
1		2400	8.87	12132	51.86	46.81	0	0	0
∆n ,	CAL. / GFW.	2500	9•36	13034	52.22	47.01	0	•	0
		2600	9.92	14012	52.61	47.23	0	•	0
		2700	10.40	15029	52.99	47.43	0	•	0
Tc =	¥.	2800	10.84	16089	53.38	47.64	0	0	00
	ATM	0067	77.11	G61/T	0/ • 56	41.84	ð	0	50
		3000	11.56	18334	54.15	48 • 04	Э.	5	>

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`		PORIATION FROM REFERENCE STATE △ H ^o Free Burney △ f ^o LOC or					
to 2750°	to 3000°K.	ATION FROM REFE					
		FORM HEAT A H ^e cal/gft.					
quid from	Gas from 2750°	-0-H HALIE) FREE ENERGY FUNCTION CAL./DEG/ OFW.	2.028 2.028 2.028 2.044 2.078 3.18	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	7.00 6.02 7.00 7.00 7.00	~ 8 8 8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	10.13 10.41 10.68 11.41 12.53
Solid to 1556°, Liquid from 1556°	Monatomic Ga	S ⁶ Entropy Cal./Deg./ gfy.	2 • 28 2 • 30 4 • 66	0 • 53 0 • 73 0 • 73 0 • 73	9.99 10.53 11.08 11.60 13.90 14.35	15.57 15.57 15.59 16.29 16.62	17.25 17.25 17.54 17.82 43.67 43.67
Solid to	Ideal Mon	H ⁰ - H ⁰ T 2015 HEAT CONTENT CAL./ GPV.	0 442 942 1485	2059 2654 3271 4578	5208 5982 6720 7482 11050 11800	14050 14050 14050 15550 15550 17050	17800 18550 19300 90336 90837 90837
		C C C C C C C C C C C C C C C C C C C	00 00 00 00 00 00 00 00 00 00 00 00 00	5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	7.50		7.50
		T TEMPERATURE 9K	200 200 200 200 200	700 800 900 11000	1300 1500 1500	22000 23000 2400	2500 2800 2800 2800
Be	VTE	GRAMS CAL-/GFV.	°K CAL /GFW.	°K CAL /GFW.	°K CAL_/GFW.	CAL. /GPN.	CAL /GFW. *K ATM.
BERYLLIUM	REFERENCE STATE	9.013 H9= 468	1,556 2,800	2,750 70,400			
BERY	REFE	Gfw 9. (H ^e _{200.15} H ^e) =	A.P. ∆ H _m	E.P. An	5.P. △ H. 1.P.	ΔH, T.P.	∆H, T _c =

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doi:
1, 1956
January
Date:
Publication

BERYLLIUM	Be		Re	ference S	itate for	Reference State for Calculating ΔH_{f}° , ΔF_{f}° , and	ng AH [°] , /	w [°] , and	
IDEAL MONATOMIC GAS	IC GAS		27. 27.	Log ₁₀ Kp: S 2750°, Idea	olid to] 1 Monatom	o <mark>Kp:</mark> Solid to 1556°, Liquid °, Ideal Monatomic Gas from	uld from om 2750°	l from 1556° to 2750° to 3000°.	
210 0								FORMATION FROM DEFEDENCE (TATE	MCE CTATE
CTO 2 Mg	GRAMS	-	೮-	H ⁰ – H ⁰ T 294.15	۰ ۲	-0-1-200.15)			
(H ² 20.15 H ²)=1 , 481	CAL./GFW.	TEMPERATURE N	HEAT	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL/DEG./ GFW.	CAL./GFW.	CALLY OFW.	Сос Тос Тос
		298	4.97	0	32.55	32,55	77900	68874	- 50.488
A.P.	¥	300	4.97	6	32.58	32.55	77902	68818	- 50.138
		400	4.97	506	34.01	32.75	77964	65776	- 35.941
∆ n	LAL. / GFW.	500	4.97	1003	35.11	33.11	77961	62736	- 27.423
		600	4.97	1500	36.02	33. 52	77914	59692	- 21.744
l		700	4.97	1996	36.79	33.94	77837	56655	- 17.689
B .P.	¥	800	4.97	2493	37.45	34.34	77739	53635	- 14.653
		006	4.97	2990	38.03	34.71	77619	50637	- 12.297
2H-	CAL /GFW.	1000	4.97	3487	38.56	35.08	77475	47645	- 10.413
		1100	4.97	3984	39 • 03	35.41	77305	44669	- 8.875
		1200	4.97	4480	39.46	35.73	77112	41712	- 7.597
5.P.	*	1300	4.97	4977	39.86	36.04	76895	38766	- 6.517
:		1400	4.97	5474	40°23	36.32	76654	35844	- 5,595
₽ ₩ ₽	CAL /GFW.	1500	4.97	5971	40.57	36.59	76389	32934	- 4.798
		1600	4.97	6468	40°89	36.85	73318	30134	- 4.116
		1700	4.97	6964	41.19	37.10	73064	27436	- 3.527
T.P.	¥	1800	4.97	7461	41.48	37.34	72811	24751	- 3.005
:		1900	4.97	7958	41.75	37.57	72558	22094	- 2.541
∆H	CAL. / GFW.	2000	4.97	8455	42 • 00	37.78	72305	19445	- 2.124
		2100	4.97	8952	42。24	37.98	72052	16822	- 1.750
		2 2 0 0	4.97	9448	42°48	38.19	71798	14180	- 1.408
T.P.	×	2300	4.97	9945	42.70	38.38	71545	11561	- 1.098
		2400	4.97	10443	42.91	38.56	71293	8965	816
PH,	CAL. / GFW.	2500	4.98	10940	43.11	38.74	71040	6390	- •558
		2600	4.98	11438	43 . 31	38.92	70788	3786	318
		2700	4.99	11937	43.49	39.07	70537	1228	- •099
Tc =	¥	2800	5.00	12436	43.67	39 . 23	•	0	0
		2900	5.01	12937	43.85	39.39	0	0	0
		3000	5.02	13438	44 • 0 2	39•55	0	0	0

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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REFERENCE STATE			ł		C.1250 HOIT NTNATA (C.1250 AA		I		
			Ч	832°, Ide	eal Monato	omic Gas 1	rom 1832	1832°, Ideal Monatomic Gas from 1832° to 3000°	•
209.00 GRAMS	2	F	5	HH	e,	-(F"+"294.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
1,536 CAL/	CAL/GPW.	TEMPERATURE •K	HEAT CAPACITY CAL./DEG/ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEQ./ GFW.	HEAT A H	CALL/GFW.	1 ° 001
544.5] [200 3008	\$: 1 1	011	13.58	13.58			
-		400	6.65 7.10	650	15.45	13.83			
	CAL. /GFW.	000	7.50	4680	23.12	15.32			
		700	7.50	5430	24.28	16.53			
1.832.		800	7.50	6180	25.28	17.56			
f		006	7.50	6930	26.16	18.46			
36,200. CAL	CAL. /GFW.	1000	7.50	7680	26.95	19•27			
-]	1200	7.50	9180	28.32	20.67			
1		1300	7.50	0666	28.92	21.29			
e		1400	7.50	10680	29.47	21.85			
3	CAL. /GFW.	1500	7.50	11430	29•99	22.37			
	٦	0001	06.1	12030	30.48	22•87			
		1800	7.50	13680	31.36	23.76			
¥		1900	5.00	55460	53.87	24.69			
C.	CAL. /GFW.	2000	5.01	55970	54.13	26.15			
		2100	5.03	56470	54.38	27.49			
	Γ	0000							
*		2400	2.00	57980	55•05	30.90			
	, rew	2500	5.12	58490	55.26	31.87			
3		2600	5.15	59010	55.46	32.77			
	ſ	2700	5.19	59530	55•66	33.62			
3		2800	5•23	60050	55 • 85	34.41			
4		2900	5.27	60570	56.03	35.15			
ATM.		3000	5•32	61100	56.21	35.85			

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BISMITH	Bt		Ř	eference	Reference State for Calculating Afr, Are, and	Calculat	1ng AH,	∆r°, and		
			Ă	Log ₁₀ Kp:	Solid fro	Solid from 298° to 544.5°	544.5°,	, Liquid from 544.5°	HO	544.5°
IDEAL MONATOMIC	GAS		ų.	to 1832°,	Ideal Mon	atomic Ga	s from 16	Ideal Monatomic Gas from 1832° to 3000°	8	•
6ł* 209•00	GRAMS		U	H ⁰ -H ⁰	۰	(11.452)	FORMAT	FORMATION FROM REFERENCE STATE	SHOE S	rate
(H ^e _{20.15} H ^o) = 1,481	CAL/GPU.	MUTAPOLIT	HEAT CAPACITY CAL/DEG/ GPW.	T ZMLIS HEAT CONTENT CAL./ GPV.	ENTROPY CAL./DEG./ GFW.	FREENENOY FUNCTION CAL./DEG./ GFW.	HEAT A H	FREE BUENCY & F		то Карала Кара Кар
		298	4.97	0	44.67	44.67	47500	38231	1	8-025
A.P.	¥	300	4.97	6	44.70	44.67	47498	38174	1	27.812
△ H.	CAL. /GFW.	500 500	4•97 4•97	506 1003	46.13 47.24	44.87 45.24	47356 47163	35084	11	19•170
		600	4.97	1500	48.14	45.64	44320	29308	1	0.676
		700	4.97	1996	48.91	46.06	44066	26825	I	8.375
8.P	¥	800	4.97	2493	49.57	46.45	43813	24381	1	6.661
ΔH,	CAL /GFW.	1000	16.4	3487	50.68	40.84	43307	21960	1 1	5•332 4.278
		1100	4.97	3984	51.16	47.54	43054	17215	1	3.420
	Γ	1200	4.97	4480	51.59	47.86	42800	14876	1	2.709
S.P.	¥	1300	4.97	4977	51.99	48.17	42547	12556	1	2.111
		1400	4.97	5474	52 . 35	48.44	42294	10262	1	1.602
5 11 (2)		1200	4.97	2611	52.70	48.72	42041	1976	1	1.162
		1600	4 •98	6469	53•02	48°98	41789	5725	1	•781
4	4	1700	4 • 98	6967	53.32	49•23	41537	3474	I	9440
	4	1000	66.4	1405	00.55	04.04	68214	6C21	•	241.
∆H,	CAL. /GFW.	2000	5.01	8465	54.13	00.04	00			
		2100	5.03	8966	54.38	50.12	0	0		0
		2200	5.04 40	9470	54.61	50.31	0	0		0
<u>.</u>	4	0052		10483			с С			- c
ΔH,	CAL. /GFW.	2500	5.12	10994	55.26	50.87	00	0		0 0
		2600	5.15	11508	55.46	51.04	0	0		0
		2700	5.19	12025	55.66	51.21	0	•		0
T _c =	¥	2800	5.23	12546	55 • 85	51.37	0	0		0
		2900	5.27	13071	56.03	51.53	0	0		0
Pe =	ATA	3000	5•32	13600	56.21	51.68	0	0		0

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DTORUM	ā		Ref	erence St	ate for C	Reference State for Calculating ΔH_{r}^{o} , ΔF_{r}^{o} , and	g dh, di	e, and	
UTOMOTO	270		Log	Log ₁₀ Kpt So	lid from	298° to 5	44.5°, L1	Solid from 298° to 544.5°, Liquid from 544.5°	1 544.5°
IDEAL DIATOMIC	GAS		to		Ideal Monat	omic Gas	from 1832	Monatomic Gas from 1832° to 2000°	
	1110	ŀ	ę	93	4	-(F ⁰ -H ⁰ 200.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
418.00	CHANN	1		T 296.15	2 6 +	FREE ENERGY	HEAT A H ^e	FREE ENERGY & F	
(H ² 241.15 H ²) = 2,453	CAL./GFW.	X	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEQ./ GFW.	F CAL./GPW.	f CAL./ GFW.	۲06 ۲
								•	
9	:	298	8.83	0	65.40	65.40	55300	43899	- 32.180
	4	300	8.83	16	65.46	65.41	55294	43828	- 31.931
∆ H–	CAL /GFW.	400	8.88	006	68 • 00	65.75	54900	40060	- 21.889
		500	8.90	1790	69°98	66.40	54410	36410	- 15.915
		600	8.91	2685	71.62	67.15	48625	33397	- 12.165
0	:	700	8.92	3575	72.99	67.89	48015	30914	- 9.652
	4	800	8.93	4465	74.18	68.60	47405	28509	- 7.788
H	CAL /GFW	006	8.93	5360	75.23	69 •28	46800	26181	- 6.358
*		1000	8.93	6250	76.17	69 • 92	46190	23920	- 5.228
		1100	8.93	7140	77 • 02	70.53	45580	21732	- 4.318
	*	1200	8.94	8040	77.80	71.10	44980	19588	- 3.567
	2	1300	8.94	8930	78.51	71.65	44370	17499	- 2.942
ΔH.	CAL. /GFW.	1400	8.94	9830	79.18	72.16	43770	15434	- 2.409
•		1500	8.94	10720	79.79	72.65	43160	13445	- 1.959
		1600	8 • 94	11615	80.37	73.12	42555	11499	- 1.570
0 +	3	1700	8.94	12510	80.91	73.56	41950	9565	- 1.229
<u>.</u>	4	1800	8.94	13400	81.42	73.98	41340	7680	- 932
Δ Η ,	CAL. / GFW.	1900	8 •94	14295	81•91	74.39	- 41325	7752	
•		2000	8 • 94	15190	82•36	74.77	- 41450	10350	- 1.130
T.P .	*								
∆ H,	CAL. / GFW.								
T _c =	¥								
	ATA								
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Publication Date: January 1, 1956 | doi: 10.1021/ba-1956-0018.ch004

BORON	NON	Æ			Solid to	2300°, L1	Solid to 2300°, Liquid from 2300° to 3000°.	2300° to	3000°.	
REF	REFERENCE STATE	TE				ı	I			
3	10.82	00440	•	2	3	•	-(B ⁶ -H ⁶ 288.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
<u>}</u>	 	CINANO	TEMPERATURE		H - H - H - H - H - H - H - H - H - H -	°.	FREE ENERGY	HEAT $ riangle$ H°	FREE ENERGY & P	
(H° 298	(H° _{211.15} H°)= 292	CAL./GFW.	¥	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GPW.	CAL./ GPW.	, K
			298	2.63	0	1•40	1.40			
A.P.	2,300	×,	300	2.65	ŝ	1.41	1.40			
4	(2,300)	CAL /GFW	400	3.45	311	2•29	1.52			
			009	4 • 5 7	1120	6100 8001	1.05			
			700	5.00	1599	4.65	2.37			
8 4	4,200	×	800	5•35	2117	5.34	2.70			
			006	5.65	2668	5 •99	3.03			
₽H 2	1 60,000	CAL. /GFW.	1000	5.90	3246	6.60	3•36			
			1100	6.10	3846	7.17	3.68			
			1200	6.27	4465	7.71	3 . 99			
ч. Ч.		¥	1300	6.42	5066	8.22	4.30			
ΔH		CAL. /GFW.	1400	6.55	5748	8.70 	09°4			
			1600	6.78	7082	05.0	5.17			
			1700	06.9	7765	10.00	5.44			
T.P.		۴,	1800	7.00	8460	10.40	5.70			
1			1900	7.10	9165	10.78	5 . 96			
			2000	7.30	9880 10605	11.15	6.21 6.45			
			2200	7.40	11340	11.84	6.69			
d. T		×	2300	7.50	17380	14.47	6.92			
			2400	7.50	18130	14.79	7.24			
h ⊲		CAL. /GFW.	2500	7.50	18880	15.10	7.55			
			2600	7.50	19630	15.39	7.84			
			2700	7.50	20380	15.68	8.14			
= ⁻¹		ž	2900	7.50	21130	16.22	8.441			
" •		ATM.	3000	7.50	22630	16.47	8.93			
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BORON

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

BORON		£		Ref	erence St	ate for (Reference State for Calculating $\Delta H_{f}^{\circ}, \Delta P_{f}^{\circ},$	ng ∆H°, ∆	r', and	
IDEAL	IDEAL MONATOMIC GAS	GAS		Log	Log ₁₀ Kp: Sc	olid to 23	Solid to 2300°, Liquid from 2300° to 30	id from	2300° to	Ř
								FORMAT	FORMATION FROM REFERENC	X
2	70.62	GRAMS	-		H ⁰ H ⁰ T 296.15	r-	THE FRENCY	HEAT A H ^o	FREE ENERGY A F	-
(H [°] 296.15 ⁻ H	(H [°] 211,15 H°) 1,510	CAL./GFW.	Х.	HEAT CAPACITY CAL./DEG/ GPW.	HEAT CONTENT CAL./ GPW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	
			298	4.97	0	36.65	36.65	141000	130490	1
A.P.		¥	300	4.97	0	36.68	36.65	141004	130423	
			400	4.97	506	38.11	36.85	141195	126867	
PH		CAL. / GFW.	500	4.97	1003	39.22	37.22	141315	123270	
			600	4.97	1500	40.12	37.62	141380	119654	<u> </u>
			700	4.97	1997	40.89	38.04	141398	116030	
8. 9.		*	800	4.97	2494	41.55	38.44	141377	112409	
			006	4.97	2990	42.14	38,82	141322	108787	
∆H		CAL. /GFW.	1000	4.97	3487	42.66	39,18	141241	105181	_
			1100	4.97	3984	43.14	39 . 52	141138	101571	
			1200	4.97	4481	43.57	39 ° 84	141016	97984	
ς. Γ.		*	1300	4.97	4978	43.97	40.15	140879	64404	
3			1400	4.97	5475	44.33	40.42	140727	90845	•
5 1			1500	4.97	5971	44 • 68	40.70	140562	87267	<u> </u>
			1600	4.97	6468	45 • 00	40.96	140386	83730	
			1700	4.97	6965	45•30	41.21	140200	80190	
т.Р.		*	1800	4.97	7462	45.58	41.44	140002	76678	
			1900	4.97	7959	45 . 85	41.67	139794	73161	
1 4		CAL. /GFW.	2000	4.97	8455	46.11	41.89	139575	69655	
			2100	4.97	8952	46.35	42 . 09	139347	66162	
			2200	4.97	9449	46.58	42.29	139109	62681	

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> In THERMODYNAMIC PROPERTIES OF THE ELEMENTS: Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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1956 doi:
Date: January 1,
Publication

BRON	BROMINE Br ₂	5			Liquid	from 298°	Liquid from 298° to 331.4°, Ideal	°, Ideal		
REFI	REFERENCE STATE	ų			Distoni	c Gas fro	Diatomic Gas from 331.4° to 3000°	to 3000°.		
ż	159.832	GRAMS	-	ືບໍ	н <mark>е</mark> -не	8	-(F°-H° 218.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H ⁶ 24	(H ⁰ ₂₉₆ . 15 H ⁰) =	CAL./GFW.	TEMPERATURE	HEAT O	T 244-15 HEAT CONTENT CAL./ GFW.	ENTROPY CAL. /DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ OFW.	HEAT A H	FREE ENERGY & F	L06 " K
			298	17-00	c	36.25	36225			-
M . P.	265.95	×	300	17+00	31	36.36	36.26			
3		730, TO	400	8.78	8337	61+20	40.36			
	2,520.	LAL. / GFW.	500	8.86	9219	63.17	44.74			
			600	8.91	10107	64.79	47.95			
0	l	\$	700	8 • 9 •	11000	66.17	50.46			
1 1 1	331.4	4	800	8.97	11895	67.36	52.50			
∆H	7.170.	CAL. /GFW.	1000	8•99 9•01	12794	68•42 60.37	54.21 55.68			
			1100	9.03	14595	70.23	56.97			
		–	1200	9.04	15498	71.02	58.11			
4. 4.		¥	1300	9 • 0	16404	71.74	59.13			
Δ H.		CAL. / GFW.		10.6	01671	72.41	60 . 05			
•			0091		97791	73.67	06.00			
			1700		20036	70.00				
Ţ.P.		¥	1800	9.12	2005	02.42	70759			
			1900	9.13	21859	75.19	63.69			
ĥ		CAL. /GFW.	2000	9.14	22774	75.66	64.28			
			2100	9.15	23687	76.10	64.83			
			2200	9.16	24602	76.53	65.35			
<u>.</u>		ž	2300	9.17	25520	76.94	65 . 85			
AHL		CAL. /GFW.	25.00	01.0	22256		000JC			
•			2600	9.21	28276	78-06	67.19			
			2700	9.22	29197	78.41	67.60			
T. =	584.	×	2800	9.23	30119	78.74	61.99			
I			2900	9.24	31043	79.07	68.37			
ے ۳	102.	ATM.	3000	9•25	31967	79.38	68.73			2

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BROMINE	Br ₂		μ. 	leference	State for	Reference State for Calculating Afr, Are	ing ∆H°,	۵۴°,	
IDEAL DIATOMIC GAS	GAS		д н	autu Log ₁₀ np; Ideal Diatomi		auu rog ₁₀ mp; liquid irom 236 to 331.4 Ideal Diatomic Gas from 331.4° to 3000°	4° to 3000°	1.4 , 00°.	
_{61w} 159.832	GRAMS	-	ە ئ	H ^o H ^o T 296.15	°r+	-(1-0-1-0-1-0-1-0-1-0-1-0-1-0-1-0-1-0-1-	FORMAT LEAT A LO	FORMATION FROM REFERENCE STATE	NCE STATE
(H [°] _{216.15} H [°] ₉) = 2, 325	CAL./GFW.	TEMPERATURE °K	HEAT O	HEAT CONTENT CAL./ GFW.	ENTROPY CAL. /DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	CAL./GPW.	CAL./ GFW.	ч , , , , , , , , , , , , , , , , , , ,
		298	8.62	0	58.65	58.65	7450	773	566
M. P.	ž	400	8.78	10	61.20	58.99	7434	738	•
∆ H 	CAL. /GFW.	500	8.86	1769	63.17	59.64	00	00	00
		600	8•91	2657	64•79	60.37	0	0	0
8.P.	×	800	8•97	4445	67•36	01•10 61•81	00	00	00
Ĩ	CA1 /CEW	006	8°99	5344	68•42 40 37	62°49	00	00	00
711 ⁴		1100	10°6 609	7145	70.23	63°74	00		o c
		1200	9.04	8048	71.02	64.32	0	00	00
S.P.	*	1300	90•6	8954	71.74	64.86	0	0	0
ΔH	CAL. /GFW.	1500	9.07 0.08	9860 10768	72.41	65•37 65-87	00	00	00
		1600	60.6	11676	73.62	66.33	00		00
		1700	9.11	12585	74.17	66.77	0	0	0
T.P.	×	1900	9.12 9.13	13498 14409	74.70	67.21 67.61	00	00	00
ΔH	CAL. /GFW.	2000	9.14	15324	75.66	68.00	0	0	0
		2100	9.15	16237	76.10	68.37	0	0	0
		2200	9.16	17152	76.53	68.74	0	0	0
T.P.	*	2400	9.17 0.18	18070 18088	76.94	60°09	00	00	00
∆ H,	CAL. /GFW.	2500	9.20	19906	77.70	69.74	0	0	00
		2600	9•21	20826	78.06	70.05	0	0	0
		2700	9•22	21747	78.41	70.36	0	0	0
T _c =	¥	2800	9•23	22669	78.74	70.65	00	00	00
ا م	ATM	0062	4 × 0	66662 Frair	10.61	10.94	0 0	0	0 0
- u		2000	•	17642	00.001	1201/	S	D	þ

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doi: 10.1021/ba-1956-0018.ch004	
Date: January 1, 1956	
Publication	

BROMINE	Br		1	Reference	State fo	Reference State for Calculating Afr. Ar	ting $\Delta H_{\hat{\Gamma}}^{\bullet},$	۰ م			
IDEAL MONATOMIC GAS	GAS			and Log ₁₀ Id eal Dia	Kp: Liqu tomic Gas	and Log ₁₀ Kp: Liquid from 298° Ideal Diatomic Gas from 331.4°	98° to 331.4 .4° to 3000°	51.4°, 00°.			
64 20 20 20	20116	•		ġ	9	-@		FORMATION FROM REFERENCE STATE	ENCE S	ATE	
9T6 • 6 /		TEMPERATI BE		H H H H H H H H -	հ-	FREE ENERGY	HEAT A H	FREE ENERGY 🛆 F			
(H ⁰ 211.15 ⁻ H ⁰) = 1,481	CAL./GFW.	¥.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GPV.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GPW.	CAL./ GPW.		, Kong Kong Kong Kong Kong Kong Kong Kong	
		906	10.4	c	10,11	10,14	09590	00901			
M.P.	¥	006	16.4	0	41.84	41.61	26753	19658		14.322	
A H		400	4.97	506	43.27	42.01	23097	18029	•	9.851	
		500	4.97	1003	44.37	42.37	23153	16763	1	7.327	
		600	4.98	1500	45•28	42.78	23206	15478	1	5.638	
0	3	700	5 • 00	1999	46.05	43•20	23259	14180	1	4.427	
	4	800	5.03	2500	46 • 72	43.60	23312	12880	1	3.518	
Ĩ		006	5.06	3004	47.31	43.98	23334	11544	1	2.803	
4u7	LAL / GTW.	1000	5.11	3513	47.85	44.34	23393	10223	1	2.234	
		1100	5.15	4026	48.34	44.68	23455	8902	ł	1.768	
0		1200	5.20	4543	48.79	45•01	23521	7585	1	1.381	
	 e	1300	5.24	5066	49.21	45°32	23591	6249	1	1.050	
Δ H.	CAL. /GFW.	1400	5.28	5592	49-60	45.61	23664	4918	1	.767	
•		1500	5.32	6122	49°96	45.88	23740	3580	1	.521	
		1600	5.35	6656	50.31	46.15	23820	2220	1	• 303	
		1700	5.38	7192	50.63	46.40	23901	883	1	.113	
<u>.</u>	¥	1800	5.40	7731	50.94	46.65	23984	- 478		•058	
AH.	CAL /GEW	1900	5.42	8272	51.23	46 .8 8	24069	- 1847		.212	
Ŧ		2000	5.43	8814	51.51	47.11	24154	- 3206		•350	
		2100	5.44	9357	51.77	47.32	24240	- 4572		.475	
0 +	3	2200	5.44	9901	52.03	47.53	24327	- 5945		• 590	
		2300	5.45	10446	52.27	47.73	24413	- 7327		•696	
ΔH.	CAL /GFW.	2400	5.45	10990	52.50	47.93	24498	- 8718		.793	
		2500	5.45	11535	52.72	48.11	24584	- 10091		.882	
		2600	5.44	12079	52.93	48 •29	24668	- 11472		•96•	
,		2700	5.44	12623	53.14	48.47	24751	- 12887		1.043	
1 c =		2800	5.43	13166	53•34	48 •64	24833	- 14283		1.114	
" •	ATM.	2900	5.42	13709	53.53	48•81	24914	- 15686		1.182	
•		2006	244	14676	11.000	07.02		CON11 -		1.643	

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CADMIUM	cum ca	~		S	olid from	1 298° to	Solid from 298° to 594°, Liquid from 594°	uid from	59 4° to	
REPER	REFERENCE STATE	S		T	1038°, Ide	sal Monato	mic Gas f	rom 1038	Ideal Monatomic Gas from 1038° to 3000°	•
45 6	112.41	GRAMS	F	ືບໍ	н. Но – Но Н	e,	-(F*	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H ⁰ _{210.15} H ⁰) =		CAL./GFW.	TEMPERATURE •K	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H	FREE ENERGY & F CAL./ GFW.	۲ ۵ ۲ ۵
¥.P.	594	*	298 300	6•23 6•23	12	12.37	12.37			
∆ H.	1,450	CAL. /GFW.	400 500	6•49 6•78	645 1310	14•23 15•71	12.62 13.04			
			600	7.10	3450	19.41	13.66			
			700	7.10	4160	20.50	14.56			
d	1,038	4	800	7.10	4870	21.45	16.00	_		
ΔH ~	23,870	CAL. /GFW.	1000	7.10	6290	23.04	16.75	_		
			1100	4.97	30730	46.55	18.62	_		
		-	1200	4.97	31230	46.98	20.96	_		
4.		¥	1300	4.97	31730	47.38	22.98	_		
3		MEC/ INC	1400	4.97	32220	47.75	24.74	_		
8 1			1500	4.97	32720	48 • 09	26.28	_		
			1600	4.97	33220	48.41	27.65	_		
			1700	4.97	33710	48.72	28.90	_		
<u>.</u>		¥	1800	4.97	34210	49.00	30.00	_		
ΔH		CAL. /GFW.	1900	4.97	35200	49.57	10016	_		
			2100	4.97	35700	49.76	32.76	_		
			2200	4.97	36200	50.00	33.55			
Ч. Ч.		*	2300	4.97	36690	50.22	34.27	_		
			2400	4.97	37190	50.43	34.94			
ĥ		CAL. /GFW.	2500	4.97	37690	50.63	35.56	_		
			2600	4.97	38190	50.83	36.15			
			2700	4.97	38680	51.01	36.69			
нс =		*	2800	4.97	39180	51.19	37.20			
ا م		ATM	2900	4.97	39680	51.37	37.69			
		-	3000	4.97	40170	46.16	38.15			

THERMODYNAMIC PROPERTIES OF THE ELEMENTS

CADMTIIM	Cd			Reference		State for Calculating AH [°] , AP [°] ,	ting AH ^e ,	∆r°, and	
	3		П	Log, Kp:	Solid fre	from 298° to	0 594°, L	to 594°, Liquid from 594°	n 59 4°
IDEAL MONATOMIC GAS	C GAS		-	to 1038°,	Ideal Mon	Monatomic Ga	Gas from 1038°	038° to 3000°	000°.
6fw 110 41	GRAMS	-	ບ	н _е – не	e	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
LF.JLL = (2H -:, 9H)	CAL/GFW.	TEMPERATURE	HEAT O	T 294.15 HEAT CONTENT CAL./ GFW.	T ENTROPY CAL (APR) / ARW	FREE ENERGY FUNCTION	HEAT A H	FREE ENERGY & F	õ
						CALL/DEGL/ OF W.	LAL./ GP.	CALL GFW.	۵ ۲
		298	4.97	0	40.07	40.07	26750	18491	- 13.554
A.P.	¥	300	4.97	6	40.10	40.07	26747	18440	- 13.434
×H−	CAL /GFW	400	4•97	506	41•53	40.27	26611	15691	
		004	4.97	1003	42.04	40.04	20443	12978	- 5.0/3
		600	4.97	1500	43.54	41.04	24800	10322	- 3.760
	1	200	4.97	1996	44.31	41.46	24586	1919	
	¥	800	4.97	2493	44.97	41.86	24373	5557	-
ΔH r	CAL. /GFW.	006		0667		42024	24100	1120	
			4007	3084	46.55	42.03	14673		ſ
		1200	4 97	4480	46.98	43.25) C	o c
S.P.	×	1300	4.97	4977	47.38	43.56	0	00	00
:		1400	4.97	5474	47.75	43.84	0	0	0
ΔHs	CAL. /GFW.	1500	4.97	5971	48 • 0 9	44.11	0	0	0
		1600	4.97	6468	48.41	44.37	0	0	0
		1700	4.97	6964	48.72	44.63	0	0	0
T.P.	×	1800	4.97	7461	49•00	44.86	0	0	0
ΔH,	CAL /GFW.	1900	4 97	7958	49.27	45.09		0 0	0 0
		2100	10.4	8952	49.76	45.50		00	0
		2200	4.97	9448	50.00	45.71	0	0	0
T.P.	×	2300	4.97	9945	50.22	45.90	0	0	0
		2400	4.97	10442	50.43	46.08	0	0	0
ΔH,	CAL. /GFW.	2500	4.97	10939	50.63	46.26	0	0	0
		2600	4.97	11436	50.83	40.44	0	0	0
		2700	4.97	11932	51.01	46.60	0	0	0
T c =	×.	2800	4.97	12429	51.19	46.76	0	C	0
		2900	4.97	12926	51.37	46.92	0	0	0
7 c =	ATA	3000	4.97	13423	51.54	47.07	0	0	0

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Liquid	.000	ICE STATE	רסנ ג ייע ג																						
Solid I from 298° to 713°, Solid II from 713° to 1123°, Liquid	Ideal Monatomic Gas from 1765° to 3000°	FORMATION FROM REFERENCE STATE	FREE ENERGY & F CAL./ GFW.																						
rom 713°	Gas from	FORMAT	HEAT A H														-1								
olid II f	onatomic	-(F°-H° 298.15)	FREE ENERGY FUNCTION CAL. /DEG./ GFW.	9•96 9•96	10.21	11.25	11.82	13.02	14.15	14.79	15.41	16.00	16.53	17.51	18.35	19•80 21•12	22.34	23.45	25.43	26.31	27.14	27.90	28.63	29.30	29.94
o 713°, S		8	ENTROPY CAL./DEG./GFW.	9•99 9•99	11.85	14.67	15.82	18.23	19.19	22.67	23.26	23.81	24.32	24.80	45 • 93	46 • 20 46 • 45	46.70	46.93 47.16	47.38	47.59	47.80	48.00	48 • 20	48.39	48 • 59
m 298° to	from 1123° to 1765°,	н <mark>о</mark> – Но	T ZMLIS HEAT CONTENT CAL./ GFW.	0	659	2054	2802	4691	5605 6588	9465	10205	10945	11685	12425 13165	49660	50160 50660	51160	51670 52180	52690	53210	53740	54270	54820	55380	55950
lid I fro	om 1123°	ს	HEAT CALIN	6.30 6.31	49°0	7.31	7.64	8.78	9••6	7.40	7.40	7.40	7.40	7.40	66 • 7	5•00 5•01	5.03	5.06	5.16	5.22	5.30	5.40	5.52	5.65	5.80
ŝ	ι,	-	TEMPERATURE ⁰ K	300 300	400	89	700	006	11000	1200	1300	1400	1500	1000	1800	1900	2100	2200	2400	2500	2600	2700	2800	2900	3000
Ca	TE	GRAMS	CAL./GFW.	¥	CAL. / GFW.		*	CAL (CEW			×	CAL. /GFW.			*	CAL. / GFW.		¥.		CAL. /GFW.			¥	ATA	
	REFERENCE STATE	40.08	°2**.15 H0) = 1 , 380	1,123.	2,070.		1,765.	35 010	• • • • • • • • • • • • • • • • • • • •						/13.	270.									
CALCIUM	REFE	ł	(H [°] 298.15	ď	ΔH		a a	Ĩ	Aug		S.P.	Δ Η.	•		т.Р.	ΔH,		E.		Ъң			T. =	" •	- .

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uary 1, 1956 d	Date: January 1, 1956 d
uary 1,	ate: Jar
	ate: Jar

	ę	Refe	rence Sta	tte for C	alculatin	Reference State for Calculating AH2, AP2, and Log, Kp;	, and Lo	g, Kpt		
	5	Solic	I from	298° to	713°, Sol	Solid I from 298° to 713°, Solid II from 713° to 1123°, Liquid	n 713° to	1123°, I	ւլզո	11d
IDEAL MONATOMIC GAS	NIC GAS	from	from 1123° to 1765°,	1765°,	Ideal Mon	Ideal Monatomic Gas	s from 17	from 1765° to 3000°	8	•
6H 40 08	CPANC	•	و	91	ę	-(E ⁰ -H ⁰ 222.15)	FORMAT	FORMATION FROM REFERENCE STATE	EXC	STATE
				T 296.15	×-	FRE ENERGY	HEAT A H ^o	FREE BUERCY A F	-	
(M ² 24.15 H ⁰) ∃ , 481	CAL./GFW.	¥	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ OFW.	CAL./GFW.	CAL./ GFW.		L06 * ×
		208	4.07	c	36,00	36.00	00000	34120		75 0.74
A.P.	¥	300	4.97	0	37.02	36.99	42198	34089	1	24.835
1	10	400	4.97	506	38•45	37.19	42047	31407	1	17.161
∆ N.	CAL /GFW.	500	4.97	1003	39.56	37.56	41863	28768	I	12.575
		600	4.97	1500	40.47	37.97	41646	26166	1	9.531
	ł	002	4.97	1996	41.23	38 •38	41394	23607	1	7.371
	4	800	4.97	2493	41.90	38.79	40845	21117	1	5.769
14		006	4.97	2990	42.48	39.16	40499	18674	1	4.534
	LAL / GLW.	1000	4.97	3487	43.01	39.53	40082	16262	1	3.554
		0011	4.97	3984	43.48	39•86	39596	13911	1	2.764
		1200	4.97	4480	43.91	40.18	37215	11727	1	2,135
S.P.	*	1300	4.97	4977	44.31	40.49	36972	9607	I	1.615
:		1400	4.97	5474	44.68	40.77	36729	7511	1	1.172
∆ Hs	CAL /GFW.	1500	4.97	1265	45.02	41.04	36486	5436	1	• 792
		1600	4.97	6468	45.34	41.30	36243	3379	1	.461
		1700	4.98	6965	45.64	41.55	36000	1337	1	•171
T.P.	¥	1800	4.99	7464	45 . 93	41.79	o	0		0
Ĩ		1900	2 • 00	7963	46 • 20	42.01	•	•		0
	CAL. / 01 T.	2000	5.01	8462	46.45	42.22	o	•		c
		2100	5.03	8964	46.70	42.44	•	•		0
d 1	\$	2200		9409	40 • 03	42.63	00	0		0
	:	00072		00401	01014	10.54	0	•		> (
ΔH,	CAL /GFW.	2500	5.22	11009	47.59	43.19	• o	0		.
		2600	5.30	11535	47.80	43.37	0	•		0
		2700	5.40	12070	48 • 00	43.53	0	0		0
Tc =	¥	2800	5.52	12616	48 • 20	43.70	0	0		0
1		2900	5.65	13175	•	43.85	0	0		0
		3000	5 • 80	13749	48 • 59	44.01	0	•		0

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Date:
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REFERENCE STATE	VTE								
12.011	GRAMS	-	υ	т. - Н.	•5	-(F°-H° 228.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
(H ² 211, 15 H2) = 251	CAL./GFW.	TEMPERATURE •K	P HEAT CAPACITY CAL./DEG./ GPW.	T 298-15 HEAT CONTENT CAL./ GFW.	T ENTROPY CAL./DEG./GPW.	FREE ENERGY FUNCTION CAL./DEG./ OFW.	HEAT A H	FREE ENERGY & F	י א רספ ר
		298	2.07	o	1.37	1.37			
	¥	300	2.08) 4	1.38	1.37			
		400	2.85	251	2.09	1.47			
	CAL / GFW.	500	3.50	569	2.80	1.67			
		600	4 • 03	947	3.49	1.92			
		700	4.43	1370	4.14	2.19			
	¥	800	4.75	1830	4.75	2.47			
		006	4.98	2318	5.33	2.76			
		1000	5.14	2823	5.86	3.04			
		1100	5.27	3344	6.35	3.31			
1000		1200	5.42	3874	6.82	3.60			
(*,)	¥	1300	5.57	4428	7.26	3.86			
		1400	5.67	0667	7.67	4.11			
		1500	5.76	5562	8.07	4.37			
		1600	5.83	6142	8 • 44	4.61			
		1700	2.90	6728	8.80	4.85			
	¥	1800	5 • 95	7320	9.14	5.08			
		1900	6 • 00	7918	9•40	5.30			
	CAL /GPW.	2000	6.05	8520	9.77	5.51			
		2100	6.10	9133	10.07	5.73			
		2200	6.14	9745	10.35	5•93			
	*	2300	6.18	10360	10.63	6.13			
		2400	6.22	10980	10.89	6.32			
	CAL. /GFW.	2500	6.26	11600	11.14	6.50			
		2600	6.30	12230	11.39	6.69			
		2700	6.33	12860	11.63	6.87			
	×	2800	6.36	13500	11.86	7.04			
	ATM	2900	6.39	14140	12.08	7.21			
		3000	6.42	14780	12.30	7.38			

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	C		Ref	erence Sti	ate for C	Reference State for Calculating ΔH_{F}° , ΔF_{F}° , and	g AH°, AF	f, and		
IDEAL MONATOMIC GAS	C GAS		Log	Log ₁₀ Kp: So]	11d Graph	Solid Graphite from 298° to 3000°	298° to 3	.000		
							FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE	
6tw 12.011	GRAMS			H°H° T 294.15	°.⊦	PREE ENERGY	HEAT A H ^o	FREE ENERGY A F		
(H [°] _{214.15} H [°]) = 1,559	CAL./GFW.	Х.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GPW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	F CAL./ GFW.	LOG K	
		298	4.98		37.76	37.76	170890	160040	-117.317	
M.P.	×	300	4 • 98	6	37.79	37.76	170895	159972	-116.549	
H	CAL /GPW	400	4.97	507	39.22	37.96	171146	156294	- 85.402	
		500	4.97	1004	40.33	38° • 33	171325	152560	- 66.688	
		600	4.97	1501	41.23	38.73	171444	148800	- 54.204	
0		700	4.97	1998	42.01	39.16	171518	145009		
	,	800	4.97	2495	42•67	39°56	171555	141219	- 38.582	
H		006	4.97	2992	43 • 26	39.94	171564	137427		
۵u		1000	4.97	3489	43.78	40.30	171556	133636	- 29.208	
		1100	4.97	3980	44•25	40°63	171532	129842		
		1200	4.97	4483	44.68	40°35	171499	126067	- 22.961	
S.P.	×	1300	4.97	4980	45 • 0 B	41.25	171442	122276	- 20.558	
:		1400	4.97	5477	45.45	41.54	171377	118485	- 18.497	
2 H 2	CAL. /GFW.	1500	4.97	5975	45.79	41.81	171303	114723	- 16.716	
		1600	4 •98	6472	46.11	42.07	171220	110948	- 15.154	
		1700	4 • 9 8	6970	46.41	42.31	171132	107195	- 13.780	
т.Р.	×	1800	4 • 99	7468	46.70	42.56	171038	103430	- 12.557	
:		1900	5 • 00	7968	46.97	42.78	170940	99671	- 11.464	
2 H 2	CAL. /GFW.	2 000	5.01	8469	47.23	43.00	170839	95919	- 10.481	
		2100	5.02	8971	47.47	43.20	170728	92188	- 9.594	
		2200	5.03	9474	47.70	43.40	170619	88449	- 8.786	
T.P.	×	2300	5.04	577	47.93	43.60	170507	84717	- 8.049	
:		2400	5.06	10482	48.14	43.78	170392	80992	- 7.375	
₽H1	CAL. /GFW.	2500	5.08	10989	48.35	43.96	170279	77254	- 6.753	
		2600	5 . 09	11497	48.55	44.13	170157	73541	- 6.181	
		2700	5.11	12007	48.74	44.30	170037	69840	- 5.652	
T _c =	*	2800	5.13	12519	48.93	44.46	169909	66113	- 5.160	
1		2 900	5.15	13033	49.11	44 . 62	169783	62396	- 4.702	
رد = ۲	ATM.	3000	5.17	13549	49•29	44.78	169659	58689	- 4.275	

CARBON

CARBON	c2		Refer	ence Stat	Reference State for Calculating ΔH°_f	culating	1	F, and	
IDEAL DIATOMIC GAS	GAS		Log ₁₀ Kp:		Solid Graphite from 298°	e from 29	8° to 3000°		
	20146	•	۲	9	٩	-(E ⁰ -H ⁰ 388 15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
(H [°] ₂₉₈ .15 H [°] ₉) 2, 096	CAL-/GFW.	TEMPERATURE %	P HEAT CAPACITY CAL./DEG./ GFW.	T 294.15 HEAT CONTENT CAL./ GFW.	ST ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL. DEG. / GFW.	HEAT A H ^e cal./gfw.	FREE ENERGY \$ F ⁶ cal./gfw.	י א רספ א ר
		298	7.00	0	47.91	47.91	200000	186532	-136.737
A. P.	*	300	7.15	12	47.95	47.91 48.19	200004	186447 181894	-135.837 - 99.390
∆ H m	CAL /GFW.	500	7.36	1445	51.60	48.71	200307	177307	- 77.506
		600	7.59	2192	52.97	49 . 32	200299	172704	- 62.912
	3	700	7.80	2962	54.15	49 . 92	200222	168113	
	4	006	7.98 8.14	9 7 5 6 0 4 5 6 0	56.15	50.05	200090	158983	- 38.609
∆H√	CAL. /GFW.	1000	8.27	5380	57.01	51.63	199734	154444	- 33.756
		1100	8.37	6210	57,81	52.17	199522	149901	- 29.785
		1200	8.45	7050	58.54	52.67	199302	145422	- 26.487
	×	1300	8.52	0062	59.22	53.15	199044	140934	- 23.695
Δ Н.	CAL. /GFW.	1400	8.59	8760	59•85	53.60	198780	136466	
•		1500	8.64	9620	64.00	54°04	198490	120251	
		1 7 0 0	8 69 8 73	11360	61.01	54 • 40 54 • 40	198206	123206	- 1/.423 - 15.839
T.P.	×	1800	8.76	12230	62.04	55 . 25	197590	118822	- 14.426
		1900	8.79	13110	62.51	55.61	197274	114453	- 13.164
4 u 7	CAL / GPW.	2000	8.81	13990	62.95	55.97	196950	110110	- 12.031
		2100	8•83	14870	63 • 39	56.31	196604	105779	- 11.008
6	1	2200	8 •85	15750	63.80	56.65	196250	101440	- 10.077
<u>.</u>		2300	8.86	16640	64.20	56.97	195920	97158	- 9.231
ΔH.	CAL. /GFW.	2400	88.88	17530	64.57	57.27	195570	92874	- 8.457
-		2600	00.00	19310	65.29	57.87	194850	84324	- 7.088
		2700	8.93	20200	65.62	58.14	194480	80108	- 6.483
T _c =	×	2800	8.95	21090	65•95	58.42	194090	75846	- 5.919
		2900	8.96	21990	66.26	58.68	193710	71620	- 5.397
- Pc =	ATM.	3000	8•98	22890	66.57	58.94	193330	67420	- 4.911

CARBON

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CARBON	°°		Re	ference S	tate for	Reference State for Calculating Aff. Aff. and	ing AH [°] , i	∆r°, and	
IDEAL TRIATOMIC GAS	IIC GAS		Γο	Log ₁₀ Kp; S	Solid Grai	Solid Graphite from 298° to 3000°	1 298° to	3000°.	
36.033			1	1	4	- (<u>)</u> - (, , , , , , , , , , , , , , , , , , ,	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
	GRAMS	-		H ^o H ^o T 296.15	۶		HEAT A H ^o	FREE EVENCY 🛆 F	
(H ^o _{210,15} H ^o) = 2 , 541	CAL./GFW.	TEMPERATURE •K	HEAT CAPACITY CAL./DEG./ OFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./OFW.	CAL./ GFW.	LOG K
		298	10•41	0	55.18	55.18	200000	184772	-135.447
, P.	×	300	10.43	19	55.24	55.18	200007	184677	-134.548
		400	11.17	1011	58°35	55.60	200348	179516	- 98.091
	LALL / UTW.	200	11.77	2249	60.91	56.42	200542	174287	- 76.186
		600	12.27	3452	63.10	57.35	200611	169033	- 61.575
0	3	200	12.69	4700	65 • 03	58.32	200590	163763	- 51.133
6	,	800	13•03	2980	66.74	59•27	200490	158498	- 43.303
HV	CAL /GFW.	006	13.31	7310	68•29	60.17	200356	153286	
A112		1000	13.53	0408	11.00	61.06	200181	148051	- 32,359
		1100	13.72	10010	10•12	61.91	199978	142822	- 28.378
	3	1200	13.87	11390	72.21	62.72	199768	137668	- 25.074
	4	1300	14•00	12790	73.32	63 . 49	199506	132504	- 22.277
Δ Η-	CAL /GFW.	1 400	14.11	14190	74.37	64.24	199220	127316	
•		0061	02.41	OTOCT	+0.01	+r.•+0	#7686T	677771	- I/*80A
		1600	14.27	17030	76.26	65.52	198604	117100	- 15,994
		1700	14.34	18460	77.13	66.28	198276	112035	- 14.403
	×	1800	14.39	19900	77.95	66.90	197940	106986	- 12,989
Ĩ	M30/ IV.	006T	14•44	21340	78.73	67.50	197586	101921	- 11.722
F		2000	14.48	22780	79.47	68°08	197220	96900	- 10.588
		2200	140.2	24240	80.05	08.04	196841	91904	- 9.564
T.P.	 0.	2300	14.58	27140		02.09	106060	01067	
	:	0040	14.60	28600	82.12		105660	00092	
ΔH.	CAL /GFW.	2500		20002	00.10				
-				01006	2/ • 70	0.00	0/261	07071	662.0 -
		0007	14005	05615	62.68	/1-1/	194840	67128	- 5.642
		2700	14.66	33000	83•85	71.63	194420	62228	- 5.036
Tc =	ж.	2800	14•68	34460	84 • 38	72.08	193960	57320	- 4.473
		2900	14.70	35930	84.89	72.51	193510	52425	- 3,950
"	4	3000	14.71	37400	85•39	72.93	193060	47590	- 3.466

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CERIUM	UM Ce			Ŵ	olid I fr	om 298° t	Solid I from 298° to 1027°, Solid II from	Solid II	from		
REFE	REFERENCE STATE			ŗ	1027° to 1	077°, L19	to 1077°, Liquid from 1077° to 3000°	1077° to	3000°.		
ł	דו 140 נ	CPANC	•	و	97 97	e	-(F°-H° 299.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE	П
5	0T•0#T		TEMPERATURE		T 296.15	n⁺	FREE ENERGY	HEAT A H	FREE ENERGY & F		
(H ⁰ 218.	(H [°] _{214.15} H [°] ₆) = 1,742	CAL/GFW.	*	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL/DEG./ GFW.	CAL./GPW.	CAL./ GFW.	х • °	
			298	6 - 89	0	16.64	16-64				
A.P.	1,077	¥	300	06.9	12	16.68	16.64				
∆ H.	(2, 200)	CAL. / GFW.	400 2000	7.70	722 1472	18•72 20•39	16.92 17.45				
			600	8.10	2262	21.83	18.05				
			700	8.50	3092	23.11	18.70				
8 8	3,200		800	8 • 90	3962	24.27	19.32				
H	75 000	CAL /GFW	006	9•30	4872	25.34	19.93				
A 15	000.61		1000	9•70	5822	26.34	20.52				
			1100	8•00	9170	29.48	21.15				
		3	1200	8.00	0266	30.19	21.58				
		ŗ	1300	8.00	10770	30.82	22•54				
4		CAL /GFW	1400	8•00	0/ 411	31.41	23.15				
1			1500	8•00	12370	31.96	23.72				
			1600	8•00	13170	32.48	24.25				
			1700	8•00	13970	32.97	24.76				
а. 1	1,027	¥	1900	8 00 8	14770	33.42	25•22 25•67				
ΔH,	(300)	CAL. /GFW.	2000	8.00	16370	34.27	26.09				
			2100	8.00	17170	34.66	26.49				
			2200	8•00	17970	35.03	26.87				
H.		×	2300	8.00	18770	35.38	27.22				
~			2400	8 • 00	19570	35.72	27.57				
			2500	8•00	20370	36.05	27.91				
			0007	8.00	0/112	30.30	28•22				
•		3	2700	8•00	21970	36.67	28.54				CE
-		¥	2800	8•00	22770	30.90	28.83				R
" •		ATM.	2900	8.00	23570	37.24	29.12				IUA
•			>>>>	220	71647	10.0	EC 0 2 7				я Г

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

CESIUM CB			Solid	from 298	° to 301.	Solid from 298° to 301.8°, Liquid from 301.8°	d from 3(01.8° to	
REFERENCE STATE			958°,	Ideal Mo	natomic 6	958°, Ideal Monatomic Gas from 958° to 3000°.	58° to 3(. 000	
132.91 ch 132.91 (M [*] _{240.15} H [*])= 1,859	GRAMS CAL_/GFW.	T TEMPERATURE N	C ⁰ P HEAT CAPACITY CAL, PEG. / GPW.	H ⁰ - H ⁰ T 294.15 HEAT CONTENT CAL/ GFW.	S ⁰ F ENTROPY CAL./DEG./ GPW.	-(F-H-29115) - FREE ENEROY FUNCTION CAL./DEG./ OFW.	FORMAT HEAT A H ⁶ CAL./GPV.	FORMATION FROM REFERENCE STATE Δ H [®] FREE BHERKY Δ F [®] LOG GPV. CAL/OFN. 1 CAL/OFN. 1	ACE STATE LOG K
are 301.8 are 510.	•K CAL./GFW.	298 298 500 500 500	7•50 7•54 7•60 7•60	0 1284 2044 2804	20•16 20•21 24•09 25•78 27-17	20.16 20.17 20.88 21.70			
958. B.P. JH, 15, 750.	•K CAL. /GFW.	700 900 1000	7.60 7.60 4.97	3564 4324 5084 22157 22157	28 34 29 36 47 96 47 96	23.25 23.25 24.62 25.81			
S.P. A H _s	°K CAL_/GFW.	1300 1400 1500 1700	1 4 4 4 4 4 4 6 0 0 0 0 0 0 0 0 0 0 0 0 0	25100 23150 24145 24145 2444 25141 255141	0001 000 000 000 000 000 000 000 000 00	20.07 31.07 32.39 34.58 35.52			
Т.Р. АН,	°K CAL. /GFW.	1800 1900 2000 2100	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	26143 26648 27156 27668	50.88 51.16 51.42 51.67	36.36 37.14 38.50			
T.P. ∆Ha	°K CAL./GFW.	2300 2400 2500	0 0 0 0 0 0 0	29790 29790 29790 30345	52.91 52.37 52.59 52.69	39.66 39.66 40.19 41.14			
Тс = Рс =	ok ATA.	2700 2800 2900 3000	5.73 5.86 6.02 6.18	30911 31491 32085 32695	53•03 53•24 53•44 53•65	41.59 42.00 42.38 42.76			

CESIUM

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CESIUM	CB		Referent Solid fr	ce State	for Calcu	Reference State for Calculating $\Delta H_{r}^{0}, \Delta P_{r}^{0},$ and Log ₁₀ Kp: Solid from 298° to 301.8° Ilouid from 301.8° to	, ∆ ^R °, 8	nd Log ₁₀ K	a d	
IDEAL MONATOMIC GAS	C GAS		958°, Id	leal Mona	Ideal Monatomic Gas	from 958°	to 3000°			
6iw 132.91	GRAMS	-	، ئ	H ⁰ H ⁰ T 298.15	°¢,	-(5-4 281.15)	FORMAT	FORMATION FROM REFERENCE STATE	INCE ST	TE
(н° _{298.15} н°;)∃, 481	CAL./GFW.	TEMPERATURE 9K	HEAT C	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	CAL./GFW.	FREE ENERGY & F f CAL./ GFW.		LOG K
		298	4.97	0	41.94	41.94	18670	12176	•	3 . 925
A.P.	¥	300	4.97	6	41.97	41.94	18665	12137	ĩ	8 • 8 4 2
H	CAL /GEW	400	4.97	506	43.40	42 . 14	17892	10168		6.555 6.555
		000	10.4	1500	44•51 45•42	42.92	17366	8204	11	210.5
		700	4.97	1996	46.18	43.33	17102	4614		1.440
B.P.	*	800	4.97	2493	46.85	43.74	16839	2847	ı	.777
		006	4.97	2990	47.43	44.11	16576	1123	1	•272
2H ~	CAL. /GFW.	1000	4.97	3487	47.96	44.48	•	•	-	0
		1100	4.97	3984	48.43	44.81	•	•		0
		1200	4.97	4480	48.86	45.13	•	•	_	c
S.P.	*	1300	4.97	4977	49.26	45.44	C	c		~
1	110, 110	1400	4.97	5475	49.63	45.72	c	•	-	c
∆ns		1500	4 • 98	5973	49.97	45.09	0	0		0
		0001	4 u	1/ 40	50.60	40.62	0	5 0		
đ		1800	1000	1473	50.88	46.73	c			
	4	1900	5.06	7978	51.16	46.97	o	. 0		0
₽ ₩ [•]	CAL. / GFW.	2000	5.10	8486	51.42	47.18	0	c		c
		2100	5.15	8668	51.67	47.39	0	•		0
		2200	5.22	9517	51.91	47.59	0	•		0
T.P.	×	2300	5.29	10042	52.14	47.78	0	c		0
		2400	5 . 38	10576	52.37	47.97	0	0		0
		2500	5 • 49	11120	52.59	48.15	0	c		c (
		2600	5.60	11675	52.81	48 . 32	0	0		0
		2700	5.73	12241	53.03	48.50	0	0		5
Tc =	*	2800	2 9 9 9 9 9 9 9 9	12821	53.24	48.67	20	0.0		00
- -	ATM.	0067				20.00	,	.		> c
U .		3000	0.18	14025	60.56	48•38		>		

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January
Date:
Publication

MITPAN	a S		Referen	ce State	for Calcu	ulating AH	[•, ∆₽°, 5	Reference State for Calculating ΔH_{f}^{\bullet} , ΔP_{f}^{\bullet} , and $Log_{10}Kp_{10}$	ā	
			Solid f	rom 298°	to 301.8°	Solid from 298° to 301.8°, Liquid from 301.8°	from 301.	.8° to		
IDEAL DIATOMIC	GAS		958°, I	deal Mona	Ideal Monatomic Gas from	from 958	958° to 3000°.	•		
ct. 265.82	CDALC	•	٢	93	. ę	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE S	TATE
8 .15		TEMPERATURE •K	HEAT CAPACITY CAL./DEG./ GFW.	T 294.15 HEAT CONTENT CALL/ GPW.	T ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H ⁶ cal./gfw.	FREE ENERGY & F		х , ,
		298	9•11	0	67.86	67.86	26630	18417	I	13•500
d. ₩	X.	300	9•11	17	67.91	67 . 86	26619	18372	1	13•385
F		400	9.18	932	70.54	68.21	24994	16050	•	8.770
e.e.	*	500	9•24	1852	72.60	68 • 90	24394	13874	I	6 • 0 6 4
∆н,	CAL. /GFW.	600	9•30	2778	74.28	69 • 65	23800	11836	I	4.311
	*	700	9•36	3708	75•72	70.43	23210	9882	I	3 • 085
△ H ₂	CAL /GFW.	800	9.42	4645	76•97	71.17	22627	8027	1	2.193
		006	9•48	5592	78.09	71.88	22054	6241	I	1.515
T.P.	¥	1000	9.53	6546	60°61	72.55	- 11138	5692	1	1.244
ΔH,	CAL. /GFW.	1100	9 ° 29	7497	80.00	73.19	- 11181	7365	I.	1.463
a F		1200	9•65	8466	80.84	73.79	- 11204	9052	I	1.648
	17 /CEW	1300	9.71	9443	81.62	74.36	- 11221	10749	ł	1.807
F		1400	6.77	10414	82•34	16•41	- 11246	12442	I	1.942
Te =	*	1500	9.83	11391	83.01	75.42	- 11265	14130	I	2.058
= °	ATA.									

CESIUM

CHLORINE	CHLORINE C1 ₂ Deferring strate	Q1 15			Ideal Dis	itomic Gas	Ideal Diatomic Gas from 298° to 3000°.	• to 300	•••	
Gfw 7	70.914	GRAMS	+	ຽ	H° H°	°.'	-(<u>F0-H</u> 200.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H ⁰ _{298.15} H ₀ ⁰) =	-H\$)= 2,194	CAL/GPW.	TEMPERATURE 9K	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GPW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	REAL A H	FREE ENERGY & F CAL./ GFW.	х , , , , , , , , , , , , , , , , , , ,
					C	20				
, M	31 021	¥	300	8•11 8•12	15	53.34	53.29			
	07.7/7		400	8.44	845	55.73	53.62			
\ AH.1,531	531.	CAL. /GFW.	500	8.62	1698	57.63	54.24			
			600	8.74	2567	59.21	54.94			
			700	8.82	3446	60.57	55.65			
8.P.	239.10	¥	800	8.88	4331	61.75	56.34			
			006	8.92	5220	62.80	57.00			
ΔH, 4.	∆ ^H , 4 ,878.	CAL. /GFW.	1000	8.96	6115	63 . 74	57.63			
			1100	8.99	7013	64.60	58.23			
			1200	9.02	1913	65.38	58.79			
.d.S		¥	1300	9.04	8816	66.10	59.32			
		_	1400	90•6	9721	66.77	59 . 83			
⊳ H₅		CAL. /GFW.	1500	9 •08	10628	67.40	60.32			
			1600	9.10	11536	61.99	60.78			
			1700	9.11	12445	68.54	61.22			
T.P.		×.	1800	9.13	13358	69 •00	61.64			
			1900	9.14	14270	69•55	62 • 04			
¢H∕		CAL. /GFW.	2000	9.16	15186	70.02	62.43			
			0012	9.17	16102	70.47	62.81			
4		ł	22200		170/1	06.01	03.17			
<u>.</u>		,	0042	02.0	14867	02 12				
AH.		CAL. /GFW.	2500	0.23	10784	70.07	64.16			
			2600	9.25	20708	72.43	64-47			
		ſ	2700	9.26	21633	72.78	64.77			
Tc =	417.	×	2800	9.27	22560	73.12	65.07			
			2900	9 . 28	23487	73.44	65.35			
וו •	76.1	ATM.	3000	9 •30	24416	73.76	65•63			

THERMODYNAMIC PROPERTIES OF THE ELEMENTS

CHLORINE

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1956
Ι,
January
Date:
Publication

CHLORINE	13		Refe	rence Sta	te for Ca	Reference State for Calculating $\Delta H^{\circ}_{\mathbf{f}}, \ \Delta F^{\circ}_{\mathbf{f}},$	∆H°, ∆F	e, and		
IDEAL MONATOMIC	GAS		Log1	Log ₁₀ Kp: Ide	al Diatom	Ideal Diatomic Gas from	298°	to 3000°.		
	110	•	8	9	•	-(F ⁰ -16 ² 200 11)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STA	TE
107-00 MID		-	<u>ۍ</u>	H H ⁻ T 296.15	۰ ۲		HEAT A H ^o	FREE ENERGY A F		
(H [°] _{211.15} H [°]) = 1,499	CAL./GFW.	×.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL. /DEG./ GFW.	CAL./GPW.	CAL./ GPW.	Ľ	ية 1
		306	h 33	C	30.46	30 46	0.4000	26122		310 415
A.P.	Å	300	5.22	10	04.06	94.66	28944	25028		18.285
		400	5.37	540	41.01	39.66	29059	23803	1	3.006
2 m		500	5.44	1081	42.22	40.06	29174	22474	1	9 . 824
		600	5.44	1625	43.21	40.51	29283	21123	1	7.694
8	20	700	5.42	2169	44.05	40.96	29388	19756	I	6.168
		800	5•39	2710	44.77	41.39	29486	18374	1	5.019
HV	CAL /GFW	006	5.35	3247	45.41	41.81	29579	16970	1	4.121
		1000	5.31	3780	45.97	42.19	29664	15564	ı	3.401
		1100	5 . 28	4309	46.47	42.56	29744	14157	I	2.812
		1200	5.25	4836	46.93	42 . 90	29821	12733	ı	2.319
s.P.	*	1300	5.22	5359	47.35	43.23	29893	11303	1	1.900
1		1400	5.20	5830	47.74	43.54	29961	9871	ı	1.541
C us	LAL. / GLW.	1500	5.17	6398	48 • 09	43.83	30026	8441	1	1.229
		1600	5.16	6915	48.43	44.11	30088	6984	I	•953
		1700	5.14	7430	48.74	44.37	30147	5548	I	•713
T.P.	×	1800	5.12	7943	49 • 03	44.62	30204	4104	ı	• 498
1		1900	5.11	8454	49.31	44.87	30257	2650	I	•304
łup		2000	5.10	8965	49.57	45 . 09	30310	1190	ı	•130
		2100	5.09	9475	49.82	45.31	30361	- 257		•026
C }	ł	2200	5.08	6963	50.06	45.53	30410	- 1732		•172
÷	¥	2300	10.6	10491	92.00	22.04	16406	- 3192		E0E •
:		2400	5.07	10998	50.50	45.92	30503	- 4657		•424
∆H,	CAL. /GFW.	2500	5.06	11504	50.70	46.10	30547	- 6103		•533
		2600	5.05	12009	50.90	46.29	30590	- 7578		•637
		2700	5.05	12514	51.09	46.46	30631	- 9032		.731
T _c =	*	2800	5.04	13019	51.27	46.63	30672	- 10516		•820
		2900	5.04	13523	51.45	46.79	30712	- 11976		• 902
" " "	ATM.	3000	5.03	14027	51.62	46.95	30750	- 13440		•979

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

					02.00	11 TT 8	92110	+c 0176°	T 4 cu14 d
CHROMIUM	Gr	Solic	MOTI I 1	01 96.7	00 (0117	11 TT NTT	0TT3 III	Solid I from 236 to 2113 , Solid II HOW 211 0 CLASS WOLL I NUMBER	הדאאדת
REFERENCE STATE	ATE	from	2176° to	, 2915°,	Ideal Mon	2176° to 2915°, Ideal Monatomic Gas	s from 2915°	15° to 3000°	00°.
Giw 52,01	GRAMS	F	ۍ ۲	H°-H°.	e,	-(F°-H° 228.15)	FORMAT	FORMATION FROM REFERENCE STATE	ACE STATE
$(H^{0}_{296,15} - H^{0}_{0}) = 973$	3 CAL./GFW.	TEMPERATURE ⁰ K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H	FREE ENERGY & F	х 901
		906	5.55	c	5 70	7			
M.P. 2.176	¥	300	5.57	01	5.73	5.70			
∆Hm z 300	CAL. / GFW.	400	6.08	594	7.41	5.93			
000 0		004 600	6 • 40 6 • 58	1220	08.8	6•30 6.88			
	- 	700	6.6R	2530	11.01	7.40			
CT6 12	:	800	6 8 2 7 17	3210	11.91	06.4			
^{∆H} * 83,360	CAL. /GFW.	1000	7.54	0050	13.50	8.85 8.85			
		1100	7.94	5410	14.24	9.33			
	3	1200	8 • 35	6230	14.95	9.76			
	4	1300	8.75	7080	15.63	10.19			
Δ H.	CAL. /GFW.	1400	8•99	01970	16.29	10.60			
•		1500	0.23	P R R O	16.07	11.00			
		1700	12.0	10780	18-10	11-76			
T.P. 2,113	*	1800	6°6	11760	18.67	12.14			
AH.	CAL /GFW.	1900	10.19	12770	19.21	12.49			
(096)		2000	10.43	14850	19.74	12.18			
4		2200	9.70	19480	22.40	13.55			
÷	4	2300	9.70	20450	22.83	13.94			
∆ H,	CAL. / GFW.	2400	9.7 0	21420	23.25	14.33			
		2500	01.0	22390	23.04	14.09			
		2200	0/ • 6	06546	06.40	15.38			
T _c =	Å	2800	0-70	25300	24.74	15.71			
، م	ATM	2900	9.70	26270	25.08	16.03			
		3000	7.35	110390	53.94	17.15			

CHROMIUM

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In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

Publication Date: January 1, 1956 doi: 10.1021/ba-1956-0018.ch	004
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te: January 1, 1956 doi: 10.1021/ba-195	
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		Į	Ref	erence S	Reference State for Calculating AH,	Calculat1	ng ∆H°, ∆	AF, and Log, Kp:	og, Kp:		
MOTHONUO	M 0.	5	Sol	1d I fro	m 298° to	2113°, 3	Solid I from 298° to 2113°, Solid II from 2113° to 2176°, Liquid	rom 2113	to 2176	, L1	lu1d
IDEAL	IDEAL MONATOMIC GAS	GAS	orf.	from 2176°	to 2915°,		Ideal Monatomic Gas from 2915° to 3000°	as from 2	2915° to 3	5000°	_
ł		311405	•	8	9	ą	-(1., 222, 232, 11)	FORMAT	FORMATION FROM REFERENCE STATE	ENCE STA	ų
	52.01		Takana T		T 294-15	×-	PREE ENERGY	HEAT A H	FREE EVENCY \$ F	_	
(H [°] _{216 · 15} H [°]) =	")= 1,481	CAL./GFW.	¥	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GPV.	ENTROPY CAL./DEG./ GPW.	FUNCTION CAL./DEG./ GFW.	CAL./GPW.	CAL./ GFW.	ğ	× `
4		*	598	4.97	0 (41.64	41.64	95000	84284		61.784
		4	300	4.97	ο ,	41.67	41.64	66676	84217	- 2	61.357
ΔH		CAL. /GFW.	400	4.97	506	43.10	41.84	94912	80636	1 44	44.061
			500	4.97	1003	44•20	42.20	94783	77083	1	33 . 695
			600	4.97	1500	45.11	42.61	94630	73558	- 26	26.795
9		;	700	4.97	1996	45.88	43 . 03	94466	70057	- 21	21.874
		4	800	4.97	2493	46.54	43.43	94283	66579	- 18	18.190
TV		CAL /GEW	006	4.97	2990	47.13	43 • 81	06076	63130	- 15	15.331
A 117			1 000	4.98	3488	47.65	44.17	93848	59698	- 13	13.048
			1100	5.00	3987	48.12	44.50	93577	56309	-	11.188
ļ		1	1200	5.02	4487	48.56	44.83	93257	52925	ъ 1	9.639
		¥	1300	5.06	4992	48.96	45.12	92912	49583	۵۵ ۱	8.336
4		CAL /CEW	1400	5.12	5501	49.34	45.42	92531	46261	-	7.222
r 1			1500	5.20	6017	49.70	45.69	92137	42967	ۍ ۱	6.260
			1600	5.30	6542	50.04	45.96	91722	39690	<u>د</u>	5.421
1			1700	5.41	7078	50.36	46.20	91298	36456	1	4.686
<u>.</u>		¥	1800	5.54	7626	50.67	40.44	90866	33266	4	4.038
ΔΗ.		CAL /GFW	1900	5.69	8187	50.98	46.68	90417	30054	е 1	3.455
			2000	5.84	8764	51.27	46.89	89964	25904	1	2.939
			2100	6.00	9356	51.56	47.11	89506	23755	-	2.472
•		ł	2200	6.17	7.965	51.85	47.33	85484	70907	1	2.055
Ļ		¥	2300	6.33	10589	52.12	47.52	85139	17772	-	1.688
			2400	6.49	11230	52.40	47.73	84810	14850	-	1.352
₩		CAL /GPW.	2500	6.65	11887	52.66	47.91	R4497	11947	-	1.044
			2600	6.80	12560	52 . 93	48.10	<u>84200</u>	9034	1	•759
			2700	6.95	13248	- 53.19	48.29	83918	6158	1	• 498
		*	2800	7.09	13950	53.44	48.46	83650	3290	ı	•256
		TT	2900	7.22	14666	53.69	48.64	83396	427	1	•032
•			3000	7.35	15394	53.94	48.81	0	0	Ū	0

CHROMIUM

COBALT	_	ß			Solid I	from 298'	Solid I from 298° to 720°, Solid II from	Solid I	I from	
REFI	REFERENCE STATE	E			720° to	1768°, L	720° to 1768°, Liquid from 1768° to 3000°	1 1768° t	o 3000°.	
č	58.94	GRAMS	T	೮್	H ⁰ -H ⁰ T 29115	°2+	-(F0-H0 200.15)	FORMAT HEAT $ riangle H^{m e}$	FORMATION FROM REFERENCE STATE △ H° FREE BRENCY △ F°	
(H ⁰ _{2N.15}	°2 _{46,15} H\$)= 1,146.	CAL/GFW.	X.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ OFW.		CAL./ GFW.	LOG E LOG
	837 L		298	5.89	0	7.18	7.18			
d. ¥	• 00 / 6 T	*	300	5.90	10	7.21 8.07	7.18			
ΔH	3,640.	CAL. / GFW.	2005	6.80	1280	10.44	7.88			
			000	7.17	1980	11.71	8.41			
8. P.	3,150.	¥	800	7.65	3510	13.91	9.53			
Ĩ	91 400.		006	8.20	4305	14.84	10.06			
4 H2	• • • • • • • • • • • • • • • • • • •	- M- / M- M.	1000	8.90	5160	15.74	11.00			
			1200	10.50	0602	17.50	11-60			
S.P.		¥	1300	11.50	8190	18.38	12.08			
4		CAL /GFW	1400	09 •60	9520	19.36	12.56			
			1500	09.60	10480	20.02	13.04			
			1700	09.00	12400	21.22	13.93			
T.P.	.021	¥	1800	8.30	16950	23.80	14.39			
ΔH,	60.	CAL. /GFW.	2000	8•30 8•30	17780	24•25 24•68	14•90			
			2100	8.30	19440	25•08	15.83			
	1 305		2200	8.30	20270	25.47	16.26			
	· · · · · · · · · · · · · · · · · · ·		2300	8.30	21100	25.84	16.67			
Ä	130.	CAL /GEW	2400	8.30	21930	26.19	17-06			
			2600	8.30	23590	26.85	17.78			
			2700	8.30	24420	27.17	18,13			
Te ≞		¥.	2800	8.30	25250	27.47	18.46			
4			2900	8.30	26080	27.76	18.77			
" "		AIR.	3000	8 • 30	26910	28.04	19•07			

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COBALT	ဗ္ဗ		æ	eference	State for	Reference State for Calculating ΔH°	ing AH° _{f'}	, ∆F°, and		
			Ļ	Log ₁₀ Kp :	Solid I f	Solid I from 298°	to 720°, Solid II	Solid II		
LUEAL MONATOMIC GAS	GAS		J.	from 720°	to 1768°,	to 1768°, Liquid from 1768°	rom 1768	to 3000°	•	
ct- 58.94	2DAMC	•		3	ę	-(8-6 -40 244.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE	Π
			•ر	T 296.15	×-		HEAT A H ^o	PRE ENERCY A P		
(H ⁰ _{241, 15} H ⁰) = 1,520	CAL./GFW.	N.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./OFW.	CAL./ GPW.	Ж. Ч.	
		298	5.50	0	42.88	42.88	101600	90955	- 66.674	
ALP.	×	300	5.51	10		42.88	101600	06806	- 66.218	~
A H_	CAL /GEW	400	5.86	580		43.10	101557	87325	- 47.716	5
		500	6 . 08	1177		43.53	101497	83777	- 36.621	
		600	6.19	1791		44.02	101411	80237	- 29.228	~
4		002	6.24	2413	47.96	44.52	101303	76719	- 23.954	-
	¥	800	6.26	3038	48.79	45.00	101128	73224	- 20.005	
		006	6.27	3664	49.53	45.46	100959	69738	- 16.935	
Ф н у		1000	6•29	4293	50.19	45.90	100733	66283	- 14.487	~
		1100	6.31	4923	50.79	46.32	100433	62846	- 12.487	~
		1200	6.33	5555	51.34	46.72	100065	59457	- 10.829	_
S.P.	*	1300	6.35	6188	51.85	47.09	99598	56087	- 9.429	_
:		1400	6.36	6824	52.32	47.45	98904	52760	- 8.236	<u>~</u>
₽ H ⁸	CAL. /GFW.	1500	6.38	7461	52.76	47.79	98581	49471	- 7.208	~
		1600	6.38	8033	53.17	48.11	98259	46211	- 6.311	_
		1700	6•39	8737	53.56	48.43	97937	42959	- 5.522	~
T.P.	*	1800	66.9	9376	53.93	48.73	94026	39792	- 4.831	
:		1900	6.38	10014	54.27	49.00	93834	36796	- 4.232	~
р н,	CAL. /GFW.	2000	6.37	10652	54.60	49 . 28	93642	33802	- 3.693	~
		2100	6.36	11289	54.91	49.54	93449	30806	- 3.205	<u> </u>
		2200	6.35	11925	55 •21	49.79	93255	27827	- 2.764	
T.P.	*	2300	6.34	12559	55.49	50.03	93059	24864	- 2.362	~
		2400	6.33	13193	55.76	50.27	92863	21895	- 1.993	~
∆H,	CAL. /GFW.	2500	6.32	13825	56.01	50.48	92665	18965	- 1.657	~
		2600	6.30	14456	56.26	50.70	92466	16000	- 1.344	
		2700	6•29	15086	56.50	50.92	92266	13075	- 1.058	
Tc =	*	2800	6 . 28	15714	56.73	51.12	92064	10136	791	_
		2900	6.28	16342	56.95	51.32	91862	7211	- •543	~
_c =	-	3000	6.27	16970	57.16	51.51	91660	4300	- •313	"

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COPPER	Cu		Sol	1d from 2	298° to 13	Solid from 298° to 1356°, Liquid from 1356°	d from	1356° to	
REFERENCE STATE	TATE		285	5°, Ideal	. Monatom!	2855°, Ideal Monatomic Gas from 2855°		to 3000°.	
Gfw 63.54 (H ^o , -H ^o) = 1,0	54 GRAMS 1,201 CAL/GFW	T TEMPERATURE %K	C ^C PHEAT CAPACITY CAL./DEG./ GFW.	H ⁰ – H ⁰ T 294.15 HEAT CONTENT CAL./ GFW.	S ⁰ T Entropy Call./Deg./GFW.	-(F"-H" 20115) FREE ENERGY FUNCTION CALLFUNCTION	FORMAT HEAT Δ H ⁶ cal./GFW.	FORMATION FROM REFERENCE STATE	CE STATE Loc K
	1,356 % 3.120	4 3 3 8 8 9 8 9 8 9 8 9 8 9 8 9 8 9 8 9 8	5.85 5.85 6.01	600 600	7•97 8•01 9•70	7.97 7.98 8.20			
∆H _m B.P. 2,855 ∆H. 72,800	2,855 %		6.16 6.31 6.46 6.61 6.76	1215 1845 2480 3130 3800 4600	11.07 12.22 13.20 14.07 14.86	8.64 9.15 9.66 10.16 10.64			
s.P. ∆ Hs	۹۲ CAL./GFW	 	7.06 7.21 7.50 7.50	5190 5895 6615 10480 11230	16.25 16.87 17.44 20.29 20.81	11.54 11.96 12.36 12.81 13.33			
Т.Р. Аң	°K Call /GFW		7.50	11980 12730 13480 14230 14980 15730	21.29 21.74 22.17 22.58 22.96 22.96	13.81 14.69 15.10 15.47 15.47			
T.P. ΔH, Tc =	•K C.AL./GF₩ •K	22000	7.50 7.50 7.50 7.50 7.50 7.50	16480 17230 17280 18730 19480 20230 20280 94500	23.68 24.01 24.33 24.64 24.64 25.21 25.21 25.21	16.19 16.52 16.84 17.15 17.72 17.72 17.72			
Pc =	ATM.	3000	6.01	95090	51.44	19.75			

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COPPER	Ð		Refer	ence Stat	e for Cal	Reference State for Calculating AHF, AFF, and	QH°, QP°,	and		
	5		Log ₁₀ Kp :		d from 29	Solid from 296° to 1356°, Liquid from 1356°	6°, Liqui	ld from 13	556°	
IDEAL MONATOMIC	GAS		to 28	2855°, Ideal		Monatomic Gas from 2855° to 3000°.	om 2855°	to 3000°.		
GH- 63.54	SWAG	-	۲	9 	ąJ	-(P**-+f* 298.15)	FORMATI	FORMATION FROM REFERENCE STATE	NCE STATE	
			•ر	T 296.15	~ ⊢	FREE ENERGY	HEAT A H	FREE EVENCY & F		
(H ^o _{240,15} H ₀ ^o) = 1,481	CAL/GFW.	Xe	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GPW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEQ./ OFW.	CAL./OFW.	CAL./ GFW.	ğ	× •
		298	4.07	c	30.74	47.05	00118	96317	- 62 606	×.
A.P.	¥	300	4.97	0	39.77	39.74	81099	71571		6 4 9
		400	4.97	506	41.20	39.94	81005	68406	- 37.378	178
5 U		500	4.97	1003	42.31	40.31	80888	65268	- 28.530	130
		600	4.97	1500	43.22	40.72	80755	62155	- 22.641	541
	à	200	4.97	1996	43 • 98	41.13	90616	59070	- 18.444	44
	, e	800	4.97	2493	44 • 65	41.54	80463	55999	- 15•299	66
HV	CAL /GFW	006	4.97	2990	45 • 23	41.91	80290	52957		60
A117		1000	4.97	3487	45.76	42°28	80097	49917	- 10.910	10
		1100	4.97	3984	46.23	42.61	79894	46916	- 9.322	122
	ł	1200	4.97	4481	40.00	42°93	79686	43938	- 8.002	02
	¥	1300	4.97	4978	47.06	43°24	79463	40957	- 6.5	6.886
3	100, 110	1400	4•98	5475	47.43	43.52	76095	38099	- 2	5.948
2 1 2		1500	4.98	5973	47.77	43.79	75843	35403	- 5.1	5.158
		1600	5.00	6472	48.09	44 • 05	75592	32712	- 4•4	4.468
		1700	5.02	6973	48 • 40	44.30	75343	30021	- 3• 6	3.859
T.P.	*	1800	5.04	7476	48.68	44.53	75096	27378	1 	3.323
1		1900	5.07	1981	48 • 96	44.76	74851	24729	- 2.844	44
		2000	5.12	8491	49•22	44.98	74611	22091	- 2.413	13
· ·		2100	5.17	9006	49.47	45.19	74375	19481	- 2.0	2.027
		2200	5.23	9525	49.71	45.39	74145	16879	- - -	216
1.P.	*	2300	5.30	10001	49.95	45•58	13921	14259	- 1.354	354
:	,	2400	5.38	10585	50.17	45.76	73705	11689		•064
¢ H^	CAL. /GFW.	2500	5.47	11127	50.39	45.94	73497	9122	'• 1	197
		2600	5.56	11679	50.61	46.12	73299	6531	1	•548
		2700	5.67	12241	50.82	46.29	73111	3964	•	.320
Tc =	×	2800	5.78	12813	51.03	46.46	72933	1421		.110
1		2900	5.89	13396	51.24	46.63	0	0	c	
Pc =	ATA.	3000	6.01	19951	51.44	46.78	0	°	ọ	

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

COPPER

DYSPROSIUM	M Dy			Soli	d from 29	171 B° to 177	Solid from 298° to 1773°, Liquid from 1773° to	d from 1	773° to	
REFERENCE STATE	I STATE			2600	°, Ideal	Monatomic	2600°, Ideal Monatomic Gas from 2600° to 3000°.	2600° t(o 3000°.	
січ 162.51 (H° _{24.15} H°)= 2,	51 2,116	GRAMS CAL/GFW.	T Temperature °K	C P HEAT CAPACITY CAL. DEG. / GPT.	H ⁰ - H ⁰ T 294.15 HEAT CONTENT CAL/GFW.	S ⁰ F Entropy Cal./DEG./ GFW.	-(FO-HO 248.15) FREE ENERGY FUNCTION CAL. DEG. GFW.	FORMAT HEAT Δ H ⁶ cal./gfw.	Command the register of the state of the st	ICE STATE LOG K
A.P. △ H _m	1,773 4,100)	1,773 °K (4,100) сл./GFW.	200 200 200 200 200	6 51 6 51 6 68 85	670 11 670	17.87 17.87 17.91 19.81 21.31	17.87 17.887 17.887 17.88 18.14			
B.P.	2,600	*	900 900 900	7.02 7.19 7.36	2040 2750 3480	22•58 23•67 24•64	19.18 19.75 20.29			
∆н, 6	60,000	CAL. /GFW.	0001	7.53 7.87	4220 4990 5760	25.52 26.32 27.06	20.84 21.33 21.83			
с. Р. ∆ Н ₃		°K CAL. /GFW.	1200 1300 1400 1500	8 04 8 21 8 38 8 38 8 55	6560 7370 8200 9050	27.76 28.41 29.02 29.61	22.30 22.75 23.17 23.58			
T.P.		×	1600 1700 1800	8.72 8.89 8.00	10790 15760	30.16 30.70 33.51	23.97 24.36 24.76			
чн о		CAL /GFW.	2100		100000 17360 18960	34.36 34.36 34.75 35.12	25.08 25.68 26.11 26.51			
-ч н		CAL_/GFW.	2400 2400 2500 2600	8 8 9 9 0 0 0 9 0 0 0 9 0 0 0 9 0 0 0 9 0 0 0	19760 20560 21360 82160	35.47 35.81 36.14 59.53	26.88 27.25 27.60 27.93			
Pc =		ok ATA	2700 2800 3000		82760 83360 84560	59.76 59.98 60.19 60.39	29.11 30.21 31.24 32.21			

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		NCE STATE LOG K						
300° to	o 3000°.	△ H ^o FREE ENERCY △ F ^o LOG ○ H ^o FREE ENERCY △ F ^o LOG orv. c.d						
ld from 10	1 2900° to	FORMAT HEAT ∆ H ^o cal./gfw.						
0°, L1qu1	Gas from	-(F ^O -H ² 298.15) FREE ENERGY FUNCTION CAL./DEG./ GFW.	17.48 17.48 17.48 18.24	19.91 19.97 20.53 21.04	22.01 22.46 22.90 23.31 23.71	24.10 24.47 24.95 25.39 25.82	26.61 26.68 27.32 27.67	27.99 28.30 28.60 29.68
Solid from 298° to 1800°, Liquid from 1800° to	2900°, Ideal Monatomic Gas from 2900° to 3000°	S ⁰ F ENTROPY CAL./DEG./ GFW.	17.48 17.52 19.47 21.02	23.43 24.42 25.31 26.87 26.87 26.87	27.56 28.21 28.83 29.41 29.41	30.50 33.29 34.13 34.52 34.52	35.59 35.59 35.59 35.59	36.53 36.82 61.24 61.47
d from 29	°, Ideal	H ⁰ - H ⁰ T 294.15 HEAT CONTENT CAL/GFW.	0 690 1390	2820 2820 5980 5980 5870	6670 7480 8310 9160 10020	10890 15880 16680 17480 18280	19880 20680 21480 22280	23080 23880 94680 95380
Soli	2 900	C ^C PEAT CAPACITY CAL./PEG./ GPW.	6.72 6.72 6.87 7.02	7.022	8•07 8•22 8•37 8•52 8•67	8 8 8 8 8 8 8 9 0 0 0 0 0 0 0 0 0 0 0 0		8•00 7•00 7•00
		T temperature °K	90000000000000000000000000000000000000	700 800 900 11000	1200 1400 1500 1600	1700 1800 2000 2100	2300 2400 2500	2700 2800 3000
		GRAMS CAL./GFW.	°K CAL. /GFW.	°K CAL /GFW.	°K CAL /GFW.	°K CAL /GFW.	°K CAL. /GFW.	°K ATM.
LE LE	NCE STATE	167.27 H\$= 1,763	1,800 °K (4,100) cm./GFW	(2,900) °K (70,000) cal./GFW				
ERBIUM	REFERENCE	Gfw 167. (H° _{211.15} H°)=	A.P. A H _m	в.Р. ДН ₄	s.P. ∆H _s	Т.Р. ∆Н,	Т.Р. ∆Н ₁	Tc = Pc =

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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EUROPIUM	Bu		Soli	d from 29	38° to 11(Solid from 298° to 1100°, Liquid from 1100° to	ld from 1	100° to		
REFERENCE STATE	TE		1700°,	°, Ideal	Monatomic	Ideal Monatomic Gas from	1700°	to 3000°.		
152.0	CDAUC	•	2	9	ę	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE	гт
-	CHANN	Tembeovition		T 296.15	×-	FREE ENERGY	HEAT A H ^o	FREE ENERCY & F		
$(H^{0}_{298,15} - H^{0}_{0}) =$	CAL./GFW.	Me	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	f CAL./GFW.	CAL./ GFW.	гос г	
		298	6.40	0	17.00	17.00				
M.P. (1,100)	*	300	6.40	12	17.04	17.00				
∆н _™ (2,500)	CAL. / GFW.	400	09°9	660	18.91	17.26				
		009	00.0	0600	21.66	18.30				
		200	7.20	2730	22.76	18.86				
B.P. (1, /00)	ž	800	7.40	3460	23.73	19.41				
AH. (42.000)	CAL /GFW.	006	7.60	4210	24.62	19.95				
- 1		1000	7.80	4980	25.43	20.45				
	ſ	1100	8•00	8270	28.45	20.94				
9	×.	1200	8.00	9070	29.15	21.60				
	•	0001	00.00	0/ 86	61.62	02.02				
ΔHs .	CAL. /GFW.	1500		11470	90 • 06	0/ • 7 7				
		1600	8•00	12270	31.45	23.79				
		1700	8•00	13070	31.94	24.26				
T.P.	×	1800	5.02	50670	54.04	25.89				
ΔH,	CAL. / GFW.	1900	5 • 05	51170	54.31	27.38				
-		21000	0100	52190	54.82	20.07				
		2200	5.24	52710	55.06	31.11				
1.P.	×	2300	5.34	53240	55.29	32.15				
		2400	5.46	53780	55.52	33.12				
h r	CAL. /GFW.	2500	5.61	54330	55.75	34.02				
		2600	5.78	54900	55.97	34.86				U
		2700	5.98	55490	56.20	35.65				RC
Tc =	¥	2800	6.21	56100	56.42	36.39				P
1	ATM	2900	6.46	56730	56.64	37.08				JU
۱ ٥		3000	6.74	57390	50.80	37.73				M

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

EUROPIUM	WILL	กส		Reference	ence State	e for Cal	State for Calculating Aft, Aft,	ΔH [°] , ΔP°,	an d	
TNPAT	THEAT MONAMONTO			Log ₁₀ Kp :		l from 29	from 298° to 1100°,	o°, Liquia	Liquid from 1100°	•00
	DTWOLATUME	UAS		to 1700°	DO°, Ideal		Monatomic Gas from 1700° to 3000°	om 1700°	to 3000°.	
40	152.0	GRAMS		ບ	94 94	ę	-(P ⁰ -H ⁰ 278.15)	FORMATI	FORMATION FROM REFERENCE STATE	INCE STATE
			TEMPERATINE		T 296.15	^ ⊢	FREE ENERGY	HEAT \triangle H ^e	FREE ENERCY & F	
(H ^e 298.1	°21.15 + HD = 1 , 481	CAL./GFW.	*	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	f CAL./GFW.	CAL./ GPW.	* ق ۲00
:		1	298	4.97	•	45.10	45.10	43200	34821	- 25.525
ж. -		¥	004	4.97	506	46.56	45.30	43046	31986	- 17.477
1			500	4.97	1003	47.67	45.67	42873	29238	- 12.780
			600	4.97	1500	48.57	46.07	42680	26534	- 9.665
			700	4.97	1996	49.34	46.49	42466	23860	- 7.450
1		2	800	4.97	2493	50.00	46.89	42233	21217	- 5.796
2. 2.		¥	006	4.97	2990	50.59	47.27	41980	18607	- 4.518
14			1000	4.97	3487	51.11	47.63	41707	16027	- 3.503
AU ₁		LAL. /GTW.	1100	4.97	3984	51.58	47 _{.96}	38914	13471	- 2.676
			1200	4.97	4480	52.02	48 • 2 3	38610	11166	- 2.033
			1300	4.97	4977	52.41	48.59	38307	8901	- 1.496
		*	1400	4.97	5474	52.78	48.87	38004	6644	- 1.037
3		M30/ 140	1500	4•98	5972	53.13	49.15	37702	4402	641
5 1			1600	4.98	6470	53.45	49.41	37400	2200	- •300
			1700	5.00	6969	53.75	49.66	37099	22	- •002
1		1	1800	5.02	697L	54.04	06*67	0	0	0
		¥	1900	5.05	1973	54.31	50.12	0	0	0
AH.		CAL /GFW	2000	5.10	8480	54.57	50 . 33	0	0	0
5			2100	5.16	8992	54.82	50.54	0	0	c
			2200	5.24	9512	55.06	50.74	0	0	0
0		à	2300	5.34	10040	55.29	50.93	0	0	0
÷		¥	2400	5.46	10580	55•52	51.12	0	0	0
1		100	2500	5.61	11133	55.75	51.30	0	0	0
1		LAL / GFW.	2600	5.78	11702	55.97	51.47	0	0	0
			2700	5.98	12290	56.20	51.65	0	0	0
			2800	6.21	12900	56.42	51.82	0	0	0
T. =		*	2900	6.46	13534	56.64	51.98	0	0	0
" •		ATM.	3000	6.74	14194	56.86	52.13	0	0	0

EUROPIUM

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Publication Date: January 1, 1956 | doi: 10.1021/ba-1956-0018.ch004

TRRENCES STATE 36.00 cauxi area cauxi<	FLUORINE	LINB P2	_			Ideal D	istomic G	Ideal Diatomic Gas from 298° to 3000°.	98° to 30	••••	
38.00 ctasts T C Normative Terms Terms Terms Terms Terms Terms Current of terms Curre	REFER	LENCE STATE									
Turbentum Turbentum Turbentum Turbentum Turbentum Turbentum Turbentum 653.54 % 208 7.449 14 48.49 48.45 48.45 53.54 % 300 7.449 14 48.49 48.45 48.45 53.54 % 300 7.449 783 50.071 48.45 48.45 122.0 Cut./GFN 500 8.41 2418 54.011 49.49 48.45 1220.0 Cut./GFN 500 8.41 2418 54.011 49.49 48.45 1220.0 Cut./GFN 10000 8.41 2418 54.011 49.49 51.02 1362. Cut./GFN 11000 8.41 2418 54.013 51.493 1362.0 Cut./GFN 11000 8.84 55.02 55.016 51.493 1375.0 Cut./GFN 11000 8.84 55.02 55.05 55.05 1562.0 V 11260	ł	38.00	GRAMS	-	ບ	H ^o -H ^o	\$2'	-(51-842	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
236 7.49 0 48.45 53.54 % 300 7.49 14 48.45 122.0 Cut./GFN 500 8.41 248 50.71 85.02 % 8.50 8.41 2418 54.01 85.02 % 900 8.41 2418 54.01 85.02 % 900 8.77 5003 55.32 1300 8.64 56.47 5003 57.50 % 11000 8.94 7663 60.77 % 11000 8.94 7663 60.77 % 11000 8.94 7663 60.77 % 11000 8.94 7663 60.77 % 11000 8.94 7663 60.77 % 11000 8.94 7663 60.77 % 13009 9.01 1144 61.64 175.9 Cut./GFN 17000 9.11 11209 45.55 % 117000 9.11 12180 45.55 % 19000 9.11 12180 45.55 % 19000 9.21 19036 175.9 Cut./GFN 2000 9.21	(H ⁰ 211.11	;-H\$)= 2,110.		TEMPERATURE		T ZNLIS HEAT CONTENT CAL./ GPW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CALL/DEG./ GFW.	HEAT A H	FREE ENERGY & F	х 901
53.54 % 122.0 Cut./Grw. 900 7.89 122.0 Cut./Grw. 950 8.19 95.02 % 95.02 % 95.02 % 950 8.91 950 8.91 950 8.91 950 8.91 950 8.91 950 8.94 950 8.94 950 8.94 960 8.94 970 9.				208	7.40	C	48.45	48.45			
122.0 Cut./GFN 500 8.19 783 50.71 85.02 % 500 8.41 2418 54.01 900 8.56 3268 54.01 55.32 1,562. Cut./GFN 900 8.71 5003 57.50 1,562. Cut./GFN 10000 8.84 58.43 57.50 % 11000 8.94 7663 60.77 598.23 % 11000 8.94 7663 60.77 % 11000 8.94 7663 60.77 % 11000 8.94 7663 60.77 % 11000 8.94 7663 60.77 % 12000 8.94 7663 60.77 % 13000 9.01 10364 62.66 17700 9.11 12180 63.20 45.55 % 13003 64.21 1775.9 Cut./GFN 19900 9.15 14008 45.55 % 13003 64.21 1775.9 Cut./GFN 2100 9.21 14008 45.55 % 13009 64.21 1775.9 Cut./GFN 2100 9.22	đ	53.54	*	300	7.49	14	64.84	48.45			
1,562 % 2,418 55,32 1,562 % 700 8,56 55,32 1,562 Cut./Grv 11000 8,90 6772 59,27 1,562 Cut./Grv 11000 8,90 6772 59,27 % 11000 8,90 6772 59,27 59,27 % 11000 8,90 6772 59,27 % 11000 8,90 6772 59,27 % 11000 8,90 6772 59,27 % 11000 8,90 6772 59,27 % 13000 9,00 9,00 61,44 1700 9,00 9,01 1200 61,44 1773.9 Cut./Grv 1900 9,11 12180 62,06 1773.9 Cut./Grv 1900 9,13 13093 63,21 173.9 Cut./Grv 1900 9,21 14924 64,61 173.9 Cut./Grv 2100 9,22 14924 65,56 173.9 Cut./Grv 2100 9,22 14924 65,56 1744.2 % 2300 9,22 14924 65,56 144.2 % 2300 9,	3	0.001	CAL /GEW	0 4 4 4	7.89	1588	50.71	48.76			
85.02 % 700 8.56 3268 55.32 1,562. Cut./Grv 10000 8.66 4130 56.47 % 800 8.66 4130 56.47 % 800 8.66 4130 56.47 % 8.00 8.68 4130 56.47 % 11000 8.99 5603 57.55 % 11000 8.99 60772 59.27 % 11200 8.99 8559 60.05 % 13000 9.02 9461 61.44 14000 9.01 11269 62.06 45.55 % 14000 9.11 12180 45.55 % 19000 9.13 13093 63.20 45.55 % 19000 9.13 13093 65.13 1773.9 Cut./Grv. 2000 9.13 13093 65.13 1773.9 Cut./Grv. 2000 9.21 19923 65.16 1773.9 Cut./Grv. 21000 9.21 199235 65.16 1773.9 Cut./Grv. 22000 9.21 199235 65.16 1744.2 % 22000 9.21 199235		7		8	8.41	2418	54.01	49.98			
85.02 % 900 8.66 4130 56.47 1,562. Cut./GFN 1000 8.94 5882 58.43 % 11000 8.90 6772 59.27 % 11000 8.90 6772 59.27 % 1200 8.94 7663 60.05 % 1200 8.94 7663 60.05 % 1400 9.06 10364 62.06 1700 9.08 11269 62.06 1773.9 Cut./GFN 1900 9.11 12180 1773.9 Cut./GFN 1900 9.13 13093 63.21 1773.9 Cut./GFN 1900 9.13 13093 63.21 1773.9 Cut./GFN 2100 9.21 14924 64.61 1773.9 Cut./GFN 2100 9.21 19933 65.13 1173.9 Cut./GFN 2100 9.21 19933 65.13 1173.9 Cut./GFN 2100 9.21 19933 65.16 1173.9 Cut./GFN 2100 9.21 19933 65.16 1173.9 Cut./GFN 21000 9.21 199535 66.74 1144.2 <td></td> <td></td> <td></td> <td>700</td> <td>8.56</td> <td>3268</td> <td>55.32</td> <td>50.66</td> <td></td> <td></td> <td></td>				700	8.56	3268	55.32	50.66			
1,562. Cut. /GFH 1000 8.77 5003 57.50 1,562. Cut. /GFH 11000 8.944 5882 58.43 % 1200 8.944 772 59.27 % 1200 8.944 7663 60.05 % 1200 8.944 7663 60.05 % 1400 9.06 10364 61.044 1700 9.08 11269 62.06 45.55 % 11200 9.013 11269 1773.9 Cut. /GFH 12000 9.11 12180 63.20 1773.9 Cut. /GFH 12000 9.13 13093 63.21 1773.9 Cut. /GFH 19900 9.13 13093 63.21 1773.9 Cut. /GFH 2100 9.22 149024 64.61 21700 9.21 19903 65.56 66.36 22000 9.23 16764 65.66 144.2 % 2300 9.22 16764 2144.2 % 2300 9.23 16764 22000 9.23 16764 65.56 21302 9.21 195335 66.74 2600 9.23 <	8	85.02	*	800	8.68	4130	56.47	51.31			
1,562. Cut./GFR 10000 8.84 5682 58.43 % 11000 8.94 7663 60.05 % 12000 8.94 7663 60.077 % 14000 9.002 9461 61.44 17000 9.008 11269 62.06 45.55 % 17000 9.11 12180 45.55 % 19000 9.13 13093 63.20 173.9 Cut./GFN 19000 9.15 14008 64.21 173.9 Cut./GFN 21000 9.18 19033 63.72 173.9 Cut./GFN 21000 9.15 14008 64.21 173.9 Cut./GFN 22000 9.23 14924 65.56 % 22000 9.27 19933 65.133 144.2 % 23000 9.22 16764 65.56 144.2 % 23000 9.23 16764 65.66 22000 9.23 17686 65.97 23000 9.22 16764 65.66 7400 9.23 16764 65.66 7400 9.2190 9.22 16764 23000 9.23 <td></td> <td></td> <td></td> <td>006</td> <td>8.77</td> <td>5003</td> <td>57.50</td> <td>51.95</td> <td></td> <td></td> <td></td>				006	8.77	5003	57.50	51.95			
1100 8.94 0772 59.27 % 1200 8.94 7663 60.05 % 14000 9.00 9461 61.44 14000 9.06 10364 62.06 1700 9.08 11269 62.06 1700 9.08 11269 62.06 1700 9.01 12180 63.20 1700 9.13 12180 63.20 173.9 CAL/GFN 19900 9.13 13093 173.9 CAL/GFN 2100 9.215 14924 64.61 2100 9.213 13093 63.72 173.9 CAL/GFN 2100 9.215 14924 66.555 % 12600 9.218 14924 66.66 9.213 199535 66.36 744 2100 9.22 16764 72 2300 9.22 16764 65.56 744 2300 9.22 16764 65.66 744 2300 9.22 16764 65.74 74 2400 9.22 16764 65.74 740 9.2600 9.23 16764 65.74 740 9.23	∆H	1,562.	CAL /GFW.	1000	48 8	5882	58.43	52.55			
*K 1200 8.94 7663 60.077 *K 1400 9.02 9461 61.44 Cut./Grw 1500 9.06 10364 62.06 45.55 *K 1700 9.11 12180 63.20 175.9 Cut./Grw 1700 9.11 12180 63.20 175.5 Fut./Grw 1900 9.13 13093 63.21 175.6 Cut./Grw 2000 9.13 13093 64.21 175.9 Cut./Grw 2100 9.20 16764 64.68 22100 9.21 14008 64.21 22000 9.21 19900 9.22 16764 65.51 7 2300 9.22 16764 65.61 7 2300 9.23 17686 65.61 144.2 * 2500 9.23 19535 66.74 2800 9.32 19612 66.36 67.45 2800 9.32 199535 66.74 2800 9.33 23257 68.74 8 2900 9.33 23257 68.44				8011	8.90	6772	59.27	53.12			
*K 1100 9.01 9461 610.17 CAL/GFW 1500 9.06 10364 62.06 45.55 *K 1700 9.11 12180 63.20 1700 9.11 12180 63.20 1700 9.11 12180 63.20 1700 9.11 12180 63.20 1700 9.15 13093 63.20 175.9 CAL/GFW 2000 9.18 14924 22000 9.20 15843 65.13 22100 9.22 16764 65.61 % 22000 9.23 17686 65.91 % 2300 9.26 18612 66.36 % 2300 9.23 17686 65.61 144.2 % 2500 9.32 19535 66.74 2800 9.32 19535 66.74 2800 9.32 23257 68.10 144.2 % 2800 9.33 27709 2800 9.33 23257 68.44 5 5 5 66.74 7 2900 9.33 27745 8 1000 9.34 2710 <t< th=""><th></th><th></th><th></th><th>1200</th><th>40.0</th><th>7663</th><th>60.00 00</th><th>53.67</th><th></th><th></th><th></th></t<>				1200	40.0	7663	60.00 00	53.67			
Cut. /GFN 1500 9.06 10364 62.06 45.55 % 1700 9.06 11269 62.64 175.9 Cut. /GFN 1500 9.013 11269 62.64 1775.9 Cut. /GFN 1900 9.11 12180 63.20 1775.9 Cut. /GFN 22000 9.18 13093 64.21 2000 9.18 14924 64.68 65.13 65.13 22000 9.22 15643 65.13 65.13 22000 9.22 15645 65.36 74 22000 9.27 19535 66.36 74 2400 9.27 19535 66.74 57 2400 9.28 19535 66.74 57 2400 9.28 19535 66.745 57 2400 9.28 19535 67.745 57 27000 9.32 22323 67.745 57 27000 9.34 232323	e,		*			8000					
45.55 % 11269 62.64 173.9 cul./GFN 1700 9.11 112180 63.20 173.9 cul./GFN 1900 9.15 14008 64.21 173.9 cul./GFN 2100 9.218 14924 64.68 * 22000 9.22 16764 65.56 * 22000 9.22 16764 65.56 * 22000 9.23 17686 65.613 22000 9.23 17686 65.66 * 22000 9.27 19635 66.36 * 22000 9.27 19535 66.74 2400 9.28 20463 67.10 2600 9.28 23325 66.74 2700 9.32 23323 67.45 2700 9.33 23257 68.14 5 7000 9.34 24191 68.44	∆ H.		CAL. /GFW.	1500	90°6	10364	62.06	55.16			
45.55 % 173.9 cut./cerr 173.9 cut./cerr 2000 9.13 173.9 cut./cerr 2100 9.13 173.9 cut./cerr 2100 9.18 173.9 cut./cerr 2100 9.21 173.9 cut./cerr 2100 9.21 173.9 cut./cerr 2100 9.23 175.9 17686 65.13 2100 9.23 175.9 17686 65.13 2100 9.23 144.2 % 2144.2 % 22000 9.32 22000 9.32 22000 9.32 2300 9.32 2300 9.32 2300 9.32 2400 9.32 23257 66.745 67.45 2700 9.32 2700 9.32 2700 9.32 2700 9.32 2700 9.32 2800 9.32 2900 9.34 2900 9.34 29.45 66.45	•			1600	9.08	11269	62.64	55.60			
45.55 * 1800 9.13 13093 63.72 173.9 CAL/GFN 2000 9.15 14008 64.21 * 2100 9.215 14024 64.68 * 2100 9.22 15643 65.13 * 2300 9.22 15764 65.13 * 2300 9.25 19612 66.36 * 2500 9.27 19535 66.36 * 2500 9.28 20463 67.45 * 2700 9.28 20463 67.45 * 2700 9.28 20463 67.45 * 2700 9.28 20463 67.45 * 2700 9.32 23323 67.45 * 2700 9.34 23257 68.44 * 3000 9.34 24191 68.44				1700	9.11	12180	63.20	56.04			
173.9 CAL/GFN 1900 9.15 14008 64.21 173.9 CAL/GFN 2000 9.15 14924 64.68 % 2100 9.22 15643 65.13 % 2300 9.23 17686 65.97 % 2300 9.25 18612 65.97 % 2700 9.27 19535 66.36 % 2500 9.28 19535 66.74 2100 9.28 19535 66.74 2300 9.28 20463 67.10 2400 9.28 23463 67.10 2700 9.32 23325 66.74 2700 9.32 23325 66.74 2700 9.32 23257 68.12 6 5.3257 68.44	T.P.	45.55	*	1800	9.13	13093	63.72	56.45			
1/3.9 Cut./GFN 2000 9.10 1492 0.100 x 2200 9.20 15843 055.13 2200 9.23 17686 65.97 x 2200 9.25 18612 66.36 2200 9.27 19535 66.36 2400 9.27 19535 66.74 2500 9.28 19535 66.74 2700 9.28 2392 67.10 2700 9.28 2392 67.16 2700 9.28 23325 66.74 2700 9.32 23325 67.79 2700 9.34 24191 68.44	:			1900	9.15	14008	64.21	56 . 84			
x 2200 9-22 16764 65-56 x 2300 9-23 17686 65-97 cul./GFN 2400 9-25 18612 66-36 2500 9-27 19535 66-74 2500 9-28 20463 67-10 2600 9-28 20463 67-10 2700 9-28 20463 67-45 2700 9-32 23323 67-45 2700 9-32 23257 68-12 e ATM 3000 9-34 24191	1 10	R.0/1	CAL / GFW.		010	15843	61.00 65.12	57.50			
*K 2300 9.23 17686 65.97 Cull/GFW 2400 9.25 18612 66.36 2500 9.25 18612 66.36 74 2500 9.27 19535 66.74 710 2600 9.28 20463 67.10 2700 2700 9.28 20463 67.10 2700 2700 9.32 22323 67.45 67.45 2700 9.32 22323 67.45 67.45 2700 9.33 23257 68.45 68.44 5 3000 9.34 24191 68.44				2200	9.22	16764	65.56	57.94			
CAL./GFN, 2400 9.25 18612 66.36 25500 9.27 19535 66.74 2700 9.28 20463 67.10 2800 9.32 21392 67.45 2800 9.32 22323 67.45 2900 9.34 24191 68.44	T.P.		¥	2300	9.23	17686	65.97	58.29			
CAL./GFN 2.300 9.421 1.9333 600.17 2600 9.288 20463 67.410 2700 9.30 21392 67.410 2800 9.33 22323 67.45 2800 9.33 23257 68.12 5 A14. 3000 9.34 24191 68.44				2400	9•25	18612	66.36 25	58.61			
= 144.2 % 2700 9.30 21392 67.45 2800 9.32 22323 67.79 29.33 23257 68.12 29.34 24191 68.44	ł∎ ⊽		CAL. /GFW.	0092	9.28	20463	67-10	50.23			
= 144.2 °K 2800 9.32 22323 67.79 = c ATM 3000 9.34 24191 68.44				2700	9•30	21392	67.45	59 . 53			
TTT:C 2900 9.33 23257 68.12 = EE ATM 3000 9.34 24191 68.44	" "	0 . A M L	¥	2800	9.32	22323	67.79	59 . 82			
= EE ATM. 3000 9-34 24191 68-44		7.5.2.7	:	2900	9•33	23257	68.12	60.11			
• • • • • •	ື	55.	ATM.	3000	9•34	24191	68°44	60•38			

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FLUORINE F IDEAL MONATOMIC GAS	P GAS		Refe Log ₁	Reference Sta Log ₁₀ Kp: Ide	te for Ca al Diatom	Reference State for Calculating AH ² , AF ² , Log ₁₀ Kp: Ideal Diatomic Gas from 298° to	∆H _c , ∆r n 298° t	f, and fo 3000°.	
						3	FORMATI	FORMATION FROM REFERENCE STATE	NCE STATE
CIM T 2.000	GRAMS	H	۶۰	H ⁰ — H ⁰ T 298.15	ึ•⊢		HEAT A H ^o	FREE ENERGY A P	
(H ⁰ _{218.15} H ⁰ ₉) = 1,558	CAL./GFW.		HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GPW.	ENTROPY CAL./DEQ./GFW.	FUNCTION FUNCTION CAL./DEG./ GPW.		CAL./ GPW.	۲06 K
		298	5.44	C	37.92	37.92	18903	14821	- 10-864
	*	300	5.44	10	37.95	37.92	18906	14796	-
	•	004	5.36	550	39.51	38.14	19061	13401	- 7.322
ΔHmm	CAL. /GFW.	500	5.28	1082	40.69	38.53	16161	11971	- 5.232
		600	5.22	1607	41.65	38,98	19301	10517	- 3.831
		200	5.17	2126	42.45	39.42	19395	9042	- 2.823
B.P.	¥	800	5.13	2641	43.14	39.84	19479	7559	- 2.065
		006	5.10	3153	43.74	40.24	19554	6063	- 1.472
∆H •	CAL. /GFW.	1000	5 • 08	3662	44.28	40.62	19624	4564	997
		1100	5.07	4170	44.76	40.97	19687	3055	607
		1200	5 •05	4676	45°20	41.31	19747	1543	281
S.P.	¥	1300	5 • 0 4	5180	45.61	41.63	19803	. 17	- •002
		1400	5.03	5684	45.98	41.92	19856	- 1508	•235
△ H ^a	CAL. /GFW.	1500	5.02	6187	46.33	42.21	19908	- 3042	.443
		1600	5.02	6689	46.65	42.47	19957	- 4571	•624
		1700	5.01	7190	46.95	42.73	20003	- 6092	• 783
T.P.	*	1800	5.01	1691	47.24	42.97	20047	- 7637	.927
		1900	5.01	8192	47.51	43.20	20091	- 9169	1.054
Ф н	CAL /GFW.	2000	5.00	8692	47.77	43.43	20133	- 10727	1.172
		2100	5•00	61 65	48.01	43.64	20173	- 12251	1.274
		2200	5.00	9695	48 • 24	43.84	20213	- 13799	1.370
T.P.	*	2300	4 .99	10191	48.47	40°47	20251	- 15353	1.458
		2400	40	10001	48.68	44.23	20288	- 16912	1.540
⊅H	CAL. /GFW.	2500	66 • 	11190	48 . 88	44.41	20325	- 18450	1.612
		2600	4 • 99	11689	49°08	44.59	20360	- 20018	1.682
		2700	4.99	12188	49.26	44.75	20395	- 21536	1.743
T.=	¥	2800	4.98	12687	49.45	44.92	20428	- 23112	1.803
		2900	4 •98	13185	49.62	45.0 8	20459	- 24665	1.858
ہ =	ATM.	3000	4.98	13683	49.79	45.23	20490	- 26220	1.910

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[956-0018.ch004
i: 10.1021/ba-1
1, 1956 doi
ublication Date: January

REFERENCE STATE 950° Ideal Monatonic Gas from S50° 2000° th 223.5° 6 MM From S50° to 3000° th 223.5° 6 MM From S50° to 3000° th 223.5° 6 MM From S50° to 3000° th 300 tr th 900 1200 22.550 22.550 th 500 7.60 1270 26.493 20.404 th 500 7.60 1270 26.493 20.404 th 500 7.60 2700 26.493 20.404 th 500 7.60 2700 26.493 20.404 th 500 7.60 2700 2700 26.433 th 500 7.60 2700 26.433 20.404 th 500 7.60 2700 26.433 20.404 th 500 7.60 2700 26.433 20.404 th 500 2								00 000 mo.rt nthref 0 000 00 000 mo.rt ntron		
ZZ3.4 T C PP-MAIL T	REFERENCE SI	LATE		950	, Ideal N	fona tomic	Gas from	950° to	3000°.	
Immunication Table and the state Table and the and Table and Table a				8	9	4	-(Po-H ^o 200.15)	FORMAT	TION FROM REFEREN	ICE STATE
Ligitify= Cut/dent Matrix constraint and constraint Land Constraint <thlondordig< th=""> Land Constraint <thlondi< th=""><th></th><th></th><th>-</th><th>-</th><th>T 294.15</th><th>×-</th><th>FREE ENERGY</th><th>HEAT A H^e</th><th>FREE ENERGY & F</th><th></th></thlondi<></thlondordig<>			-	-	T 294.15	×-	FREE ENERGY	HEAT A H ^e	FREE ENERGY & F	
298 7.60 14 22.55 (500) xL/GFN 500 7.60 1270 26.40 500 xL/GFN 500 7.60 23.00 31.67 700 7.60 200 35.9 31.67 700 7.60 200 35.9 31.67 700 7.60 4310 31.67 700 7.60 4310 31.67 700 7.60 4310 31.67 700 7.60 4310 31.67 700 7.60 4310 31.67 700 7.60 497 20890 49.94 7 11000 4.97 20890 49.49 7 11000 4.97 21380 50.40 7 11000 4.97 21380 51.61 7 11000 4.97 21380 51.61 7 11000 4.97 21380 51.61 7 11000 4.93 23.80 51.61 7 1500 5.01 2380 51.61 7 1500 5.01 2380 51.61 7 1600 5.01 2380 51.61 7	(H ⁰ _{298.15} Hg) =	CAL./GFW.			HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	×
(300) κ $\frac{200}{10}$ $\frac{7.600}{7.600}$ $\frac{1270}{70}$ $\frac{26.640}{203}$ (950) $\kappa_{\rm L/GFW}$ 500 7.600 $\frac{1270}{20}$ $\frac{26.640}{203}$ (15,200) $\kappa_{\rm L/GFW}$ 500 7.600 $\frac{1270}{200}$ 26.40 (15,200) $\kappa_{\rm L/GFW}$ 500 7.600 $\frac{2700}{32.67}$ 28.10 (15,200) $c_{\rm L/GFW}$ 10000 4.97 20890 49.49 21310 (15,200) $c_{\rm L/GFW}$ 11000 4.97 20890 49.49 21.17 (15,200) $c_{\rm L/GFW}$ 11000 4.97 20890 49.49 21.17 (15,200) $c_{\rm L/GFW}$ 11000 4.97 21380 51.61 21.270 κ 11000 4.97 21380 51.61 21.270 52.117 κ 11000 4.99 22380 51.61 52.270 κ 11700 5.01 2380 51.61 22300 52.270 κ κ 1700 5.01 22380			aUc	7	C	22 60				
(500) c_{AL}/GFW . 400 7.60 1270 26.40 (950) c_{AL}/GFW . 500 7.60 2790 28.10 (15, 200) c_{AL}/GFW . 700 7.60 2790 29.48 (15, 200) c_{AL}/GFW . 1000 4.97 20890 49.497 (15, 200) c_{AL}/GFW . 1100 4.97 21380 59.40 % 11000 4.97 21880 59.49 76.61 % 11000 4.97 21880 59.49 76.7 % 1300 4.997 21880 59.49 76.41 % 1300 4.997 21880 59.10 55.24 % 1500 5.01 23880 51.61 76.61 % 1500 5.01 23880 51.83 52.44 % 1500 5.01 25.43 52.64 52.64 % 1700 5.01 25.91 52.64 52.64 52.64 % 21000 5.01 25.91 52.64 52.64			3006	7.60	14 0	22.55	22.51			
	•	4	400	7.60	1270	26.40	23.23			
(950) % 7.60 2790 29.48 700 7.60 3550 30.66 700 7.60 4310 31.67 900 7.60 4310 31.67 900 7.60 497 21880 49.49 700 4.97 21880 50.40 900 4.997 21380 49.49 900 4.997 21380 49.49 900 4.997 21380 50.40 9100 4.998 22380 51.17 9100 4.998 22380 51.17 9100 4.998 22380 51.17 9100 4.998 22380 51.17 9100 5.01 2380 51.17 9100 5.01 2380 51.17 9100 5.01 2380 51.17 9100 5.01 2380 51.83 9100 5.01 2380 51.17 9100 5.01 2380 51.83 9100 5.01 2380 51.83 9100 5.01 2380 51.83 9100 5.01 2380 51.83 9100 5.01 2390 <t< td=""><td></td><td>CAL. /GFW.</td><td>500</td><td>7.60</td><td>2030</td><td>28.10</td><td>24.04</td><td></td><td></td><td></td></t<>		CAL. /GFW.	500	7.60	2030	28.10	24.04			
(950) % (15,200) cut./dsw. % 7.60 % 7.60 % 7.60 % 7.60 % 1000 % 1000 % 1100 % 1100 % 1100 % 1200 % 1300 % 1300 % 1400 % 1400 % 1400 % 1400 % 1400 % 1700 % 1700 % 1700 % 1700 % 1700 % 1700 % 1700 % 1700 % 1700 % 1700 % 1700 % 1700 % 1700 % 1700 % 1700 % 1700 % 1800 % 1900 % 25380 % 2700 % 2700 % 2800 % 2800 <td< td=""><td></td><td></td><td>600</td><td>7.60</td><td>2790</td><td>29•48</td><td>24.83</td><td></td><td></td><td></td></td<>			600	7.60	2790	29•48	24.83			
(350) x 800 7.60 4310 31.67 (15, 200) cut./cfw. 900 7.60 4310 32.57 % 1100 4.97 20890 49.97 32.67 % 1100 4.97 20890 59.04 % 1100 4.97 21880 51.61 % 1300 4.997 21880 51.61 % 1300 4.997 21880 51.61 % 1500 5.03 22380 51.61 % 1500 5.03 23380 51.61 % 1500 5.03 23380 51.61 % 1500 5.03 24880 51.61 % 1800 5.03 24880 52.43 % 1800 5.03 253.90 52.91 % 1800 5.03 55.31 52.94 % 2300 5.04 55.31 55.91 % 2800 5.91 55.91 55.91 % 2800 5.91			700	7.60	3550	30.66	25.59			
(15, 200) CAL./GFW. 900 7.60 5070 32.57 • K 11000 4.97 20890 49.497 • K 11100 4.97 20890 49.497 • K 11200 4.987 20890 49.497 • K 11300 4.997 21880 50.400 • K 11300 4.998 22380 51.61 • K 1400 4.998 22380 51.61 • K 1500 4.998 23380 51.61 • K 1500 5.011 23880 51.61 • K 1600 5.011 23880 51.61 • K 1800 5.012 23890 52.14 • K 1800 5.012 23890 52.14 • K 1800 5.012 25390 52.270 • K 21000 5.12 25910 52.270 • K 22000 5.212 25940 53.271 • K 2200 5.218 29660 <td></td> <td>*</td> <td>800</td> <td>7.60</td> <td>4310</td> <td>31.67</td> <td>26.29</td> <td></td> <td></td> <td></td>		*	800	7.60	4310	31.67	26.29			
(15, 200) cut./GFW. 1000 4.97 20890 49.49 •K •K 1100 4.97 21380 50.40 •K 11200 4.98 22380 51.61 17 •K 11400 4.99 22380 51.61 17 •K 11400 4.99 23380 51.61 17 •K 11700 5.01 23880 51.61 17 •K 11700 5.01 23880 51.61 17 •K 11700 5.01 23880 52.43 52.43 •K 11700 5.01 23880 52.43 52.43 •K 11700 5.01 23800 52.43 52.43 •K 1900 5.01 25910 52.43 52.43 •K 2100 5.01 25910 53.27 0 •K 2200 5.01 25910 53.47 2700 •K 21000 5.01 25910 53.47 2700 •K 2200 5.01 2		:	006		5070	32.57	26.94			
		CAL /GFW.	1000		20890	49.49	28.60			
•K 1200 4.97 21880 50.40 •K 1300 4.98 22380 51.17 cAL/GFW 1500 4.98 22380 51.17 cAL/GFW 1500 4.98 22380 51.17 n •K 1500 4.98 22380 51.17 n •K 1500 4.98 22380 51.17 1600 5.01 23880 51.83 51.83 n •K 1800 5.01 23880 51.83 n •K 1800 5.01 23880 51.83 n •K 1800 5.01 252.43 n •K 2000 5.12 255.91 n •K 2100 5.25 25430 n •K 2200 5.261 552.91 n * 2200 5.261 552.91 n * 2200 5.25430 552.91 n * 2200 5.261 553.71 n * 2200 5.261 553.71 n * 2200 5.261 553.71 n * 22000 5.61 264.61 <t< td=""><td></td><td></td><td>1100</td><td>4.97</td><td>21380</td><td>49.97</td><td>30.54</td><td></td><td></td><td></td></t<>			1100	4.97	21380	49.97	30.54			
•K 1300 4.98 22380 50.80 c.dL./GFW 1400 4.98 22880 51.17 c.dL./GFW 1500 4.99 23880 51.17 v 1500 5.01 23880 51.61 v 1600 5.01 23880 51.61 v 11700 5.01 23880 51.83 v 11700 5.03 24880 52.14 v 11700 5.03 24880 52.14 v 11900 5.18 25910 52.70 v 22000 5.18 25910 52.71 v 2100 5.25 25430 53.47 v 22000 5.47 256910 52.70 v 22000 5.47 25090 53.47 22000 5.47 256910 55.91 55.70 v 22000 5.47 26600 54.41 v 23000 5.61 28620 54.41 v 28000 5.91 26910 55.91 v 28000 5.94 2910 55.91 v 28000 5.94 2910 55.91 v v <td></td> <td></td> <td>1200</td> <td>4.97</td> <td>21880</td> <td>50.40</td> <td>32.17</td> <td></td> <td></td> <td></td>			1200	4.97	21880	50.40	32.17			
M. /GFW. 1400 4.998 22880 51.17 CAL./GFW. 1500 4.998 23380 51.651 *K 1600 5.01 23880 51.651 *K 11700 5.03 24380 51.651 *K 11700 5.03 24380 51.651 *K 11700 5.03 24380 51.63 *K 11800 5.03 24380 52.43 *K 1900 5.18 25910 52.43 *K 22000 5.47 25910 52.43 *K 2100 5.25 25430 53.27 *K 2100 5.47 256910 53.27 *K 2200 5.47 25690 53.47 *K 2300 5.47 25690 53.47 *K 2300 5.47 2700 55.41 *K 2800 5.44 29620 53.47 *K 2800 5.44 29640 54.41 *K 2800 5.44 29610 54.41 *K 2800 5.44 29810 55.41 *K 2800 5.44 29810 54.41 *K			1300	4.98	22380	50.80	33.59			
Cut. /GFN. 1500 4.99 23380 51.51 * 1600 5.01 23880 51.83 * 1700 5.03 24380 52.14 * 1800 5.01 23880 51.83 * 1800 5.03 24380 52.14 * 1900 5.03 24880 52.43 * 2000 5.18 252.43 * 2000 5.18 252.43 * 2200 5.12 25910 * 2200 5.25 254.43 * 2200 5.47 256910 * 2200 5.47 25690 * 2200 5.47 25690 * 2200 5.47 25690 * 2200 5.47 25690 * 2200 5.47 2760 * 2200 5.47 2760 * 2500 5.47 2760 * 2500 5.44 29500 * 2700 5.44 29610 * 2800 5.44 29610 * 2800 5.44 29610 * * 2960<		:	1400	4.98	22880	51.17	34.83			
-k 1600 5.01 23880 51.83 -k -k 1700 5.03 24380 52.14 -k 1800 5.07 24380 52.14 -k 1800 5.07 24380 52.14 -k 1800 5.012 25390 52.27 -k 2000 5.18 25910 52.27 -k 2100 5.25 25430 52.27 -k 2200 5.47 25910 52.97 -k 2200 5.47 25910 53.27 -k 2200 5.47 27800 53.47 -k 2200 5.47 27800 54.41 -k 2500 5.910 54.41 -k 2500 5.910 54.41 -k 2500 5.910 54.41 -k 2800 6.80 54.46 -k 2800 6.80 54.46 -k 2800 5.910 55.09 -k 31750 55.31	∆ H₅	CAL. /GFW.	1500	66 •7	23380	51.51	35.93			
• K 1700 5.03 24380 52.14 • K 1800 5.07 24880 52.14 • K 1900 5.12 252.43 1900 5.12 25390 52.27 2100 5.18 25390 52.27 • K 2100 5.12 255430 52.27 • K 2200 5.47 25910 52.27 • K 2200 5.47 25910 53.27 • K 2200 5.47 27600 53.47 • K 2200 5.47 27600 53.47 • K 2700 5.41 27600 54.48 • K 2500 5.44 29810 54.44 • K 2800 6.80 54.68 • K 2900 6.80 55.09 • ATM 300430 55.09			1600	5.01	23880	51.83	36.91			
•K 1800 5-07 24880 52-43 CAL./GFN 1900 5-12 25390 52-70 CAL./GFN 2000 5-18 25910 52-97 *K 2100 5-18 25910 52-97 *K 2200 5-37 25390 53-47 *K 2300 5-47 27500 53-47 *K 2400 5-647 27600 53-94 *K 2400 5-617 28050 53-94 *K 2500 5-47 27500 53-94 *K 2700 5-47 27600 54-61 *K 2800 5-94 29210 54-61 *K 2800 5-94 29210 54-63 *K 2800 6-33 30430 54-63 * 2800 6-80 6-80 55-09 * 31750 55-31 55-31			1700	5.03	24380	52.14	37.80			
	1.P.		1800	5.07	24880	52.43	38.61			
Cut. /GFN. 2000 5.18 25910 52.97 * 2100 5.25 25430 53.27 * 2200 5.47 27500 53.47 2200 5.47 27500 53.47 * 2200 5.47 27500 * 2200 5.47 27500 * 2200 5.47 27500 * 2500 5.47 28650 * 2500 5.94 28650 * 2500 5.94 294.63 * 2800 5.94 294.63 * 2800 6.33 30430 * 2800 6.80 55.09 * 3000 6.80 31750		:	1900	5.12	25390	52.70	39.34			
*K 2100 5+37 25450 53+47 *K 2200 5+37 259450 53+47 *K 22400 5+61 28650 53+47 2500 5+61 28650 53+47 *K 25600 5+61 28650 *K 2600 5-94 294 * 2500 5-94 28650 *K 2600 5-94 294 * 2700 6+14 29810 *K 2800 6+33 30430 *K 2800 6+80 *X 2900 6+80 *X 300430 55+09	∆ H,	CAL. / GFW.	2000	5.18	25910	52.97	40.02			
% 2300 5.47 27500 % 2400 5.61 28050 CAL/GFN 2500 5.47 27500 2500 5.47 27500 53.71 2600 5.61 28050 53.71 2600 5.94 29210 54.64 2700 6.14 29810 54.64 2700 6.33 30430 54.63 % 2800 6.57 31080 55.09 * 3000 6.80 31750 55.09	-			C 2 • C	06402	53.47	41012			
A 2400 5.61 28050 53.94 CAL/GFW 2500 5.78 28620 54.18 2600 5.94 29210 54.41 2700 6.14 29810 54.64 2700 6.14 29810 54.63 2700 6.14 29810 54.63 2700 6.14 29810 54.64 2700 6.14 29810 54.63 2700 6.33 30430 54.63 ATM 3000 6.80 31750	4	à	2300	5.47	27500	53.71	41.76			
CAL./GFW 2500 5.78 28620 54.18 2600 5.94 29210 54.41 2700 6.14 29810 54.64 2700 6.14 29810 54.64 2800 6.33 30430 54.68 * 2900 6.80 31750 55.09	Ļ	ę.	2400	5.61	28050	53.94	42.26			
2600 5.94 29210 54.41 2700 6.14 29810 54.63 . . 2800 6.33 30430 . . 2900 6.57 31080 . . 3000 6.80 31750	ΔHL	CAL /GFW.	2500	5.78	28620	54.18	42.74			
= • x 2700 6.14 29810 54.63 6 2800 6.33 30430 54.86 2900 6.57 31080 55.09 = x TM 3000 6.80 31750 55.31			2600	5.94	29210	54.41	43.18			
= •k 2800 6.33 30430 54.86 = ×14 2900 6.57 31080 55.09 = ×14 3000 6.80 31750 55.31			2700	6.14	29810	54.63	43.59			
= ATM 2900 6.80 31750 55.09 6	-	2	2800	6.33	30430	54.86	44•00			
= ATM. 3000 6.80 31750 55.31 4		2	2900	6.57	31080	55.09	44.38			
	۳. =	ATM.	3000	6.80	31750	5	44.73			

FRANCIUM

FRANCIUM	T.I.		Referen	nce State	for Calc	Reference State for Calculating AH, AF, AF, and	Hr, Ar,	and	
			Log ₁₀ Kp:		from 298	• to 300	, Liquid	Solid from 296° to 300°, Liquid from 300°	
IDEAL MONATOMIC GAS	C GAS		to 350°,		Ideal Monatomic	Gas from	950° to 3000°	3000°.	
	511485	ŀ	8	9	٩	-(L ⁰	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
C22 •		TEMPERATURE	HEAT CAPACITY	HT HT T 296.15 HEAT CONTENT	ST T Entropy	FREE ENERGY	HEAT \triangle H ^o	FREE ENERCY $ riangle F^{+}_{+}$	ž
(H ² 24.15 ⁻ H ²) = 1,481	CAL/GFW.	¥	CAL./DEG./ GFW.	CAL./ GPW.	CAL. /DEG./ GFW.	CAL./DEG./ GFW.	CAL./GFV.	CAL./ GFW.	2
e, m	¥	298 300	4•97 4•97	0 0	43•51 43•51	43•48 43•48	17389	11165	- 8.062
		400	4.97	506	46 ° 44	89°E†	16636	92.20	
2 N a		200	4•97	1003	46.05	44•05	16373	7398	
		000	16.4	1996	40.90	44•40	15846	1006	- 2.04/
B.P.	Å	800	4.97	2493	48.38		15583		
		006	4.97	2662	48.97	45.65	15320	560	- •135
∆H •	CAL. /GFW.	1000	4.97	3487	49.49	46.01	0	0	0
		1100	4.97	3984	49.97	46.35	0	0	0
		1200	4.97	4481	50.40	46.67	0	0	0
5.P.	×	1300	4.98	4978	50.80	46.98	0	0	0
:		1400	4.98	5476	51.17		0		0
₽ H ^e	CAL. /GFW.	1500	4.99	5975	51.51		0	0	0
		1600	5.01	6475	51.83	-	0		0
		1700	5.03	6977	52.14		0		0
T.P.	×	1800	5.07	7481	52.43	-	0	0	0
1		1900	5.12	0662	52.70	-	0		0
4 ut		2000	5.18	8505	52.97	-	0		0
		2100	5.25	9027	53•22	48°93	0		0
		2200	5.37	9556	53.47	49.13	0	-	0
T.P.	×	2300	5.47	10098	53.71	49•32	0		0
		2400	5.61	10652	53.94	49.51	0	0	0
	CAL. /GFW.	2500	5.78	11221	54.18	49.70	0	-	0
		2600	5.94	11807	54.41	49.87	0		0
		2700	6.14	12411	54.63	50.04	0	0	0
T _c =	×	2800	6.33	13034	54.86	50.21	0	-	0
		2900	6.57	13679	55 • 09	50.38	0		0
	ť	3000	6.80	14347	55•31	50.53	0	0	0

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ADVANCES IN CHEMISTRY SERIES

*Isotope of Longest Known Half Life.

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FRANCIUM

GADOL	GADOLINIUM Gd		Solid fi	rom 298°	to 1600°,	Liquid f	rom 1600°	Solid from 298° to 1600°, Liquid from 1600° to 3000°.	
REFER	REFERENCE STATE								
€fw	157.26 GRAMS	F	ზ	H ^o – H ^o	ۍ کو	(517802 - Ho	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
(H ^o _{298.15} H ₀ ^o) =	-H°)= 2,172 CAL./GFW.	temperature ^o K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL/DEG./ GFW.	HEAT A H	FREE ENERGY Δ F cal./GFW.	LOG K
		298	8.72	0	15.77	15.77			
A.P.	(1,600)*K	300	8.67	16	15.83	15.78			
∆ H	(3 700) CAL /GFW.	8	00•1	780	18.06				
		000	7.33	2200	19.00	10.04			
		700	7.50	2940	22.07	17.87			
a. A.	(3,000)*K	800	7.67	3700	23.08	18.46			
∆н,	(74 .500) CAL /GFW.	800	7.83 8.00	4480 5270	23.99	19-02			
		1100	8.17	6080	25.60	20.08			
		1200	8.33	6900	26.31	20.56			
S.P.	×	1300	8.50	7740	26.99	21.04			
ч <	CAL /GEW	1400	8.67	8600	27.62	21.48			
1		1500	8.84	9480	28.23	21.91			
		1600	8.00	14070					
- F	3	1700	8.00	14870	31.60	22.86			
:	2	1900	8.00	16470					
ΔH	CAL. / GFW.	2000	8.00	17270	32.90	24.27			
		2100	8 • 00	18070	• •	24.69			
		2200	8.00	18870	33.66	25.09			
a. 	×	2300	8.00	19670	34.02	25.47			
ΔH.	CAL /GFW	2400	8 • 00	20470	34.36	25.84			
		2500	8.00	21270	34.68	26.18			
		2600	8.00	22070	35.00	26.52			
•	3	2700	8.00	22870		26.83			
	4	2800	8.00	23670					
" a	ATM.	2900	00.00	24410	36.14	27.72			
,		->>>		>					

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

GADOLINIUM

GADOLINIUM	R		Referen	ce State	for Calcu	Reference State for Calculating Af. AF. and Log. (KD)	. ∆r	nd Log. K		
IDEAL MONATOMIC GAS	C GAS		Solid f	Solid from 298°	to 1600°,	to 1600°, Liquid from 1600° to 3000°	rom 1600°	to 3000		
_{cir} 157.26	2MAQ2	-	و	- 97 - 97	2	-(F°-H° 298.15)	FORMATI	FORMATION FROM REFERENCE STATE	NCE ST	ATE
		TEMPERATURE	٩	T 296.15	'n-	FREE ENERGY	HEAT A H ^o	FREE ENERGY $ riangle F^{\circ}$		
(H [°] 211, 15 + 40) = 1 - 820	CAL./GFW.	*	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.		CAL./ GPW.	3	وم ۲
		298	6.58	0	46.42	46.42	82500	19667	1	\$3.777
- -	×	300	6.58	12	46.46	46.42	82496	73307	1	53.408
	:	400	6.52	668	48 • 34	46.67	82368	70276	1	38.400
∆ H _m	CAL. /GFW.	500	6.43	1316	49.79	47.16	82336	67241	1	29.393
		600	6.32	1953	50.95	47.70	82253	64235	1	23.399
		700	6.20	2579	51.92	48.24	82139	61244	1	19.122
B.P.	×	800	6 • 08	3193	52.74	48.75	81993	58265	1	15.918
		006	5.97	3795	53.45	49.24	81815	55301	1	13.429
∆H v	CAL. /GFW.	1000	5 • 89	4388	54.07	49.69	81618	52378	1	11.448
		1100	5 • 83	4973	54.63	50.11	81393	49460	•	9.827
		1200	5.79	5554	55.14	50.52	81154	46558	•	8.480
S.P.	¥	1300	5.79	6133	55.60	50°89	80893	43700	ł	7.347
:		1400	5.81	6713	56.03	51.24	80613	-	1	6.375
∆ H₅	CAL. /GFW.	1500	5.86	7296	56.43	51.57	80316		•	5.539
		1600	5.92	7885	56.81	51.89	76315	36136	1	4.807
		1700	6.01	8481	57.17	52.19	76111	32642	ł	4.196
T.P.	×	1800	6.11	9087	57.52	52.48	120317		1	3.653
-		1900	6.22	9703	57.85	52.75	75733		ł	3.168
	CAL. /GFW.	2000	66.93	10330	58.17	53.01	75560	25020	1	2.733
		2100	0.00	10970	58.49	53.27	75400	22480	1	2.339
		2200	6.58	11622	58.79	53 • 51	75252	19966	٠	1.983
1.P.	*	2300	6.71	12286	59.08	53.74	75116	17478		1.660
		2400	6.83	12963	59.37	53.97	74993	14969	1	1.363
∆H,	CAL. /GFW.	2500	6.95	13652	59 ° 62	54.19	74882	12457		1.088
		2600	7.07	14353	59 •93	54.41	74783	5966	ł	.837
		2700	7.18	15066	60.20	54.62	74696	7466	1	•00•
Te=	×	2800	7.29	15790	60.46	54.83	74620	4984	1	• 389
1	į	2000	7.39	16524	60•72	55.03	74554	2489	1	.187
۲ _د =	ATM.	3	A + • -	1 1 2 00		22.00	DALL	Đ	1	• 000

GADOLINIUM

GALLIUM G	Ga Ga		Solid	1 from 29	8° to 303	Solid from 298° to 303°, Liquid from 303°	from 303	s° to	
REFERENCE STATE	E		2,510°,)°, Ideal	Mona tom 1	c Gas fro	n 2,510°	Ideal Monatomic Gas from 2,510° to 3000°.	
64 69.72 (H ^o 200.15 H ^o ₂) = 1,331	GRAMS CAL/GFW.	T TEMPERATURE %K	C C HEAT CAPACITY CAL, DEG. / GFW.	Н ⁰ — Н ⁰ Т 299.15 НЕАТ СОИТЕМТ САL/ GFW.	S ⁰ F ENTROPY CAL. /DEG./ GFW.	-(F-H-29113) FREE ENERGY FUNCTION CAL./DEG./ GFW.	FORMAT HEAT A H ⁶ CAL./GFW.	PORMATION FROM REFERENCE STATE △ H [®] FREE ENERGY △ F [®] LOC GFV. cal./GFV. 1 100	CE STATE LOG K
M.P. 303	×	298 300	6•23 6•24	011	9•82 9•86	9•82 9•83			
△H _m 1,335	CAL. / GFW.	400 500	6.65 6.65	2010 2675	16.18 17.66	11.16 12.31			
		600	6.65 6.65	3340	19.87	13.31			
B.P. 2,510	*	800	6.65	4670	20.079	14.96			
ΔH, 61,200	CAL. /GFW.	900 1000	6.65 6.65	5335 6000	21•57 22•27	15•65 16•27			
		1100	6•65 • • • •	6665	22.90	16.85			
S.P.	¥	1200	6.65	7995	24.01	17.86			
Δ H,	CAL. /GFW.	1400	6.65 6.65	8660 9325	24.51	18.33 18.76			
		1600	6 • 6 5	0666	25.39	19.15			
T.P.	*	1800	6.65	11320	26.18	19.90			
ΔH,	CAL /GFW.	1900 2000	6•65 6•65	11985	26.54 26.88	20.24			
		2100	6.65	13315	27.20	20.86			
T.P.	×	2200	6.65 6.65	12980	27.81 27.81	21.16			
д н,	CAL. /GFW.	2400	6.65 6.65	15310	28.09 28.36	21.72			
		2600	5.07	77670	52.91	23.04			
	4	2700	5.00	78180	53.10	24.15			
Tc =	5	2900	5.05	79190	53.47 53.47	25.19			
Pc =	ATM.	3000	5•05	79690	53.64	27.08			

GALLIUM

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In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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GALLTUM	e C		Referen	ice State	for Calcu	Reference State for Calculating AF, AF, and	τ. Δ	and		
			Log ₁₀ Kpt		from 298'	to 303°,	Liquid	Solid from 298° to 303°, Liquid from 303°		
TURAL M	LUKAL MONATOMIC GAS		to 2,510°	.0°, Ideal	Monatom!	le Gas fre	am 2,510°	', Ideal Monatomic Gas from 2,510° to 3000°.		
9	69.72 CB146	•	7	9	,	-(1	FORMAT	FORMATION FROM REFERENCE STATE	NCE STAT	
		TEMPERATINE	و∙	T 296.15	2	FREE ENERGY	HEAT △ H ^e	FREE ENERGY 🛆 F		
(H ⁶ _{216,15} H ⁶) =	= 1,566 CAL/GFW.	×.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEQ./ GPW.	FUNCTION CAL. /DEG./ GFW.	CAL./GFW.	CAL./ GFW.	Š	× [•]
		000					ſ			
A. P.	*	867	0000	0	40.38	40.38	65000	55888		40.968
	1.0	400	6.45	641	42.22	40.62	63631	53215	1 1	20.077
∆ n •	CAL / GPW.	500	6.45	1288	43.67	41.10	63613	50608	- 53 -	22.122
		600	6•29	1926	44.83	41.62	63586	48010	- 17	17.489
1	ł	700	60 •9	2545	45.78	42.15	63540	45424	- 14	14.183
	ŕ	800	5.91	3145	46.59	42.66	63475	42835	-	11.702
Ĩ	CAL /GEW	006	5.75	3728	47.27	43.13	63393	40263	о: 1	777.0
Aug		1000	5.63	4297	47.87	43.58	63297	37697	۵۵ ۱	8.239
		1100	5.53	4854	48 • 40	43.99	63189	35139	v I	6.982
	J	1200	5.44	5403	48 • 88	44.38	63073	32593	n L	5.936
2 . .	¥	1300	5•38	5944	49.31	44.74	62949	30059	رب ا	5.053
H <	CAL /GEW	1400	5.32	6419	49.71	45.09	62819	27539	1	4.299
n 1		1500	5.28	1009	50.08	45.41	62684	25019	1	3.645
		1600	5.24	7535	50.42	45.72	62545	22497	1	3.072
	i	1700	5.21	8057	50.73	46.00	62402	20021	~ I	2.573
<u>.</u>	¥	1800	5.18	8577	51.03	46.27	62257	17527	~	2.127
ΔH.	CAL /GFW.	1900	5.16	760ô	51.31	46.53	62109	15046	-	1.730
-		2000	5.14	9610	51.57	46.77	61960	12580	-	1.374
		2100	5.13	10123	51.82	47.00	61808	10106	-	1.051
, ,		2200	5.11	10635	52.06	47 . 23	61655	7645	1	• 759
<u>.</u>	¥.	2300	5.10	11145	52 • 29	47.45	61500	5196	ı	• 493
:		2400	5.09	11655	52.51	47.66	61345	2737	1	•249
₽ н	CAL. /GFW.	2500	5.08	12163	52.71	47.85	61188	313	ı	•027
		2600	5.07	12671	52.91	48.04	٩ ٩	0	0	
		2700	5.06	13177	53.10	48.22	•	0	0	
Tc =.	¥.	2800	5.06	13683	53.29	48.41	•	•	0	
	124	2900	5.05	14189	53.47	48.58	0	•	0	_
	AIR	3000	5.05	14693	53.64	48.75	•	0	J	

GALLIUM

GERI	GERMANIUM G	Ģe		Solid from	298°	0 1210.4	to 1210.4°, Liquid from 1210.4° to 3000°	from 121(0.4° to 3(.00
REF	REFERENCE STATE	æ								
	72.60							FORMAT	FORMATION FROM REFERENCE STATE	INCE STATE
6fw (H ⁰ 298. 1	""""""""""""""""""""""""""""""""""""""	GRAMS CAL./GFW.	T TEMPERATURE °K	P HEAT CAPACITY CAL./DEG./ GFW.	H ⁰ H ⁰ T 294.15 HEAT CONTENT CAL./ GFW.	S ^C ENTROPY CAL/DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H ^o cal/gfw.	FREE ENERGY 🛆 F ^e f CAL./ GFW.	" רספ
			208	5.50	C	7.43	7.43			
M.P.	1,210.4	¥	300	5.60	10	7.46	7.43			
-H <	7,600.	CAL /GFW.	400	5.94	588	9.12	7.65			
			200	6.16	1194	10.47	8.09			
			600	6 • 32 • • • E	1820	11.61	8.58			
8.P	3,100.	Å	800	6 • 56	3110	13.46	9.58			
;	79.900.		006	6.66	3770	14.24	10.06			
ČH Ţ		CAL. /GFW.	1000	6.77	4440	14.95	10.51			
			1100	6.87	5120	15.60	10.95			
			1200	6.97	5810	16.20	11.36			
Ч. Ч.		*	1300	1.00	14110	23•04	12.19			
4		CAL /CEW	1400	7.00	14810	23.56	12.99			
			1500	1.00	15510	24•04	13.70			
			1600	7.00	16210	24 • 50	14.37			
			1700	7.00	16910	24.92	14.98			
Ч. Т.		ж.	1800	7.00	17610	25.32	15.54			
ΔH,		CAL. /GFW.	1900	00.7	18310	25.70	10.07			
			2100	7.00	19710	26.40	17.01			
			2200	7.00	20410	26.73	17.45			
Т.Р.		*	2300	7.00	21110	27.04	17.86			
			2400	7.00	21810	27.33	18.24			
ĥ		CAL. /GFW.	2500	7.00	22510	27.62	18.62			
			2600	7.00	23210	27.89	18.97			
			2700	7.00	23910	28.16	19.30			
Tc =		*	2800	7.00	24610	28.41	19.62			
		ļ	2900	7.00	25310	28.66	19,93			
"			3 000	7.00	26010	28.90	20.23			

GERMANIUM

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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GERMANIUM	æ	μ η	leference	State fo	or Calcula	ating AH [°] ,	∆r°, an	Reference State for Calculating AH [°] , AP [°] , and Log ₁₀ Kp:		
IDEAL MONATOMIC	GAS		Solid from 298°		1210.4	Liquid 1	from 1210	to 1210.4°, Liquid from 1210.4° to 3000°	•••	
Gfw 72.60	GRAMS	T	ຽ	H ⁰ - H ⁰	°,	-(10-10-11)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATI	
		TEMPERATURE	HEAT CAPACITY	T 276.15 HEAT CONTENT	ENTROPY	FREE ENERGY	HEAT △ H [●]	FREE BUENCY A F	2	
^{w 246.15^{-16/-} 1,768}		4	CAL./DEG/ GFW.	CAL./ GPW.	CAL./DEG./ GFW.	CAL./DEG./ OFW.	CAL./OFW.	CAL./ GFW.	3	د 2
		298	7.34	0	40.10	40-10	00006	80259	- 58	.833
K. P.	*	300	7.35	14	40.15	40.11	90006	80197	- 58	58.428
~ # ~		400	7.43	756	42 • 28	40.39	90168	76904	- 42	42.021
		500	7.26	1491	43°93	40.95	90297	73567	- 32	32.158
		600	6 ° 9	2204	45•23	41.56	90384	70212	- 25	25.576
		700	6.72	2889	46.28	42°1Ų	00420	66853	- 20	20.874
	*	800	6.46	3548	47.16	42.73	90438	63478	- 17	17.342
2		006	6.24	4183	47.91	43.27	90413	60110	- 14	14.597
2HV	CAL. /GFW.	1000	6.06	4797	48.56	43.77	90357	56747	- 12	12.403
		1100	19.4	5395	49.13	44.23	90275	53392	- 10	10.608
		1200	5.80	5981	49.64	44.66	90171	50043	б 1	9.114
	¥	1300	5.71	6556	50.10	45.06	82446	47268	- 7	7.947
H		1400	5.65	7124	50.52	45.44	82314	44570	ف ۱	6.958
5]		1500	5.60	7686	50.91	45.79	82176	41871	ن ن	6.101
		1600	5.57	8244	51.27	46.12	82034	39202	رب م	•354
		1700	5.54	8800	51.60	46.43	81890	36534	4	4.696
T.P.	×	1800	5.53	9353	51.92	46.73	R1743	33863	4	4.111
		1900	5.53	9066	52.22	47.01	81596	31208	1 1	3.589
	CAL /GFW.	2000	5.52	10458	52.50	47.28	81448	28568	1 M	3.121
		2100	5.53	11011	52.77	47.53	81301	25924	- 2	2.697
		2200	5.53	11564	53 • 03	47.78	81154	23294	- 2	2.314
÷	×	2300	5.54	12117	53.28	48.02	81007	20655	ר י	1.962
1		2400	5.55	12671	53.51	48.24	80861	18029	-	1.641
110 L		2500	5.55	13226	53.74	48.45	80716	15416	-	1.347
		2600	5.56	13782	53.96	48.66	80572	12790	-	1.075
1		2700	5.57	14338	54.17	48.86	80428	10201	ı	•825
Te=	×	2800		14896	54.37	49.05	80286		ı	• 593
	ATM	2900	5.58	15453	54.56	49.24	80143	5033	1	.379
- 9.		3000	• 1	10012	C1 • 4C	49.44	8000 2		,	•1/8

GERMANIUM

GOLD	Au			Solid fro	m 298° to) 1336°, L	iquid fro	Solid from 298° to 1336°, Liquid from 1336° to	0
REFERI	REFERENCE STATE			2980°, Id	leal Monat	2980°, Ideal Monatomic Gas from 2980°	from 298()° to 3000°	•
Gíw] (H° _{28, 15} H°) =	197.0 GRAMS 0= 1.434 CAL/GFW.	T Temperature °K	Co P HEAT CAPACITY CAL./DEG./ GFW.	H ⁰ - H ⁰ T 296.15 HEAT CONTENT CAL./ GFW.	S ⁰ T ENTROPY CAL./DEG./GFW.	- (10 - 10 - 10 - 10 - 10 - 10 - 10 - 10	FORMAT HEAT A H ⁶ cal./gfw.	PORMATION FROM REFERENCE STATE △ H ^o FREE ENERGY △ F ^o CALL' GFW. 1 100 100 100 100 100 100 100 1	ICE STATE LOG K
ď	1,336 °K	298 300	6 • 07 6 • 07	011	11•32 11•36				
∆ H 	2, 955 CAL./GFW.	400 200 600	6•18 6•28 6•40	624 1245 1880	13•12 14•51 15•66	11.56 12.02 12.53			
6	2, 980 °K	800	6 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	3180	16.67	13.56			
ΔH v	77,540 CAL./GFW.	1000	6.90 7.02	4530 5220	19.04 19.04 19.70	14•07 14•51 14•96			
a. A	*	1200 1300	7.27	5930 6660 10330	20•32 20•90 23-64	15•38 15•78 16-27			
Δ H₅	CAL. /GFW.	1500	7.00	11030	24.12	16.77			
Τ.Ρ . Δ Η.	°K CAL/GFW	1700 1800 1900	7•00 7•00	12430 13130 13830	24-99 25-39 25-77	17.68 18.10 18.50			
I i	*	2100	7.000	15230 15930 16630	26.47 26.80 27.11	19•56 19•56			
∆H ,	CAL. /GFW.	2400 2500 2600	7•00	17330 18030 18730	27•41 27•69 27•97	20•19 20•48 20•77			
Tc =	*	2700 2800 2900	7•00 7•00 7•00	19430 20130 20830	28•23 28•49 28•74	21•04 21•31 21•56			
ے م	ATM.	3000	6•30	09066	54.97	21.95			

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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GOLD	Au		Refer	ence Stat	e for Cal	Reference State for Calculating AH ^e ,	CH [°] , CF°	AF, and Log ₁₀ Kp:	0 ^K P t
IDEAL MONATOMIC GAS	C GAS		20110 2980°,		IFOM 298 TO 13567, Ideal Monatomic Gas	Gas from	Liguid from 1336 to from 2980° to 3000°	1336° to to 3000°.	
197.0							FORMATI	FORMATION FROM REFERENCE STATE	ICE STATE
	GRAMS	L		H ⁰ – H ⁰ T 296.15	°.+	TELES ENERGY	HEAT A H ^o	FREE ENERGY 🛆 F	
(H ^o _{298.15} H ^o) = 1,481	CAL./GFW.	PERFERATURE OK	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.		CAL./ GPW.	LOG K
		298	26.4	0	43.12	43.12	84700	15219	- 55.139
A.P.	×	300	4•97	6.0	43.15	43.12	84698		
∆ H	CAL. / GFW.	500	16.4	1003	44 • 58	43.52	8458	71998 68868	- 39•341 - 30•104
		600	4.97	1500	46.59	44.09	84320	65762	- 23.955
		700	4.97	1996	47.36	44.51	84166	62683	- 19.572
B.P.	×	800	4.97	2493	48 • 02	44.91	84013		- 16.289
		006	4 97	2660	48.61	45.29	83840		- 13.740
∆H •	CAL. /GFW.	11000		1949	61 • 6 4	40°04 00°14	83657	53567	
		1200	- 6 • + •	4482	00.05	40.90	83404	47588	- 10°049
ď	×.	13.00	4.99	4980	50.43	46.60	83020	44631	- 7.503
	:	1400	5.01	5480	50.81	46.90	79850	41812	- 6.527
Δ H _s	CAL. /GFW.	1500	5.04	5983	51.15	47.17	79653	39108	- 5.698
		1600	5.07	6488	51.48	47.43	79458	36402	- 4.972
		1700	5.12	8669	51.79	47.68	79268	33708	- 4.333
T.P.	×	1800	5.18	7513	52.08	47.91	79083	31041	- 3.768
		1900	5.25	8034	52.36	48.14	78904	28383	- 3.264
ΔH,	CAL. /GFW.	2000	5.32	8562	52.63	48°35	78732	25732	- 2.811
		0017	14.0	6606	52.90	48.57	78569	23066	
		0022		1106 7	CT • CC	10.01	41481	20444	- 2.030
	×			10762	53.640	40.15	18208	10871	
Δ Н.	CAL. /GFW.	2500	5.80	11337	53.87	49.34	78007	12557	- 1.097
-		2600	5.90	11922	54.10	49.52	77892	9954	836
		2700	6.00	12517	54.32	49.69	77787	7344	- 594
Te =	×	2800	6.11	13122	54.54	49°86	77692		370
•		2900	6.21	13738	54.76	50°03	77608		162
Pc =	ATM.	3000	6•30	14364	54.97	50.19	0	0	0

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: January
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HAFINTUM	1		Solid from 298		to 22207	Liquid f	rom 2250'	to 2250°, Liquid from 2250° to 3000°.	
REFERENCE STATE	STATE								
17	178.50 cetus	•	2	61	2	-(F°-H° 206.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
		TEMPERATURE	٩	T 298.15	'n⁺	FREE ENERGY	HEAT A H ^o	FREE ENERGY Δ F	
(H ^o _{298.15} H ^o) =	1,448 _{cal./gfw.}	, K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./GFW.	х° 901
		200	1 1	c	10 01				
M.P.	2,250* •K	300	6.10	11	10.95				
		400	6.22	627	12.72	•			
"(C) "H⊽	CAL/GFW	500	6.34	1255	14.12	11.61			
		600	6.46	1900	15.29	12.13			
		100	6.58	2550	16.29	12.65			
8.P. (0)	x, (mete)	800	6.70	3210	17.18	13.17			
(158,000)		006	6.82	3890	17.98	13.66			
AL LUCE	UNU CAL /GFR.	1000	5.94	4575	18.70	14.13			
		1100	1.06	5275	19•37	14.58			
		1200	7.18	2665	19.99	15.00			
S.P.	¥	1300	7.30	6710	20.57	15.41			
:		1400	7.42	7450	21.11	15•79			
₽HS	CAL. /GFW.	1500	7.54	8200	21.63	16.17			
		1600	7.66	8960	22.12	16.52			
		1700	7.78	9730	22.59	16.87			
T.P.	*	1800	06 • 1	10510	23.04	17.21			
	M33/ 17.5	1900	8•02	11310	23.47	17.52			
łu o	CAL. / GLW.	2000	8.14	12120	23.88	17.82			
		2100	67 • 6 6	12940	24.28	18.12			
T.P.	*	2300	8.00	19790	27.34				
		2400	8.00	20590	27.68	•••			
ΔH,	CAL. / GFW.	2500	8.00	21390	28.01	19.46			
		2600	8.00	22190	28.33	19.80			
		2700	8 • 00	22990	28.63	20.12			
T _c =	*	2800	8 • 00	23790	28.92	20.43			
1		2900	8.00	24590	29.20	20.73			
- ~	ATM.	3000	8 • 00	25390	29.47	21.01			

*D. K. Deardorf and E. T. Hayes, J. Metals 8, 509 (1956) have just reported what is probably the best determination of the melting point of hafnium as 2495° ± 30° K. The transition temperature remains uncertain.

HAFNIUM

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HAPNIUM	H		Referenc	ce State	for Calcul	Reference State for Calculating AH ^o , AP ^o , and Log ₁₀ Kp:	, ∆r", a	nd Log ₁₀ Kj	8 d
IDEAL MONATOMIC	C GAS		Solid fr	from 298°	to 2250°,	2250°, Liquid from		2250° to 3000°	•
6iw 178.50	GRAMS	-	ະ	94 - 94	e	(11.11. 11. 11. 11.	FORMATI	FORMATION FROM REFERENCE STATE	NCE STATE
(H [°] _{240.15} H [°]) = 1,481	CAL./GPW.	TEMPERATURE	P HEAT CAPACITY CAL./DEG/ GFW.	T 298.15 HEAT CONTENT CAL./ GPW.	T ENTROPY CAL./DEG./ OFW.	FREE ENERGY FUNCTION CALL, DEG. / GFW.	HEAT A H	FREE ENERGY & F	¥ و
		800	10.4				1 4 8 0 0 0	1 5 7 0 4 3	1 1
A.P.	¥	300	16.4	2 0:	44.67	40.44	167998	157882	-115.026
∆ H	CAL. / GFW.	400	5.01	508	46.11	44.84	167881	154525	1 84.435
		009	5.29	1013	4/•24	45.63	167633	147899	- 53.876
		700	5 • 50	2072	49.01	46.05	167522	144618	- 45.155
	*	800	5.73	2634	49.76	46.47	167424	141360	
Δ Η,	CAL. /GFW.	1000	6.20	3827	51.09	40.88	167252	134862	- 29.476
		1100	6.41	4458	51.69	47.64	167183	131631	- 26.155
		1200	6.59	5108	52.26	48.01	167118	128394	- 23,385
	¥	1300	6.76	5776	52.79	48.35	167066	125180	- 21.046
∆н.	CAL /GFW.	1400	6.90	6420	53.30	48.69	167009	121943	- 19.037
•		1500	10.7	7155	53.78	49 • 01	166955	118730	- 17.300
		0001		108/	74074	44.63	106001	604411	
T.P.	¥	1800	7.21	9293	55.08	40°03	166783	112308	- 14.458
Ĩ		1900	7.24	10016	55.47	50.20	166706	105906	- 12.181
1 17	CAL / GFW.	2000	7.24	10740	55.84	50.47	166620	102700	- 11.222
		2100	7.24	11464	56.19	50.74	166524	99513	- 10.356
4.1	;	2200		12187	56.53	51.00	166417	96325	- 9.568
	4	2300		12908	56.85	51.24	141118	93245	- 8.860
Δн.	CAL /GFW	2400	7.17	13627	57.16	51.49	161037	90285	- 8.221
		2500	7.13	14341	57.45	51.72	160951	87351	- 7.636
		0007	60.7	24041	51.13	66.16	160862	84422	- 7.096
-	•	2100		19761	66.76	92.010	1607091	81497	- 6.596
	4	2800		16462	58.25	52.38	160672	78548	- 6.130
P. =	ATM.	2900	6.97	17161	58•50	52 . 59	160571	72601	- 5.697
		2002		10014		01.030	101001	10071	(6300 -

HAFNIUM

HELIUM	Не	6			Ideal Mor	natomic Ge	Ideal Monatomic Gas from 298° to 3000°.	38° to 30	.00	
REFEREN	REFERENCE STATE	œ								
Gfe	4.003	GRAMS	-	ບ	H ⁰ -H ⁰	•.'	-(F°-H° 218.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
(H ⁰ _{298.15} H ₀ ⁰) =	= 1,4 81	CAL_/GFW.	temperature ^o K	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL. /DEG./ GFW.	HEAT A H	FREE ENERGY A F	L06
103			298	4.97	0	30.13	30.13			
W.P.(ATM)	3.5	¥	300	4.97	0.	30.16	30.13			
∆ H	5.	CAL. / GFW.	500 500	4 97	506 1003	31.59	30 . 33 30 . 69			
			600	4.97	1500	33.60	31.10			
4	4.22		200	4.97	1996	34.36	31.51			
Ľ.	4 • 1	4	006	10.4	2990	35.61	32.29			
∆H v	20.	CAL /GFW.	1000	4.97	3487	36.14	32.66			
			1100	4.97	3984	36.61	32.99			
			1200	4.97	4480	37.04	33.31			
		4	1400	10.4	5474	37.81	39.00			
ΔHs		CAL /GFW.	1500	4.97	1165	38.15	34.17			
			1600	4.97	6468	38.47	34.43			
	01.0		1800	4.97	7461	38.77	34.68			
•		 e	1900	4.97	7958	39.33	35.15			
₽H ⁴	•	CAL. /GFW.	2000	4.97	8455	39.58	35.36			
			2100	4.97	8952	39.82	35.56			
			2200	10.4	8446		11.05			
<u>.</u>		¥	0062		C#66		05.00			
Д н,		CAL. /GFW.	2500	16.4	10939		36.32			
			2600	4.97	11436		36.49			
			2700	4.97	11932	41.07	36.66			
Te =	5.3	*	2800	4.97	12429		36.82			
			0062	10.4	12920		30.98			
د =	92.•2		3000	17.4	13421	00.14	31.13			

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS;

Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

HELIUM

HOLMIUM		Ю		Solid fr	om 298° t	o 1773°,	Solid from 298° to 1773°, Liquid from 1773° to 3000°	om 1773°	to 3000°.	
REFE	REFERENCE STATE	TE								
<u>}</u>	164.94	GRAMS	-	ບ	H0 - H0	2	-(F°H° 296.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
	l		TEMPERATIO		T 296.15	•+	FREE ENERGY	HEAT A H ^o	FREE ENERGY A F	
(H [°] 298.	(H ⁰ _{298 . 15} H ₀ ⁰) =	CAL./GFW.	X.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	F CAL./ GFW.	L06 × "
¥.P.	(1,773)	¥	300	6.51 6.51	0	17.81	17.78			
1	(001.4)	741 / CEW	004	6.68	670	19.71	18.04			
	1007(2)		500	6. 85	1350	21.21	18.51			
			009	7.02	2040	22.48	19.08			
8. P.	(2,600)	×	700	7.19	2750	23.57	19.65			
	1000 [-1		800	7.36	3480	24.54	20.19			
∆H v	(60.000)	CAL. /GFW.	006	7.53	4220	25.42	20.74			
			1000	7.070	4985	26.22	21.24			
			0011		0016	06.02	c/ • 17			
A.S.		×.	1300	8.04 104	0000	21.00	22.20			
			1400	8.38	8200	28.92	23-07			
5 1		CAL. / GPW.	1500	8.55	0906	29.51	23.48			
			1600	8.72	0166	30.06	23.87			
;		1	1700	8.89	10790	30.60	24.26			
<u>.</u>		×	1800		15760	33.41	24.66			
ΔH ,		CAL. / GFW.	1900	8.00	16560	33.84				
	_		2000	88	17360	34.26	25•58 26•01			
			2200	8.00	18960	35.02				
d.		¥	2300	8•00	19760	35.37	26.78			
3		110, 110	2400		20560	35.71	27.15			
e 1		CAL. / GFW.	2500		21360	36.04	27.50			
			2600		22160	36.35	27.83			
ر بر ا			2700		82760	59.66	29.01			
۲ • = •		¥	2800		83360	59 • 88	30.11			
م		ATM	2900		83960	60.09	31.14			
			3000	6 •00	84560	60.29	32.11			

HOLMIUM

HYDROGEN	DGEN H ₂				deal Diat	tomic Gas	Ideal Diatomic Gas from 298° to 3000°.	to 3000		
HIAIN	REFERENCE STATE	~								
ł	2.0160	CDAMS	-	و	H0 - H6	e	-(F°-H [°] 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
2			TEMPERATURE		T 299.15	•-	FREE ENERGY	HEAT A H ^o	FREE ENERCY & F	
(H ^o _{298 . 15} H ₀ ^o) =	-H°)= 2,024	CAL./GFW.	×.	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	F CAL./GFW.	2° 200
			298	6.89	0	31.21	31.21			
M. P.	13.96	×	300	6.89	12	31.25	31.21			
	28.0		400	6.98	706	33.25	31.49			
∆Hm		CAL. / GFW.	500	66 • 9	1406	34.81	32.00			
			600	7.01	2105	36.08	32.58			
	20.30		700	7.04	2808	37.17	33.16			
8. P.	FO.00	×	800	7.08	3514	38.11	33.72			
	215.8		006	7.14	4224	38.95	34.26			
∆H∆		CAL. /GFW.	1000	7.22	4942	39.70	34.76			
			1100	7.32	5669	40•40	35.25			
			1200	7.43	6407	41.04	35.71			
9.		¥	1300	7.52	7154	41.64	36.14			
4		CAL /GEW	1400	7.62	1161	42.20	36.55			
5 1			1500	7.72	8678	42.73	36.95			
			1600	7.82	9456	4 3 . 23	37.32			
			1700	16•1	10242	43.70	37.68			
d. H		×.	1800	8 • 00	11038	44.16	38.03			
дн,		CAL. / GFW.	0061	8.10	74211		58•35 0 × 0 × 0			
			2000		00001	45.41	20,00			
			2200	8.38	14316	45.80	39.30			
d. H		×	2300	8.46	15158	46.18	39.59			
			2400	8.53	16007	46.54	39 • 88			
₽		CAL. / GFW.	2500	8 • 60	16864	46.89	40.15	_		
			2600	8.67	17727	47.23	40.42	_		
	33.94		2700	8.73	18598	47.55	40.67			
T. =		*	2800	8.78	19473	47.87	40.92	_		
ا م	12.80	ATM	2900	8.82	20353	48.1 8	41.17	_		
			3000	8.86	21237	48 • 48	41.41			

HYDROGEN

										ſ
HYDROGEN	H			Reference		State for Calculating AMP, APP, and	iting ∆H°.	, AP, and	-	
IDEAL MONATOMIC	C GAS			Log ₁₀ Kp:	Ideal D1	Diatomic Ge	Gas from 2:	298° to 3000°	•••	
1.0080			-	9	9	- (Lo - Ho 310 11)	FORMATI	FORMATION FROM REFERENCE STATE	NCE STATE	
64	GRAMS	-		H ^o - H ^o T 296.15	չ-	FREE ENERGY	HEAT A H	FREE ENERGY 🛆 F		
(H ² ^{240, 15} H ²) = 1,481	CAL./GFW.		HEAT CAPACITY CAL./DEQ./ GFW.	MEAT CONTENT CAL./ GPW.	ENTROPY CAL./DEG./ GPW.	FUNCTION CAL./DEQ./ GFW.	CAL./GFW.	CAL./ GPW.	100 K	
		208.	4	0	77.30					
d a	¥	300	4	0	27.42	27.39	52093	48578	- 35.610	
	1	400	4.97	506	28.85		52243	4735		
Δ H	CAL. /GFW.	500	4.97	1003	29.96		52390	4611		
		600	4.97	1500	30.87		52537	4483	- 16.33	
		100	4.97	1996	31.63		52682	435	- 13.599	_
B.P.	¥	800	4.97	2493	32.30	29.19	52826	42234	- 11.538	
		006	4.97	2990	32.88		52968	40908	- 9.934	
DH,	CAL. /GFW.	0001		3487	33.40		53106	39556	- 8.645	
		0011	•	6966	33.88	30.26	53238	38190	- 7.588	
		0071	16.4	4480	34.31	30.58	53366	36818	- 6.706	
S.P.	*		÷ .	1164	34•71	30.89	53490	35433	- 5,957	
-		1400	4 • 01	5474	35.08	31.17	53608	34036	- 5.313	
∆ Hs	CAL. /GFW.	0001	* <	1/65	39.42	31.44	53722	32647	- 4.756	
				20400	50° (4	31.70	53830	31238	- 4.266	
			• • <	1050	40.05	31.99	53933	29810	- 3.832	
T.P.	¥	0001		104/	20.32	32.18	54032	28400	- 3.448	
	ļ			9661	90°06	32.41	54127	26976	- 3.102	
4 11 4		2100	4.07	0408	0000	C092C	04210	06662	- 2.790	-
		2200	4.07	0440	27.20	CD 970		C0142	80c•7 -	
a +	;	2300	4.97	5700	37.54	00000	10040	16072		_
	:	2400	4.97	10442	37.75	33.40	54528	10776		
ΔH,	CAL. /GFW.	2500	4.97	10939	37.96	33,59	54597	18322	- 1.60	
		2600	4.97	11436	38.15	3.7	54662	16884	- 1.419	
		2700	4.97	11933	38.34	339 3	54724	15412	- 1.247	
Te =	*	2800	4.97	12429	38.52	34.09	54782	13958	- 1.089	
•		2900	4.97	12926	38.70		54839	12470	- • 940	_
ہ =	ATM.	3000	4.97	13423	38•86	34.39	54895	11035	803	

HYDROGEN

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I WUIGNI	ų		Solid	l from 29	8° to 429	Solid from 298° to 429.32°, Liquid from 429.32°	iid from	429.32°		
REFERENCE STATE	ų		to 23	to 2320°, Ideal		Monatomic Gas fi	from 2320°	to 3000°	•	
c. 114.82	20146	•	8	9	9	-(1-,-10, 201,)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE	
	GKAMS	1	ე <u>ო</u>	H ⁻ -H ⁻ T 290.15	2-	FREE ENERGY	HEAT ∆ H°	FREE ENERGY A F		
(H [°] _{296, 15} H [°] ₉) = 1,57	578 CAL./GFW.	Ne Ne	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	۲00 K	
		298	6 • 39	0	13.82	13.82				
M.P. 429.32	¥	300	6.40	12	13.86	13.82				
		400	6.90	680	5	14.11				
∆ H ^m 100.	CAL / GPW.	500	7.10	2170	19•20	14.86				
		600	7.10	2880	20.49	15.69				
		700	7.10	3590	-0-	16.47				
B.P. 2, 32U.		800	7.10	4300	22.54	17.17				
		006	7.10	5010	23.37	17.81				
	CAL /GFW.	1 000	7.10	5720	24.12	18.40				
		1100	7.10	6430	24.80	18.96				
		1200	7.10	7140	25.42	19.47				
S.P.	×	1300	7.10	7850	25.98	19.95				
;		1400	7.10	8560	26.51	20.40				
5 10		1500	7.10	9270	27.00	20.82				
		1600	7.10	0866	27.46	21.23				
		1700	7.10	10690	27.89	21.61				
T.P.	*	1800	7.10	11400	28.29	21.96				
1		1900	7.10	12110	28.68	22.31				
5 1	CAL / GFW.	2000	7.10	12820	29•04	22.63				
		2100	7.10	13530	29.39	22.95				
		2200	7.10	14240	29.72	23.25				
T.P.	¥	2300	7.10	14950	30.04	23.54				
		2400	5.76	69640	53.63	24.62				
∆H,	CAL. /GFW.	2500	5.71	70210	53.86	25.78				
		2600	5.66	70780	54.09	26.87				
		2700	5.62	71340	54.30	27.88				1
Te=	×	2800	5.58	11900	54.50	28 . 83				N
		2900	ŝ	72460	54.70	29.72				DI
_	ATM.	3000	5.51	73010	54.89	30.56				UN
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MUIUNI	a		Referenc Solid fr	e State f om 298° t	or Calcul	Reference State for Calculating AH ^e , AF ^e , and L colid from 298° to 420.32°, Linuid from 420.32°	, ∆P°, 81 from 429	Reference State for Calculating AH ^e , AF ^e , and Log ₁₀ Kp; solid from 298° to 429.32°, Linuid from 429.32° to		
IDEAL MONATOMIC GAS	C GAS		2320°, I	deal Mona	tomic Ges	, Ideal Monatomic Gas from 2320°	10° to 3000°			
ct- 114.82	SUA U	•	و	01	ę	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	INCE SI	ATE
	-	TELBERT		T 296.15	×-	FREE ENERGY	HEAT A H	FREE ENERGY & F		
(H [°] _{211.15} H [°] ₆) = 1,482	CAL./GFW.	Xe	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEO./ GFW.	FUNCTION CAL. DEG. / GFW.	F CAL./GFW.	f CAL./ GFW.		LOG K
		298	4 • 98	0	41•51	41.51	57000	48744	1	35.731
A.P.	×	300	4.98	0	41.54	41.51	56997	48693	1	35.475
3		400	5.06	510	42.98	41.71	56830	45962	1	25.114
∆ n m		500	5.24	1024	44.13	42.09	55854	43389	•	18.966
		600	5.51	1562	45.11	42.51	55682	40910	1	14.902
		700	5.80	2127	45.98	42.95	55537	38464	1	12.009
B.P .	×	800	6.06	2721	46.77	43.37	55421	36037	I	9.845
		006	6.26	3338	47.50	43.80	55328	33611	1	8.162
₩ 2	LAL. /67%.	1000	6•39	3971	48.16	44.19	55251	31211	t	6.821
		1100	6.46	4614	48.78	44.59	55184	28806	1	5.723
		1200	6.48	5261	49.34	44 . 96	55121	26417	1	4.811
5.P.	*	1300	6.47	2009	49.86	45.32	55059	24015	I	4.037
3	110, 110	1400	6.42	6554	50.33	45.65	54994	21646	1	3.379
2 H 2		1500	6.36	7192	50.78	45.99	54922	19252	ł	2.805
		1600	6.29	7826	51.18	46.29	54846	16894	I	2.307
		1700	6.22	. 8452	51.56	46.59	54762	14523	1	1.867
T.P.	×	1800	6.15	9070	51.92	46.89	54670	12136	1	1.473
1		1900	6.07	9681	52.25	47.16	54571	9788	1	1.125
4uo		2000	6 •00	10285	52.56	47.42	54465	7425	1	.811
		2100	5.94	10882	52.85	47.67	54352		1	•529
		2200	5.87	11472	53.12	47.91	54232	2752	•	.273
T.P.	×	2300	5.81	12057	53.38	48.14	54107		I	•040
	,	2400	5.76	12635	53.63	48.37	0	0		0
∆H,	CAL. /GFW.	2500	5.71	13209	53.86	48•58	0	0		0
		2600	5.66	13777	54.09	48.80	0	0		0
		2700	5.62	14342	54.30	48.99	0	0		0
Tc =	×	2800	5.58	14902	54.50	49.18	0	0		0
		2900	5.54	15458	54.70	49.37	0	0		0
re =		3000	5.51	16010	54.89	49.56	0	0		0

INDIUM

IODINE	NE I ₂			Solid	from 298'	to 386.6	Solid from 298° to 386.8°, Liquid from 386.8°	l from 38	6.8	
REFE	REFERENCE STATE	e)		to 456	°, Ideal	Distomic	to 456°, Ideal Diatomic Gas from 456° to 3000°.	456° to	3000°.	
-10 -10 -10	253.82	GRAMS	F	ئ	H° - H°	۰, م	-(E ⁰ -H ⁰ 228.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H ^o _{290.15} H ₀) =	-H ⁰)= 3,178	CAL./GFW.	TEMPERATURE •K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL. /DEG./GFW.	FREE ENERGY FUNCTION CAL. /DEG./ GFW.	HEAT & H	FREE ENERGY & F cal/ GFW.	۲00 K
-			298	13.14	0	27.90	27.90			
Ľ	386.8	÷	004	19.20	5234	41.85	28.77			
ΔH	3.770.	CAL. / GFW.	500	8.95	16676	66.88	33.53			
			600	8.98	17573	68.51	39.23			
a			200	00.0	18472	06.69	43.52			
	456.			20.0	11000	11.10	49.04			
~ μ⊽	9,970.	CAL. /GFW.	1000	90°6	21182	73.12	51.94			
			1100	9.08	22088	73.98	53.90			
			1200	60°6	22997	74.77	55.61			
9.2		×	1300	9.11	23907	75.50	57.11			
∆H₅		CAL. /GFW.		9.14	24010	10.10				
			1600	9.15	26645	77.40	60.75			
			1700	9.16	27561	77.96	61.75			
J.P.		*	1800	9.18	28478	78.48	62.66			
₽H		CAL. /GFW.	2000	9.21	30317	79.45	64.30			
			2100	9.22	31237	06 • 62	65•03	_		
			2200	9•23	32160	80•33	65.72			
d.		ж.	2300	9•25	33085	80.74	66.36			
ΔH.		CAL /GFW	2400	9.26	34010	81.13	66•96	_		
-			2600	9.29	35864	81.87	68.08			
			2700	9.30	36794	82.22	68.60	_		
T c =		¥	2800	9.31	37724	82.56	60°69	_		
•			2900	9.33	38655	82•89	69.57			
			3000	9•34	39586	83•20	70.01			

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IODINE		I2		Refere	ence State	for Calc	ulating A	He, AF		Kp :
IDEAL D	IDEAL DIATOMIC	GAS			Ideal Dia	ITOM 200 00 00000 Ideal Diatomic Gas	condic Gas from 456° to 3000°.	IFOM 386. to 3000	•••	
efe	253.82	GRAMS	Ŧ	წ	,	e,	-(50-110 229.115)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
(H [°] _{216 · 15} H°) =)= 2,41 8	CAL./GFW.	TEMPERATURE •K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GPV.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CALL/DEG./ GFW.	HEAT A H ^o Cal./GPW.	FREE ENERGY & F	ж 60 ГОС
0		*	298	8.81	0	62•28	62.28	14880	4629	- 3.393
			300	8•82 8•90	903	62•34 64•89	62°29 62°64	14872	4564 1337	- 3,325 - ,730
			500	8.95	1795	66.88	63.29	0	0	0
			000	8°98 9°00	2692 3591	68•51 69•90	64•03 64•77	00	00	00
а. Р.		¥	800	9.02	4493	71.10	65.49	0	0	0
∆H ,		CAL. /GFW.	0001	9°0*6	5396 6301	72.17	66.18 66.82	00	00	00
			1100	9.08	7207	73.98	67.43	0	00	00
S.P.		¥	1200	60°6	8116	74.77	68.01	00	00	00
			0001	110	2206	00001				. .
Δ H _s		CAL. /GFW.	1500	9.14	10850	76.81	60.58	00	00	00
			1600	9.15	11765	77.40	70.05	0	0	0
Ţ.P.		×	1 /00	01.01 01.0	13597	78.48	70.93	00	00	00
ΔH,		CAL. / GFW.	1900	9.19	14515	78.98	71.35	00	00	00
			2100	9.22	16356	06.67	72.12	00	00	00
T.P.		*	2200	9•23 9•25	17280	80.33 80.74	72.48	00	00	00
Дщ		CAL. /GFW.	2400	9.26	19129	81.13	73.16	00	00	00
			2600	9.29	20983	81.87	73.80	<u> </u>		- c
			2700	0.30	21912	82.22	74.11	0	0	0
1 c =		¥	2800	9.31	22842		74.41	0	0	0
"		ATM.	2900	9°33	23772		74.70	0	0	0
			3000	9.34	24705	83•20	74.97	0	0	0

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IODINE	н		Refere	nce State	for Calc	ulating A	Hr, Ar,		Kp :
IDEAL MONATOMIC GAS	OMIC GAS		Solid 456°,	Solid from 298° 456°, Ideal Diat	to 386.8 tomic Gas	from 298° to 386.8°, Liquid from 386.8° Ideal Diatomic Gas from 456° to 3000°.	from 386 to 3000	5.8° to)°.	
₆ tw 126.91 (н [°] _{3м.15} .H [°]) = 1,	91 GRAMS 1,481cal./gfw.	T TEMPERATURE •K	C P HEAT CAPACITY CUL,DEG, GFW.	H ⁰ - H ⁰ T 29.15 HEAT CONTENT CAL./ GFW.	S ⁰ T ENTROPY CAL./DEG./GFW.	-(10 H 299.15) FREE ENERGY FUNCTION CAL./DEG./ GFW.	FORMATI HEAT Δ H ⁶ cal./gfw.	CHARTION FROM REFERENCE STATE △ H ^o FREE BNEROY △ F ^o CAL.' GFW. f CAL.' GFW. 100	ICE STATE LOG K
I. I.	*	298 300	4 97 4 97	00	43•18 43•21	43•18 43•18	25482 25479		- 12•291 - 12•176
ΔHm	CAL /GFW.	\$00 200 200	4 07	1003 1500 1500		43.38 43.75 44.16	23371 18147 18195	13887 11992 10755	- 7.588 - 5.242 - 3.917
Ŀ Ŀ	*	700 800 9006	4 97 4 97	1996 2493 2990	47.42 48.09 48.67	44•57 44•98 45•35	18242 18288 18333		- 2.970 - 2.255 - 1.702
ΔH ,	CAL /GFW.	1100	4.97	3487 3984		45.72	18378		- 1.254 - 888
. s.P. ∆ H _s	ek Call /GFW.	1200 1300 1400 1500	4 4 4 4 6 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	4484 4979 5478 5978			18465 18507 18551 18551	3213 1932 659 - 621	- •585 - •324 •090
T.P.	×°	1600 1700 1800	5.02 5.03	6479 6982 7486			18638 18683 18729	- 1906 - 3179 - 4473	- 260 - 408 - 543
ΔH,	CAL /GFW.	2200 2200	5.09 5.11 14	7992 8500 9011 9523	52.67 52.67 52.92 53.15	48 21 48 42 48 63 48 63	18776 18823 18874 18974	- 5772 - 7057 - 8363 - 9631	• 663 • 771 • 870
т. Р . Дн ₁	°K CAL./GFW.	2300 2400 2500 2600	5 • 18 5 • 18 5 • 20 5 • 20	10038 10555 11075 11596	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	49002 49002 49033 49033 49033	19032 19032 19089 19146		10040 101640 10114 10183
Tc = Pc =	9K ATIA	2700 2800 2900 3000	5 24 5 26 5 26 5 30	12119 12644 13171 13703	54.21 54.40 54.59 54.77	49•73 49•89 50•05 50•21	19204 19264 19325 19325	1 1 1 1	1.308 1.363 1.413 1.465

IRIDIUM	1		Solid	Solid from 298° to 2727	to 2727		from 27:	Liquid from 2727° to 3000°.	0°.
REFERENCE STATE	р р								
Głw 192.2	GRAMS	-	ບ	He - He	8'	-(F°-+f° 226.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H ⁰ _{298.15} H ₀ ⁰) =	CAL./GFW.	TEMPERATURE •K	HEAT O	T 276-15 HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL. DEG. OFW.	HEAT A H ^o cal./gfw.	FREE ENERGY & F	רספ ני ג ר
		298	00-9	0	8.70	8.70			
M.P. 2,727	×,	300	9.00	11	8.74	8.71			
△H _m (6,300)	CAL. /GFW.	400 500	6.13 6.27	620 1235	10•49 11•86	8•94 9•39			
		600	6.41	1870	13.02	16*6			
		700	6.55	2525	14•03	10.43			
B.P. (4,400)	×	800	6•70 •	3190	14.92	10.94			
∆н, (134, 700)	CAL. /GFW.	1000	*0*0 9*08	4545	15.43	11.89			
		1100	7.12	5250	17.10	12,33			
		1200	7.26	5970	17.73	12.76			
S.P.	*	1300	7.41	6700	18.31	13.16			
3	M30/ 1VJ	1400	7.55	7440	18.86	13.55			
5		1500	7.69	8200	19.38	13.92			
		1700	7.97	9780	20.37	14.62			
T.P.	×	1800	8.12	10590	20.83	14.95			
:		1900	8.26	11410	21.27	15.27			
t h ∆	CAL. /GFW.	2000	8•40	12240	21.70	15.58			
		2200	89.68	13950	22.51	16.17			
T.P.	×	2300	8.83	14820	22.90	16.46			
		2400	8.97	15710	23.28	16.74			
h	CAL. /GFW.	2500	9.11	16620	23.65	17.01			
		2600	9 • 25	17540	24.01	17.27			
		2700	9 • 39	18470	24.36	17.52			
Tc =	*	2800	9•50 0.50	25710	27.35	17.84 18.16			
P = 2	ATM.	3000	9.50	27610	27.67	18.47			
	-	>>>							

IRIDIUM

Publication Date: January 1, 1956 doi: 10.1021/ba-1956-0018.ch0	2
² ublication Date: January 1, 1956 doi: 10.1021/ba-1956-0018	ch0
Publication Date: January 1, 1956 doi: 10.1021/ba-1956-	18.
² ublication Date: January 1, 1956 doi: 10.1021/ba-195	00-
² ublication Date: January 1, 1956 doi: 10.1021/ba-	
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IRIDIUM	ង		Refere	ence St a te	e for Cal	culating /	ur ^e , Δr ^e ,	Reference State for Calculating AH ^e , AP ^e , and Log ₁₀ Kp:	Kpt
IDEAL MONATOMIC GAS	C GAS		Solid	Solid from 298°		, Liquid	from 272	to 2727°, Liquid from 2727° to 3000°	
_{6fw} 192.2	GRAMS	F	ບ	He-He	e,	-(F ⁰ -H ⁰ 218.15)	FORMAT	FORMATION FROM REFERENCE STATE	ACE STATE
(H [°] _{298.15} H [°] ₀) = 1,481	CAL./GFW.	TEMPERATURE ⁰ K	HEAT CAPACITY CAL. DEG. / GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL. /DEG./ GFW.	HEAT A H	FREE ENERGY & F	ړ ۳ د ۲
		298	4.97	0	40.24	46.24	150000	138807	-101.752
M.P.	×	300	4.97	0	46.27	46.24	149998	138739	-101-079
:		400	4.98	506	47.70	46.44	149886	135002	- 73.767
∆ H	CAL. / GFW.	500	5.01	1005	48 • 82	46.81	149770	131290	- 57.390
		600	5.07	1509	49.73	47.22	149639	127613	- 46.486
		200	5.18	2021	50.52	47.64	149496	123953	- 38.703
6.P.	¥	800	5.31	2546	51.22	48.04	149356	120316	- 32.871
ΔH ,	CAL. /GFW.		5.00	06.96	52.44	48.81	140094	113084	- 24.716
		1100	5.78	4209	52.99	49.17	148959	109480	- 21.753
		1200	5.93	4795	53.49	49.50	148825	105913	- 19.290
5.P.	ж,	1300	6.08	5396	53 •9 8	49 . 83	148696	102325	- 17.203
:		1400	6.21	6010	54.43	50.14	148570	98772	- 15.420
△ H ₅	CAL. /GFW.	1500	6.33	6637	54.86	50.44	148437	95217	- 13.874
		1600	6.44	7276	55.28	50.74	148296	91672	- 12.521
		1700	6.54	7925	55.67	51.01	148145	88135	- 11.330
Т.Р.	×.	1800	6.62	8584	56.05	51.29	147994	84598	- 10.271
1	CAL /CEW	1900	69.00	9249	56.41	51.55	147839	81073	- 9.325
łup		2000	0.70	1266	C/ • 0C	51.04	144 /081	18611	
		2200	6.83	11280	57.40	52.28	147330	70572	- 7.010
T.P.	°K	2300	6.85	11974	57.70	52.50	147154	67114	- 6.377
		2400	6.87	12650	57.99	52.72	146940	63636	- 5.794
ΔH	CAL. / GFW.	2500	6.87	13337	58.27	52.94	146717	60167	- 5.259
		2600	6.87	14024	58.54	53.15	146484	56706	- 4.766
		2700	6.86	14710	58.80	53 . 36	146240	53252	- 4.310
T _c =	*	2800	6.85	15396	50 •05	53 • 56	139686	20005	- 3.902
		2900	6.83	16079	59.29	53.75	139419	46793	- 3.526
Pc =	ATM.	3000	6.81	16761	59•52	53.94	139151	43601	- 3.176

IRIDIUM

IRON	Pe F			Solid I	from 298	• to 1183	, Solid	I from 1	Solid I from 298° to 1183°, Solid II from 1183° to 1673°	673°,
REFERENCE STATE	CE STATI	ы		Solid I	II from 1	673° to 1	812°, L1q	uid from	Solid III from 1673° to 1812°, Liquid from 1812° to 3000°.	3000°.
_{6fw} 55,	55.85	GRAMS	F	ზ -	H ⁰ - H ⁰ T 296.15	۰ _۲	-(Bro-Ho 2011)	FORMAT MEAT A U	FORMATION FROM REFERENCE STATE	NCE STATE
(H ⁰ 298.15 H ⁰) =		1,070 CAL/GFW.	TEMPERATURE ¶	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.		CAL./ GPW.	20 20 20 20 20 20 20 20 20 20 20 20 20 2
	218 1		298	5.99	0	6• • 9	6•49			
		r.	000	6.00	11	6.52 8.32	64-9			
∆ H•	3,670	CAL. /GFW.	200	66.9	1317	6 8 0	7.21			
			600	7.54	2042	11.16	7.76			
Ч	3,160	ж.	700 800	8•25 9•23	3700	12.37 13.53	8•33 8•91			
HV	83.900 CM /GFW	CAL /GFW	006	10.74	4694	14.70	9.49			
A 17			11000	13•80 10•83	5882 7229	15•95 17•25	10.07			
			1200	8.17	8438	18.30	11.27			
J		*	1300	8•38	9266	18.96	11.84			
Δ H-		CAL /GFW.	1400	8.58	10114	19.59	12.37			
•			1500	8.77	10981	20.19	12.87			
			1700	9.48	12949	21.41	13-80			
T.P.	1,033	¥	1800	9•58	13902	21.96	14.24			
Δ Н.	0	CAL /GFW.	1900	10.54	18613	24.55	14.76			
-			0007	10.58	19669	25.09	15.26			
			2200	10.66	21793		16.21			
T.P.	1,183	*	2300	10.70	22861					
Ĩ	215	CAL /GEW	2400	10.74	23933	27.04				
			0067	10•78	60047	21.48				
			2000	10-86	27173	28.31	18-25			
Tc =	1,673	¥	2800	10.90	28261	28.70	18.61			
-	שאו	T,	2900	10.94	29353	29 •09	18.97			
- e =	31		3000	10.98	30449	29.46	19.32			

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IRON

IRON	Pe		leference	State fo	or Calculé	ating $\Delta H_{\Gamma}^{\circ}$, ∆r°, an	Reference State for Calculating ΔH_{f}° , ΔF_{f}° , and $Log_{10}Kp$:	
IDEAL MONATOMIC	C GAS	U 2 (Solid I f	rom 298°	to 1183°,	Solid I	[from 1]	Solid I from 298° to 1183°, Solid II from 1183° to 1673°	73°,
			Solid III	rrom 16	73 to 18	12', L1qu	Ld from 1	Solid III from 16/3' to 1812', Liquid from 1812' to 3000'.	
et. 55.85	GRAMS	+	e	9H - 9H	e	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
		TEMPERATURE		T 298-15		FREE ENERGY	HEAT A H ^o	FREE ENERGY & F	
$(H^{0}_{2H_{0},15} - H^{0}_{0}) = 1,637$	CAL/GFW.	¥	CAL. DEG. / GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	20 2
		208	717Y	0	11-64	11.44	00830	61088	- 65.176
K.P.	×	300	6.14	11	43.15	43.12	00830	88841	
		400	6.10	625	44.92	43.36	99816	85180	
ΔHm	CAL. /GFW.	500	5.95	1228	46.26	43.81	14799	81531	- 35.639
		600	5.78	1815	47.33	44.31	99603	10677	- 28.377
		700	5.64	2386	48.21	44.81	99386	74298	- 23,198
B.P.	*	800	5.53	2944	48.96	45.28	99074	70730	- 19.324
		006	5.44	3492	49.60	45.72	98628	67218	- 16.323
DH.	CAL. /GFW.	1000	5.37	4033	50.17	46.14	18616	63761	- 13,936
		1100	5.33	4568	50.68	46.53	97169	60396	- 12.000
		1200	5 • 30	6605	51.15	46.91	16496	11012	- 10.394
S.P.	*	1300	5.29	5629	51.57	47.24	96193	53800	- 9.045
3		1400	5.30	6158	51.96	47.57	95874	50556	- 7.892
2 H2		1500	5.31	6688	52.33	47.88	95537	47327	- 6.896
		1600	5.34	7221	52.67	48.16	95183	44127	- 6.027
		1700	5.38	7277	53.00	48•44	94638	56607	- 5.262
T.P.	×.	1800	5 .43	8298	53.31	48.70	94226	37796	- 4.588
3		1900	67°5	8844	53.60	48°95	90061	34866	- 4.010
4114		2000	5.55	9396	53.88	49.19	89557	31977	- 3.494
		2100	5.61	9954	54.16	49.42	89055	29100	- 3.028
		2200	5.68	10519	54.42	49 ° 64	88556	26274	- 2.610
ġ.	×	2300	5.75	11090	54.67	49 • 85	88059	23452	- 2.228
:		2400	5.82	11669	54.92	50.06	87566	20654	- 1.880
	CAL /GFW.	2500	5.90	12255	55.16	50.26	87076	17876	- 1.562
		2600	5.97	12848	55.39	50.45	86589	15115	- 1.270
		2700	6.04	13449	55.62	50.64	86106	12369	- 1.001
T _c =	*	2800	6.12	14056	55.84	50.82	85625	9633	751
G		2900	6.19	14673	26.06	51.01	85150	6937	- • 523
rc =	A18.	3000	6.26	15294	56.27	51.18	84675	4245	- •309

IRON

KRYPTON	ON Kr	5			Ideal Moi	natomic G	Ideal Monatomic Gas from 298° to 3000°.	98° to 30		
REFER	REFERENCE STATE	ы								
Cłw	83.80	GRAMS	F	೮	H° – H° T 234.15	-^0	-(F°-H° 233.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
(H ⁰ _{298.15} H ₀ ⁰) =	H\$)= 1,481	CAL/GFW.	tenperature 9K	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	CAL./GPW.	CAL./ GFW.	LOG K
			298	4.97	0	39.19	39.19			
A.P.	115.9	¥	300	4.97	0	39.22	39.19			
×H−	105	CAL /GFW.	400	4.97	506	40.65	39.39			
	• Te C		200	4.97	1003	41.76	39.76			
				4.04	1006	64.64	40.58			
8.P.	119.75	×		79.4	2493	44.10	66.04			
14			000	4.97	2990	44.68	41.36			
∧u ⊂	2,158.	LAL. / GFW.	1000	4.97	3487	45•20	41.72			
			1100	4.97	3984	45.68	42.06			
		2	1200	4.97	4480	46.11	42.38			
		*	1300	4.97	4977	46.51				
Δ H.		CAL. / GFW.	1400	4.97	5474	46.88				
			0061	- 5 • 4	1/66	77 • 1 4	.			
			1600	4.97	5468	47.54	-			
4			1700	16.4	4060	42°14	-			
			1800	10.4	104/	21 • 24				
ΔH		CAL. / GFW.	0061	10.4	8455 8455	40.04	44.43			
			2100	4.97	8952	48.89	44.63			
			2200	4.97	9448	49.12	44.83			
Т.Р.		*	2300	4.97	9945		45•02			
			2400	4.97	10442		45.20			
₽		CAL. / GFW.	2500	4.97	10939	49.76	45.39			
			2600	4.97	11436	40.95	45.56			
			2700		11932	50.14	45.73			
Tc =	209.4	*	2800		12429					
		ATM	2900		12926	50.49	40.04			
	04•0		3000	10.4	13423					

KRYPTON

ADVANCES IN CHEMISTRY SERIES

LANTHANUM	ANUM La			Solid	from 298	° to 1193	s°, Liquid	from 11	Solid from 298° to 1193°, Liquid from 1193° to 3000°.	0°.
REFERENCE	ENCE STATE									
Gíw	138.92	GRAMS	F	ື້	H H.	ŝ	-(F°-H° 218.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H ⁰ _{298.15} H ⁰) =	H°)= 1,569	CAL./GFW.	TEMPERATURE °K	HEAT C	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H	FREE ENERGY A F	י א ⁰⁰ רספ
			298	6.65	0	13•60	13.60			
A. A.	1,193	¥	300	6.65	12	13.64	13.60			
ΔHm	(2, 700)	CAL. /GFW.	400 500	6.81 6.97	685 1370	15.57	13•86 14•37			
			600	7.13	2080	18.40	14.94			
			700	7.29	2800	19•51	15.51			
8 4	5,640	×	800	7.45	3540	20.49	16.07			
∆н,	95,500	CAL. /GFW.	006	7.61	4290	21.38	17.13			
			1100	7.93	5840	22.04	17.64			
			1200	8•00	9380	25.94	18.13			
S.P.		×	1300	8 • 00	10180	26.58	18.75			
3			1400	8 • 00	10980	27.17	19.33			
5 u 0		CAL. /GFW.	1500	8.00	11780	27.73	19,88			
			1600	8•00	12580	28 • 24	20.38			
			1700	8.00	13380	28.73	20.85			
d. 1		¥	1800	8.00	14180	29. 18 24. 62	21.631			
ΔH		CAL. /GFW.	2000	8.00	15780	30.03	22.14			
			2100	8 • 00	16580	30.42	22.53			
			2200	8 • 00	17380	30.79	22.84			
4. H		×	2300	8.00	18180	31.15	23.25			
H<		CAL VEW	2400	8.00	18980	31.49	23.59			
			0092	8.00	20580	18.16	24.22			
			2700	8 • 00	21380	32.43	24.52			
T _c =		×	2800	8.00	22180	32.72	24.80			
•			2900	8 • 00	22980	33.00	25.08			
			3000	8•00	23/80	12.66	66 • 67			

LANTHANUM

LANTHANUM	al		Refer	rence Stat	te for Ca	lculating	∆H°, ∆P°	Reference State for Calculating $\Delta H_{F}^{\bullet}, \ \Delta F_{F}^{\bullet}$, and $\mathrm{Log}_{1,0}\mathrm{Kpt}$	o ^{Kp} :
IDEAL MONATOMIC GAS	C GAS		Solid	Solid from 298°	• to 119	5°, Liquid	from 11	to 1193°, Liquid from 1193° to 3000°.	•••
ct- 138.92	CPANS	-	و	0 - K0	2	-(10-11 202.15)	FORMATH	FORMATION FROM REFERENCE STATE	ICE STATE
* ¹⁵		TEMPERATURE	P HEAT CAPACITY CAL./DEG./ GFW.	T 294.15 HEAT CONTENT CAL./ GPW.	T ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CALL/DEG./ GFW.	HEAT A H ⁰ call/grv.	FREE ENERGY & F	۲ م ال ال
		298	5.44	G	43.56	43-56	00900	00667	E 44. AA
	*	300	64.9	10	43.60	43.57	86566	90610	-
Ĩ	:	400	5.89	578	45.23	43.79	66766	87629	- 47.882
∆ H	CAL. / GFW.	500	6.22	1185	46 . 58	44.21	99415	84680	- 37.016
		600	6.46	1819	47.74	44.71	66666	81735	- 29.774
		200	6.67	2475	48.75	45.22	99275	78807	- 24.606
B.P.	¥	800	6.87	3152	49.65	45.71	99212	75884	- 20.732
		006	7.07	3849	50.47	46.20	99159	72978	- 17.722
2H ,	CAL. /GFW.	1000	7.25	4566	51.23	46.67	90166	70066	- 15.314
		1100	7.39	5298	51.92	47.11	99058	67180	- 13.348
		1200	7.50	6043	52.57	47.54	96263	64307	- 11.712
S.P.	¥	1300	7.57	6796	53.18	47.96	96216	61636	- 10.362
		1400	7.62	7556	53.74	48.35	96176	58978	- 9.207
Δ H _s	CAL. /GFW.	1500	7.64	8319	54.27	48.73	96139	56329	- 8.207
		1600	7.66	9084	54.76	49 • 09	96104	53672	- 7.331
		1700	7.66	9850	55.22	49.43	96070	51037	- 6.561
T.P.	ж.	1800	7.66	10616	55.66	49.77	96036	48372	- 5.872
		1900	7.65	11382	56.08	50.09	96002	45728	- 5.259
ΔH,	CAL. /GFW.	2000	7.65	12147	56.47	50.40	95967	43087	- 4.708
		2100	7.64	11671	56.84	50.70	05931	40440	- 4.209
		2200	7.64	13675	57.20	50.99	95895	37793	- 3.754
T.P.	*	2300	1.04	14439	10.04	12.16	95859	35162	- 3.341
		2400	1.04	15203	57.86	51.53	95823	32535	- 2.962
∀H	CAL. /GFW.	2500	7.64	15967	58.17	51.79	95787	29887	- 2.612
		2600	7.65	16732	58.47	52.04	95752	27268	- 2•292
		2700	7.66	17498	58.76	52.28	95718	24627	- 1.993
T c =	*	2800	7.67	18264	59•04	52.52	95684	21988	- 1.716
		2900	1.69	19032	59.31	52.75	95652	19353	- 1.458
Pc =	ATM.	3000	7.70	19802	59.57	52.97	95622	16722	- 1.218

LANTHANUM

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		STATE LOG K 10 P						
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600.6°	:o 3000°	MATION FROM REFERE		-				
d from	2024° t	FORM HEAT $ riangle H^{0}$ cal./gfw.						
, Liqui	B from	- (F ^{H⁻ 298.15) FREE ENERGY FUNCTION CAL./DEQ./ GFW.}	15•49 15•49 15•49	16.23 16.78	16.23 16.78 17.61 18.36 19.68 19.68 20.26	16.23 16.78 176.1 19.10 19.10 19.00 20.80 20.80 21.28 20.28	16.23 16.78 16.78 16.78 19.10 19.61 19.61 19.68 20.80 21.75 21.28 22.28 23.28 22.28 23.28 25.28	16.23 16.78 19.16 19.16 19.16 19.16 19.16 19.16 20.25 20.80 21.28 21.28 21.28 21.28 21.28 21.28 21.28 21.28 23.34 24.00 25.08 23.34 24.43 25.68 23.54 25.680
Solid from 298° to 600.6°, Liquid from 600.6° to	2024°, Ideal Monatomic Gas from 2024° to 3000°	State Contract of the contract	15.49 15.53 17.38	20.13	20.13 23.15 24.11 25.70 25.70	2019 2019 2019 2500 2500 2500 2500 2500 2700 2700 2700	20018 23018 23018 25015 25015 25015 25007 25007 25007 25007 25007 25007 2002 2002	220.13 220.13 25.115 25.101 25.101 25.101 25.115 22.02 28.02 28.02 28.02 29.03 20.02 52.03 52.05 52.05 52.05 52.05 52.05 52.05 52.05 52.05 52.05 52.05 52.05 52.05 52.05 52.05 52.05 55.05
298° t	al Mona		0 12 656	2014	2014 3884 4605 5318 6723 6723	2014 2014 3884 5318 5024 7723 7723 7723 7723 7723 7415 9450 9450 9450 9450 9450	2014 3884 5318 5318 5318 5318 5318 5318 8100 8100 8450 9450 9450 10110 1126500 110500 1100000000000000000000000000	2014 3884 55318 55318 55318 7524 7523 5516555 551655555555
ld from	t°, Ide	H ⁰ - H ⁰ T 299.15 TY HEAT CONTENT W. CAL./ GFW.				-		
TOS	2024	C ⁰ PEAT CAPACITY CAL./DEG./ GPW.						
		T Temperature °K	298 300 400	500	500 700 800 11000	500 700 700 800 1000 1100 1200 1200 1500	500 700 800 800 1100 1100 11500 11500 11700 11800 21000 21000	500 700 700 800 800 800 1100 1100 1100 1100 1100 1100 1100 2100 2100 2100 2100 2100 2100 2500
		GRAMS CAL./GFW.	X S		ek CAL /GFW.	ak All /GFW.	rk k k k cal. /GFW. Cal. /GFW.	NK CAL / GFW.
Pb	E STATE	644	600.6 %					
LEAD	REFERENCE STATE	^{61w} 207•2] (H [°] _{280.15} H [°]) = ¹	T		4			
LI	RE	, ₩°		P H	ΔH B.P. ΔH,	∆Н, В.Р. Д.Н, А.В.	В.Р. Ан, 2. Н. 2. Н. 2. Н.	Ан _ж В.Р. ДН ₄ 2.Р. ДН ₄ Д.Н,

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LEAD	Pb		Refer	ance State	for Cal	culating /	M [•] , ∆ [₽] °,		o ^K P 8	
IDEAL MONATOMIC GAS	IC GAS		2024°,	Solid From 238° to 600.6°, 2024°, Ideal Monatomic Gas	rom 298 to 500.57, Liqui Ideal Monatomic Gas from	67, Liquid Aas from 2	Liquid from 600.67 from 2024° to 3000	1 600.67 to to 3000°.		
c- 207.21		•	1	9	•	-(L ⁰ -L ⁰ 248 14)	FORMAT	FORMATION FROM REFERENCE STATE	ACE STATE	
	GKAMS	-	<u>კ</u> .	H H H	۰ ۲		MEAT A H ^e	FREE ENGREY A P		
$(H^{\circ}_{298,15} - H^{\circ}_{0}) = 1.9481$	· CAL./GFW.		HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL. (GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL. /DEG./ GFW.	CAL./GFW.	CAL./ GPW.	ິເ	× [•]
		298	4.97	0	41.89	41.89	46800	38929	- 28.	28.536
A.P.	×	300	4.97	6	41.92	41.89	46797	38880	- 28.	28.326
		400	4.97	506	43.35	42.09	46650		- 19.	19.814
	CAL. / GFW.	500	4.97	1003	44.46	42.46	46479	33684	- 14.	14.724
		600	4.97	1500	45.36	42.86	46286	31148	- 11.	11.346
		700	4.97	1996	46.13	43.28	44912	28826	•6 •	000
B.P.	×	800	4.97	2493	46.79	43.68	44688	26544		7.252
:		006	4.97	2990	47.38	44.06	44472	24330	- 2.	5.908
~u^	CAL /GPW.	1000	4.98	3488	47.90	44.42	44264	22064	4	4.822
		1100	4 •99	3986	48 • 38	44.76	44063	19852		3.944
		1200	5.02	4487	48.81	45.08	43872	17664	۳ ۳	3.217
S.P.	×	1300	5.06	4990	49.22	45.39	43690	15467	- 2	2.600
:		1400	5.11	5498	49.59	45.67	43518	13320	- 2	2.079
5 us		1500	5.19	6014	40.95	45°95	43364	11159	י י	1.625
		1600	5.29	6537	50.29	46.21	43227	9019	-	1.231
		1700	5.41	7072	50.61	46.45	43112		1	•885
T.P.	×	1800	5.56	7621	50.92	46.69	43011	4761	1	•578
1		1900	5.72	8184	51.23	46.93	4 2934	2635	•	•303
711	CAL. / GFW.	2000	5.90	8765	51.53	47.15	4 2 8 8 5		-	•055
		2100	6.10	9365	51.82	47.37	0	0	0	
		2200	6.30	6866	52.11	47.58	0	0	0	
1.P.	×	2300	6.52	10626	52.39	47.77	0		0	
:		2400	6.74	11288	52.67	47.97	0		0	
4	CAL. /GFW.	2500	6.95	11973	52.95	48.17	0		0	
		2600	7.17	12679	53.23	48.36	0		0	
		2700	7.37	13406	53.51	48.55	0		0	
Tc =	×	2800	7.57	14153	53.78	48.73	0	0	0	
		2900	7.76	14920	54 • 05	48.91	0	0	0	
		3000	7•93	15704	54.31	49.08	0	0	0	

LEAD

LITHIUM	E1	-		Solid	from 29	8° to 453.	Solid from 298° to 453.7°, Liquid from 453.7° to	ld from 4	53.7° to	
REFERENCE STATE	E STATI	ß		1604°	, Ideal !	Monatom1c	1604°, Ideal Monatomic Gas from 1604° to 3000°	1604° to	3000°.	
	6.940		•	1	91	2	-(F°-H° 296.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
			TEMPERATURE	- مر	T 296.15	n [⊥]	FREE ENERGY	HEAT A H	FREE ENERGY & F	
(H ⁰ _{298.15} H ₀ ⁰) =	1,092	CAL./GFW.	٩K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GPW.	CAL./ GFW.	LOG K
			298	5.91	C	6 • 75	6.75			
M.P. 45	453.70	×	300	5.92). 11		6.76			
	722 . A		400	6.50	630		*			
	0.1	CAL. /GFW.	500	7.20	2049	11.71	7.62			
			600	7.06	2763	13.01	9.41			
- 1 . 604.	. 4.		100	6.95	3402	14•09	6 6 6			
B.F. 13 (0		¥	006	06.90	4122	15.83	10.45			
∆H, 32,190.	ŝ	CAL. /GFW.	1000	6.89	5536	16.55	11.02			
			1100	6.88	6224	17.21	11.56			
		Γ	1200	6.87	6912	17.81	. 12.05			
S.P.		*	1300	6.86	7598	18.36	12.52			
:			1400	6.94	8284	18.R6	•••			
₽ H ®		CAL. /GFW.	1500	6.82	8967	19.34				
			1600	6 • 80	954R	10.78	13.75			
			1700	16.4	45404	41.79	15.09			
T.P.		×	1800	4.97	45901	42.08	16.58			
1		10 VCEN	1900	4 • 98	46399	42.35	17.93			
1			0002	4 .00	- 5001	00.24	01.61			
			0012	4 v	41.390	4 / • Q t	21.01.0			
Ţ.P.		Å	2300	5.01	48396	43.30	22.26			
			2400	5.03	48898	43.51	23.14			
ΔĦ		CAL. / GFW.	2500	5.05	49402	43.72	23.96			
			2600	5.07	49908	43.92	24.73			
			2700	5.10	50416	44.11	25.44			
T _c =		χ.	2800	5.13	50928	44 • 30	26.12			
			2900	5.17	51443	•	26.75			
ہ و =		ATM.	3000	5•21	51962	44 • 65	27.33			

LITHIUM

MUIHTI	ы		Referen	ce State	for Calcu	lating AH	1. A ¹ .	Reference State for Calculating Afr, Arr, and Log ₁₀ Kp:	5 đ
IDEAL MONATOMIC GAS	GAS		Solid F	rom 2987 Ideal Mon	Solid from 298° to 453.7°, Liquid from 453.7° to 1604°, Ideal Monatomic Gas from 1604° to 3000°.	, Liquid s from 16	from 453. 04° to 30	7° to 00°.	
6fw 6 • 940	GRAMS	F	ບ	он – он	2	-(1 -16 239.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
		TEMPERATURE	-	T 299.15	•-	FREE ENERGY	HEAT A H	FREE BUDGY Δ F	
(H ² 20.15 H ²) = 1,481	CAL/GFW.	¥	CAL./DEG./ GPW.	HEAT CONTENT CAL./ GPW.	CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./BFW.	CAL./ GFW.	LOG K
		298	4.97	0	33.14	33.14	38439	30570	- 22-409
A.P.	¥	300	4.97	6	33.17	33.14	38437	30523	- 22.237
× H <	CAL /GEW	400	4.97	506	34.60	33.34	38315	27903	- 15.246
		500	4.97	1003	35.71	33.71	37393	25393	- 11.100
		600	4.97	1500	36.62	34.12	37176	23010	- 8,382
	:	700	4.97	1996	37.38	34.53	36973	20670	- 6.454
	4	800	4.97	2493	38•05	34.94	36777	18345	- 5.012
AH.	CAL /GFW.	006	4.97	2990	38.63	35.31	36583	16063	- 3.900
4		1000	4.97	3487	39.16	35.68	36390	13780	- 3.011
		1100	4.97	3984	39•63	36.01	36199	11537	- 2•292
		1200	4.97	4480	40.06	36.33	36007	9307	- 1.695
	•	1300	4.97	4977	40.46	36.64	35818	7088	- 1.191
∆н.	CAL. /GFW.	1400	4.97	5474	40.83	36.92	35629	4871	- •760
		1500	4.97	5971	41.17	37.19	35443	2698	- • 393
		1600	4.97	6468	41.49	37.45	35259	523	- •071
c •		1700	16.4	5969	41.79	01.TE	0	0	0
	¥	1800	4.97	7462	42.08	37°94	0	0	0
Δ H.	CAL /GFW.	1900	4.98	7959	42.35	38.17	0	0	0
-		2000	4•98	8458	42.60	38,38	0	0	0
		2100	4 00	89568	42.84	38.58	0	0	0
T.P.		2200	00•4		80°54	38.79	00	0	0 0
		0062	10.0	1085	00.00	06.00	C	C	Э
Ĩ	CAL /GEW	2400	5 • 03	10459	43.51	39.16	0	0	0
F		2500	5.05	10963	43.72	39,34	0	0	0
		2600	5.07	11469	43.92	39.51	0	0	0
1		2700	5.10	11981	44.11	39.68	0	0	0
Tc =	¥	2800	5.13	12492	44.30	39.84	0	0	0
	ATH	2900	5.17	13006	44 • 48	40.00	0	0	0
		3000	5.21	13525	44.65	40.15	0	0	0

LITHIUM

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In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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LITHIUM TDEAL DIATOMIC	L12 ASS		Refer Solid	ence Stat from 298	Reference State for Calculating AH ^o , AP ^o . and Lo Solid from 298° to 453.7°, Liquid from 453.7° to	culating 7°, Liqui	∆H°, ∆P° d from 45	Reference State for Calculating Aff, Aff. and Log ₁₀ Kp; Solid from 298° to 453.7°, Liquid from 453.7° to	10 ^{Kp}	-
ATHATYTA TURAT			1604°,	-	Ideal Monatomic Gas from 1604° to 3000°	Gas from	1604° to	3000°.		
		,	١	9	9	-(F ⁰ 1 ⁰ 244 14)	FORMAT	FORMATION FROM REFERENCE STATE	INCE S	rate
1000 T 000	GRAMS	-	ა.	H ^o H ^o T 296.15	r.⊢	FREE ENERGY	HEAT A H ^e	FREE ENERGY & F		
(H ^e _{211.15} H ^e) = 2,312	CAL./GFW.		HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	f CAL./ GFW.		L06 K
A.P.	×	300	8.62	0 2	47.05	47•05 47-07	50467	40463	11	29.661
		400	8.83	688	49.64	47.42	50096	37096	I	20.269
∆ H	CAL. / GFW.	200	8.94	1778	51.62	48.07	48147	34047	ŀ	14.882
		600	9.02	2674	53.25	48.80	47615	31277	1	11.393
		700	9.08	3582	54.66	49.55	47125	28589	1	8.926
B.P.	*	800	9.13	4488	55.86	62.0 6	46645	25973	I	7.096
		006	9.18	5410	56.95	50.94	46185	23424	1	5.688
2H 7	CAL /GFW.	1000	9•22	6328	57.92	51.60	45723	20903	ł	4.568
4		1100	9.26	7247	58.79	52.21	45266	18459	I	3.667
		1200	9•30	8176	59 ° 60	52.79	44819	16043	I	2.922
S.P.	¥	1300	9.34	9115	60.35	53.34	44386	13667	I	2.297
:		1400	9.37	10050	61.05	53.88	54064	11287	I	1.762
2 H2	CAL / GFW.	1500	9.41	10978	61.69	54.38	43511	8996	1	1.310
		1600	90044	11921	62•30	54.85	43092	6708	•	•916
		1700	9•48	12867	62.87	55.31	- 27474	7733	1	• 664
T.P.	*	1800	9.51	13817	63.42	55.75		9814	1	101.1
		1900	cc•6	14//0	69.60	01.000	104/2 -	11902	I	1.308
ΔHr	CAL /GFW.	2000	6 •58	15726	64•42	56.56	- 27601	13959	t	1.525
T.P.	×									
:										
1 1	CAL/GFW.									
T c =	¥								-	
ک :	ATM.									
			-							

LITHIUM

LUTETIUM	Lu		Solid	1 from 296	3° to 200(Solid from 298° to 2000°, Liquid from 2000° to	l from 20	00 [•] to	
REFERENCE STATE	PATE		2200°,	, Ideal P	Monatomic	Ideal Monatomic Gas from 2200°	2200° to	to 3000°.	
ci. 174.99	99 GRAMS	-	e	ен – Но	٩	-(F ¹⁰ -H ¹⁰ 299.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
		TEMPERATINE		T 298.15	, -	FREE ENERGY	HEAT A H ^o	FREE EVENCY & F	
$(H^{0}_{296,15} - H^{0}_{6}) =$	CAL./GFW.	Жe	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GPW.	FUNCTION CAL./DEG./ GFW.	CAL./GPW.	CAL./ GPW.	ч , СОС
		298	6.45	0	11.75	11.75			
" _{P.} (2,000)) *	300	6.45	11	11.79	11.76			
× 1 (4.600)) ca (cew	400	6.60	1220	13.66	12.00			
		009	00.00	2015		13.05			
		2002	7.05	2710	17.47	13-60			
B.P. (2,200)	* (0	800	7.20	3425	18.42	14.14			
		006	7.35	4150	19.28	14.67			
∆H, (59,000))) CAL. /GFW.	1000	7.50	4890	20.06	15.17			
		1100	7.65	5650	20.78	15.65			
		1200	7.05	6420	21.46	16.11			
S.P.	ž								
Δ H.	CAL. / GFW.	1500	8.25	8830	23.25	17.37			
		1600	8.40	9660	23.78	17.75			
		1700	8.55	10510	24.30	18.12			
Ţ.P.	×	1800	8.70	11370	24.79	18.48			
		1900	8.85	12250	25.26	18.82			
Δ Η,	CAL. /GFW.	20002	00.8	17740	28.04	19.17			
		2200		19340	28.78	10.00			
1.6	ж,	2300	6.07	79250	55.98	21.53			
		2400	6.05	79850	56.24	22.97			
Δ Η,	CAL. /GFW.	2500	6 • 04	80460	56.49	24.31			
-		2600	6.02	81060	56.72	25.55			
		2700	6.01	81660	56.95	26.71			
1.=	×	2800	6.01	82260	57.17	27.80			
	:	2900	6.00	82860	57.38	28.81			
= °	ATM.	3000	9.00	83460	57.58	29.76			

LUTETIUM

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Publication

LUTETION	Γn		Refere	ence State	e for Cal	Reference State for Calculating $\Delta H_{\rho}^{\circ}, \ \Delta F_{\rho}^{\circ}$, and Log ₁ $_{\Lambda}$ Kp:	H°, ΔP°,	and Log,	Kp:
			Solid	from 298'	to 2000	Solid from 298° to 2000°, Liquid from 2000° to	from 200	0° to	
IDEAL MONATOMIC GAS	C GAS		2200°,	Ideal Mc	onatomic (2200°, Ideal Monatomic Gas from 2200° to 3000°	200° to	3000°.	
174.99		•	و	5	2	-(F°-H° 298.15) -	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
	-			T 298.15	~-	FREE ENERGY	HEAT A H ^e	FREE ENERCY Δ F	
$(H_{2m,15}^{\circ} H_{0}^{\circ}) = 1,48\%$	CAL./GFW.	°K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	f CAL./GFW.	CAL./ GFW.	۲00 K
		298	4.99	0	44.14	44.14	67200	57543	- 42.181
0	<u>د</u>	300	4 • 99	6	44.17	44.14	67198		- 41.880
	4	400	5.09	512	45.62	44.34	67047	54263	- 29.650
ΔHm	CAL. / GFW.	500	5.28	1030	46.77	44.71	66900	51090	- 22.332
		600	5 • 53	1570	47.76	45.15	66755	47939	- 17.463
		700	5.77	2136	48 • 63	45.58	66626	44814	- 13.992
9	*	800	5.98	2723	49.41	46.01	66498	41706	- 11.394
	:	006	6.13	3329	50.13	46.44	66379	38614	- 9.377
AH-	CAL. /GFW.	1000	6.23	3948	50.78	46.84	66258	35538	- 7.767
		1100	6•29	4574	51.38	47.23	66124	32464	- 6.450
		1200	6.32	5205	51.93	47.60	65985	29421	- 5.358
92	×	1300	6.32	5837	52.43	47.94	65827	26385	- 4.436
	:	1400	6.31	6469	52 . 90	48.28	65659	23351	- 3.645
ΔHs	CAL. /GFW.	1500	6.29	7100	53 . 33	48.60	65470	20350	I
		1600	6.27	7728	53.74	48.91	65268	17332	ı
		1700	6.24	8353	54.12	49.21	65043	14349	- 1.844
a F		1800	6.21	8976	54.47	4 9 •49	64806	11382	- 1.381
	4	1900	6.18	9595	54.81	49.76	64545	8400	966
ΔM	CAL. /GFW.	2000	6.15	10212	55.13	50°03	59672	5492	- •600
		2100		10825	55.43	50.28	59485	2743	285
		2200	6.10	11436	55.71	50.52	59296	50	- •00 4
T.P.	×	2300		12045	55 • 98	50.75	0	0	0
	1	2400	6.05	12651	56.24	50.97	0	0	0
Δ н.	CAL. /GFW.	2500	6.04	13256	56.49	51.19	0	0	0
		2600	6.02	13859	56.72	51.39	0	0	0
	ſ	2700	6.01	14461	56.95	51.60	0	0	0
T.=	*	2800	6.01	15061	57.17	51.80	0	0	0
	:	2900	6.00	15662	57.38	51.98	0	0	0
Pc =	ATM.	3 000	6 • 0 0	16262	57.58	52.16	0	0	0
	-								

LUTETIUM

MAGN	MAGNESIUM Mg	80		Sol1	d from 29	38° to 92:	Solid from 298° to 923°, Liquid from 923° to	from 92	3° to	
REFE	REFERENCE STATE	ы		1390°,	°, Ideal	Monatom1(Ideal Monatomic Gas from 1390° to 3000°.	1 1390° t	o 3000°.	
ef G	24.32	GRAMS	-	ೇ	H° H° T 234.15	°¢-	-(F°-H° 228.15)	FORMAT HEAT A U	FORMATION FROM REFERENCE STATE	ICE STATE
(H ⁶ 298.1	(H [°] _{296.15} H°) = 1,195	CAL./GFW.	TEMPERATURE °K	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ OFW.	CAL./GPW.	CAL./ GFW.	۲06 K
			298	96•5	0	18-1	18-1			
¥.P.	923	*	300	5.97	10	7.85	7.82			
3	071 0		400	6.24	620	9•60	8.05			
	0#T62	LAL. / GTW.	500	6•48	1256	11.02	8.51			
			000	6.76	1920	12.23	9•03			
8.P.	1,390	×		7.42	3330	14.26	10-10			
	•		006	7.81	4095	15.15	10.60			
₽ ₩7	30, 750	CAL. /GFW.	1000	7.88	7010	18.29	11.28			
			1100	8.14	7810	19.06	11.96			
			1200	8.40	8640	19.78	12.58			
		¥.	1300	8•66	9490	20.46	13.16			
4		CAL /GEW	1400	4.97	41074	43°19	13.86			
. 1			1500	4.97	41570	43.53	15.82			
			1600	4.97	42070	43.85	17.56			
			1700	4.97	42560	44.15	19.12			
		×	1800	4.97	43060	44 • 44	20.52			
₽H		CAL. /GFW.	2000	16.4	44060	96 • 44	22.93			
			2100	4.97	44550	45 • 20	23.99			
, ,		4	2200	4.97	45050	45.43	24.96			
<u>-</u>		4	0062		00004	47.00	00 00 90		-	
ΔHγ		CAL /GFW.	2500	4.98	46540	46.07	27.46			
			2600	4 • 98	47040	46.26	28.17			
			2700	4.99	47540	46.45	28.85			
1° #		×	2800	5.00	48040	46.63	29.48			
ا م		ATM.	2900	5.01	48540	46.81	30.08			
			3000	5.02	49040	40.97	30.03			

MAGNESIUM

	R .		Refere	nce State	for Calc	Reference State for Calculating ΔH_{ρ}° ,	H°, ΔP°,	and Log ₁₀ Kp:	Kp:
MOTOTINA	e B		Solid	from 298°	to 923°,	Solid from 298° to 923°, Liquid from	923°	to	
IDEAL MONATOMIC	C GAS		1390°,		natomic G	Ideal Monatomic Gas from 1390° to 3000°	390° to 3	5000°.	
Glw 24.32	GRAMS	+	و	H0 H0	ę	-(E ⁰ -H ⁰ 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
Í		TEMPERATURE		T 294.15	,	FREE ENERGY	HEAT A H	FREE ENERGY 🛆 F	
$(H^{2_{38.15}}_{2_{98.15}} + H^{0}_{0}) = 1,481$	CAL./GPW.	*	CAL./DEG./ GFW.	CAL./ GFW.	CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	LOG K
		298	4.97	0	35•51	35•51	35600	27341	- 20.042
ALP.	×	300	4.97	6	35.54	35.51	35599	27292	- 19.883
		400	4.97	506	36.96	35.70	35486	24542	- 13.410
∆ Hm	CAL. / GFW.	500	4.97	1003	38.07	36.07	35347	21822	- 9.539
		600	4.97	1500	38 • 98	36.48	35180	19130	- 6.968
		700	4.97	1996	39.75	36•90	34986	16464	- 5.140
B.P.	×	800	4.97	2493	40.41	37.30	34763	13843	
3		006	4.97	2990	40.99	37.67	34495	11239	~
2HV	CAL /GPW.	1000	4.97	3487	41.52	38.04	32077	8847	- 1•933
		1100	4.97	3984	41.99	38.37	31774	6551	- 1.301
		1200	4.97	4480	42.42	38.69	31440	4272	778
S.P.	ر ۲	1300	4.97	4977	42.82	39•00	31087	2019	- • 339
:		1400	4.97	5474	43.19	39 • 28	0	0	0
₽ H ®	CAL. /GFW.	1500	4.97	5971	43.53	39°55	0	0	0
		1600	4.97	6468	43.85	39 • 81	0	0	0
		1700	4.97	6964	44.15	40.06	0	0	0
T.P.	×	1800	4.97	1942	44 • 44	40.30	00	00	00
Δ H ,	CAL /GFW.	0061	10.4	9751	10.44	40.04			. .
-		2100	4.97	8952	45.20	40.94	0	0	00
		2200	4.97	9448	45.43	41.14	0	0	0
T.P.	×.	2300	4.97	9945	45.66	41.34	0	0	0
:		2400	4.97	10443	45.87	41.52	0	0	0
₽H	CAL. /GFW.	2500	4 • 98	10940	46.07	41.70	0	0	0
		2600	4.98	11438	46.26	41.87	0	0	0
		2700	4 • 99	11937	46.45	42.03	0	0	0
Tc =	×	2800	2.00	12436	46.63	42.19	00	0 0	0 0
		2900	10.6	12937	18.04	65.924	o	C	5
_ e =		3000	5.02	13438	46.97	42.48	0	Ó	0

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MANGANESE	ESE Mn	a l	Solt	d I from	298° to	1000°, So	11 II DI	om 1000°	Solid I from 298° to 1000°, Solid II from 1000° to 1374°, Solid	Solid
REFERE	REFERENCE STATE	ы	III	from 137 [,]	4° to 141	0°, Solid	IV from	1410° to	III from 1374° to 1410°, Solid IV from 1410° to 1517°, Liquid	quid
			from	from 1517° to	to 2314°,	Ideal Mon	Ideal Monatomic Gas	s from 23	from 2314° to 3000°	00°.
Cfr	54.94	GRAMS	+	ئ	H ^e – H ^e 7 3011	\$. ⁺	-(F°-H° 20115)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
(H [°] _{216.15} H°) =	,= 1,19 4	CAL./GFW.	TEMPERATURE •K	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFV.	ENTROPY CAL. /DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT & H	FREE BABICY & F cal/ GFW.	LOG K
			298	62.09	C	7.65	7.65			
A.P.	1,517	¥	300	6•29	11	7.69	7.66			
3	3,500	110, 110	400	6.75	664	9.57	16•1			
∆ 11	2226	CAL. / GFW.	500	7.18	1360	11.12	8.40			
			600	7.54	2100	12.46	8.96			
9	2,314	3	200	7.87	2870	13.65	9.55			
		2	000	8.60	4510	15.71	10-10			
ζH,	52,520	CAL. /GFW.	1000	9.30	5920	17.18	11.26			
			1100	9•30	6850	18.06	11.84			
		ſ	1200	9.30	7780	18.87	12.39			
J.		¥	1300	9.30	8710		12.92			
:			1400	10.70	10220	20.73	13.43			
₽ ₽		CAL. /GFW.	1500	11.30	11780	21.81	13.96			
			1600	11.00	16380	24.94	14.71			
			1700	11.00	17480	25.61	15,33			
Т.Р.	7,000	*	1800	11.00	18580	26.24	15.92			
ΔH,	535	CAL /GFW.	0061	00.11	19080	27.40	10048			
			2100	11.00	21880		17.52			
	162 6		2200	11.00	22980	28 • 45	18.01			
ч. Т	#/0 f T	*	2300	11.00	24080	28.93	18.47			
3	545		2400	5.02	77180	51.86	19.71			
∆ H,)	CAL. /GFW.	2500	5.04	77690	52.07	21.00			
			2600	5.07	78190		22.19			
	טוע ו		2700	5.10	78700		23.32			
Tc =	07 F (T	×	2800	5.14	79210	52.64	24.36			
- - -	430	ATM.	0067	6100	00161	20020	cc•c2			
			3000	67•6	06708	00.66	67.02			

MANGANESE

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

MANGANESE		E E	lefe	rence	State fo	r Calcula	ting AHe,	Reference State for Calculating ΔH_{ρ}^{*} , ΔP_{ρ}^{*} , and $\mathrm{Log}_{1,0}\mathrm{Kpt}$	l Log _{1 O} Kp	: Solid I 298	2 38°
TDEAL MONAMONTO	UT NO	4 070	to 1(000°,	Solid II	1000 [°] to	1374°, 5	Solid III	1374° to	to 1000°, Solid II 1000° to 1374°, Solid III 1374° to 1410°, Solid IV	VI bii
TANUM UNDER	OTHO:		1410°	ę	1517°, L1	Liquid 1517°	ę	2314°, Ideal	Monatomic Gas	c Gas 2314°	° to 3000:
Giv 54.94	_	GRAMS		F	U	не – н	ŝ	-(516 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
			-	TEMPERATURE	P HEAT CAPACITY	T 298.15 HEAT CONTENT	T	FREE ENERGY	HEAT ∆ H ^e	FREE ENERCY Δ F	2
(H ^o _{298.15} H ₀) = 1,	1,481 C	CAL./GFW.		¥	CAL./DEG./ GFW.	CAL/ GFW.	CAL./DEG./ GFW.	CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	2 2 2
				298	4.07	G	41.40	41.40	66730	56640	- 41.510
A.P.	0	×		300	4.97	0	41.52	67-17	66728	56579	
3	ſ	M30/ IV		400	4.97	506	42.95	41.69	66572	53220	
		LAL. / 614.		500	4.97	1003	44.06	42.06	66373	49903	- 21.814
				600	4.97	1500	44.97	42.47	66130	46624	- 16.984
4	ē			700	4.97	1996	45.73	42.88	65856	43400	- 13.551
а. -	,-	¥		800	4.97	2493	46.40	43.29	65553	40209	- 10.985
Ĩ	Ľ	CAL /GEW		006	4.97	2990	46.98	43.66	65210	37067	- 9.001
Aut	ر ا	· · · · ·		1000	4.97	3487	47.51	E0*77	64297	33967	- 7.424
				1100	4.97	3984	47.98	44.36	63864	30952	- 6.150
				1200	4.97	4480	48.41	44.68	63430	27982	- 5.096
5.P.	•	¥		1300	4.97	4977	48.81	44.99	62997	25050	- 4.211
1	L	CAL /GEW		1400	4.97	5474	49.18	45.27	61984	22154	- 3.458
8u 0				1500	4.97	5971	49.52	45°24	60921	19356	- 2.820
				1600	4.97	6468	49-84	45.80	56818	16978	- 2.319
				1700	4.97	6965	50.14	46.05	56215	14514	- 1.865
.н.	•	¥		1800	4.97	7462	50.43	46.29	55612	12070	- 1.465
HV	Ľ	CAL /GEW		1900	4.97	1959	50.69	46.51	55009	9675	- 1.112
1	•			2000	4.98	8456	50.95	46.73	54406	7306	798
				2100	4.98	8954	51.19	46.93	53804	4958	- •515
1				2200	4. 99	9453	51.42	47.13	53203	2669	- •265
÷	•	¥		2300	5 • 00	9952	51•65	47.33	52602	346	- •032
3	,			2400	5 • 02	10453	51.86	15°27	0	0	0
μ		LAL. / UFW.		2500	5.04	10956	52.07	47.69	0	0	0
				2600	5.07	11461	52.26	47.86	0	0	0
1				2700	5.10	11970	52.46	48.03	0	0	0
T _c =	•	¥		2800	5.14	12482	52.64	48.19	0	0	0
۱ م		ATM		2900	5.19	12998	52.82	48.34	0	0	0
				3000	5•25	13520	53.00	48.50	0	0	0

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MANGANESE

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In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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i doi:
l, 1956
January 1
Date:
Publication

MERCURY	Hg			Liquid 1	rom 298°	Liquid from 298° to 629.88°, Ideal	°, Ideal		
REFERENCE STATE	VTE			Monatom	ic Gas fr	Monatomic Gas from 629.88°	to 3000°.	•	
chu 200.61	GRAMS	-	و	H0 - H0	2	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
3		TEMPERATURE	PEAT CAPACITY	T 294.15 HEAT CONTENT	T ENTROPY	FREE ENERGY FUNCTION	HEAT ∆ H ^e ,	FREE ENERGY Δ F ⁶	K F00
10 L 12 L 10		e	CAL./DEG./ GFW.	CAL./ GPW.	CAL./DEG./ GFW.	CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	2
		298	6•69	0	18.19	18.19			· · · · · · · · · · · · · · · · · · ·
M.P. CO4•CU	×	300	6.68	12	18.23	18.19			
∆н _m 548.6	CAL / GFW.	400	6 • 5 4	672	20.13	18.45			
			0440	1970	86.12	10.40			
00 003		2007	4.97	16650	46.03	22.25			
B.F. 00 J. 00 J. 00	¥	800	4.97	17140	46.70	25•28			
∆н, 14,137.	CAL. /GFW.	900 1000	4•97 4•97	17640	47•28 47•81	27•68 29•67			
		1100	4.97	18630	48 • 28	31.35			
2.6	×	1200	4.97	19130	48•71	32.77			
			16.4	19020	11.04	35.11			
ΔHs	CAL. /GFW.	1500	4.97	20620	49.82	36.08			
		1600	4.97	21120	50.14	36.94			
	3	1700	4.97	21610	50.44	37.73			
	4	1900	4.97	22610	50.99	39.09			
۵ ۴,	CAL. /GFW.	2000	4.97	23110	51.25	39.70			
		2100	4.97	23600	51.49	40.26			
a +	3	2200	4.97	24100	51.72	40.77			
	4	2300	4.97	24600	51.94	41.25			
ΔH,	CAL. / GFW.	2500	4.97	25590	52.36	42.13			
]	2600	4.97	26090	52.55	42.52			
		2700	4.97	26580	52.74	42.90			
Tc =	*	2800	4.97	27080	52.92	43.25			
، ا	ATM.	2900	4.97	27580	53 • 09	43.58			
		0006	10.4	0/087	07+66	16.04			

MERCURY

MERCURY	JRY	Hg	Ref	cerence S	tate for	Calculati	lng AH ^e , 2	Fr, and]	Reference State for Calculating AH ⁶ , AF ⁶ , and Log ₁₀ Kp: Liquid	Liquid
IDEAL	IDEAL MONATOMIC	GAS	from	2 98°	o 629.88°	, Ideal !	to 629.88°, Ideal Monatomic Gas		from 629.88° t	to 3000°.
*9 9	200.61	GRAMS	-	ۍ.	H ⁰ - H ⁰ T 298.15	er-	-(F°-H° 298.15)	FORMATI	FORMATION FROM REFERENCE STATE	ICE STATE
(H ⁶ 298.15	298.15 H ⁰) = 1,481	CAL/GFW.	TEMPERATURE °K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL. /DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.		CAL./ GFW.	ч , , , , , , , , , , , , , , , , , , ,
			298	4.97	0	41.79	41•79	14650	7613	- 5,580
		ž	300	4.97	9	41.82	41.79	14647	7570	- 5.515 - 2.861
∆Hm		CAL. /GFW.	500	4.97	1003	44.36	42.36	14330	2940	
			600	4.97	1500	45.27	42.77	14180	680	- •247
9		ж	200	4.97	1996	46.03	43.18	0	0	0
		:	800	4.97	2493	46.70	43.59	0 0	00	00
∆н^		CAL. /GFW.	1000	16.4	3487	47.81	44.33	00	00	00
			1100	4.97	3984	48•28	44.65	0	0	0
		*	1200	4.97	4480	48.71	44.98	0	0	0
Ľ.		4	1300	4.97	4977	49.11	45.29	0	0	0
∆ H₅		CAL. /GFW.	1400	4.97	5474	49.48	45°57 45°84	00	00	00
			1600	4.97	6468	50.14	46.10			0 0
			1700	4.97	6964	50.44	46.35	0	0	0
d. H		×	1800	4.97	7461	50.73	46.59	0	0	0
ΔH,		CAL. /GFW.	1900	4.97	7958	50.99	46.81	00	00	00
]	2100	4.97	8952	51.49	47.23	0	00	00
			2200	4.97	9448	51.72	47.43	0	0	0
a. ≓		×	2300	4.97	6966	51.94	47.62	0	0	0
H			2400	4.97	10442	52.15	47.80	0	0	0
5			2500	4.97	10939	52.36	41.99	0	0	0
			2600	4.97	11436	52°55		0	0	0
•		ł	2700	4.97	11932	52.74	-	0	0	0
" "		¥	2800	4.97	12429	52.92	48.49	0	0	0
וו ב		ATM.	2900	4.97	12926	53.09	48.64	00	0	00
			3000	4•97	13423	02.66	48.19	D	D	0

T 1

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MOL YBDENUM	om mune			Solid fr	om 298° t	o 2890°,	Liquid fr	om 2890°	Solid from 298° to 2890°, Liquid from 2890° to 3000°.	
REFEREN	REFERENCE STATE									
3	95.95	GRAMS	-	و	60	9	-(F ⁰ -H ⁰ 296.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
5			-		T 296-15	×-		HEAT A Nº	EREE EVERCY A E	
(H ⁰ 2M. 15 H ⁰	(H ⁰ _{246,15} H ₀ ⁰) = 1,092	CAL./GFW.	¥.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./OFW.	CAL./ GPW.	۲06 ۳
					•					
A.P.	2,890	×.	3006	90.00		0.80	0.00			
	600		400	5.97	595	8 • 54	7.06			
ΔH	0 , 0	CAL. /GFW.	500	6.15	1203	68 •6	7.49			
			600	6.28	1825	11.03	7.99			
			700	6.35	2460	12.00	9.49			
	001 ,c	*	800	6.44	3100	12.85	8°98			
			006	6.55	3750	13.62	9**6			
	FL, UUU	CAL. /GFW.	1000	6.70	4410	14.32	9•91			
			1100	6.86	5090	14.96	10.34			
			1200	7.05	5790	15.57	10.75			
٩. ٩		*	1300	7.24	6510	16.14	11.14			
3			1400	7.45	7250	16.68	11.51			
5 u 2		CAL / GFW.	1500	7.65	8000	17.21	11.88			
			1600	7.83	8780	17.71	12.23			
			1700	8.00	9570	18.19	12.57			
T.P.		*	1800	8.18	10380	13.65	12.89			
Ĭ			1900	8.35	11200	19.10	13.21			
			2000	8.52	12040	19,53	13•51			
			2100	8.69	12900	19.95	13.81			
•		à	2200	8.85	13770	20.36	14.11			
		 e	0062	20.6	14000					
1			2400	61.6	DeccT	T • T 7	14°00			
		CAL. / GFW.	2500	9•36	16510	21.52	14.92			
			2600	9•53	17460	21.89	15.18			
			2700	9.70	18420	22 • 25	15.43			
Tc =		*	2800	9.87	19400	22.61	15.69			
			2900	10.00	26990	26.46	17.16			
= °.		AI M.	3000	10.00	27990	26.80	17.47			

MOLYBDENUM

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MOLYBDENUM	Ŵ		Referenc	ce State	for Calcu	lating AH	¢, ∆₽°, 8	Reference State for Calculating AH [°] , AP [°] , and Log ₁₀ Kp;	8 d
IDEAL MONATOMIC GAS	C GAS		Solid f	from 298°	to 2890°,	to 2890°, Liquid from	rom 2890°	2890° to 3000°.	•
. 95.95			1	1	9	-(1- 10 30 11)	FORMAT	FORMATION FROM REFERENCE STATE	ACE STATE
25	GRAMS	-	<u>კ</u> ო	H H ⁻ T 294.15	۶-		HEAT A H ^e	FREE ENERCY A F	
$(H^{0}_{290,15} H^{0}_{0}) = 1.9481$	CAL/GPW.	TEMPERATURE 9K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	LOG *
		298	4.97	0	43 • 46	43.46	157500	146578	-107-449
A.P.	*	300	4.97	6	43.49	43.46	157498	146509	-106.740
		400	4.97	506	44.92	43.66	157411	142859	- 78.061
△ H	CAL /GFW.	200	4.97	1003	46.03	44°03	157300	139230	- 60.861
		000	4.97	1500	40°04	44°44	157175	135629	
0	3		4.07	0661	41.010	44.00	156803	128477	- 41.620
	6	006	4.97	2990	48.95	45.63	156740	124943	
ΔH v	CAL. /GFW.	1000	4.97	3487	49.47	45 . 99	156577	121427	- 26.540
		1100	4.97	3984	46.95	46.33	156394	117905	- 23.427
		1200	4.97	4481	50.38	46.65	156191	114419	- 20.940
\$.P.	¥	1300	4.97	4978	50.78	46.96	155968	110936	- 18.651
:		1400	4. 98	5475	51.15	47.24	155725	107457	- 16.777
△ H ^s	CAL. /GFW.	1500	4 • 98	5973	51.49	47.51	155473	104053	- 15,161
		1600	5.00	6472	51.81	47.77	155192	100632	- 13.745
		1700	5.02	6973	52.12	48.02	154903	97222	- 12.498
T.P.	×	1800	5.04	7476	52.40	48.25	154596	93846	- 11.393
Δ Ν.	CAL. /GFW.	2000	5.13	8492	52.94	48.48	154282	90480 87132	- 10.407
-		2100	5.18	2006	53.19	48.91	153607	83803	- 8.721
		2200	5.25	9529	53.43	49.10	153259	80505	- 7 <u>°</u> 997
T.P.	×	2300	5.34	10059	53.67	49.30	152879	77163	- 7.332
		2400	5.44	10598	53.90	49° 49	152519	73894	- 6.728
₽H	CAL. /GFW.	2500	5.56	11147	54.12	49.67	152137	70637	- 6.175
		2600	5.69	11709	54.34	49 ° 84	151749	67379	- 5.663
		2700	5.84	12286	54.56	50.01	151366	64129	- 5.190
T _c =	×	2800	6.00	12878	54.77	50.18	150978	60930	- 4.755
		2900	6.19	13487	54.99	50.34	143997	61260	- 4.616
Pc =	ATM.	3000	6•39	14116	55•20	50•50	143626	58426	- 4•256

MOLYBDENUM

MUIMYOOAN	PN WNIW	a			Solid I	rom 298°	I from 298° to 1141°, Solid II from	Solid I	I from	
REFER	REFERENCE STATE	M			1141° to	1297°, L:	to 1297°, Liquid from 1297° to 3000°	1 1297° t	o 3000°.	
Gfw (H ⁶ 298.15 ⁻¹	• 144•27 •••••5=1,804	GRAMS CAL./GPW.	T Temperature °K	C C C C C C C C C C C C C C C C C C C	H ⁰ - H ⁰ T 2915 HEAT CONTENT CAL./ GPW.	S ⁰ F ENTROPY CAL./DEG./ GFW.	-(P	FORMATI HEAT A H ⁶ CAL./GPV.	FORMATION FROM REFERENCE STATE △ H [®] FREE ENERGY △ F [®] LOG orv. c. c.l/ orv. 1 100	ICE STATE LOG K
ď.	1,297	*	298 300	7•20 7•21	130	17.50 17.54	17.50 17.50			
ΔH	(2, 600)	CAL./GFW.	400 200	7.75 8.28	761	19.69 21.48	17.79 18.36			
	COL F		600	8.81 9.35	3325	23•03 24•43	19•01 19•68			
ΩH γ	0, 200 67, 800	CAL /GFW.	800 900 1000	9.88 10.42 10.95	4287 5302 6370	25•72 26•91 28•04	20•37 21•02 21•67			
			1100	11.49	7492	29.10	22.29			
P.S.		¥	1200	8•00 8•00	8780 12180	30.23 32.87	22 . 92 23 . 51			
ΔH₅		CAL /GFW.	1400	8.00	12980	33.47 34.02	24•20 24•84			
			1600	8.00	15380	34.53	25.42 25.98			
а. Г	1,141 /7/0/	*	1800	8.000	16180	35•48 35•48	26.98 26.98			
f ∎⊲	(0#c)		2000 2100	8•00 8•00	17780 18580	36•32 36•71				
T.P.		¥.	2200	0000	19380 20180	37.68				
ΔH		CAL. /GFW.	2400	8.00	20980 21780	37•78 38•10	29•04 29•39			
			2600	8.00	22580	38 • 42	20.07			
T _c =		*	2800	00.00	24180	39.01	30.38			
" "		ATM	3000	8 • 00 8 • 00	24980 25780	39•29 39•56	30.68 30.97			

NEODYMIUM

MITINVICAN	ŪN.		Refer	ence Stat	te for Cal	Reference State for Calculating Afr, Afr, and	AHC, AF	, and		
UNTUINAN			۲۰۵۱ Log	Kp: Solid	1d I from	I from 298° to 1141°	•	Solid II		
IDEAL MONATOMIC GAS	MIC GAS		HOLL	1141° to	1297°, L	from 1141° to 1297°, Liquid from 1297° to 3000°	1 1297° t	o 3000°.		
	GRAMS	-4	و	01	2	-(E ⁰ -H ⁰ 228.15)	FORMATI	FORMATION FROM REFERENCE STATE	ACE STATE	
144.27		TEMPERATURE		T 294.15	~ ⊢	FREE ENERGY	HEAT \triangle H	FREE ENERCY Δ F ^a		
$(H^{298.15} - H_{0}^{9}) = 1,498$	98 CAL./GFW.	*	CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	Loc .	× •
		208	5.28	C	45.24	45.24	76800	68529	- 50.235	35
M.P.	¥	300	5.29	10	45.28	45.25	76797	68475	- 49.888	88
		004	5.67	558	46.85	45.46	76597	65733	- 35.917	17
	CAL. / UFW.	500	6.02	1143	48.15	45.87	76380	63045	- 27.558	58
		600	6.28	1758	49.28	46.35	76141	60391	- 21.999	6
		700	6 • 48	2397	50.26	46.84	75872	57791	- 18.044	4
6.P.	¥	800	6.63	3054	51.14	47.33	75567	55231	- 15.089	68
		006	6.74	3723	51.93	47.80	75221	52703	- 12.798	86
7H 7	CAL /GFW.	1000	6.82	4401	52.64	48°24	74831	50231	- 10.978	78
		1100	6.87	5086	53 •2 9	48.67	74394	47785	- 9.494	4
		1200	06 •9	5774	53 . 89	4 9 • 08	73794	45402	- 8.269	69
5.P.	¥	1300	6.91	6465	54.44	49.47	71085	43044	- 7.236	36
1		1400	6.90	7155	54.96	49.85	70975	40889	- 6.383	83
6 11 D		1500	6.87	7843	55.43	50.21	70863	38748	- 5.645	÷5
		1600	6.83	8528	55.87	50.54	70748	36604	- 4.999	66
		1700	6.79	9210	56.29	50 • 88	70630	34471	- 4.431	31
T.P.	×	1800	6.74	9886	56.67	51.18	70506	32364	- 3.929	50
		1900	6.68	10557	57.03	51.48	70377	30249	- 3.479	- 10
4.0		2000	6.62	11222	57.38	51.77	70242	28122	- 3.072	72
		2100	6.56	11881	57.70	52 • 05	70101	26022	- 2.708	80
		2200	6.50	12533	58.00	52.31	69953	23929	- 2.377	17
1.P.	×	2300	6.44	13180	58.29	52.56	69800	21845	- 2.075	15
I V		2400	6.38	13821	58.56	52.81	69641	19769	- 1.800	00
4u⊳	CAL / GPW.	2500	6.32	14456	58 • 82	53.04	69476	17676	- 1.545	45
		2600	6.27	15086	59 • 07	53.27	69306	15616	- 1.312	112
		2700	6.22	15711	59.30	53.49	69131	13565	- 1.097	101
Tc=	×.	2800	6.18	16331	59•53	53.70	68951	-	1	.897
	ATH	2900	6.14	16947	59.75	53.91	68767	9433		•710
		3000	0110	ACC / T	CA+2C	01.40	A1000		•	20

NEODYMIUM

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NBON		Ne			Ideal Mo	natomic d	Ideal Monatomic Gas from 298° to 3000°.	96° to 3(
REFER	REFERENCE STATE	31								
		11140	,	8	1	٩	- (*** *** ***)	FORMAT	FORMATION FROM REFERENCE STATE	4CE STATE
2	20.185		TEMPERATURE	ارم ا	и — И — И — Т _ 298.15	×-	FREE ENERGY	HEAT A H	FREE EVENCY & F	
(H ⁰ _{2M.15} H ⁰) =		1,481 CAL/GFW.	¥.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GPV.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ 6PW.	LOG K 10 F
			208	4.07	0	34.05	34.95			
A.P.	24.55	¥,	900	10.4	0	34.98	34.95			
			400	4.97	506	36.41	35.15			
A H.	80.1	CAL. / GFW.	500	4.97	1003	37.52	35.52			
			600	4.97	1500	38.42	35.92			
			700	4.97	1996	39.19	36.34			
8.P.	27.07	×	800	4.97	2493	39°85	36.74			
			006	4.97	2990	40.44	37.12			
ΔH Δ	422.	CAL. /GFW.	1000	4.97	3487	40.96	37.48			
			1100	4.97	3984	41.43	37.81			
			1200	4.97	4480	41.87	38.14			
S.P.		×	1300	4.97	4977	42.26				
			1400	4.97	5474	42.63				
₽ ₩ ₽		CAL. /GFW.	1500	4.97	1165	42.97				
			1600	4.97	6468	43.30	39.26			
			1700	4.97	4969	43.60	39.51			
T.P.		×	1800	4.97	7461	43.88	39.74			
			1900	4.97	7958	44.15	39.97			
₽H		CAL. /GFW.	2000	4.97	8455	-	40.18			
			2100	4.97	8952	-	40.39			
			2200	4.97	9448		40.59			
T.P.		×	2300	4.97	6945	-	40.78			
			2400	4.97	10442	45.31	40.96			
ΔH,		CAL. /GFW.	2500	4.97	10939	45.51	41.14			
			2600	4.97	11436	•	41.32			
			2700	4.97	11932	45.89	41.48			
Tc =	45.5	*	2800	4.07	12429	-	41.65			
			2900		12926	-	41.80			
" •	26.9	ATM.	3000	4.97	13423	. 46.42	41.95			

NEON

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NICKEL	ŦN			Solid fr	om 298° t	:0 1728°,	Liquid fr	om 1728°	Solid from 298° to 1728°, Liquid from 1728° to 3000°.	
REFERE	REFERENCE STATE									
Gfæ	58.71	GRAMS	F	گ	H ^o - H ^o T 22415	°.	-(F°-H° 228.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H ⁰ _{246.15} H ₀) =) = 1,144	CAL./GFW.	temperature °K	HEAT COL. D	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	CAL./GFW.	FREE ENERGY & F CAL./ GFW.	х ^ь 901
			298	6.23	0	7.14	7.14			
A.P.	1,728	¥	300	6.24	12	7.18	7.14			
3			400	6.76	662	6 0 05	7.40			
	4,210	LAL / GTW.	500	7.47	1373	10.64	06•1			
			600	8.37	2165	12.08	8.48			
0	•	3	700	7.35	2940	13•28	9.08			
d	5,110	4	800	7.44	3690	14•28	10.6			
ΔH	88,870	CAL. /GFW.	0001	7.62 7.80	4445 5210	15.17 15.98	10.24			
			1100	7.98	5985	16.72	11.28			
			1200	8.16	6780	17.41	11.76			
5.P.		*	1300	8.34	7600	18•07	12.23			
3		ABC/ 175	1400	8.52	8450	18.70	12.67			
1			1500	8.70	9320	19.30	13•09			
• •			1600	8.88	10210	19.87	13.49			
			1700	9•00	11110	20.42	13.89			
н. Ч.	630 ^{°K}	*	1800	9•20	16230	23.37	14.36			
ΔH	0	CAL. /GFW.	0061	02.09	18070	24.34	15.31			
			2100	9.20	18990	24.79	15.75			
			2200	9.20	19910	25.22	16.17			
T.P.		¥	2300	9•20	20830	25.63	16.58			
			2400	9.20	21750	26.02	16.96			
ΔH,		CAL. /GFW.	2500	9•20	22670	26.39	17.33			
			2600	9.20	23590	26.76	17.69			
			2700	9•20	24510	27.10	18.03			
T _c =		* *	2800	9•20	25430	27.44	18•30			
ا م		ATM	2900	9.20	26350	27.76	18.68			
•			3000	9.20	01212	10.82	70.040			

NICKEL

56-0018.ch004
a-19.
10.1021/b
doi:
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January
Date:
Publication

NICKEL N1	F	Ref e renc	e State fo	or Calcul	Reference State for Calculating $\Delta H_{ m P}^{ m s}, \ \Delta F_{ m P}^{ m s},$ and Log ₁₀ Kp:	, ∆P°, an	d Log _{1 O} Kp	
IDEAL MONATOMIC GAS	۲ ۵	Solid from 298°	om 298° to	0 17 28°, 3	to 1728°, Liquid from 1728° to 3000°	m 1728°	to 3000°.	
GH. 58.71 CEAM		٤	6 1 6 1 6		-(F°-H° 298.15)	FORMATI	FORMATION FROM REFERENCE STATE	ICE STATE
	TEMPERATURE		T 296.15	n [⊢]	FREE ENERGY	HEAT ∆ H [®]	FREE ENENCY & F	
(H ² _{206,15} H ₀) = L ^{DDL} CAL/GFW		HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GPW.	CAL./GFW.	CAL./ GPW.	LOG K
	298	5.58	0	43.52	43.52	101260	90413	- 66.277
.e.	300	5.58	10	43.55	43.52	101258	90347	- 65.823
	400	5.70	574	45.18	43.74	101172	86720	- 47.385
∆ H _m CAL./GFW		5.83	1151	46.46	44.16	101038	83128	- 36.337
	00	5.91	1738	47.53	44.64	100833	79563	- 28.983
		5 . 96	2332	48.45	45.12	100652	75033	- 23.740
B.P.	800	5.97	2929	49.24	45.58	100499	72531	- 19.816
	006	5.96	3525	49°95	46.04	100340	69038	- 16.765
DH, CAL. /GFW		5.94	4120	50.57	46.45	100170	65580	- 14.333
		5 . 90	4712	51.14	46.86	99987	62125	- 12.344
	1200	5.86	5301	51.65	47.24	09781	58693	- 10.690
s.P. %	1300	5.82	5885	52.12	47.60	99545	55280	- 9.294
		5.78	6465	52.55	47.94	99275	51885	- 8.100
∆Hs CAL./GFW		5.74	7041	52 • 95	48.25	98981	48506	- 7.067
	1600	5.70	7613	53.31	48.56	98663	45159	- 6.168
	1700	5.66	8181	53.66	48.85	98331	41823	- 5.376
T.P. %	1800	5.62	8745	53 • 98	49.13	93775	38677	- 4.695
	1900	5.59	9306	54.28	49.39	93416	35637	- 4.098
∆H, CAL./GFW		5.56	9863	54.57	40.64	93053	32593	- 3.561
	5100	5.53	10417	54.84	49 • 88	92687	29582	- 3•078
		5.50	10968	55.10	50.12	92318		- 2.640
T.P. %K	2300	5.47	11517	55.34	50.34	91947		- 2.243
	2400	5 • 45	12063	55.57	50.55	91573	20653	- 1.880
∆H, CAL./GFW		5.43	12607	55.80	50.75	91197	17672	- 1.544
	- 2600	5.41	13149	56.01	50.96	90819	14769	- 1.241
	2700	5.40	13690	56.21	51.14	90440	11843	958
Tr = %	2800	5.38	14229	56.41	51.33	90059	8943	- • 698
	2900	5.37	14767	56.60	51.51	89677	6041	455
P _c = ATM.	3000	5.36	15303	56.78	51.68	89293	3163	- •230

NIGBIUM		Re Re		Soli	d from 29	8° to 277	0°, Liqui	d from 2'	Solid from 298° to 2770°, Liquid from 2770° to 3000°.	.00
REFER	REFERENCE STATE	R								
	92 . 91			,				FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
		GRAMS	-	°.	H ⁰ H ⁰ T 296.15	ջ,⊢		UEAT A U ⁰		
(H ⁰ _{298 , 15} H ⁰) =	H ₅)= 1,264	CAL./GFW.	TEMPERATURE °K	HEAT OLL	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	CAL./GPW.	CAL./ GFW.	х • 901
			208	5,05	C	0 72				
1	2.770	ł	300		11	8.77	8.74			
Ľ.		¥	400	6.04	610	-				
∆H	(6,400)	CAL. / GFW.	500	6.14	1220	11.85	9.41			
			600	6.24	1840	12.98	9 • 92			
			200	6.33	2470	13.94	10.42			
a 	5,200	, ,	800	6.43	3110	14.80	10.92			
6		2	006	6.52	3750	15.56	11.40			
	166,500	CAL /GFW	1000	6.62	4410	16.25	11.84			
Au7			1100	6.72	5080		12.28			
	-		1200	6.81	5750	17.48	12.69			
			1300	6.91	6440	18.02	13.07			
Ľ		4	1400	7.00	7130					
Δ H.		CAL. /GFW.	1500	7.10	7840	-				
•			1600	7.20	8550	19.49	14.15			
			1700	7.29	9280					
0 }			1800	7.39	10010		14.79			
		4	1900	7.48	10760		15•09			
ΔH,		CAL. /GFW.	2000	7.58	11510		15.38			
			0022	1000	13050	10.12	15.04			
			2300	7.87	13830	22.21	16-20			
<u>.</u>		¥	2400	7.96	14620					
1		141 / CEW	2500	8.06	15420	22.88				
			2600	8.16	16230					
			2700	8 • 25	17050	23.51	17.20			
۱ ۲			2800	8 • 00	24270		17.46			
-		•	2900	8 • 00	25070		17.76			
" "		ATM.	3000	8•00	25870	26.67	18.05			

NIOBIUM

ă Ľ		525
Reference State for Calculating Af [*] , A [*] , and Log Solid from 298° to 2770°, Liquid from 2770° to 30	FROM REF E ENERGY 2 CAL./GFV.	166837 166771 163175
i from 277	FORMATION FROM REFEREN HEAT Δ H ^o FREE ENERGY Δ F ^o CAL. OFT. CAL. 7 OFT.	177500 177502 177619
Solid from 298° to 2770°, Liquid from 2770° to 30	-(F ⁰ -H ⁰ 281.15) PREE ENEROY FUNCTION CAL./DEQ./ OF W.	44°49 44°50 44°78
98° to 277	S ⁰ T ENTROPY CAL./DEG./GFW.	44• 49 44• 54 46• 60
ld from 2!	H ⁰ - H ⁰ T 2015 HEAT CONTENT CAL./ GPV.	0 13 729
Soli	T C ⁰ TEMPERATURE HEAT CARACITY PK CAL./DEG./ GPV.	7.21 7.21 7.09
	T TEMPERATURE •K	298 300 400
GAS	GRAMS CAL-/GPV.	
LDEAL MONATOMIC GAS	.91 1,997	•
IDEAL	Głw 92 (H ^e _{216.13} H\$) =	d. M

NIGBIUM	AN N		Ref	erence Stu	ate for C	Reference State for Calculating ΔH_{P}^{\bullet} , ΔP_{P}^{\bullet} , and $Log_{10}Kpt$	B CH, CF	f, and Lo	g ₁₀ kp:
IDEAL MONATOMIC GAS	ILC GAS		Sol	Solid from 298°		to 2770°, Liquid from 2770° to 3000°	1d from 2	770° to 3	.000
			1	9	•	- (F ⁰ -M ⁰ 244 14)	FORMATI	FORMATION FROM REFERENCE STATE	ACE STATE
	GRAMS	TEMPERATURE		H - H - 548-15	د -	FREE ENERGY	HEAT A H ^o	FREE ENERGY & F	
$(H_{241,15}^{0} - H_{0}^{0}) = L_{342,15}^{0}$	J CAL/GPW.	ж.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GPW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	ч , ГОС
		298	7.21	0	44.49	67*77	177500	166837	-122-299
0		300	7.21	13	44 • 54	44.50	177502	166771	-121.502
	2	400	2.09	729	46.60	44.78	177619	163175	- 89.162
∆ H	CAL. / GFW.	200	6•89 6•70	1428	48.16	45.31 45.80	177708	159553	- 69.745
		2002	0		3	46.47	177800	152264	- 47.542
0	ł	800	Q.		2.	47.01	177807	148623	- 40.605
	4	006	Q,)3	47.53	177801	144978	- 35.207
ΔH.	CAL. /GFW.	1000	Q.		6	48.02	177764	141324	- 30.889
		1100	ý,		27	48.47	177708	137690	- 27.359
		1200	võ i		0	48.89	177645	134061	- 24.417
	*	1300	ň		8	49 • 29	177556	130418	- 21.927
		1400	ň		2	49.65	177462	126810	- 19.797
ΔHs	CAL. / GFW.	0061	ñ		τ.	10.00	177344	123194	- 17.950
		1 3000	Ň			50•34	177225	119593	- 16.335
		00/1	n i			00.00	C80/11	115987	- 14.911
T.P.	*	1800	26.92	9456	56•21	50.96	176946	112398	- 13.646
	:	1900	*6°G	10049	50.53	51.25	176789	108807	- 12.514
Δ Η,	CAL. / GFW.	2000	86.4	10040	50.83	51•51	176636	105236	- 11.499
		2200		11853	57.41	52.03	176303	101014	186-01 -
		2300	6.16	12465	57.68	52.27	176135	94554	- 8.984
ż	4	2400	6.24	13086	57.94	52.49	175966	91030	- 8.289
A M	CAL /GEW	2500	6.33	13714	58.20	52.72	175794	87494	- 7.648
F 1	ž 10 / 100	2600	6.42	14351	58 • 45	52 . 94	175621	83971	- 7.058
		2700	6.51	14998	58.70	53.15	175448	80435	- 6.510
	1	2800	6.61	15654	58.93	53.34	168884	91011	- 6.011
Tc≡`	¥	2900	6.71	16321	59.17	53•55	168751	73718	- 5.555
= °	ATM.	3000	6.82	16997	59.40	53.7 4	168627	70437	- 5.131
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NIOBIUM

NITR	NITROGEN N ₂	0			Ideal D14	atomic Ga	Ideal Diatomic Gas from 298° to 3000°.	3° to 300	•••	
REFE	REFERENCE STATE	ല								
ł	28-016	C D A W C	F	و	97 91	ą	-(E ⁰ -H ⁰ 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
2					T 299.15	°.−	FREE ENERGY	HEAT A H ^o	FREE ENERGY & F	
(H ⁰ 298. 13	$(H^{0}_{298,15} - H^{0}_{9}) = 2_{9}072$	CAL./GFW.	Xe	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	LOG K
			208	A. O.A	c	45.77	45.77			
A.P.	63.18	¥	300		12	45.81	45.77			
			400	6.99	709	47.82	46.05			
₽₩	172.	CAL. /GFW.	500	7.07	1412	60°30	46.57			
			600	7.19	2125	50.69	47.67			
	32 66	4	800	7.35	2852	51.81	47.72			
6		<	88	1001	1955	52.60	40.86			
∆ H ∕	1,335.	CAL. /GFW.	1000	7.81	5129	54.51	6 8 6 4			
]	1100	7.94	5918	55.26	49. 88			
			1200	8 • 0 6	6718	55.96	50.37			
J.S.		¥	1300	8.16	7530	56.61	50.82			
			1400	8.25	8351	57.21	51.25			
° µ °		CAL /GFW.	1500	8•33	9180	57.79	51.67			
			1600	8.39	10017	58.33	52.17			
			1700	8.45	10860	58.84	52•46			
ч. -	35.62	×	1800	8.51	11709	59.32	52.82			
ΔH	55.	CAL. /GFW.	2000	8.60	13421	60.22	53.51			
			2100	8.64	14283	60.64	53.84			
			2200	8.67	15149	61.05	54.17			
d. F		*	2300	8.70	16018	61.43	54.47			
H		CAL /GEW	2400	8.73	16890	61.80	54.77			
			2500	8.75	17764	62.16	55.06			
			2600	8.78	18641	62.51	55.35			
,			2700	8.80	19521	62.84				
"	126.26	¥	2800	8.82	20402	63.16				
11 a	22 E.I	ATM	2900	8 8 9	21286	63.47	56.13			
		-	3000	8.80	22171	03.11	90•38			

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NITROGEN	N		Refer	ence Stat	e for Cal	Reference State for Calculating Aff, Aff, and	oh°, ∆r°,	and		
IDEAL MONATOMIC	GAS		Log ₁₀ Kp:		l Distomi	Ideal Diatomic Gas from	2 98 °	to 3000°.		
		•	1		•		FORMATI	FORMATION FROM REFERENCE STATE	NCE STATE	
6tw 14.008	GRAMS	Telebentine		H°H° T 294.15	ւ-	FREE ENERGY	HEAT A H ^o	FREE ENERGY 🛆 F		
$(H^{\circ}_{298,15} - H^{\circ}_{0}) = 1, 481$	CAL./GFW.	×.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	F CAL./GFW.	F CAL./ GFW.	° LOG	Χ,
	ſ	298	4.97	0	36.61	36.61	113000	108760	- 79.	726
L	. *	300	4.97	0	36.65	36.62	113003	108881	- 79.	79.326
		400	4.97	506	38.07	36.81	113151	107487	- 58.	58.733
△ H _m	CAL. / GFW.	500	4.97	1003	39.18	37.18	113297	106057	- 46.	46.360
		600	4.97	1500	40.09	37.59	113437	104593	- 38.101	101
	Γ	700	4.97	1996	40.85	38.00	113570	103112	- 32.	32.195
B.P.	*	800	4.97	2493	41.52	38.41	113695	101599	- 27.	27.757
		006	4.97	2990	42.10	38.78	113812	100087	- 24.	24.306
2H2	CAL. /GFW.	1000	4.97	3487	42.63	39.15	113922	98552	- 21.	21.540
]	1100	4.97	3983	43.10	39.48	114024	97007	- 19.	19.275
		1200	4.97	4480	43.53	39.80	114121	95461	- 17.	17.387
S.P.	×	1300	4.97	4977	43.93	40.11	114212	93906	- 15.	5.788
		1400	4.97	5474	44.30	40.39	114298	92332	- 14.	14.414
∆ H _s	CAL. /GFW.	1500	4.97	5971	44.64	40.66	114381	90771	- 13.	3.226
		1600	4.97	6468	44.96	40.92	114459	89195	- 12.	12.183
	[1700	4.97	6964	45.26	41.17	114534	87606	- 11.	11.262
T.P.	*	1800	4.97	7461	45.55	41.41	114606	86004	- 10.	441
		1900	4.97	7958	45.82	41.64	114676	84409	•	9.708
₽ ₩ ⁴	CAL. /GFW.	2000	4.97	8455	46.07	41.85	114744	82824	• •	9•050
]	2100	4.97	8952	46.31	42.05	114810	81231	80 1	8.453
		2200	4.97	6446	46.54	42.25	114874	79652		7.912
T.P.	*	2300	4.97	9466	46.76	42.44	114937	78045		7.415
		2400	4.97	10443	46.98	42.63	114998	76406	• •	957
ΩH,	CAL. /GFW.	2500	4. 98	10941	47.18	42.81	115059	74809	• • •	6.539
		2600	4.98	11439	47.37	42.98	115118	73232	• • •	6.155
	ſ	2700	4.99	11937	47.56	43.14	115176	71598	۔ 5•	5.795
T.=	 X	2800	4.99	12436	47.74	43.30	115235	69987	۔ ۍ	5.462
	:	2900	5.00	12936	47.92	43.46	115293	68371	۔ 2	5.152
Pc =	ATM.	3000	5.01	13437	48 • 09	43.62	115351	66751	- - -	4.862
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NITROGEN

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MUIMSO		Os		Sol1d	l from 294	8° to 300	Solid from 298° to 3000°, Liquid at 3000°.	l at 3000	•		
REFE	REFERENCE STATE	I									
č	0 20 7		,	1	1	٩	-fr°-fr° 200 111)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE	.
25	2.06T	CHANN	-		H H	ۍ- ۲	EDEE ENEDOV	HEAT A H ^o	FREE ENERCY A F		
(H ^o _{298.15} H ₀) =	- H <mark>0</mark>) =	CAL./GFW.	•K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GPW.	CALL/ GPW.	гос , к Гос	
			298	5.95	0	7.80	7.80				
M.P.	(3,000)	×	300	5.95	11	7.84	7.81				
H <	(000) 2)	CAL /GFW	400	6 • 0 4	610	9.56	8.04				
	1000 511			61.0	10121	10.00					
			000	6.31	2460	13.00	64.6				
8 . 9.	(4,500)	%	800	6.39	3100	13.86	66°6				
			006	6.48	3740	14.61	10.45				
∆H ,	(150,000)	CAL. /GFW.	1 000	6.57	4390	15•29	10.90				
			1100	6.66	5060	15.92	11.32	_			
			1200	6.75	5730	16.50	11.73	_			
а.		*	1300	0.83	6410	17.03	12.10	_			
H <		CAL /GEW	1400	6.92	1090	17.54	12.48	_			
			TOUC	10.1	0611	70.02	C 9 • 7 T	_			
			1600	7.10	8490	18.49	13.19	-			
			1700	7.19	9210	18.93	13.52	_			
<u>.</u>			1800	1701	0566	19.34	13.85				
ΔH,		CAL. / GFW.	006T	7.45	11400	20.12	14.42	_			
			2100	7.54	12150	20.48	14.70	_			
			2200	7.63	12910	20.83	14.97	_			
a. 		*	0062	1	13680	11.12	67°67				
-			2400	7.80	14450	04•12	15.48				
1 ⊔		CAL. / GFW.	2500	7.89	15240	21.82	15.73	_			
			2000	1.98	16030	22.14	86°4T	_			
			2700	8.07	16840	22.44	16.21				0
Т _{с =}		×.	0082	6T•8	04971	5/•77 5/•72	10.43	_			5M
יי בי		ATM.	3000	1 0 0 0 0	26200	25.60	16.87	. –			IUI
,		_									

Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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January
Date:
Publication

MULINSO	80		Referen	ce State	for Calcu	lating AH	, ∆ ⁷ , 8	Reference State for Calculating AH ^e , AP ^e , and Log ₁₀ Kp:	8
IDEAL MONATOMIC GAS	IIC GAS		Solid f	from 298°	to 3000°,	to 3000°, Liquid at	c 3000°.		
6ł- 190.2	GRAMS	-	٤	9H - H0	e	-(1-46 226.15)-	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
		TEMPERATIRE		T 294.15	•-	FREE ENERGY	HEAT ∆ H°	FREE EVENCY & F	
(H ⁰ _{210.15} H ₀ ⁰) = 1,481	CAL./GFW.	¥.	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GPW.	FUNCTION CAL./DEG./ GFW.	CAL./GPW.	CAL./ GFW.	90 7 °
		298	4.97	0	46.00	46-00	160000	148610	-108-938
d	*	300	4.97	6	46.03	46.00	159998	148541	-108.221
i	:	400	4.97	506	47.46	46.20	159896	144736	- 79.086
∆ H	CAL. / GFW.	500	5.00	1005	48.57	46.56	159795	140960	- 61.617
		600	5.04	1506	40.49	46.98	159676	137200	- 49.979
		700	5.12	2014	50.27	47.40	159554	133465	- 41.673
P.	×	800	5•23	2532	50.96	47.80	159432	129752	- 35.449
		006	5.37	3061	51.59	48.19	159321	126039	- 30.608
ΔH,	CAL. /GFW.	1000	5.52	3606	52.16	48.56	159216	122346	- 26.741
		1100	5.69	4166	52.69	48.91	159106	118659	- 23.577
		1200	5.87	4744	53.20	49°25	159014	114974	- 20.941
s.P.	¥	1300	6.04	5340	53.67	49.57	158930	111298	- 18.712
		1400	6.21	5952	54.13	49.88	158862	107636	- 16.804
ΔHs	CAL. /GFW.	1500	6.37	6581	54.56	50.18	158791	103981	- 15.151
		1600	6.52	7226	54.98	50.47	158736	100352	- 13.707
		1700	6.66	7885	55.38	50.75	158675	96710	- 12.433
•		1800	6.78	8557	55.76	51.01	158627	93071	- 11.299
	"	1900	6.89	9240	56.13	51.27	158580	894.39	- 10.287
Δ Η,	CAL. /GFW.	2000	66•9	9634	56.48	51.52	158534	85814	- 9.376
		2100	7.07	10637	56.83	51.77	158487	82152	- 8.549
		2200	7.15	11348	57.16	52.01	158438	78512	- 7.799
T.P.	×	2300	7.22	12067	57.48	52.24	158387	74874	- 7.114
		2400	7.28	12792	57.79	52.46	158342		- 6.487
дн,	CAL. /GFW.	2500	7.34	13523	58.08	52.68	158283	67633	- 5.912
		2600	7.39	14260	58.37	52.89	158230	64032	- 5.382
		2700	7.44	15002	58.65	53.10	158162	60395	- 4.888
T =	×	2800	7.48	15748	58.93	53.31	158098	56738	- 4.428
		2900	7.52	16498	59.19	53 • 51	158028	53135	- 4.004
= °	ATM.	3000	7.55	17251	59.44	53.69	151050	49530	- 3.608

OSMIUM

0XC	OXYGEN	0 ² 0			Ideal D14	atomic Ga	Ideal Diatomic Gas from 298° to 3000°.	3° to 300	•••	
RE	REFERENCE STATE	ATE								
Głw	32.000	GRAMS	T	ື້	¥°₩°	e,	-(F"-H" 299.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H ⁰ _{214 . 15} H ₀ ⁰) =	-H°)= 2,075	CAL/GFW.	TEMPERATURE •K	HEAT CAPACITY CAL./DEG/ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H	FREE ENERGY & F	L06 К
			208	7.02	0	49-01	49-01			
м.Р.	54.36	¥	300	7.02	13	90°64	49.02			
:			400	7.20	723	51.10	49. 30			
PH	106.3	CAL. / GFW.	500	7.43	1454	52.73	498 3			
			800	7.67	2209	54.11	50.43			
			28	7.88	2987	55+30	51.04			
	90.19	ř	800	8.00	3785	10.00	10°10			
AH.	L R T L	CAL /GFW.		8.21	2004 2004	56.00	52.72 52.78			
	• ^ ^ ~				6265	59.00	53.31			
			1200	8.53	7114	\$9.74	53 . 82			
S.P.		¥	1300	8.60	0161	60.42	54.29			
			1400	8.67	8834	61.06	54.75			
₽₩ [®]		CAL. /GFW.	1500	8.74	9105	61.66	55.19			
			1600	8.80	10582	62.23	55.62			
			1700	8.86	11464	62.76	56.02			
T.P.	23.89	¥	1800	8.92	12353	63.27	56.41			
A M C		CAL /GEW	1900	8.97	13248	03.70	91.00			
-	E. 77		2002		15053	04.00	57.50		•	
			2200	9.14	15965	65.08	57.83			
T.P.	43.80	¥	2300	9.19	16881	65.49				
1			2400	9.25	17803	65.88	58.47			
± ⊲	177.6	CAL./GFW.	2500	9.30	18731	00.00				
			2000	14.0	20001	66.98	56.95			
T	154,7R	*	2800	94.6	21544	67.32	59 . 63			
			2900	9.50	22492	67.66	59.91			
" •	50.14	ATA	3000	9.55	23445	67.98				

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OXYGEN	o		Refer	ence Stat	te for Cal	Reference State for Calculating AH ^c , AF ^c , and	ΔH°, ΔP°	and		
IDEAL MONATOMIC GAS	C GAS		Log ₁₀ Kp :	Kp: Idea	I Diatomi	Ideal Diatomic Gas from	m 298° to	to 3000°.		
		,	8	9	9	-(L ^o -L ^o 288 11)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STA	TE
000.41 win	GRAMS	-		H ⁰ H ⁰ T 296.15	۲- ۲	FREE FREAV	HEAT A H ^o	FREE ENERGY 🛆 F		
$(H^{0}_{299.15} - H^{0}_{9}) = 1,607$	CAL./GFW.	Me.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	LOG LOG	2° 2°
		298	5.24	0	38.47	38.47	59550	55387	1	40.601
, E	×	300	5.23	10	38.50	38.47	59553	55362	1	40.334
		400	5.13	528	30°66	38.67	59716	53940	1	29.473
ΔHm	CAL. / GFW.	500	5.08	1038	41.13	39.06	59861	52476	∾ 1	22.938
		600	5.05	1544	42.05	39.48	59989	50989	1	18.574
		700	5.03	2048	42.83	39.91	60104	49478	1	15.449
B.P.	×	800	5.02	2550	43 • 50	40.32	60207	47951	1	13.100
		006	5.01	3051	60° 44	40.70	60301	46414	-	11.271
Δ H,	CAL. /GFW.	1000	5.00	3551	44.62	41.07	60387	44867	I	9.806
		1100	4 •99	4051	45.09	41.41	60468	43319	ı	8.607
		1200	4. 99	4550	45.53	41.74	60543	41751	I	7.604
S.P.	×	1300	4 •99	5049	45.93	42.05	60614	40178	ı	6.755
		1400	4.98	5548	46.30	42.34	60681	38603	I	6.026
△ H ₅	CAL. / GFW.	1500	4.98	6046	40.04	42.61	60743	37028	I	5.395
		1600	4•98	6544	46.96	42.87	60803	35443	ı	4.841
		1700	4•98	7042	47.27	43.13	60860	33847	I	4.351
T.P.	×	1800	4•98	7540	47.55	43.37	60913	32275	I	3.918
		1900	4.98	8038	47.82	43.59	60964	30678	ı	3.529
ΔH,	CAL. /GFW.	2000	4•98	8535	48.07	43.81	61011	29091	ı	3.178
		2100	4•98	9033	48.32	44.02	61056	27477	I	2.859
		2200	4•98	9531	48.55	44.22	61098	25876	I	2.570
T.P.	×	2300	4.98	10029	48.77	44.41	61138	24292	I	2.308
		2400	4•98	10527	48.98	44.60	61175	22679	I	2.065
∆ H,	CAL. /GFW.	2500	4.98	11025	49.19	44.78	61209	21060	ı	1.841
		2600	4•99	11523	49.39	44.96	61241	19433	ı	1.633
	ſ	2700	4 •99	12022	49.57	45.12	61271	17855	I	1.445
T.=	×	2800	4 •99	12521	49.76	45.29	61299	16219	ı	1.265
9		2900	5.00	13021	49.93	45.44	61325	14635	ı	1.102
= °	ATM.	3000	5.00	13521	50.10	45.60	61348	13018	I	• 948

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

PALL	PALLADIUM P	Pd		Solid	from 298	• to 1823	°, Liquid	from 182	Solid from 298° to 1823°, Liquid from 1823° to 3000°.	
REFE	REFERENCE STATE	ы								•
Gf	106.4	GRAMS	F	ಲ್	H ⁰ - H ⁰	°,	-(F°-H° 238.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
$(H^{0}_{2^{10}, 15} - H^{0}_{6}) =$	-н°)= 1,308	CAL/GFW.	temperature °K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	REAL A H	FREE ENERGY & F CAL./ GFW.	LOG K
			298	6-26	0	9-05	50°6			
A . P.	1,823	×	300	6.27	11	60.6	90.6			
:			400	6.35	640	10.89	9.29			
∆ Hm	4 ,000	CAL. /GFW.	500	64.6	1280	12.32	9.76			
			600	6.62	1940	13.52	10.29			
	001		700	6.76	2610	14•55	10.83			
8 6	5,400	×	800	9.90	3290	15.46	11.35			
ДН-	94,000	CAL /GFW.	006	7.04	3980	16•28	11-86			
				7.32	5420	17.70	12.80			
			1200	7.46	6170	18.37	13.23			
S.P.		×	1300	7.60	6930	18.97	13.64			
:			1400	7.74	2690	19.54	14.05			
₽		CAL. /GFW.	1500	7.88	8460	20.08	14.44			
			1600	8.02	9250	20.59	14.81			
			1700	8.16	100060	21.08	15.17			
d. T		×	1800	8 30	10890	21.55	15.50			
ΔH,		CAL. /GFW.	0002	8.30	16550	19-70	16.34			
			2100	8.30	17380	25.02	16.75			
		ſ	2200	8.30	18210	25.40	17.13			
T.P.		%	2300	8.30	19040	25.77	17.50			
			2400	8•30	19870	26.13	17.86			
∆H,		CAL. /GFW.	2500	8•30	20700	26.47	18.19			
			2600	8.30	21530	26.79	18.51			
			2700	8.30	22360	27.10	19.82			
Tc =		Υ.	2800	8 30	23190	27.41	19.13			
			2900	8•30	24020	27.70	19.42			
" "		ATM.	3000	8 • 30	24850	27•98	19.70			

THERMODYNAMIC PROPERTIES OF THE ELEMENTS

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PALLADIUM

PALLADIUM	Pd		Refe	rence Sta	te for Ca	lculating	CH, CF	Reference State for Calculating AH, AF, AF, and Log, Kp:	, Kp t
IDEAL MONATOMIC GAS	IC GAS		Solt	Solid from 298°	8° to 18 2	3°, Liqui	d from 16	to 1823°, Liquid from 1823° to 3000°	••••
106.4			1	1	9	-(L ⁰ - L ⁰ , 10 , 11	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
	GKAMS	TEMPERATINE	ل ه ا	H - H	ۍ- ۲	FREE ENERGY	HEAT △ H°	FREE ENERGY & F	
L ²²⁹ e ^L = (² H ⁻¹) = L ² & L	CAL/GFW.	¥.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	F CAL./GFW.	F CAL./ GFW.	L06 K
		298	4.97	0	39.90	39.90	94000	84802	- 62.164
A.P.	¥	300	4.97	6	39.93	39.90	93998	84746	- 61.742
-		400	4.97	506	41.36	40.10	93866	81678	
∆ 14	CAL. / GFW.	0009	4 . 07	1500	42.47	40.47	93723	78648	
	ſ	700	4.97	1997	44.14	20004	79550	10044	CCC•17 -
B.P.	¥	800	4.98	2494	44.91	41.70	93204	69724	
		006	5.02	2994	45.40	42.08	93014	66806	- 16.223
ΔH v	CAL. /GFW.	1000	5•08	3499	45.93	45.44	92809	63909	- 13.968
		0011	5.20	4013	46.42	42.78	92593	61023	- 12.125
		0021	50.00	4041	40.88	43.10	92371	58159	- 10.593
S.P.	¥			1600	41.32	43.41	92161	55306	- 9.298
1				500C	4	43.71	61616	52485	- 8.193
5 u D			90.00	1020	100100	40°04	12816	49686	- 7.239
		1700	10-2		6C • 04	07.44	100T6		- 0.403
9 +	, NO	1800	7.69	8376	40°64	64.44	61486	44090	- 5.012
	•	1900	8.17	6916	49.97	45.05	87449	38657	- 4.446
ΔH	CAL. / GFW.	2000	8.63	10009	50.30	45.30	87459	36079	- 3.942
		2100	0°6	10894	50.73	45.55	87514	33523	- 3.488
		2200	10044	11820	51.16	45.79	87610	30938	- 3.073
T.P.	×	2300	9.77	12781	51.59	40.04	87741	28355	- 2.694
		2400	10.03	13771	52.01	46.28	87901	25789	- 2,348
ΔH	CAL. /GFW.	0042	10.24	14785	52.42	46.51	88085	23210	- 2.029
		0002	0C • 0T	01961	68.74	40.75	88286	20582	- 1.730
		00/7	10.40	16858	53.22	46.98	88498	17974	- 1.454
Tc =	×	0002	5+ 0 F	006/T	00.60	47.21	88716		- 1.200
		0062	14.01	46681	16.65	47.44	88934	12751	
۲ ₆ =	ATM.	0000	74007	SSST	24 • 32	41.00	89149		- •737

PALLADIUM

Publication Date: January 1, 1956 | doi: 10.1021/ba-1956-0018.ch004

PHOS	PHOSPHORUS	4			Red Tric	linic Sol	Red Triclinic Solid from 298° to 704°,	98° to 7	04°,	
REFE	REFERENCE STATE	TE			Ideal D1	atomic Ga	Ideal Diatomic Gas from 704° to 3000°.	4° to 30		
ł	30.975	GRAMS	-	ບ	H° – H°	°2,	-(1-40 200-15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
(H [°] _{298 . 15} H°)	= 🛃	CAL./GFW.	TEMPERATURE	HEAT	T 294-15 HEAT CONTENT CAL./ GFW.	T ENTROPY CAL. /DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H ^o cal./Gfw.	FREE ENERGY A F	гос ж "
			208	4.08	0	5.46	5.46			
A G	870	Å	300	4.98	6	5.49	5.46			
			400	5.37	527	6.98	5.67			
ΔH		CAL. /GFW.	200	5.76	1083	8.22	6.06			
			600	6.14 6.53	1678	9•30 10-28	6.51 6.08			
9		×	800	4.34	23450	30.13	.82			
		:	006	4.37	23890	30.65	4.11			
∆H		CAL. /GFW.	1000	4.40	24330	31.10	6.77			
			1100	4.42	24770	31.53	9•02			
			1200	4.43	25210	31.92	10.92			
S.P.	704	¥	1300	4.44	25660	32.27	12.54			
	000 1		1400	0 1 • 1 •	26100	32.50	13.96			
° ⊔ ⊲	7		0061	- + - + - + - + - + - + + - + + - +	04407	16.26	12.61			
			0001	1 + • +	21000	93.02	10.32			
			1700	4 • 48	27440	33.40	10 23			
i.		¥	1900	4.50	28340	33.96	19.05			
ΔH		CAL. /GFW.	2000	4.50	28790	34.19	19.80			
			2100	4.51	29240	34.41	20.49			
			0082	4001	30150	34.82	21.12			
<u>.</u>		4	2400	4.52	30600	35.02	22.27			
ДH,		CAL. /GFW.	2500	4.53	31050	35.20	22.78			
			2600	4.53	31500	35.38	23.27			
			2700	4.53	31950	35.55	23.72			
1, = _		×	2800	4 • 5 4	32410	35.71	24.14			
•			2900	4 • 5 4	32860	35.87	24.54			
" "		ATA	3000	4.55	33320	36.03	24•93			

PHOSPHORUS

10.1021/ba-1956-0018.ch004
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doi:
1956
Τ,
January
Date:
Publication

PHOSPHORUS	4			Reference	State fo	Reference State for Calculating $\Delta H_{\mu}^{o}, \Delta F_{\mu}^{o}$	ting AHe,	∆r°, and	
			-	Log ₁₀ Kp:		Red Triclinic Solid from 298° to	1d from 2	298° to	
IDEAL DIATOMIC	IC GAS		• -	704°, Ide	al Diatom	Ideal Diatomic Gas from	om 704°t	704° to 3000°.	
	CPANC	۰	و	91	ę	-(F ⁰ -H ⁰ 298.15)	FORMATI	FORMATION FROM REFERENCE STATE	NCE STATE
-		TEMPERATINE		T 290.15	'n⊢ .	FREE ENERGY	HEAT A H ^e	FREE ENERGY 🛆 F	
(H ² _{24.15} H ²) = 2,13	2,133 CAL/GFW.	×	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.		F CAL./ GFW.	LOG K
		298	7.65	•	52.11		42725		- 22•315
K.P.	¥	300	7.66	14	52.16		42721		- 22,124
		400	8.04	664	54.42	52.43	42470		- 14.353
∆ H.	CAL /GFW.	500	8.30	1618	56.25	53 . 02	42177	22272	- 9.735
		600	8•48	2459	57.78	53 • 69	41828	18320	- 6.673
		700	8•60	3314	59.11	54.38	41415	14430	- 4•505
B.P.	¥	800	8•68	4179	60•26	70°55	0	0	0
		006	8.74	5052	61•29	55.68	0	0	0
ФН,	CAL. /GFW.	1000	8.79	5930	62 • 20	56.27	0	0	0
		1100	8.83	6812	63 • 05	56.86	0	0	0
		1200	8.86	7698	63 . 83	57.42	0	0	0
S.P.	۴ ۲	1300	8•88	8586	64.53	57.93	0	0	0
:		1400	8.91	9477	65.19	58.43	0	0	0
∆ H _s	CAL. /GFW.	1500	8.93	10370	65.81	58.90	0	0	0
		1600	8 • 94	11265	66.38	59 • 34	0	0	0
		1700	8.96	12161	66.92	59.77	0	0	0
T.P.	*	1800	8.97	13059	67.44	60.19	0	0	0
H V		0061	66.0	96661	26.10	80.00	0 0	00	5 0
		2100		15760		61.20			o c
		2200	0.0	16661	69.24	61.67			
T.P.	°K	2300	9.03	17565	69.64	62.01			0 0
		2400	9.04	18468	70.03	62.34	0	0	0
∆H,	CAL. /GFW.	2500	9.05	19373	70.40	62.66	0	0	0
		2600	9.05	20280	70.75	62°95	0	0	0
		2700	90°6	21186	71.09	63 . 25	0	0	0
T _c =	* ×	2800	9.07	22090	71.42	63.54	0	0	0
6		2900	9°08	23000	71.74	63.81	0	0	0
_ c =		3000	60•6	23910	72.05	64•08	0	0	0

1000000000000000000000000000000000000	PHOSPHORUS	RUS	Р 4		Re Re	6	State for	Calculat:	1ng AH ^e ,	∆r°, and		
v 123.900 celars r <t< th=""><th>IDEAL T</th><th>ETRATOM</th><th></th><th></th><th>ž X</th><th>8</th><th>l Distomic</th><th>c Gas froi</th><th>11'0m 704°</th><th>2000°.</th><th></th><th></th></t<>	IDEAL T	ETRATOM			ž X	8	l Distomic	c Gas froi	11'0m 704°	2000°.		
Turner of the character of the cha		000 22	31105	•	1	9	9	-(F°H° 298.15)	FORMAT	ION FROM REFERE	NCE STAT	ų
mail_Hg)= 3,356B Cut./GFN matrixed metric matrix cut./metrix cut./metrix m w 300 12,00 17,00 17,10 71,17 30,428 30,814 17,317 134,317 m w 300 18,28 300 18,28 300,814 17,317 134,317 134,317 m w 300 18,28 3500 75,77 66,68 30,814 173,317 m 500 18,28 3500 75,77 68,771 394,292 154,417 m 500 19,022 75,77 68,771 294,68 4292 m 800 19,022 75,516 76,571 294,68 4292 m 800 19,022 75,516 76,571 294,68 4292 m 800 19,922 11080 86,88 74,577 53600 21512 m 86,88 74,577 53600 74,411 13020 88,921 74,577 536400 216400 m 11000 19,572 11090 94,610 74,577 52960 74,411 m m 11200 19,562 189,927 74,578 126,027 <td< th=""><th></th><th>F</th><th>CKAMIS</th><th>TEMPEDATION</th><th></th><th>T 296.15</th><th>×-</th><th>FREE ENERGY</th><th>HEAT A H°</th><th>FREE ENERCY & F</th><th></th><th></th></td<>		F	CKAMIS	TEMPEDATION		T 296.15	×-	FREE ENERGY	HEAT A H°	FREE ENERCY & F		
m 300 16.06 300 17.17 66.58 30822 17397 m cut./em 300 17.17 67.51 30.822 12948 m cut./em 300 19.21 3100 55.65 56.85 30822 12948 m cut./em 300 18.73 5500 75.77 68.751 30.822 12948 m cut./em 500 19.73 5560 79.16 77.178 67.51 29488 4292 m m cut./em 1000 19.421 13020 85.06 71.77 55360 72.5102 m m m status status status status m status status status status status status m m status status status status status m status status status	19. 15 HG)			y,		HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	f CAL./GFW.	f CAL./GFW.	2 C	× °
m w 500 16°00 30 500 17.17 67.51 30.422 15978 m cut./dev 500 17.51 1710 71.77 67.51 30.422 15948 m cut./dev 500 19.02 75.77 68.751 30.422 15948 m cut./dev 900 19.02 75.40 82.006 71.778 67.51 30.422 m w 800 19.21 9100 84.61 73.18 29468 4292 n w 800 19.21 9100 86.892 73.16 73.17 67.51 20408 n w 800 19.21 84.61 73.18 29468 4292 n w 800 19.21 19020 86.892 73.60 73.16 n w 11000 19.44 13020 86.92 73.46 73.19 n m 11300 19.52 11490 90.77 73.91 53800 72102 n m 11300 19.52 11490 90.52 75.90 52200 71944 n m 11300 19.52 18904 92.52 <th< th=""><th></th><th></th><th></th><th>000</th><th>16 05</th><th>U</th><th>56 0E</th><th>LA 05</th><th>00000</th><th>1 7 3 0 7</th><th></th><th>763</th></th<>				000	16 05	U	56 0E	LA 05	00000	1 7 3 0 7		763
M CAL/GFN 400 17.51 1710 71.77 500 50.22 12878 P * 500 18.28 3500 75.77 68.77 29988 8543 P * 800 19.621 9150 75.77 68.77 29488 8423 P * 800 19.621 9150 84.61 70.22 29488 8423 P * 800 19.621 9150 84.61 70.23 29488 8543 P 800 19.621 9150 84.61 70.73 29488 8423 P 800 19.621 9150 84.61 70.23 29468 4292 P - 900 19.621 9150 84.61 70.23 29468 4292 P - - 800 19.62 11080 88.92 75.90 75.918 75.90 75.918 M - 0 19.62 19920 96.88 76.89 70.25 7944 1 1100 19.62 19900 96.98 81.66 75.920 74.417 1 - 1500 19.67 16900 97.55 82	A.P.		*	300	16.00	30	000000000000000000000000000000000000000	000	308140	14314	1 1	12.616
Ma Cut./GFW 500 18.28 3500 75.77 68.77 29988 8543 P % % 800 19.21 9150 84.61 73.18 53830 25102 H Cut./GFW 800 19.21 9150 84.61 73.18 53830 25102 H 900 19.35 11080 88.92 71.72 29468 4292 H 000 19.44 13020 19.57 13020 90.79 75.90 75102 23480 14417 H Cut./GFW 11000 19.62 14980 90.79 77.18 53380 14400 H Cut./GFW 11200 19.62 14980 92.50 74.57 53380 71.41 H Cut./GFW 11200 19.62 15940 92.50 77.18 53360 72161 H Cut./GFW 1500 19.62 14900 92.52 80.62 52320 72969 729				400	17.51	1710	71.78	67.51	30422	12878	1	7.036
P *x 500 19-07 7240 82-06 70.23 29468 4222 P *x 800 19-07 71.77 28812 4292 H Cut./GFW 800 19-07 71.77 28812 4292 N 900 19-57 11080 86.88 74.57 53660 21512 N 1000 19-44 13020 88.92 75.90 53480 12512 1100 19-44 13020 88.92 75.90 53460 21512 1100 19-57 13020 88.92 75.90 53280 14417 1100 19-57 18940 95.52 75.90 53280 14417 1100 19-57 18940 95.52 75.93 52920 74417 1200 19-57 18940 95.52 80.62 52250 7410 1500 19-57 18940 95.53 81.66 75.55 7410 1500 19-57 18940 95.55 80.62 52250 7410 1500 19-75 26770 99.61 52250 7410 1700 19-75 26770 99.61 52170 64	ΔHm		CAL. /GFW.	500	18.28	3500	75.77	68.77	29988	8543		3.734
P γ				600	18.73	5360	79.16	70.23	29468	4292		1.563
m % 800 19-21 9150 84-61 73-18 - 53830 - 251512 % CAL/GFW 1000 19-45 11080 86.88 74.57 - 53460 - 21512 % CAL/GFW 1000 19-45 11080 86.88 74.57 - 53460 - 21512 % CAL/GFW 1000 19-45 14900 90-79 77-18 - 53280 - 21512 % % 1100 19-62 18900 92-50 74.67 - 53280 - 21512 % % 1100 19-62 18900 92-53 75-38 - 7394 % CAL/GFW 1500 19-62 18900 95-52 23080 - 21010 % M CAL/GFW 1500 19-75 20100 95-35 81-66 - 21512 % CAL/GFW 1500 19-75 2040 99-35 81-66 - 52380 - 2140 % CAL/GFW 1800 19-75 2040 100-47 84-51 - 52380 - 2170 % % CAL/GFW 1900 19-75 20100 101-55 86.21 - 51820 10770 % % <th< th=""><th></th><th></th><th></th><th>700</th><th>19•02</th><th>7240</th><th>82.06</th><th>71.72</th><th>28812</th><th>154</th><th>1</th><th>• 0 4 8</th></th<>				700	19•02	7240	82.06	71.72	28812	154	1	• 0 4 8
H CuL./GFW. 900 19-35 11080 86.88 74-57 - 53600 - 21512 H CuL./GFW. 11000 19-44 13020 88-92 77-18 - 53480 - 14417 H - - W - - - 53480 - 18000 H - 11000 19-57 15940 92-57 15940 92-57 - 53280 - 18000 H - 11300 19-65 18900 94-06 79-53 - 52260 - 7394 H - 11300 19-65 20860 95-52 80-62 - 52380 - 18000 H - - 11000 19-74 26800 99-88 81-66 - 52720 - 7394 H - - - 1900 19-72 26400 99-85 82-655 - 52720 - 7394 P - - - - 1900 19-74 28740 100647 84-51 - 52720 - 7394 H - - - - 1900 19-75 32690 100047 84-51 - 52170 06463 H - - - - -	8.P.		×	800	19•21	9150	84.61	73.18				6.858
Nu CAL/GFI 1000 19.44 13020 88.92 75.90 53480 18000 2 W 1100 19.57 16940 92.50 77.18 53280 14417 3 W 1200 19.65 18940 92.76 79.53 53280 14417 4 1300 19.65 18940 92.50 79.53 53280 14417 1 1300 19.65 18940 94.65 79.53 53280 14417 1 1300 19.65 18940 94.65 79.53 522820 79.64 1 1 1500 19.65 22830 96.88 31.666 7225200 7410 1 1 1 19.00 19.74 28740 100.477 84.651 52380 74603 1 1 1 1900 19.74 28740 100.477 84.651 522870 14403 1 1 1 1000 19.770 29463 51820 14403 1 1 1900 19.770 29440 100.477 84.651 522870 748.050 1 1 1000 19.776 28740 100.2.6				006	19.35	11080	86.88	74.57				•224
1100 19.52 14980 90.79 77.18 53280 14417 1200 19.57 16940 92.50 78.39 52920 7394 1200 19.65 18900 94.065 79.53 52920 7394 1400 19.65 28860 95.55 80.65 52920 7394 1400 19.65 22830 96.88 81.66 52570 7394 1700 19.68 22880 96.88 81.66 52550 7394 1700 19.70 24800 96.88 81.66 52550 7394 1700 19.72 26770 99.815 82.65 52380 7394 1700 19.72 26770 99.85 83.61 52170 7394 1700 19.75 30720 100.47 84.51 52170 52280 1900 19.76 32690 102.555 86.21 51650 16770 1 1900 19.75 32690 102.555 86.21 51650 16770 1 1900 19.75 32690 102.555 86.21 51650 16770 1 1900 19.75 32690 102.555	∆н,		CAL. /GFW.	1000	19.44	13020	88.92	75.90			•••	3 . 934
- - - - 1200 19-57 15940 92-50 7303 - 53080 - 10864 H 1300 19-65 18900 94-06 79-53 - 52920 - 7394 H 1300 19-65 20860 95-52 80-66 - 52720 - 3888 H 1400 19-68 22830 96-88 81-66 - 52550 - 410 P - - 19-68 22830 96-88 81-66 - 52570 - 3988 P - - - 19-70 24800 99-35 83-65 - 52170 6463 P - - - 19-70 24800 199-75 30720 100-47 84-51 - 52170 6463 P - - - - 30720 100-47 84-51 - 52170 6463 P - - - - - 100-70 199-75 30720 1012-55 86-21 - 51650 16770 P - - - - - - 51650				1100	19.52	14980	90.79	77.18				2.864
7394 7394 7394 7394 7394 1400 19.65 20860 95.52 80.62 52720 388 1400 19.66 24800 96.88 81.66 25380 25380 25380 25380 25380 25380 25380 25380 25380 25380 25380 25380 25380 2720 1. 32690 19.770 30720 100.47 84.51 52100 19350 16770 99.38 16770 99.38 16770 99.38 16770 100.2.55 86.21 51650 16770 16770 16770 16770 16770 16770 16770 16770 16770 16770 16770 16770 16770 16770 16770 16770 16770 16770 16770 <				1200	19.57	16940	92.50	78.39		-		1.978
Ha 1400 19.65 20860 95.52 80.62 - 52720 - 3888 Ha 1500 19.68 22830 96.88 31.66 - 52350 - 410 P * 1700 19.70 29400 98.15 82.65 - 52380 2966 P * 1700 19.72 26770 99.35 83.61 - 52170 P * 1900 19.74 28740 100.47 84.51 - 52170 H CuL/GFN 1900 19.75 30720 101.54 85.38 - 51650 16770 H CuL/GFN 2000 19.75 32690 102.55 86.21 - 51650 16770 H CuL/GFN 2000 19.76 32690 102.55 86.21 - 51650 16770 H CuL/GFN 2000 19.76 32690 102.55 86.21 - 51650 16770 H CuL/GFN - * * * - 51650 16770	5.P.		*	1300	19.62	18900	94.06	79.53			-	1.243
Ma CAL./GFW 1500 19-68 22830 96.88 31.666 = 52550 - 410 P vk 1600 19-70 24800 98.15 82.65 = 52380 2996 P vk 1700 19-72 26770 99.35 83.61 = 52300 2996 P vk 1800 19-74 28740 100.47 84.61 = 52000 9938 H CAL./GFW 2000 19-75 30720 101.64 85.38 = 51820 13350 P vk 1900 19-75 32690 102.55 86.21 = 51820 13350 H CAL./GFW 2000 19-76 32690 102.55 86.21 = 51820 13770 H CAL./GFW 2000 19-76 32690 102.55 86.21 = 51650 16770 H CAL./GFW 2000 19-76 32690 102.55 86.21 = 51650 16770 H CAL./GFW A A A A A A A L M A A A B A A A				1400	19.65	20860	95.52	80.62		ŝ		• 606
Image: constraint of the state of the st	Δ H₅		CAL. /GFW.	1500	19.68	22830	96.88	81.66				•059
				1600	19.70	24800	98.15	82.65		2996	ı	•409
% 1800 19.74 28740 100.47 84.51 - 52000 9938 % 1900 19.75 30720 101.54 85.38 - 51820 13350 % % % 100.647 86.21 - 51820 13350 % % 1000 19.76 32690 102.55 86.21 - 51650 16770 % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % % %				1700	19.72	26770	99 • 35	83.61		6463	1	•830
CAL_/GFWL 1900 19.75 30720 101.54 85.38 - 51820 13350 AL_/GFWL 2000 19.76 32690 102.55 86.21 - 51650 16770 CAL_/GFWL ATM.	T.P.		×	1800	19.74	28740	100.47	84.51		96 66	1	1.206
CAL./GFW. 2000 19.76 32690 102.55 86.21 - 51650 16770			ļ	1900	19.75	30720	101.54	85.38		13350	1	l •535
	₽H¢		CAL. / GFW.	2000	19•76	32690	•			16770	1	l•832
	T.P.		×									
	д н,		CAL. / GFW.									
11	Tc =		¥									
-	= °		ATM.									

PHOSPHORUS

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Publication Date: January 1, 1956 | doi: 10.1021/ba-1956-0018.ch004

PHOSPHORUS	<u>م</u>		Ř	eference	State for	Reference State for Calculating AH ^c , A ^c ,	tng AH ^e ,	∆ ^P °, and		
IDEAL MONATOMIC GAS	MIC GAS		3 2	Log ₁₀ Kp: 704°, Idea	Red Tricl 1 Diatomi	OKP: Red Triclinic Solid from 298°, Ideal Diatomic Gas from 704° to 3	d from 298° to m 704° to 3000°	8° to 3000°.		
. 30.975			1	. 1	•	-(*** *** ***)	FORMATI	FORMATION FROM REFERENCE STATE	NCE STATE	
Give the second	GRAMS	TEMPERATURE	<u>ۍ</u>	Ha - Ha	۶-	FREE ENERGY	HEAT A H ^e	FREE ENERGY $ riangle F^{*}$		
(H ² _{211, 15} H ²) = 1, 201	DT CAL/GPW.	¥	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	200 201	
		298	26.4	0	38•38	38*86	79800	90869		70
×.P.	¥	200	16.4	б	39.01		79800		- 50.812	12
	1	400	4•97	506	40 • 44	39.18	79779		- 36.279	79
∆ H	CAL. / GFW.	200	4.97	1003	41.55	39 ° 55	79720		- 27.563	63
		000	4.97	1500	42.45	39 ° 95	79622	59732	- 21.7	59
		700	4.97	1996	43 • 22	40.37	79484	56426	- 17.618	18
9.8	*	800	4.97	2493	43.88	40.77	58843	67843	- 13.071	て
	1	006	4.97	2990	44.47	41.15	58900	45462	- 11.283	83
ΔH.	CAL. /GFW.	1000	4.97	3487	44 • 99	41.51	58957	45067	- 9.850	50
		1100	4.97	3984	45.47	41.85	59014	43680	- 8.679	79
		1200	4.97	4481	45.90	42.17	59071	42295	- 7.703	03
dy	¥.	1300	4.97	4978	46.30	42.48	59118	40879	- 6.872	72
		1400	4•97	5475	46.66	42.75	59175	39491	- 6.165	65
ΔHs	CAL. /GFW.	1500	4 • 98	5972	47.01	43 • 03	59222	38072	- 5.547	47
		1600	4.99	6471	47.33	43 . 29	59271	36647	- 5.005	05
		1700	5.00	6970	47.63	43.53	59330	35241	- 4.530	30
TP	×.	1800	5.01	7470	47.92	43.77	59380	33820	- 4.106	8
	:	1900	5 • 04	7973	48.19	44•00	59433	32396	- 3.726	26
ΔH	CAL. /GFW.	2000	2.06	8478	48 • 45	44.22	59488	30968	- 3.383	83
		2100	5°06	6868	48 • 70	44.43	59545	29536	- 3.073	33
		0022	51.0	1646	48 • 93	44.02	2 3 6 0 7	28125	- 2.793	66
T.P.	*	2300	9.18	10012	49.10	44•81	59662	26680	- 2.535	35
		2400	5.22	10532	49•38	45.00	59732	25268	- 2.300	8
ΔH,	CAL. / GFW.	2500	5•28	11057	49.60	45.18	59807	23807	- 2.081	81
		2600	5.34	11588	49.81	45.36	59888	22370	- 1.880	80
		2700	5.40	12125	50.01	45.52	56975	20933	- 1.694	94
) 	Jan Series	2800	5.47	12669	50.21	45.69	60059	19459	- 1.518	18
- -	4	2900	5.54	13219	50.40	45 . 85	60159	18022	- 1.358	58
Pc =	ATM.	3000	5.62	13777	50.59	46.00	60257	16577	- 1.207	07

150

	ITATE Log K		2.097	.822	• 496	• 264	1.359	.876					
	ACE S	ł	I	1 1	I	I							
f', and to 3000.	FORMATION FROM REFERENCE STATE △ H [®] FREE BUENCY △ f [®] of LOG of cal./of v. b	2886	2879	1882	1362	848	- 4976	- 3611					
Reference State for Calculating AH [°] , AP [°] , and Log ₁₀ Kp: Red Triclinic Solid from 298° to 704°, Ideal Diatomic Gas from 704° to 3000°.	FORMATIC HEAT A H ^a I CAL./GFV.	4180	4181	4403	4482	4488	- 16000	- 15770					
Calculat1 nic Solid : Gas from	-(Po-H 2111) PREE ENERGY FUNCTION CALL/PEG/ GFW.	9•80	9•80	10.65	11.20	11.74	12.27	12.77					
tate for ed Tricli Diatomic	\$ ⁶ Entropy Cal/DEG./ GFW.	9•80	9•83	12•01	14.50	15.48	16•35	17.14					
ference S g ₁₀ Kp: R 4°, Ideal	H ⁶ - H ⁶ T 294.15 HEAT CONTENT CAL./ GFW.	0	10	1360	1980	2620	3270	3940					
Re Lo	C ⁰ F HEAT CAPACITY CAL/DEG/ GFW.	5•63	5•63	0•00 6•15	6•30	6.45	6.60	6•75					
	T Teaperature °K	298	300	200 200	600	700	800	006					
				r									
PHOSPHORUS P CUBIC WHITE (≪) SOLID	30°975 grais = cal./gfn.	317.4 *	150. CAL/GFW.	55 4. •x	2, 960. CAL /GFW.	*	CAL /GFW.	*	CAL. /GFW.	•	CAL /GFW.	*	ATM.
PHOSPHORUS CUBIC WHIT	Gfw (H ⁰ _{206.15} H °) =	, A.	۵H	9. 1.	Δн ,	.as	Δ H _s	ä	۵ ۴,	T.P.	₩ Δ	Te =	۳¢ =

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

PHOSPHORUS

PLATINUM	Pt			Solid 1	from 298°	to 2043°	, Liquid i	from 2043	Solid from 298° to 2043°, Liquid from 2043° to 3000°.	
REFERENCE STATE	STATE	•								
_{6fw} 195.09	•09	GRAMS	F	ზ	H°-H°	۰, ۲	-(1	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
$(H^{0}_{2M,15},H^{0}_{5}) = 1$	1,384	CAL./GFW.	TEMPERATURE	HEAT CAL./D	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENEROY FUNCTION CAL./DEG./ GFV.	HEAT A H	FREE ENERGY & F	۲ ۵0 ۲
			298	6.19	0	10.00	10-00			
ж.Р. 2,	2,043	*	300	6.20	11	10.04	10.01			
			400	6.34 5 . 5 .	645	11.86	10.25			
	- 1	CAL. /GFW.	000	6.57	1920	12020	11.24			
		ſ	700	6.70	2580	15.46	11.78			
8.P.	4,100	 ×	800	6.83	3260	16.37	12.30			
			006	6. 96	3950	17.18	12.80			
∆н, 122 ,	122,000	CAL. /GFW.	1000	7.09	4660	17.93	13.27			
			1100	7•22	5380	18.61	13.72			
			1200	7.30	0110	19.25	14.16			
S.P.		×	1300	7.49	6850	19.84	14•58			
			1400	20.1	0091	20.39	14•97			
∆ Hs		CAL. /GFW.	1500	7.15	8370	20.93	15,35			
			1600	7.85	9150	21.43	15.72			
			00/1	46 •7	0466	21.91	16.07			
T.P.			1800	8 • 05	10740	22.37	16.41			
			1900	8,15	11550	22.81	16.74			
д н,		CAL. /GFW.	2100	67.0	12370	20.02	19.34			
			2100	0.00	006/T	26.02	1 /•40			
			2300	8.30	19560	20.31	14-18			
1.P.		¥	2400	8.30	20390	27.03	18.54			
AH.		CAL /GFW	2500	8.30	21220	27.37	18.89			
F			2600	8.30	22050	27.69	19•21			
			2700	8.30	22880	28.01	19.54			
,			2800	8.30	23710	28.31	19.85			
		¢	2900	8.30	24540	28.60	20.14			
ک ر =		ATM.	3000	8•30	25370	28.88	20.43			

PLATINUM

PLATINUM	Pt		Referen	nce State	for Calc	ulating A	H°, ∆F°,	Reference State for Calculating Af ^o , Af ^o , and Log ₁₀ Kp:	Kp:
IDEAL MONATOMIC GAS	łAS		Solid 1	Solid from 298°	to 2043°	, Liquid	- from 2 0 43	to 2043°, Liquid from 2043° to 3000°	•
Gfw 195.09 GRAMS	2	-	ບ	H° - H°	°.	-(F°-H° 228.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
1,57 2		TEMPERATURE OK	HEAT	T 294.15 HEAT CONTENT	ENTROPY	FREE ENERGY FUNCTION	• -	FREE ENERGY A F	×
		•		CALLY GFR.	CALL/DEG/ GFW.	CAL./DEG./ GFW.	CAL:/ GFW.	CALL/ UFW.	9
	Γ	298	6.10	o	45.96	45.96	134800	124078	- 90.955
M.P.		300	6.11	11	46.00	45.97	134800	124012	- 90.342
		400	6.46	655	47.80	46.19	134810	120434	- 65.807
∆ H _m CAL./	CAL. / GFW.	500	6•43	1291	49•26	46.68	134811	116821	- 51.065
]	600	6.26	1926	50.42	47.21	134806	113218	- 41.243
	Γ	700	6.06	2542	51.37	47.74	134762	109625	- 34.229
B.P.		800	5.88	3138	52.16	48.25	134678	106046	- 28.972
		006	5.73	3718	52.85	48.72	134568	102465	- 24.883
DH. CAL. /GFW.	/GFW.	1000	5.61	4285	53.44	49.17	134425	98915	- 21.619
	7	1100	5.52	4841	53.97	49•58	134261	95365	- 18.949
	[1200	5.45	5389	54.45	4 0. 96	134079	91839	- 16.727
м, м,		1300	5.40	5931	54.88	50.33	133881	88329	- 14.850
		1400	5.36	6469	55 • 28	50.67	133669	84823	- 13.242
Δ H _s CAL./	CAL. /GFW.	1500	5.33	7003	55.65	51.00	133433	81353	- 11.853
•		1600	5.32	7536	55.99	51.29	133186	77890	- 10.638
	Γ	1700	5.31	8067	56.32	51.58	132927	74430	- 9.568
		1800	5.31	8538	56.62	51.85	132658	71008	- 8.621
		1900	5.32	9129	56.91	52.11	132379	61589	- 7.774
DH, CAL	CAL. /GFW.	2000	5.33	9661	57.18	52.35	132091	68771	- 7.514
-	7	2100	5.34	10194	57.44	52.59	127094	60902	- 6.338
	ſ	2200	5.36	10729	57.69	52.82	126799	57763	- 5.738
T.P		2300	5.38	11266	57.93	53.04	126506	54631	- 5.191
		2400	5.40	11804	58.16	53 . 25	126214	51502	- 4.689
ΔH, CAL/	CAL. /GFW.	2500	5.42	12345	58 . 38	53.45	125925	48400	- 4.231
	7	2600	5.44	12888	58.59	53.65	125638	45298	- 3.807
	Γ	2700	5.47	13434	58.80	53.83	125354	42221	- 3.417
T_= %		2800	5.50	13982	59 • 00	54.01	125072		- 3.054
		2900	5•52	14533	59.19	54.18	124793		- 2.719
P _c = ATM.		3000	5 • 55	15087	59 • 38	54.36	124517	33017	- 2.405
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PLATINUM

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POLONIUM	Po			Solid fro	m 298° to	Solid from 298° to 527°, Liquid from 527° to	quid fro	n 527° to	
REFERENCE STATE	VTB			1235 °, I d	eal Monat	1235°, Ideal Monatomic Gas from 1235°	from 123	5° to 3000°.	•
cim 210.	GRAMS	-	ບ	He-He	ۍ م	-(1-14-14-	FORMAT	FORMATION FROM REFERENCE STATE	4CE STATE
(H ^o _{200.15} H ^o) =	CAL./GFW.	TEMPERATURE •K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ OFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H	FREE BRENCY & F	ч 106 к 106
		298	6.30	0	15.00	15.00			
M.P. 527	¥	300	6.30	11	15.04	15.01			
(3,000) ^H	CAL /GFW	400 500	6.80 7.30	670	16.92	15.25			
		600	7.50	5120	25.55	17.02			
. 031		700	7.50	5870	26.71	18.33			
B.P. 1, 235	¥	800	7.50	6620	27.71	19.44			
14.400		006	7.50	7370	28.60	20.42			
	CAL. /GFW.	1000	7.50	8120	29.39	21.27			
		1200	7.50	9620	30.05	22.74			
a		1300	4.98	39430	52.64	22.31			
	:	1400	4.98	39930	53.00	24.48			
Δ H _s	CAL. /GFW.	1500	4.99	40420	53 . 35	26.41			
		1600	5.01	40920	53.67	28.10			
075		1700	5.02	41430	53.97	29.60			
T.P. 0.0	•к	1800	5.04	41930	54.26	30.97			
1		0061	>0°0	42430	54.80	32.21			
h 13		2100	5.14	43460	55.05	34.36			
		2200	5.18	43970	55 . 29	35.31			
T.P.	¥.	2300	5.23	44490	55.52	36.18			
		2400	5.28	45020	55.74	36.99			
Δн.	CAL. / GFW.	2500	5.34	45550	55 . 96	37.74			
-		2600	5.39	46080	56.17	38.45			
		2700	5.45	46630	56.37	39.10			
1	*	2800	5.51	47170	56.57	39.73			
	4	2900	5.57	47730	56.77	40.32			
= "	ATM.	3000	5.62	48290	56.96	40.87			

POLONIUM

POLONTIA	Po		Rei	Reference S	tate for	State for Calculating $\Delta H_{ m p}^{\circ}, \ \Delta F_{ m p}^{\circ},$ and	ng ∆H°, ∆	F, and	
	•		Lot	Log ₁₀ Kp: So	olid from	298° to	527°, L1q	Solid from 298° to 527°, Liquid from 527°	527°
IDEAL MONATOMIC GAS	MIC GAS		to	•	Ideal Mona	Monatomic Gas	from 123	from 1235° to 3000°	٥°.
ct. 210.	3#183	F	و	01	ę	-(F°H° 299.15)	FORMATI	FORMATION FROM REFERENCE STATE	ICE STATE
}		TEMPERATI DE	_	T 298.15	~~	FREE ENERGY	HEAT △ H ^o	FREE ENERGY Δ F	
(H [°] _{298,15} H [°] ₉) = 1,481	31 CAL/GFW.	X.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	f CAL./GFW.	LOG K 10 K
		298	4.97	0	45.13	45.13	34450	25467	
0		300	4.97	6	45.16	45.13	34448	25412	- 18.514
I	:	400	4.97	506	46.59	45 . 33	34285	22418	
∆ H	CAL /GFW.	004	4.97	1003	47.70	45.70	34083	19478	
		000	- 5 • +	0061	6/ • 24	40.29	30830	10880	141.00 -
		100	4.97	1997	49.56	46.71	30577	14582	- 4.553
B.P.	*	800	4.97	2493	50.22	47.11	30323	12315	- 3.364
		006	4.97	2990	50.81	47.49	30070	10081	- 2.448
ΔH,	CAL /GFW.	1000	4.97	3487	51.33	47.85	29817	7877	- 1.721
		1100	4.97	3984	51.80	48.18	29564	5694	- 1.131
		1200	4.97	4480	52.24	48.51	29310	3522	641
26	*	1300	86*7	4978	52.64	48.82	0	0	0
	:	1400	4.98	5476	53.00	40°04	0	0	0
Δ H _s	CAL. /GFW.	1500	4•99	5974	53•35	49.37	0	0	0
		1600	5.01	6474	53.67	49.63	0	0	0
		1700	5.02	6976	53.97	49.87	0	0	0
TP	х.	1800	5.04	7479	54.26	50.11	0	0	0
	4	1900	5.07	7984	54.54	50.34	0	0	0
ΔH,	CAL /GFW.	2000	5.10	8493	54.80	50.56	0	0	0
		2100	5.14	9006	55.05	50.77	0	0	0
		2200	5.18	9521	55•29	50.97	0	0	0
T.P.	×.	2300	5.23	10041	55.52	51.16	0	0	0
		2400	5 • 28	10567	55.74	51.34	0	0	0
ΔH,	CAL. / GFW.	2500	5.34	11098	55.96	51.53	0	0	0
-		2600	5.39	11634	56.17	1.7	0	0	0
		2700	5.45	12176	56.37	51.87	0	0	0
=		2800	5.51	12724	56.57	52.03	0	0	0
-	2	2900	5.57	13278	56.77	52.20	0	0	0
	ATM.	3000	5.62	13838	56.96	52.35	0	0	0
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POLONIUM IDEAL DIATOMIC	Po ₂ GAS		Ϋ́Γ̈́Ϋ́	Reference Log ₁₀ Kp: to 1235°,	State for Solid fro Ideal Mon	Reference State for Calculating AH [°] , AP [°] , and Log ₁₀ Kp: Solid from 298° to 527°, Liquid fro to 1235°, Ideal Monatomic Gas from 1235° to 3	1ng AH ^e , 527°, L1 8 from 12	State for Calculating ΔH_{f}° , ΔF_{f}° , and Solid from 298° to 527°, Liquid from 527° Ideal Monatomic Gas from 1235° to 3000°.	.527° 00°.	
6tw 420. (H [°] . _{241.15} H°) =	GRAMS CAL./GPW.	T Temperature 9K	C ⁰ PHEAT CAPACITY CAL./DEG/ GFW.	H ⁰ - H ⁰ T 294.15 HEAT CONTENT CAL/GFW.	S ⁰ F Entropy Call./DEG/ GFW.	-(F0-H0 298.15) FREE ENERGY FUNCTION CALDEG./ GPW.	FORMAT HEAT A H ^o cal./gfw.	PORMATION FROM REFERENCE STATE △ M ⁶ FREE ENERCY △ F ⁶ LOG of v. chu, 0FV. f	LOG	ш ⁵
		298	8.84	0	65•80	65.80	32900	22226	- 10	- 16.292
	CAL /GFW	300	8.84	16	65.86	65.81	32894	22160	ř ,	- 16.144
.		400	8.89	006	68.41	66.16	32460	18632	- 1	10.180
B.P.	×	500	8•91	1790	70.40	66 . 82	31950	15240	i	6.661
Δн ,	CAL. /GFW.	600	8•92	2680	72.02	67.56	25340	12788	1	4.658
		700	8•92	3580	73.40	68•29	24740	10754	1	3.357
H <	CAL /GFW	800	8•93	4470	74.59	69•01	24130	8794	1	2.402
*		006	8•93	5360	75.64	69•69	23520	6924	1	1.681
T.P.	¥	1000	8•93	6250	76.58	70.33	22910	5110	1	1.116
۵H	CAL. / GFW.	1100	8 • 93	7150	77.43	70.93	22310	3357		•667
e H	*	1200	8 • 94	8040	78.21	71.51	21700	1648	ı	• 300
Δ H .	CAL /GFW.	1300	9 6•8	8940	78•92	72.05	- 37020	- 2752		•462
-		1400	8 • 94	9830	79•59	72.57	- 37130	- 156		•024
T c =	¥	1500	8.94	10720	80•20	73.06	- 37220	2530	ł	• 368
Pc =	ATM.									

POLONIUM

POTASSIUM		K		Solic	d from 29	8° to 336	Solid from 298° to 336.4°, Liquid from 336.4° to	1d from 3	536.4° to	
REPERENCE STATE	E STAT	ы		1039'	', Ideal	Monatom1c	1039°, Ideal Monatomic Gas from 1039° to 3000°	1039 [°] to	3000°.	
E.	39.100	GRAMS	-	ະ	H° - H°	8.	-(F°-H° 228.15)-	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H [°] _{296.15} H°) =	1,695	1,695 CAL/GFW.	TEMPERATURE •K	HEAT O	T 298.15 HEAT CONTENT CAL./ GFW.	T ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H ^C cal/GFW.	FREE ENERGY & F	۲06 K
			208	7.16	0	15.30	15.30			
C 19 E E	336.4	×.	300	7.18	13	15.43	15.39			
		4	400	7.53	1324	19.26	15.95			
Ω H 5	554.	CAL. / GFW.	200	7.34	2067	20.92	16.79			
				7.12	35.00	22.22	10 24			
	1039.		8008	7.11	4220	24.30	19.03			
	•	4	006	7.16	4934	25.14	19.66			
H18,	18,530.	CAL. /GFW.	1000	7.26	5654	25.90	20,25			
			1100	4.97	25404	44.78	21.69			
			1200	4.97	25900	45.21	23.63			
		×	1300	4.97	26397	45.61	25.31			
			1400	4.97	26894	459 8	26.77			
ΔHs		CAL. /GFW.	1500	4.97	27391	46.32	28.06			
			1700	4.98	28386	40.05	30.26			
0 +		3	1800	4.99	28885	47.23	31.19			
		4	1900	5.00	29384	47.50	32.04			
ΔH		CAL. /GFW.	2000	5.01	29884	47.76	32.82			
			2100	5.03	30387	48 • 00	33.53			
			2200	5.06	30891	48 • 24	34.20			
T.P.		×	2300	5.09	31398	48 • 46	34.81			
			2400	5.12	31909	48.68	35.39		-	
₽₩		CAL. /GFW.	2000	0100	32423	48.89	35.93			
			2200	5.25	22462	40.20	26.01			
I		3	2800	5.31	19955	67 64	37.36			
" -		¥	2900	5.38	34526	49.68	37.78			
		ATM.	3000	5.47	35068	49•86	38.18			

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

POTASSIUM

POTASSIUM	×		Refere	nce State	e for Cal	culating .	AH2, AP2,	Reference State for Calculating $\Delta H_{\phi}^{\bullet}$, $\Delta P_{\phi}^{\bullet}$, and Log, $\Lambda D_{\phi}^{\bullet}$,Kp :
			Solid	from 298	to 336.	Solid from 298° to 336.4°, Liquid from 336.4°	i from 33	6.4° to	2
IDEAL MONATOMIC GAS	C GAS		1039°,	Ideal Mc	onatomic (Ideal Monatomic Gas from 1039°		to 3000°.	
CH 70.00	20116	ŀ	۲	9	٩	-(P⁶H⁶ 200, 15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
001.85		TEMPERA TURE	مر	T 296.15	k+	FREE ENERGY	HEAT $ riangle$ H ^o	FREE ENERGY \triangle F	
(H ² 20.15 ⁻ H ²) = 1,481	CAL/GFW.	*	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GPW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.		CAL./ GFW.	гос к Гос
		298	4.97	0	38•30	38•30	21420	14589	- 10.694
A.P.	*	300	4.97	O	38.33	38.30	21416	14546	- 10.597
3		400	10.4	506	39.76	38.50	20602	12402	- 6.776
∆ M.m.	CAL. / GFW.	500	4.97	1003	40.87	38.87	20356	10381	- 4.537
		600	4.97	1500	41.77	39.27	20127	8409	- 3.063
		700	4.97	1996	42.54	39°69	19907	6474	- 2.021
	¥	800	4.97	2493	43 . 20	40°0	19693	4573	- 1.249
		006	4.97	2990	43.79	40.47	19476	2691	653
		1000	4.97	3487	44.31	40.83	19253	843	184
		1100	4.97	3984	44.78	41.16	0	0	0
		1200	4.97	4480	45.21	41.48	0	0	0
s.P.	¥	1300	4.97	4977	45.61	41.79	0	0	0
3		1400	4.97	5474	45.98	42.07	0	0	0
2 HS	CALL / GFW.	1500	4.97	5971	46.32	42.34	0	0	0
		1600	4.97	6469	46.65	42.61	0	0	0
		1700	4. 98	6966	46.95	42.86	0	0	0
Ŀ.	*	1800	66.4	7465	47.23	43 • 09	0	0	0
H <	CAL /CEW	1900	5 • 00	1964	47.50	43 • 31	0	0	0
t i		2000	2.01	8464	47.76	43.53	0	0	0
		2100	50.03	8967	48•00	43.73	0	0	0 0
0 +		0022	0000	1/ 46	*7 • 0 *	オガ・ウオ	50	2 0	00
	4	0062	50.0	8/66		CT • + +	0	5	0
	110, 110	2400	5.12	10489	48 • 08	16.44	0	0	0
4u	CAL /GFW.	2500	5.16	11003	48 • 87	44.49	0	0	0
		2600	5.20	11521	40°10	44.67	0	0	0
		2700	5.25	12043	49.30	44.84	0	0	0
Tc =	×	2800	5•31	12571	49.49	45•01	0	0	0
1		2900	5.38	13106	49.68	45.17	0	0	0
		3000	5.47	13648	49.86	45•32	ο	0	0

POTASSIUM

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: January
Date
Publication

POTASSIUM	K ₂		Referent Solid fi	ce State rom 298°	Reference State for Calculating AH [°] , AF [°] , and Log ₁₀ Kp; Solid from 298° to 336.4°, Liquid from 336.4° to	lating AH	e, ∆Fe, a from 336.	nd Log ₁₀ K 4° to	.	
IDEAL DIATOMIC GAS	GAS		1039°, 1	Ideal Mon	, Ideal Monatomic Gas from 1039° to 3000°	B from 10	39° to 30			
ciw 78°200 (₩ -₩)= 2,566	GRAMS Cal /GPW	T Teleneraatture 9k	C ⁰ PEAT CAPAGITY	H ⁰ - H ⁰ T 294.15 HEAT CONTENT CALL CONTENT	S ⁰ ENTROPY	-(T"-H" 20115) FREE ENERGY	FORMAT HEAT \$ H ⁶	PORMATION FROM REFERENCE STATE		TATE Loc k
		298	90•6	0	59.67	59-67	30580	21965	•	16.101
₽ ₩ 0	CAL. / GFW.	300	9 0 •6	17	59•72	59.67	30571	21913	I	15.964
		400	9.12	926	62.34	60.03	28858	19330	1	10.562
B.P.	¥	500	9.18	1841	64.38	60.70	28287	17017	1	7.438
Δн ,	CAL. /GFW.	600	9 • 2.3	2762	66.06	61.46	27756	14808	I	5.394
5P.	¥	700	9•28	3685	67.48	62 • 22	27247	12701	1	3 • 965
Ф Н •	CAL. / GFW.	800	9.33	4618	68.72	62 • 95	26758	10662	I	2.912
		006	9•38	5552	69 • 83	63.67	26264	8669	I	2.105
T.P.	¥	1000	9.43	6494	70.82	64.33	25766	6746	1	1.474
ΔHt	CAL. / GFW.	1100	9•48	7444	71.72	64•96	- 12784	6840	1	1.359
T.P.	×.	1200	9 • 53	8390	72.55	65•56	- 12830	8614	1	1.568
д н,	CAL. / GFW.	1300	9 • 58	9342	73.31	66.13	- 12872	10411	1	1.750
		1400	9•63	10300	74.02	66 • 67	- 12908	12208	1	1•905
Tc=	¥	1500	9•68	11279	74.69	67.18	- 12923	14002	ł	2.040
Pc =	ATM									

POTASSIUM

PRASE	PRASEODYMIUM Pr				Solid I f	rom 298°	Solid I from 298° to 1071°, Solid II from	Solid I	I from	
REFER	REFERENCE STATE				1071° to	1208°, L1	to 1208°, Liquid from 1208° to 3000°.	1208° to	o 3000°.	
ż	140.92	GRAMS	-	ۍ	H°-H°	°.	-(10-110-110)-	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H ⁰ 298. 15	° _{214.15} H°)= 1,697	CAL/GFW.	temperature ^o K	HEAT C	T ZMLIS HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H ^C CAL./OFW.	FREE ENERGY & F	2 ° 100 ° 100 °
			208	6.45	G	17.45	17.45			
A.P.	1,208	¥	300	0 4 0	. 11	17.49	17.46			
ΔH	(2.400)	CAL. / GFW.	4 00 6 0 0 7 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	6•78 7-10	670	19.39	17.72			
	•		89	7.42	2090	22.26	18.78			
			700	7.74	2850	23.43	19.36			
8.P.	3,290	*	800	8.06	3640	24.48	19.93			
ΔH	79.500	CAL. /GFW.	1000	8•38 8•70	4460 5320	26.35	20•50			
	•		1100	8 • 00	6500	27.47	21.57			
			1200	8 • 00	7300	28.16	22.08			
S.P.		×	1300	8 •00	8100	30.79	24.56			
3			1400	8.00	0068	31.39	25.04			
с. С.		LAL. / GFW.	1500	8.00	0016	31.94	25.48			
			1 700		10000	32.40	06-62			
T.P.	וייס	*	1800	8.00	12100	33.40	26.68			
			1900	8.00	12900	33 . 83	27.05			
h r⊲	(320)	CAL. /GFW.	2000	8•00	13700	34.24	27.39			
			2100	00.8	14500	34.63	27.73			
T.P.		¥	2300	00 • 8	16100	35.36	28.36			
			2400	8.00	16900	35.70	28.66			
ĥ		CAL. /GFW.	2500	8 • 00	17700	36.03	28.95			
			2600	8 • 00	18500	36.34	29.23			
			2700	8 • 00	19300	36.64	29.50			
Tc =		×	2800	8 • 00	20100	36.93	29.76			
9			2900	00°8	20900	37.21	30.01			
		4	nnne	00.00	00112	04 • 1 0	62.06			

PRASEODYMIUM

0000	amana anyadada	ЦЦ Ш								
1320	HTC ADVAVA	4								
er.	145*	GRAMS	+	e	9H - 9H	e	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
	I		TEMPEDATION		T 294.15	•	FREE ENERGY	HEAT A H ^o	FREE ENERCY & F.	
(H [°] 298.1	1 ⁰ 298. 15 H0 ⁰) =	CAL./GFW.	¥,	HEAT CAPACITY CAL. /DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	F CAL./GFW.	CAL./GFW.	20 2 2
			298	6.50	0	17-21	17.21			
A P	(1,300)	×	300	6.50	12	17.25				
		:	400	6.75	670	19.15				
∆Hm	(3,000)	CAL. / GFW.	500	7.00	1360	20.69	17.97			
			009	7.25	2070	21.98	18.53			
			200	7.50	2810	23.12	19.11			
8.P.	(3,000)	×	800	7.75	3570	24.14	19.68			
			006	8.00	4360	25.07	20.23			
ΔH ,	(70,000)	CAL. /GFW.	1000	8.25	5170	25.92	20.75			
			1100	8.50	6010	26.72	21.26			
			1200	8.75	6870	27.47	21.75			
S.P.		¥	1300		10760	30.49	22.22			
			1400	8 • 00	11560	31.08	22.83			
∆ H₅		CAL. /GFW.	1500	8•00	12360	31.64	23.40			
			1600	8•00	13160	32.15	23.93			
			1700	8.00	13960	32.64	24.43			
4 P		 %	1800	8•00	14760	33.09				
		:	1900	8•00	15560	33 • 53				
дн,		CAL. /GFW.	2 000	8.00	16360	33.94	25.76			
•			2100	8.00	17160	34.33	26.16			
		ſ	2200	8 • 00	17960	34.70	26.54			
0 7		30	2300	8.00	18760	35.05	26.90			
			2400	8 • 00	19560	35.40	27.25			
ΔH.		CAL /GFW.	2500	8 • 00	20360	35.72	27.58			
			2600	8.00	21160	36.04	27.91			
			2700	8.00	21960	36.34	28.21			
1		3	2800	8 • 00	22760	36.63	28.51			
		4	2900	8.00	23560	36.71				
			3000	00.0	24360	36.98	28. RK			

THERMODYNAMIC PROPERTIES OF THE ELEMENTS

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In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

PROMETHIUM

PROTACTINIUM Pa	ಥ		Sol1d	from 298°	to 1500°	, Liquid	from 150	Solid from 298° to 1500°, Liquid from 1500° to 3000°.	•
REPERENCE STATE	g								
		,	١	1	٩	-(F ⁰ -f ⁰ 200 11)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
uw 231	GKARS	Teubcovition		H - H - H	s-	FREE ENERGY	HEAT A H ^o	FREE ENERGY 🛆 F	
(H ^o _{218.15} H ₀ ^o) =	CAL./GFW.	Me	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	۲00 ۲ °
		298	6-79	0	12.40	12.40			
M.P. (1.500)	¥	300	6.80	12	12.44	12.40			
	110	400	7.10	710	14.44	12.67			
^{∆ Nm} (3,500)	CAL / GPW.	500	7.40	1430	16.05	13.19			
		600	7.70	2190	17.43	13.78			
		700	8•00	2970	18 • 64	14.40			
^{B.P.} (4,300)	¥	800	8•30	3790	19.73	15.00			
	CAI /CEW	006	8.60	4630	20.72	15.58			
(000°011) 110		1000	06•8	0166	+0•17	61.01			
		1100	9•20	0410	16.22	60°01			
8	2	1200	9.50	0961	23.32	07-11			
	2	1300	08.6	0168					
3	CAL /CEW	0041	10.10	0166	24 • 63	01.01			
2 u ²		1500	10.00	13830	27.87	18.65			
		1600	10.00	14830	28.51	19.25			
		1700	10.00	15830	29.12	19.81			
T.P.	*	1800	10.00	16830	29.69	20.34			
		1900	10.00	17830	30•23	20.85			
₽1	CAL. / GFW.	2000	10.00	18830	30.74	21.33			
		2100	10.00	19830	31.23	21.79			
		2200	10.00	20830	31.70	22.24			
T.P.	*	2300	10.00	21830	32.14	22.65			
:		2400	10.00	22830	32.57	23.06			
₽ ₩	CAL. /GFW.	2500	10.00	23830	32.97	23.44			
		2600	10.00	24830	33.37	23.82			
		2700	10.00	25830	33.74	24.18			
Tc =	*	2800	10.00	26830	34.11	24.53			
ا م	ATM	2900	10.00	27830	34 • 46	24.87			
		0006	00.01	00000	00.00	670/7			

PROTACTINIUM

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REFERENCE STATE 1900° Ideal Monatomic Gas from 1800° to 3000° to 3000° <thto 3000°<="" th=""></thto>	RADIUM		Ra		Solic	Solid from 298°		to 973°, Liquid from 973°	from 973	s° to		
226.05 GAMS T C H ^m - H ^m Fold ATTAIN FOLMATION FFORM FEATURE FOLMATION FFORM FEATURE 4.13 ¹ H ⁰ = CLL/GPR F H ^m HEX.ALL	REFEI	RENCE STAI	ΓE		1800	•	Mon atomi c	Gas from	1800° to			
u, j, legal Cut/Gen, mark wave barry marksons cut/Gen, barry marksons <th< th=""><th>Gfw</th><th>226.05</th><th>GRAMS</th><th>-</th><th>రి</th><th>H⁰ - H⁰ T 24115</th><th>s,⊢</th><th>-(F⁰-H⁰ 218.15)</th><th>FORMAT HEAT A N⁶</th><th>ION FROM REFEREN</th><th>ICE STATE</th><th></th></th<>	Gfw	226.05	GRAMS	-	రి	H ⁰ - H ⁰ T 24115	s,⊢	-(F ⁰ -H ⁰ 218.15)	FORMAT HEAT A N ⁶	ION FROM REFEREN	ICE STATE	
973 % 973 % 17.00 12 17.004 973 % 500 5.50 5.50 1410 210.98 700 8.00 9.00 2190 22.05 700 8.50 3010 23.28 700 8.50 3010 23.53 700 8.50 3010 23.54 700 8.50 3010 23.54 700 8.50 3010 23.53 700 8.50 3010 23.54 700 8.50 3010 23.56 700 7.50 1200 7.50 750 7.50 902 29.26 750 7.50 10520 31.59 750 7.50 10520 31.59 750 7.50 11270 31.59 750 7.50 11270 31.59 750 7.50 11270 31.59 750 7.50 12770 32.59 750 7.50 12770 32.59 750 7.50 12770 32.59 750 7.50 12770 32.59 750 5.49 48790 52.04	(H ⁰ 298.15	= (<mark>0</mark> H -	CAL./GFW.	TEMPERATURE 9K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL. /DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.		
(2,000) CAL/GFW. 400 7.50 690 18.98 7.500 CAL/GFW. 500 7.50 1410 20.59 7.500 CAL/GFW. 500 8.50 3810 22.01 7.50 1410 2190 25.53 7.50 7.50 3890 25.55 7.50 7.50 4810 25.55 7.50 7.50 9020 28.55 7.50 7.50 9770 30.52 7.50 7.50 9770 30.52 7.50 7.50 1200 7.50 31.67 7.50 1700 7.50 1270 32.53 % 1900 7.50 12700 31.67 7.50 12700 51.37 32.53 % 1900 5.05 48250 52.01 % 1900 5.05 48250 52.01 % 1900 5.05 12770 32.55 % 1900 5.05 48250 52.01 % 1900 5.05 48250 52.01 % 2200 5.05 49350 52.01 % 2200 5.05 49350 52.01 <th></th> <th>973</th> <th></th> <th>298 300</th> <th>6•49 6•50</th> <th>12</th> <th>17.00</th> <th>17.00 17.00</th> <th></th> <th></th> <th></th> <th></th>		973		298 300	6•49 6•50	12	17.00	17.00 17.00				
V. J. Grue, M.		(000.2)	F i	400	7.50	690	18•98 20•59	17.26				
(1,800) % (32,700) CAL/GFW. 1000 7.50 % 1100 7.50 8270 % 1100 7.50 8270 % 1100 7.50 8270 900 7.50 900 7.50 9100 7.50 9202 29.92 % 1100 7.50 9770 9203 9770 9203 9770 9203 9770 9203 9770 9204 7.50 1700 7.50 1700 7.50 1700 7.50 1700 7.50 1700 7.50 1700 7.50 1700 7.50 1700 7.50 1700 7.50 1900 5.09 447720 97 1900 9.4930 52.01 9.4930 52.03 9.4930 52.04 9.4930 52.04 9.4930 52.04 9.4930 52.04 9.4930 53.01 9.4930 53.01 <				600 700	8.00	2190	22.01	18.36 18.08				
(32, 700) cut./GFW. 1000 7.50 7520 28.55 % 1100 7.50 9770 29.92 % 11200 7.50 9770 30.52 % 1300 7.50 9770 30.52 % 1300 7.50 10770 30.52 % 1400 7.50 10770 31.59 1700 7.50 12770 32.93 % 1900 7.50 12770 32.95 % 1900 7.50 12770 32.96 % 1900 5.09 46690 51.37 % 2100 5.15 47200 51.64 % 2200 5.24 47720 51.64 % 2200 5.24 47720 51.64 % 2200 5.244 47720 51.64 % 2200 5.24 47720 51.89 % 2200 5.244 49350 52.61 % 2600 6.65 52.440 53.53	8.P.	(1,800)	*	800	0.00	3890	24.44	19.58				
	~ H∆	(32,700)	CAL. /GFW.	1000	7.50	7520	28.55	21.03				
% 1300 7.50 9770 30.52 Cull./GFW 1500 7.50 11270 31.69 Cull./GFW 1500 7.50 11270 31.69 % 1500 7.50 12770 32.63 % 1700 7.50 12770 32.63 % 1900 7.50 12770 32.53 % 1900 5.09 45690 51.37 % 1900 5.05 47200 51.64 % 22000 5.35 48250 52.14 % 22000 5.35 48250 52.14 % 22000 5.35 49350 52.14 % 22000 5.49 49350 52.14 % 22000 5.45 49350 52.14 % 22000 5.45 49350 52.14 % 22000 5.65 49350 52.14 % 22000 5.35 52.14 52.661 % 22000 5.35 52.61 52.61 % 23000 5.65 49350 52.61 % 25000 6.65 5130 53.53 % 29000				1200	7.50	9020	<u></u>	22.41				
	9		10	1300	7.50	0170		23.01				
CAL./GFW. 1200 7.50 11270 31.09 * 1600 7.50 12770 32.07 * 1900 7.50 12770 32.95 * 1900 7.50 12770 32.95 * 1900 5.09 46690 51.37 * 2000 5.15 47200 51.64 * 2100 5.24 47720 51.64 * 2200 5.35 48250 51.64 * 2200 5.35 48250 51.64 * 2200 5.35 48250 51.64 * 2200 5.35 48250 52.61 * 2200 5.64 49350 52.61 * 2200 5.64 49350 52.61 * 2700 6.26 51130 53.31 * 2800 6.53 51770 53.55 * 3000 7.25 53150 54.02			4	1400	7.50	10520	\sim	23.56				
*K 1700 7.50 12770 32.53 *K 1900 7.50 13520 32.96 *K 1900 5.09 46690 51.37 Cull./GFN 2000 5.15 47720 51.87 *K 2100 5.24 47720 51.89 *K 2200 5.49 47720 51.89 *K 2200 5.49 49790 52.14 *K 22400 5.84 49920 52.14 *K 2700 5.84 49920 52.38 *K 2700 5.84 49920 52.31 *K 2700 6.53 51130 53.31 * 2700 6.53 51770 53.55 * 2800 6.85 524440 53.78 * 2900 7.25 53150 54.40	∆H₅		CAL. /GFW.	1600	7.50	12020	\sim	24.56				
K 1200 5.09 45520 51.37 CAL/GFN 21000 5.15 47200 51.37 K 1900 5.15 47200 51.64 X 2100 5.15 47200 51.64 X 2200 5.35 47200 51.64 X 2200 5.49 48790 52.61 X 2300 5.65 49350 52.61 Z00 5.65 49350 52.61 52.61 Z00 5.65 49350 52.85 52.85 X 2700 6.04 50520 53.08 X 2800 6.653 51130 53.31 X 2900 7.25 53150 54.02 X 2900 7.25 53150 54.02				1700	7.50	12770		25•02				
C.M. / GFN. 2000 5-15 47200 51.64 X 2100 5-24 47720 51.89 X 2200 5-35 48250 52.14 X 2200 5-49 49350 52.38 X 22600 5-65 49350 52.61 X 22600 5-65 49920 52.61 X 22600 5-65 49920 52.61 X 22600 5-65 49920 52.61 X 22600 5-65 52.01 52.61 X 22000 5-65 52.61 52.61 X 22000 5-65 53.08 53.08 X 22000 6.85 51130 53.55 X 29000 6.85 52440 53.78 X 30000 7.25 53150 54.02	Т.Р.		×	1900	5.09	02001		26.80				
2100 5-24 47720 51.89 vk 2200 5-35 48720 52.14 vk 22400 5-49 49720 52.38 cull /GFN 2500 5-84 49920 52.38 coll 2500 5-84 49920 52.38 coll 2500 5-84 49920 52.86 coll 2500 6-04 50520 52.81 vk 2700 6-26 51130 53.01 vk 2800 6-85 51130 53.31 and 7.25 53150 53.78 and 7.25 53150 54.02	₽₩₽		CAL /GFW.	2000	5.15	47200	50	28.04				
•x 2300 5.49 48790 52.38 •x 2400 5.65 49350 52.61 •x 2500 5.84 49920 52.85 •x 2700 6.04 50520 53.08 •x 2700 6.53 51130 53.31 •x 2800 6.65 51130 53.31 •x 2900 6.85 51130 53.78 •x 2900 6.53 51170 53.78 •x 2900 6.53 51130 53.78 •x 2900 6.85 52440 53.78				2200	5.35	47/20	n n	30.21				
CAL /GFN, 2500 5.84 49920 52.85 2600 6.04 50520 53.08 2700 6.53 51130 53.08 2700 6.65 51130 53.31 2800 6.85 51770 53.55 7.78 33150 53.78	T.P.		×	2300	5.49	48790	ŝ	31.17				
2600 6.04 50520 53.08 2700 6.26 51130 53.31 2800 6.53 5170 53.55 * 2900 6.85 52440 53.78 * 3000 7.25 53150 54.02	AH.		CAL /GFW	2500	5.84	49920	co co	32.89				
= x 2200 0.20 51150 52.51 54.5 = x 2200 6.53 51770 53.55 35.0 = x 3000 7.25 52440 53.78 35.7 = x 4.02 36.3				2600	6 • 04	50520	Õ (33.65				
= °K 2900 6.85 52440 53.78 35.7 = ATM 3000 7.25 53150 54.02 36.3				2800	• • •	51770		5 • 0				R
= ATM 3000 7.25 53150 54.02 3	Tc =		×	2900	8	52440	3.7	5.7				ND
	ے م		ATM.	3000	• 5	315	4 • 0	36.31				IUM

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RADIUM	Ra		Refere	nce State	for Calc	Reference State for Calculating $\Delta H_{m{ ho}}^{m{ ho}}$, $\Delta F_{m{ ho}}^{m{ ho}}$, and	₩°, Δ₽°,	and	
TDEAT MONAMONTO CAS	0		Log10Kp:	p: Solid	Solid from 298°	° to 973°	, Liquid	to 973°, Liquid from 973°	
AN OLIMOTANON TRADIT	3		to 1800°,	0°, Ideal		Monatomic Gas from 1800° to 3000°	m 1800° t	to 3000°.	
226-05		-	1	9	٩	-(L°)(******)	FORMATI	FORMATION FROM REFERENCE STATE	ACE STATE
Gfw CECCO GRAMS	<u> </u>	-		H ^o -H ^o T 298.15	۶-		HEAT A H ^o	FREE ENERGY 🛆 F ^e	
(H ² ^{26.15} H ²) = 1,481 CAL./GFW	GFW.	TEMPERATURE •K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./GFW.	LOG K
	[298	4.07	C	42.15	10 01	00700	10015	
Å.		300	4.97	0 (G ,	42.18	42.15	38697	31155	- 22.696
		400	4.97	506	43.60	42.34	38516		
∆ H _m CAL./GFW	GFW.	500	4.97	1003	44.71	42.71	38293	26233	- 11.457
]	600	4.97	1500	45.62	43.12	38010	23944	- 8.685
		200	4.97	1996	46.39	43.54	37685		- 6.715
B.P.		800	4.97	2493	47.05	43•94	37303		- 5.249
		006	4.97	2990	47.63	44.31	36880	16990	- 4.126
ΔH _γ CAL. /GFW	GFW.	1000	4.97	3487	48.16	44.68	34667	15057	- 3.291
]	1100	4.97	3984	48.63	45.01	34414	13107	- 2.604
	Γ	1200	4.97	4481	49.07	45.34	34161	111181	- 2.036
S.P. %K		1300	4 • 98	4978	49.47	45.65	33908	9273	- 1.559
		1400	66 • 7	5477	49-84	45.93	33657	7379	- 1.152
∆ H _s CAL. /GFW	GFW.	1500	5 • 00	5976	50.18	46•2C	33406	5521	804
]	1600	5.01	6476	50.51	46.47	33156		498
	Γ	1700	5.03	6978	50.81	46.71	32908		- •235
T.P. %		1800	5.05	7482	51.10	46.95	32662		100
		1900	60•5	1989	51.37	47.17	0	0	0
∆Ht CAL./GFW	GFW.	2000	5.15	8501	51.64	47.39	0	0	0
]	2100	5 • 2 4	9020	51.89	47.60	0	0	0
	Γ	2200	5•35	9550	52.14	47.80	0	0	0
T.P. %K		2300	5.49	10092	52 . 38	48.00	0	0	0
		2400	5.65	10649	52.61	48.18	0	0	0
ΔH ₆ CAL. /GFW.	/GFW.	2500	5.84	11224	52 . 85	48.37	0	0	0
	7	2600	6.04	11818	53 • 08	48.54	0	0	0
	Γ	2700	6.26	12433	53.31	48.71	0	0	0
T _c = %		2800	6.53	13072	53.55	48.89	0	0	0
		2900	6.85	13741	53.78	49°05	0	0	0
P _c = ATM.		3000	7.25	14446	54•02	49.21	0	0	0

RADIUM

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Date:
Publication

REFERENCE STATE									
222		•	1	93	•	-(P ⁰ -H ⁰ 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
			⊾	T 298.15	~	FREE ENERGY	HEAT A H°	FREE ENERCY & F	
= 1,481 _c	CAL./GFW.	M.	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.		F CAL./GFW.	LOG K
] [208	4.07	0	42.10	42.10			
(202) "		300	16.4	0	42.13	42.10	_		
		400	4.97	506	43.56	42.30			
(693) _c	CAL /GFW.	500	4.97	1003	44.66	42.66	_		
		600	4.97	1500	45.57	43.07			
		700	4.97	1996	46.34	43.49			
(211)		800	4.97	2493	47.00	43.89			
		006	4.97	2990	47.58	44.26			
(3, 920)	CAL /CEW	1000	4.97	3487	48.11	44.63			
		1100	4.97	3984	48.58	44.96			
		1200	4.97	4480	49 . 01	45.28	_		
20		1300	4.97	4977	49.41	45.59	_		
_		1400	4.97	5474	49.78	45.87	_		
U	CAL. /GFW.	1500	4.97	5971	50.12	46.14			
		1600	4.97	6468	50.44	46.40			
		1700	4.97	6964	50.74	46.65			
		1800	4.97	7461	51.03	46.89	_		
¥.		1900	4.97	7958	51.30	47.12			
U	CAL /GFW	2000	4.97	8455	51.55	47.33			
,		2100	4.97	8952	51.79	47.53			
		2200	4.97	9448	52.03	47.74			
20 20		2300	4.97	9945	52.25	47.93			
_		2400	4.97	10442	52.46	48.11			
L		2500	4.97	10939	52.66	48.29			
		2600	4.97	11436	52.85	48.46			
		2700	4.97	11932	53.04	48.63			
đ		2800	4.97	12429	53.22	48.79			
•	4	2900	4.97	12926	53.40	48.95			
	ATM.	3000	4.97	13423	53.57	49.10			

RHENTUM	Re				Solid fro	Solid from 298° to 3000°.	3000°.		
REFERENCE STATE	ATE								
Gfw 186.22	GRAMS	-	ి	н. - Н.	<i>°</i> .'	-(1	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
$(H^{0}_{246,15} - H^{0}_{6}) = 1,307$	D7 CAL/GFW.	TEMPERATURE 9K	HEAT	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEQ./ GFW.	HEAT A H	FREE ENERGY & F	רס6 א ניי א
		298	6.14	0	8.89	8-89			
M.P. 3,453	۲	300	6.14 6.14	11	8.93	8.00			
\ (7,900)	D) CAL /GFW.	500	6.31	1240	12.06	9.58			
		600	6.44	1890	13.25	10.10			
		700	6.57	2550	14.26	10.62			
B.P. 5, 900	*	800	6.70	3210	15.14	11.13			
		006	0 83 0 83	3880	15.93	11.62			
000 FAT 102 000) CAL /GFW.		06.00	5270	17.33	6007T			
		1200	7.22	5980	17-94	12-96			
26	¥	1300	7.35	6710	18.53	13.37			
	:	1400	7.48	7460	19.08	13.76			
Δ H.s	CAL, /GFW.	1500	7.61	8220	19.61	14.13			
		1600	7.74	0668	20.09	14.48			
		1700	7.87	9770	20.56	14.82			
T.P.	¥	1800	8•00	10560	21.02	15.16			
		1900	8.13	11370	21.45	15.47			
ΔH,	CAL. / GFW.	2100	8.30	13010	22.28	16.09			
		2200	8•52	13850	22.67	16.38			
T.P.	*	2300	8.65	14710	23.05	16.66			
		2400	8•78	15580	23.43	16.94			
∆H,	CAL. /GFW.	2500	8.91	16470	23.79	17.21			
		2600	9°04	17360	24.14	17.47			
		2700	9.17	18280	24.48	17.71			
T. =	Å	2800	9.30	19200	24.82	17.97			
		2900	9.43	20140	25.15	18.21			
ہ =	ATM.	3000	9•56	21080	25.47	18.45			

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RHENIUM	Re		ц	leference	State for	Reference State for Calculating $\Delta H_{f f}^{\circ},\ \Delta F_{f f}^{f o},$	tng ∆H°,	∆F°.	
IDEAL MONATOMIC	IC GAS		æ	and Log ₁₀ Kp:		Solid from 298°	1° to 30 00 °	0°.	
66 JBL		•	8	1	9	-(F°-ff° 200 15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
•	GKAMS		<u>ე</u> .	H ^o H ^o T 296.15	ւ-	FREE ENERGY	HEAT A H [°]	FREE ENERGY & F	
(H ^e _{298.15} H ₀ ^e) = 1,481	CAL./GFW.	ж.	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL. DEG. / GFW.	CAL./GFW.	F CAL./ GFW.	LOG K
		298	4.07	C	61.624	45.13	185650	174845	-128-170
A.P.	×	300	4.97	o o	45.16	45.13	185648	174779	-127.336
		400	4.97	506	46.59	45.33	185536	171172	- 93.531
∆ Hm	CAL. / GFW.	500	4.97	1003	47.70	45.70	185413	167593	- 73.259
		600	4.97	1500	48.61	46.11	185260	164044	- 59.757
		700	4.97	1996	49.37	46.52	185096	160519	- 50.120
B.P.	×	800	4.97	2493	50.04	46.93	184933	157013	- 42.897
		006	4.97	2990	50.62	47.30	184760	153539	- 37.286
2H ,	CAL. /GFW.	1000	4.97	3487	51.14	47.67	184567	150087	- 32.804
		1100	4.97	3984	51.62	48.00	184364	146645	- 29.138
		1200	4.97	4481	52 • 05	48.32	184151	143219	- 26.085
S.P.	¥	1300	4.97	4977	52.45	48.63	183917	139821	- 23.508
:		1400	4.97	5475	52.82	48.91	183665	136429	- 21.299
∆ Hs	CAL. /GFW.	1500	4.98	5972	53.16	49.18	183402	133077	- 19.390
		1600	4. 99	6471	53.48	49.44	183131	129707	- 17.716
		1700	5.00	6970	53.78	49.69	182850	126376	- 16.246
T.P.	×	1800	5.02	7472	54.07	49.92	182562	123072	- 14.942
		1900	5.06	7975	54.34	50.15	182255	119764	- 13.775
ΔH,	CAL. / GFW.	2000	5.10	8483	54.60	50.36	181953	116493	- 12.729
		2100	5.15	8995	54.85	50.57	181635	113238	- 11.784
		2200	5.22	9513	55.09	50.78	181313	109989	- 10.926
T.P.	×	2300	5.30	10039	55.33	50.97	180979	106735	- 10.141
		2400	5.40	10573	55.56	51.16	180643	103531	- 9.427
ΔH,	CAL. /GFW.	2500	5.51	11118	55.78	51.34	180298	100323	- 8.770
		2600	5.64	11676	56.00	51.51	179966	97130	- 8.164
		2700	5.79	12247	56.21	51.68	179617	93946	- 7.603
T c =	×	2800	5.96	12835	56.43	51.85	179285	90777	- 7.085
I		2900	6.15	13440	56.64	52.01	178950	87629	- 6.603
""	ATM.	3000	6.35	14065	56.85	52.17	178635	84495	- 6.155

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

RHENIUM

RHODIUM	R	Rh		Solid	Solid from 298°	to 2239	°, Liquid	from 223	to 2239°, Liquid from 2239° to 3000°.	••
REFERENCE STATE	STAT	ы								
Gíw 10	102.91	GRAMS	-	. წ.	H° H° H°	°.	- (51-882	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H ^o _{296 . 15} H ₀ ^o) =		CAL./GFW.	TEMPERATURE •K	HEAT	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL. /DEG./ GFW.	HEAL & H	FREE ENERGY & F cal./gfw.	۲06 K
			298	6.11	0	7.60	7-60			
M.P. 2,	2,239	¥	300	é•11	11	7.64	7.61			
ΔH _m (5,	(2,200)	CAL. / GFW.	500 500	6.52 6.52	1260	9.41 10.82	7.84			
			600	6.73	1920	12.02	8.82			
			100	6.03	2600	13.07	9.36			
B.P. (4,	(4,000)	*	800	7.35	3300	14.00	9.88			
ΔH, (118,400)	400)	CAL. /GFW.	1000	7.55	0624	15.66	10.87			
			1100	7.76	5570	16.40	11.34			
			1200	7.96	6370	17.10	11.80			
S.P.		×	1300	8.17	7180	17.75	12.23			
			1 400	8.38	8010	18•36	12.64			
∆ H₅		CAL. /GFW.	1500	8.58	8860	18.95	13.05			
]	1000	8.80	9720	19.50	13.43			
			1700	00•6	10600	20.04				
T.P.		×	1800	9•20 9	11490	20.55				
Δ Н.		CAL. / GFW.	2000		13370	21.56	14.94			
-			2100	•	14350	22.03				
			0082		15340	25.26				
ž		¥	2400		22540	25.68	16-29			
ΔH.		CAL /GFW.	2500		23540	26.09	16.68			
-			2600	10.00	24540	26.48	17.05			
			2700	10.00	25540	26.86				
T. =		×	2800	10.00	26540	27.22				
•			0062	10.00	27540	27.57	18.08			
" •		ATM.	3000	10.00	28540	27.91	18•40			

RHODIUM

RHODIUM	Σ	Rh		Refer	ence Stat	e for Cal	Reference State for Calculating ΔH_{f}° , ΔF_{f}° , and Log ₁₀ Kp:	ΔH [°] _r , ΔP [°] _r ,	and Log ₁	^o Kp:	
IDEAL	IDEAL MONATOMIC GAS	C GAS		Solid	from 298	• to 2239	Solid from 298° to 2239°, Liquid from 2239° to 3000°	from 223	9° to 300	•••••••••••••••••••••••••••••••••••••••	
	10.01		_ ·	1	9	9	-(E ⁰ -H ⁰ 346 11)	FORMATI	FORMATION FROM REFERENCE STATE	NCE STAT	щ
245		GRAMS	TEMPERATURE		H ^o H ^o T 298.15	հ-	FREE ENERGY	HEAT A H ^o	FREE ENERCY & F		•
(H ⁰ 298.15 H ⁰) =)= 1,483	CAL./GFW.	×	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	F CAL./ GFW.	Š	× °
			298	5.02	0	44.39	44.39	133000	122031	80 1	89.454
A.P.		×	300	5.02	6	44.41	44.38	132998	121967	80 1	88.860
			400	5.17	519	45.88	44.59	132889	118301	¢ I	64.642
ΔHm		CAL. / GFW.	005	5.39	1046	47.06	44.97	132786	114666	ين ا	50.123
			009	5.62	1596	48.05	45.40 45.40	132676	107660	11	40.454
đ		Å	800	6.03	2763	40.04	46.29	132463	103871		28.378
		:	006	6.20	3375	50.46	46.71	132345	100305	2 1	24.359
∠ Η ∠		CAL. /GFW.	1000	6.33	4002	51.12	47.12	132212	96752	- 2	21.147
			1100	6.43	4640	51.73	47.52	132070	93207	-	18.520
			1200	6.50	5287	52.29	47.89	191917	89689	-	16.335
S.P.		×	1300	6.56	5940	52.81	48.25	131760	86182	يب ۱	14.489
			1400	6.59	6598	53.30	48.59	131588	82672	- -	12.906
2 H 2		CAL. /GFW.	1500	6.62	7259	53.75	48.92	131399	66162	-	11.540
			1600	6.63	13971	54.18	49.23	131201	75713	1	10.341
			1700	6.63	8584	54.58	49.54	130984	72266	I	9.290
T.P.		×	1800	6.64	9248	54.96	49.83	130758	68820	1	8.355
			1900	6.63	1166	55.32	50.11	130491	65416	1	7.524
'n⊳		CAL. /GFW.	2000	6.63	10574	55.66	50.38	130204	62004		6•775 • 005
			0012	0.00	16211	50.00 50.00		199521	1/0023		5 4 8 2
d L			2300	5.62	12562	56.59	51.13	124022	51963		4.937
		:	2400	6.62	13224	56.87	51.36	123684	48828	I	4.446
ΔH,		CAL. / GFW.	2500	6.62	13885	57.14	51.59	123345	45720	ı	3.996
			2600	6.62	14547	57.40	51.81	123007	42615	ł	3.582
			2700	6.62	15209	57.65	52.02	122669	39536	ı	3.200
T c =		Å	2800	6.63	15871	57.89	52.23	152331	36455	I	2.845
			2900	6.63	16534	58.12	52.42	121994	33399	ı	2.516
Pc =		ATM.	3000	6•64	17198	58•35	52•62	121658	30338	1	2.210

THERMODYNAMIC PROPERTIES OF THE ELEMENTS

RHODIUM

RUBIDIUM	Rb		Soli	d from 29	8° to 312	Solid from 298° to 312.0°, Liquid from 312.0°	id from	312.0° to	
REFERENCE STATE	æ		974°,	, Ideal M	lona tom 1 c	Ideal Monatomic Gas from 974° to 3000°	97 4° to :	3000°.	
^{ciw} 85.48	GRAMS	+	ზ ^ь	H ⁶ H ⁶ T 291.15	°r-	-(F°-H° 228.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H [°] 21.15 ⁻ H [°]) = 1,790	CAL./GFW.	TEMPERATURE OK	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL/DEG./ GFW.	CAL./OPW.	CAL./ GPW.	רס6 ג רס6 ג
		298	7.50	0	18•22	18•22			
M.P. 312.0	*	300	7.55	14	18.27	18.23			
QH- DH-	CAL. /GFW.	400	7.50	1324	22•22	18•91			
-096			06.1	4/02	23.90	19.70			
		000	7.50	3574	26.42	21.32			
B.P. 974.	Å,	800	7.50	4324	27.42	22.02			
		006	7.50	5074	28.30	22.67			
ΔHv 16.540.	CAL. /GFW.	1000	4.97	23087	40.04	23.56			
		1100	4.97	23584	47.11	25.67			
		1200	4.97	24080	47.55	27.49			
5.P.	*	1300	4.97	24577	41.94	29•04			
ΔH.	CAL /GFW.	1400	4.97	25074	48.31	30.40			
•		1200		1/667	00 00	20.10			
		1000	4.00	20002	40.09	22.09			
T.P.	×	1800	66.4	27065	49.56	34.53			
:		1900	5.01	27565	49 . 83	35.33			
₩ ⊽	CAL. / GFW.	2000	5.02	28067	50.09	36.06			
		2100	5.05	28570	50.34	36.74			
1		2200	5.07	29076	50.57	37.36			
1.P.	×	2300	5.11	29585	50.80	37.94			
Ĩ		2400	5.15	30098	51.02	38.48			
4 u 5	CAL. / GFW.	2500	5.20	30616	51.23	38.99			
		2600	5.26	31139	51.44	39.47			
		2700	5.32	31668	51.63	39.91			
Tc =	*	2800	5.39	32203	51.83	40.33			
		2900	5.47	32746	52.02	40.73			
- c =		3000	5.56	33298	52•21	41.12			

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MITUTATIA	_	4		Referer	nce State	for Calc	ulating M	f ^e , Δ ^r ^e ,	Reference State for Calculating ΔH_{f}° , ΔF_{f}° , and $Log_{10}Kpt$	kp :	
UNTATAON	-			Solid i	rom 298°	Solid from 298° to 312.0°, Liquid from 312.0°	, Liquid	from 312	.0° to		
IDEAL MONATOMIC GAS	NATOMIC	GAS		974°, 1	[deal Mon	Ideal Monatomic Gas from 974° to 3000°	s from 974	1° to 300	°.		
	85. 48			1	!	٩	-(E [°] -H [°] 246 14)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE	
0 	02.00	GRAMS	H	Ե	H ^o H ^o T 296.15	s.⊢	CDEF ENERGY	HEAT A H ^o	FREE ENERGY A F		
(H ⁰ _{298.15} H ₀) =	1,481	CAL./GFW.		HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	LOG	× °
			298	4.97	0	40.63	40.63	19600	12918	6 -	9.469
		×	300	4.97	O,	40.66	40.63	19595	12878	б 1	9.382
			400	16.4	206	42.09	40.83	18782	10834	- 2	5.919
ΔHm		CAL. /GFW.	500	4•97	1003	43.20	41.20	18529	8879	۳ ۱	3.881
			600	4.97	1500	44.10	41.60	18276	6972	-	2.539
			700	4.97	1996	44.87	42.02	18022	5107	-	1.594
B.P.		×	800	4.97	2493	45.53	42.42	17769	3281	1	.896
			006	4.97	2990	46.12	42.80	17516	1478	•	.358
ΔH *		CAL. /GFW.	1000	4.97	3487	79°9	43.16	0	0	0	
			1100	4.97	3984	47.11	43.49	0	0	0	
			1200	4.97	4480	47.55	43.82	0	0	0	
d S		×	1300	4.97	4977	42.94	44.12	0	0	0	
			1400	4.97	5474	48.31	44.40	0	0	0	
∆H₅		CAL. /GFW.	1500	4.97	5971	48•66	44.68	0	0	0	
			1600	4.98	6469	48°87	44.94	0	0	0	
			1700	4•98	6967	49 • 28	45.19	0	0	0	
T.P.		×	1800	4 • 99	7465	49•56	45.42	0	0	0	
			1900	5.01	2962	49.83	45.64	0	0	0	
ΔH		CAL. /GFW.	2000	20.02	1040	50°06	40°80	0 0	00	00	
			2200	5.07	9476	50.57	10001				
- +		2	2300	5.11	9985	50.80	46.46	0			
		4	2400	5.15	10498	51.02	46.65	0	0	0	
ΥH.		CAL /GFW.	2500	5.20	11016	51.23	46.83	0	0	0	
ī			2600	5.26	11539	51.44	47.01	0	0	0	
			2700	5.32	12068	51.63	47.17	0	0	0	
ا ب		20	2800	5.39	12603	51.83	47.33	0	0	0	
		2	2900	5.47	13146	52.02	47.49	0	0	0	
" •		ATM.	3000	5.56	13698	52.21	47.65	0	0	0	
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THERMODYNAMIC PROPERTIES OF THE ELEMENTS

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	40		Refer	• ence Stat	ce for Cal	culating	AHe, APe	eference State for Calculating کللو، کلو، and Log, Kp:	Kp:	
			Solld	l from 296	Solid from 298° to 312.0°, Liquid from 312.0°	.0°, Liqui	ld from 3.	12.0° to	2	
IDEAL DIATOMIC	GAS		974°,		Ideal Monatomic Gas from 974° to 3000°	las from :	97 4° to 3(000°.		
		,	٩	1		-(F ⁰ -H ⁰ 288 15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STAT	Ľ
(H ^{238.15} H ⁰) = 2,606	2,608 CAL-/GFW.	TEMPERATURE 9K	C P HEAT CAPACITY CAL./DEG./ GFW.	H - H - 298.15 HEAT CONTENT CAL./ GFW.	ST ENTROPY CALL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H ^O cal./GFW.	FREE ENERGY & F	ĕ	× [°]
		000					000000			
A.P.	×	298	60 • 6	0	04•03	64•63	04472	12161	1	14•021
∆ H _m	CAL. / GFW.	300	9 0 0	17	64 • 75	64•70	27539	19076	- 1,	13,898
		400	9•11	926	67.36	65.05	25828	16660	1	9.103
B.P.	×	500	9.16	1839	69•40	65•73	25241	14441	ı ı	6.312
ФН ~	CAL. /GFW.	600	9•20	2756	71.07	66.4 8	24658	12328	1	064.4
-as	*	100	9•25	3678	72.49	67.24	24080	10325	1	3.223
ΔH	CAL. / GFW.	800	9•29	4608	73.73	67.97	23510	8398	1	2.294
		006	9.34	5537	74.83	68 •68	22939	6532	•	1.586
T.P.	×	1000	9•38	6472	75.81	69.34	- 12152	5318		1.162
ΔM	CAL. / GFW.	1100	9.43	7413	76.71	69•98	- 12205	7056	•	1.402
T.P.	×	1200	9.47	8360	77.53	70.57	- 12250	8834	1	1.609
ДH,	CAL. / GFW.	1300	9•51	9313	78 • 30	71.14	- 12291	10563	1	1.775
		1400	9•56	10258	20.00	71.68	- 12340	12328	1	1.924
Tc =	×	1500	9•60	11222	79.66	72.18	- 12370	14120	1	2.057
ہ :	ATM.									

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			NCE STATE		LOG K 10 F																													
1308°	, Solid IV	to 3000°.	FORMATION FROM REFERENCE STATE	FREE ENERGY & F	CAL./ GFW.																													
I II from	1773°, 5	2700° to	FORMAT	HEAT A H ^o	f CAL./GFW.																													
8°, Solid	1473° to	uid from	-(116 200.15)	FREE ENERGY	FUNCTION CAL./DEG./ GFW.	6.90	6.90	7.13	7.56	8.05	8.54	9.02	9•48	9°63	10.36	10.77	11.17	11.54	11.91	12.25	12.59	12.90	13.22	13•53	13.83	14.10	14038	14.65	50°41	41.41	15.38	15.70	16.01	16.29
Solid I from 298° to 1308°, Solid II from 1308°	to 1473°, Solid III from 1473° to 1773°	to 2700°, Liquid from 2700°	9	×-	ENTROPY CAL./DEG./GFW.	6.90	6.93	8.60	9.92	11.01	11.96	12.82	13.58	14.29	14.95	15.56	16.13	16.71	17.21	17.67	18.11	18.70	19.11	19.50	19.87	20.21	cc•02	20.87	11.12	21.41	21.75	24.32	24.59	24.84
I from 29	3°, Solid	773° to 2	9	T 290.15	HEAT CONTENT CAL./ GFW.	0	10	265	1180	1780	2400	3040	3690	4360	5050	5750	6460	7240	1960	8680	9400	10450	11200	11950	12700	13450	14200	14950	00/01	10490	17200	24150	24900	25650
Solid .	to 147	from 1773°	1		HEAT CAPACITY CAL./DEG./ GFW.	5.70	5.70	5 . 85	6.00	6.15	6.30	6.45	6.60	6.75	6 • 90	7.05	7•20	7.20	7.20	7.20	7.20	7.50	7.50	7.50	7.50	7.50		04.7		00.01	7.50	7.50	7.50	7.50
			,		Ne Ne	298	300	400	500	600	700	800	006	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200		2400		2000	2700	2800	2900	3000
Ru	ልጥድ	411		GKAMS	CAL./GFW.		**	•	CAL. / GFW.			Å		CAL. /GFW.			×		CAL. /GFW.			×		CAL. / GFW.			×		CAL. /GFW.				:	ATM.
RUTHENIUM	REFERENCE STA		101.101		(H [°] 298.15 H°) ≡		(2.700)		(6,100)			(4,000)		(135,700)								1,308		09			L, 4 / J	c	>			1.773	•	320
RUT	REP		;	25	(H [°] 298.1		4	i	∆H			8. P.		ΔH,			2		ΔH₅			T.P.		٩ų			d.		ĥ			1, =	:	້

RIFFIRNTIM	Ri I	Refer	ence Sta	te for Ca	lculating	Reference State for Calculating $\Delta H_{\rho}^{\bullet}$, $\Delta F_{\rho}^{\bullet}$, and Log, ΛK_{P}^{\bullet}	, and Log		Solid I from
		2 98°	to 1308°	, Solid I	298° to 1308°, Solid II from 1308°	08° to 14	to 1473°, Solid III		from 1473° to
IDEAL MONATOMIC GAS	GAS	1773	, Solid	Solid IV from 1773° to	773° to 2	2700°, Liquid		from 2700° to	to 3000°.
	CDAMC	F	و	62	ę	-(k16 238.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
T.TOT			•ر	T 299.15	* -	FREE ENERGY	HEAT A H ^o	FREE ENERGY & F	
(H [°] _{214.15} H [°] ₅) = 1,490	CAL./GFW.	Ne Ne	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	f CAL./ GFW.	гос к 100 к
		298	5.14	0	44.55	44.55	144000	12776	- 07-320
M.P.	¥	300	5.15	10	44.58	44.55	144000	132705	
:		400	5.41	537	46.10	44.76	143947	128947	- 70.459
∆ H.m.	CAL. /GFW.	500	5.69	1093	47.34	45.16	143913	125203	- 54.729
		600	5.92	1673	48 • 40	45.62	143893	121459	- 44.245
		200	60°9	2274	49•32	46.08	143874	117722	- 36.757
B.P.	*	800	6.20	2889	50.14	46.53	143849	113993	- 31.144
		006	6.27	3513	50.88	46.98	143823		- 26.774
∆H ~	CAL. /GFW.	1000	6.30	4142	51.54	47.40	143782	106532	- 23.284
		1100	6.30	4772	52.14	47.81	143722	-	- 20.428
		1200	6 • 30	5402	52.69	48.19	143652	96066	- 18.049
S.P.	*	1300	6•29	6032	53 . 19	48.55	143572	95394	- 16.038
:		1400	6.29	6661	53.66	48.91	143421	16916	- 14.314
∆ Hs	CAL. / GFW.	1500	6.30	1621	54°09	49.23	143331	88011	- 12.824
		1600	6.32	7922	54.50	49.55	143242	84314	- 11.516
		1700	6•35	6668	54.88	49.85	143155	80646	- 10.367
Т.Р.	×	1800	6 • 39	9192	55•25	50.15	142742	76952	- 9.342
		1900	6 • 45	9834	55.60	50.43	142634	73303	- 8.431
ΔH ,	CAL. /GFW.	2000	6.51	10481	55 . 93	50.69	142531	69671	- 7.612
		2100	6.58	11136	56.25	50.95	142436	66038	- 6.872
		2200	6.66	11798	56.56	51.20	14234A	6237R	- 6.196
T.P.	*	2300	6.74	12468	56 . 85	51.43	142268	58778	- 5.585
:		2400	6.83	13146	57.14	51.67	142196	55148	- 5.021
∆H,	CAL. /GFW.	2500	6.91	13833	57.42	51 . 89	142133	51508	- 4.502
		2600	7.00	14529	57.69	52.11	142079	47907	- 4•027
		2700	7•08	15233	57.96	52.32	142033	44266	- 3.582
T c =	×	2800	7.17	15945	58•22	52.53	135795	40875	- 3.190
1		2900	7.24	16666	58.47	52.73	135766	37514	- 2.827
۲ ₆ =	ATM.	3000	1.32	17394	58•72	52.93	135744	34104	- 2•484

RUTHENIUM

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CLAL/GFNL T C H ^m		ļ		Idea	1 Monatom	ite Gas fr	l from 132 om 1860°	5° to 18 to 3000°	60°,	
Cut./GFW, W Tut. Tut. Meter./ Tut./GFW Tut. Tut. Ext./FeW Tut. Tut. Ext./FeW Tut. Tut. Ext./FeW Tut./FeW HEAT AH Ext./FeW HEAT AH Ext./F	0.35	GRAMS	-	υ	е Н. Но – Н	en	-(F°H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
298 6.49 0 16.28 *K 300 6.50 11 16.28 *K 500 7.05 1370 19.77 *K 700 7.35 2335 22.23 *K 700 7.62 2835 22.23 *K 700 8.46 525.09 23.27 *K 11000 8.46 525.99 23.27 *K 11000 8.74 6110 23.27 *K 11200 8.00 7.350 25.99 *K 11200 8.00 7.350 25.99 *K 11200 8.00 11400 31.76 *K 1200 8.00 12400 31.76 *K 1300 8.00 14800 31.76 *K 1900 6.31 61970 57.36 *K 1900 6.31 61970 57.36 *K 2300 6.1340 57.36 57.36 *K 1900 6.31 61970 57.36 *K 1900 6.33 61340 57.36 *K 2300 6.33 61340 57.36 *K 25000 6.33 61440		CAL./GFW.	TEMPERATURE 9K		T 298.15 HEAT CONTENT CAL./ GFW.	T ENTROPY CAL. /DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H	FREE ENERGY & F	Lo6 * .
"K 300 6.50 11 16.32 "K 500 7.05 1370 19.77 "K 700 7.65 2835 22.23 "K 900 8.18 2090 21.08 "K 700 7.65 2835 22.23 "K 900 8.18 4415 24.26 "K 11000 8.46 5250 25.99 "K 11000 8.74 6110 25.99 "K 11200 8.00 11400 30.21 "K 1300 8.00 11600 30.21 "K 1300 8.00 11600 30.21 "K 1300 8.00 114000 31.76 "K 1300 8.00 114000 31.76 "K 1900 6.31 61340 57.62 "K 1900 6.33 61340 57.96 "K 2300 6.12 57.96 57.96 "K 1900 6.31 61970 57.96 "K 2300 6.33 61340 57.96 "K 2300 6.12 65.96 57.96 "K 23000 6.04			298	6+•9	0	16.28	16.28			
The second se	, 325	3	300	6.50	11	16.32	16.29			
Cut./GFW. 500 7.005 1370 199.77 *K 700 7.905 3610 232.23 *K 900 8.18 4415 249.22 *K 1000 8.46 5250 25.09 *K 11000 8.46 5250 25.09 *K 11200 8.76 6110 25.99 *K 11200 8.00 11400 8.00 7350 27.65 *K 11200 8.00 11400 8.00 11400 30.21 *K 1200 8.00 11400 8.00 12400 30.21 *K 1300 8.00 11400 31.76 32.22 *K 1900 6.31 611340 57.36 28.23 *K 1900 6.33 61340 57.36 28.23 *K 1900 6.33 61970 57.36 28.23 *K 23000 6.1440 57.36 57.36 57.36 *K 23000 6.04 650.30 58.29 57.36 <td>(129)</td> <td>¥</td> <td>004 40</td> <td>6.78</td> <td>675</td> <td>18.23</td> <td>16.55</td> <td></td> <td></td> <td></td>	(129)	¥	004 40	6.78	675	18.23	16.55			
700 7.62 2835 22.23 % 900 8.18 4415 24.22 % 1000 8.46 5250 23.27 % 1100 8.74 6110 23.27 % 1100 8.00 7.55 25.99 % 1100 8.00 7.62 25.91 % 1100 8.00 7.55 25.99 % 1100 8.00 7.55 27.652 % 1100 8.00 11600 30.21 1700 8.00 11600 30.21 27.652 % 1500 8.00 114600 30.21 % 1900 8.00 114600 31.76 % 1900 8.00 14400 37.04 % 1900 6.33 61340 57.67 % 22000 6.33 61340 57.67 % 2300 6.13 63830 58.28 % 2300 6.1440 58.28 % 2500 6.04 65050 % 2500 6.05 59.86 % 2500 6.05 59.86 % 25000 6.05<	())))	CAL /GFW.	000	7 • 34	1370					
"K 900 7.90 3610 23.27 "K 900 8.18 4415 24.22 "K 11000 8.46 5250 25.91 "K 11000 8.00 7350 25.91 "K 1100 8.00 7350 25.91 "K 1100 8.00 7350 25.91 "K 1100 8.00 11600 30.21 "K 1500 8.00 12600 30.21 "K 1500 8.00 12600 30.21 "K 1900 6.39 61340 57.62 "K 1900 6.39 61340 57.36 "K 1900 6.31 61970 57.36 "K 2200 6.1340 57.67 "K 2300 6.13 62600 "K 2300 6.13 63830 "K 2500 6.04 65050 "K 2500 6.04 65050 "K 2400 6.04 65050 "K 2500 6.04 65050 "K 2500 6.04 65050 "K 2600 6.04 "K 25			700	7.62	2835					
Tk 900 8.18 4415 24.22 CAL/GFW 1000 8.46 5250 25.09 % 1100 8.74 6110 25.91 % 1200 8.00 1350 25.91 % 1300 8.00 11600 30.21 % 1500 8.00 12400 30.21 % 1500 8.00 12400 30.21 % 1500 8.00 12400 30.21 % 1500 8.00 12400 31.76 % 1900 6.33 61340 57.04 % 1900 6.33 61340 57.36 % 22000 6.33 61970 57.36 % 22000 6.33 61970 57.36 % 22000 6.13 63830 57.26 % 22000 6.13 63830 57.26 % 22000 6.13 65050 58.49 % 2500 6.04 65050 58.49 % 25000 6.04 65650 58.49 % 2500 6.04 65660 59.46 % 25000 6.04	,860)		800	7.90	3610					
CAL /GFW 10000 8 • 46 5 2 5 0 2 5 • 0 9 °K 11000 8 • 74 6110 2 5 • 9 1 °K 1200 8 • 00 7 3 5 0 2 5 • 9 1 °K 1200 8 • 00 13 5 0 2 7 • 6 2 °K 1400 8 • 00 11 6 00 3 0 • 2 1 °K 1500 8 • 00 12 4 00 3 0 • 2 1 °K 1700 8 • 00 12 4 00 3 0 • 2 1 °K 1900 8 • 00 13 2 00 3 1 • 2 8 °K 1900 8 • 00 14 8 00 3 2 • 2 2 °K 1900 6 • 3 1 6 1 3 4 0 5 7 • 0 4 °K 2100 6 • 3 1 6 1 9 7 0 5 7 • 0 4 °K 22000 6 • 3 1 6 3 2 2 0 5 7 • 0 4 °K 22000 6 • 0 6 5 7 • 0 4 5 7 • 0 4 °K 23000 6 • 0 6 5 9 • 0 9 5 7 • 0 4 °K 23000 6 • 0 6 5 9 • 0 9		¥	006	8.18	4415		19.32			
"K 1100 8.74 6110 25.91 "K 1200 8.00 7350 25.98 "K 1400 8.00 11600 30.21 CAL/GFW 1500 8.00 12400 30.21 "K 1700 8.00 12400 30.21 "K 1900 8.00 12400 31.76 "K 1900 8.00 12400 31.76 "K 1900 8.00 12400 31.76 "K 1900 8.00 12400 32.22 "K 1900 6.39 61340 57.04 "K 2000 6.31 61970 57.36 "K 2100 6.18 65220 57.96 "K 2100 6.18 65220 57.96 "K 2200 6.18 65220 57.96 "K 2500 6.04 65660 59.49 "K 2500 6.04 65660 59.96 "K 2800 6.04 65660 59.96 "K 2800 6.05 659.96 59.96	,800)	CAI /GEW	1000	8.46	5250		19.84			
*K 1200 8.00 7350 26.98 *K 1400 8.00 8150 27.62 CAL_/GFW 1600 8.00 13200 30.21 *K 1400 8.00 13200 30.21 *K 1700 8.00 13200 31.76 *K 1700 8.00 13200 31.28 *K 1900 6.39 61340 57.04 *K 2000 6.31 61970 57.36 *K 2200 6.31 61970 57.36 *K 2200 6.13 63830 58.23 *K 2200 6.13 63830 58.23 *K 2200 6.04 65050 58.23 *K 2500 6.04 65050 58.24 *K 2500 6.04 65050 59.42 *K 2500 6.04 65050 59.42 *K 2800 6.05 67440 59.42			1100	8.74	6110		20.36			
"K 1300 8.00 8150 27.62 C.M. / GFW 1400 8.00 11600 30.21 1500 8.00 12400 30.21 "K 1500 8.00 12400 30.21 "K 1500 8.00 12200 31.28 "K 1900 6.39 61340 57.04 "K 2100 6.24 62600 57.96 "K 2100 6.13 61340 57.96 "K 2200 6.13 61340 57.96 "K 2200 6.13 61970 57.96 "K 2100 6.03 61340 57.96 "K 2200 6.13 63830 58.23 "K 2200 6.04 65650 58.24 "K 2500 6.04 65660 59.49 "K 2500 6.04 65650 59.49 "K 2800 6.04 65050 59.49 "K 2800 6.04 65050 59.44			1200	8.00	7350		20.86			
-k 1400 8.00 11600 30.21 Cull / GFW 1500 8.00 12400 31.28 -k 1700 8.00 12400 31.28 -k 1700 8.00 14000 31.28 -k 1900 6.39 61340 57.04 -k 1900 6.31 61970 57.04 -k 2000 6.31 61970 57.36 -k 22000 6.18 63830 58.23 -k 2100 6.03 64440 58.49 -k 2500 6.04 65050 58.24 -k 2500 6.04 65660 59.49 -k 2700 6.04 65660 59.49 -k 2800 6.04 65050 58.74 -k 2800 6.04 65660 59.49 -k 2800 6.04 65860 59.49 -k 2800 6.04 65860 59.49		,	1300	8•00	8150	27.62	21.36			
CAL_/GFW. 1500 8.00 12400 30.76 % 1600 8.00 13200 31.28 % 1800 8.00 14800 31.28 % 1900 6.39 61970 57.04 % 2000 6.31 61970 57.04 % 2100 6.13 63830 57.67 % 2200 6.13 63830 58.23 % 2300 6.13 63830 58.23 % 2300 6.04 65650 58.28 % 2500 6.04 65660 % 2700 6.04 65660 % 2700 6.05 64440 2700 6.04 65660 59.49 % 22600 6.04 65660 2700 6.04 65660 59.49 % 2800 6.05 64440 58.49 2700 6.04 65660 59.20 % 2800 6.05 64470 8 63860 59.964		4	1400	8.00	11600	30.21	21.93			
.k 1500 8.00 13200 31.28 .k .k 1700 8.00 14800 31.76 .k 1900 6.39 61340 57.04 .cul./GFW 2100 6.31 61970 57.36 .k 2100 6.31 61340 57.36 .k 2100 6.31 61370 57.36 .k 2200 6.13 63220 57.36 .k 2300 6.13 63220 57.36 .k 2300 6.13 63220 58.23 .k 2500 6.04 65650 58.49 .k 2500 6.04 65660 59.20 .k 2700 6.04 65660 59.20 .k 2800 6.04 65660 59.42 .k 2800 6.05 67470 59.42		CAL /GFW.	1500	8.00	12400	30.76	22.50			
"K 1700 8.00 14000 31.76 "K 1900 8.00 14800 32.22 "K 1900 6.39 61340 57.04 "K 1900 6.31 61970 57.36 "K 2000 6.31 61340 57.36 "K 2100 6.24 62600 57.36 "K 22000 6.13 63830 57.36 "K 2300 6.13 63830 57.36 "K 2500 6.13 63830 58.23 "K 2500 6.04 65650 58.79 "K 2500 6.04 65660 58.79 "K 2700 6.04 65660 59.49 "K 2800 6.04 65660 59.20 "K 2800 6.04 65660 59.42 "K 2800 6.04 65660 59.44			1600	8.00	13200	31.28	23.03			
* 1800 8.00 14800 32.22 CuL./GFW 1900 6.39 61340 57.04 CuL./GFW 2000 6.31 61340 57.04 K 2000 6.31 61340 57.04 K 2000 6.31 61340 57.04 2100 6.24 62600 57.04 2200 6.13 63830 57.04 2200 6.13 63830 57.05 2200 6.13 63830 57.06 X 2200 6.13 63830 57.06 X 2200 6.13 658.09 57.06 X 2500 6.04 65050 58.74 Z 2500 6.04 65050 59.84 X 2600 6.04 65050 59.42 X 2600 6.04 65260 59.42 X 2800 6.04 65260 59.42 X 6.04			1700	8.00	14000	31.76	23.53			
* 1900 6.39 61340 57.04 CAL/GFW 2000 6.31 61970 57.36 CAL/GFW 2100 6.31 61970 57.36 * 22000 6.31 61970 57.36 * 22000 6.31 61970 57.36 * 22000 6.013 63830 58.23 * 22000 6.013 63830 58.23 * 2500 6.013 65050 58.24 CAL/GFW 25000 6.04 65050 58.74 * 2700 6.04 65260 58.74 * 28000 6.04 65260 59.49 * 28000 6.04 65260 59.42 * 30000 6.04 658060 59.42 * 3000 6.04 658060 59.42	190		1800	8 • 00	14800	32.22	24•00			
CAL / GFW. 2000 6.31 61970 57.36 2100 6.24 62600 57.67 2200 6.18 63220 57.96 2300 6.13 63830 58.23 64440 58.49 2400 6.09 64440 58.49 2400 6.04 65650 58.98 2700 6.04 65660 58.98 2200 6.04 65660 58.98 3000 6.04 66860 59.42 3000 6.05 67470 59.42 68080 59.64		*	1900	6•39	61340	57.04	24.76			
2100 6.24 62600 57.67 2200 6.18 63220 57.96 2300 6.13 63830 58.23 2400 6.13 63830 58.23 2500 6.04 65050 58.74 2600 6.04 65660 58.98 2700 6.04 65260 59.42 28000 6.04 65260 59.42 2900 6.05 67470 59.44 2900 6.05 67800 59.44	360)	CAL /GFW	2000	6.31	61970	57.36	26.38			
2200 6.18 63220 57.96 2300 6.13 63830 58.23 2400 6.13 63830 58.23 25500 6.09 65050 58.49 25600 6.04 65660 58.98 22600 6.04 65660 58.98 22700 6.04 65260 59.20 22900 6.04 66260 59.42 22900 6.05 67470 59.42 3000 6.05 67470 59.64		;	2100	6.24	62600	57.67	27.87			•
2300 6.13 63830 58.23 2400 6.09 64440 58.49 2500 6.06 65050 58.49 2500 6.04 6560 58.98 2700 6.04 6560 58.98 2700 6.04 65260 58.98 2800 6.04 65260 59.42 2900 6.08 68860 59.64 3000 6.08 68080 59.64			2200	6.18	63220	57.96	29.23			
2400 6.09 64440 58.49 2500 6.06 65050 58.74 2500 6.04 65660 58.98 2700 6.04 65660 58.98 2800 6.04 65860 59.42 2900 6.04 65860 59.42 3000 6.05 63860 59.64		3	2300	6.13	63830	58•23	30.48			
2500 6.06 65050 58.74 2600 6.04 65660 58.98 2700 6.04 66260 59.20 2800 6.04 66860 59.20 2900 6.05 67470 59.42 3000 6.05 67470 59.64		4	2400	60•9	64440	58.49				
2600 6.04 55660 58.98 2700 6.04 65260 59.20 2800 6.04 66260 59.42 2800 6.05 6942 59.42 3000 6.05 67470 59.664			2500	6 • 0 6	65050	58.74				
2700 6.04 66260 59.20 2800 6.04 66860 59.42 2900 6.05 67470 59.64 3000 6.08 68080 59.84		LAL. / ULW.	2600	6.04	65660	58.98				
2800 6.04 66860 59.42 2900 6.05 67470 59.64 3000 6.08 68080 59.84			2700	6.04	66260	59.20	34.66			
2900 6.05 67470 59.64 3000 6.08 68080 59.84			2800	6.04	66860	59°42	35.55			
			2900	6 • 05	67470	59.64	36.38			
		ATH	3000	6 • 0 8	68080	59.84	37.15			

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CAMAPTIM	ě	Re	ference S	State for	Reference State for Calculating AHs,		AF, and Log, Kpt	Log, "Kp :	
	5	So	11d I fre	om 298° t	0 1190°,	Solid II	from 1190	Solid I from 298° to 1190°, Solid II from 1190° to 1325°, Liquid	°, Liquid
IDEAL MONATOMIC GAS	C GAS	ů. J	from 1325°	to 1860	to 1860°, Ideal Monatomic Gas	onatomic	Gas from	from 1860° to 3000°	3000°.
150.35			1	1	•	-(F°-H° 288 16)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
	GRAMS	1	<u>გ</u> .	H°H° T 296.15	r-	FREE ENERGY	HEAT A H°	FREE ENERGY & F	
(H [°] _{219. 15} H°) =	CAL./GFW.		HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GPW.	CAL./ GFW.	гос к 001
		298	7.25	0	43.72	43.72	50000	41819	- 30.655
0		300	7.25	14	43.77	43.73	50003	41768	- 30.430
	•	400	7.28	740	45.86	44.01	50065	39013	- 21.317
ΔHm	CAL. / GFW.	500	7.33	1471	47.49	44.55	50101	36241	- 15.842
			1.03	6022	48 83 8 9 9 4	45.10	50115	33465	-
			040	2444	10.04	40.11	50109	30691	- 9.582
B.P.	×		7.97	1000 1004	51.80	10.94		21950	060.1 -
HV	CAL /GFW	1000	7.32	5157	52.60	47.45	10664	22397	- 4.895
•		1100	7.24	5885	53.29	41.94	49775	19657	- 3.905
		1200	7.14	6605	53.92	48.42	49255	16927	- 3.083
5P.	×	1300	7.04	7314	54.49	48.87	49164	14233	- 2,392
		1400	6.92	8012	55 • 00	49.28	46412	11706	- 1.827
Δ H _s	CAL. /GFW.	1500	6.81	8698	55.48	49 ° 69	46298	9218	- 1.343
		1 700	69°0	9373	55 . 91	50.06	46173	6765	- 924
			6C.00	10001	16.00	14-00	10037	2054	
T.P.	×	1000	0040	10001	20.02	0/ 0/ 5	16264	C+81	* 77• -
Υ. Η Υ	CAL /GEW	2000	6.31	01911	57.36	51.38	00		o c
		2100	6.24	12597	57.67	51.68	0	0	0
		2200	6.18	13218	57.96	51.96	0	0	0
T.P.	×	2300	6.13	13834	58.23	52.22	0	0	0
		2400	60°9	14444	58.49	52.48	0	0	0
ΔH,	CAL. /GFW.	2500	6.06	15052	58.74	52.72	0	0	0
		2600	6 • 0 4	15657	58 • 98	52 . 96	0	0	0
		2700	6 • 0 4	16260	59.20	53.18	0	0	0
T,=	*	2800	6 • 0 4	16864	59°42	53.40	0	0	0
,		2900	6 • 05	17469	59°64	53.62	0	0	0
Pc =	ATM.	3000	6 • 08	18075	59 • 84	53.82	0	0	0
	-								

SAMARIUM

SCANDIUM	Sc		Solid	from 298°	to 1673°	Solid from 298° to 1673°, Liquid from 1673° to	from 167.	3° to	
REFERENCE STATE	VTE		2750°,	Ideal Mo	Ideal Monatomic Gas from	as from 2	2750° to :	to 3000°.	
6iw 44•96	GRAMS	-	ບ	H0-H0	8,	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
$(H^{\circ}_{298,15} - H^{\circ}_{0}) =$	CAL./GFW.	TEMPERATURE ⁰ K	P HEAT CAPACITY CAL./DEG./ GFW.	T 294.15 HEAT CONTENT CAL./ GFW.	T ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H	FREE ENERGY A F cal/ gfw.	יי ג רספ ג
		298	6.01	0	00 • 6	00.0			
" ₂ (1,673)	¥0	300	6.01	11	*0 •6	10.6			
(7 BEA)		400	6.12	617	10.78	9•24			
	CAL. / GFW.	000	6.33	1860	12.010	9.69			
		700	6.44	2500	14.20	10.72			
(2,750)	20	800	6.55	3150	15.15	11.22			
	4	006	6.66	3810	15.93	11.70			
△H, (72,850)	CAL /GFW.	1000	6.77	4480	16.64	12.16			
		0011	0.88	0/19	17.29	12.59			
		1200	66•9	5860	17.89	13.01			
S.P.	×	1300	7.10	6560	18.46	13.42			
		1400	1.21	7280	18.99	13.79			
∆ Ms	CAL. /GFW.		2001	0108	10.05	14.10			
		1700	8.00	13350	22.72	14.87			
¢,	à	1800	8.00	14150	23.18	15.32			
	<u>4</u>	1900	8 • 00	14950	23.61	15.75			
ΔH	CAL /GFW.	2000	8.00	15750	24.02	16.15			
		2000	00.8	04441	24.41	10.53			
		2200		00011	5- • ± 2	16.01			
7.P.	*	2400	8.00	18950	25.48	17.59			
		2500	8.00	19750	25.81	17.91			
h u D		2600	8•00	20550	26.12	18.22			
		2700	8 • 00	21350	26.42	18.52			
ا +		2800	5.87	06876	53.19	19.31			
	4	2900	6.03	06756	53.40	20.48			
Pc =	ATM.	3000	6.21	96100	53.61	21•58			

SCANDIUM	Sc		Refere	nce State	for Calc	ulating A	He, Me,	Reference State for Calculating $\Delta H_{P}^{\bullet}, \ \Delta F_{P}^{\bullet}$, and $Log_{1,0}Kp_{1,0}$	Kp :
IDEAL MONATOMIC GAS	LC GAS		Solid	from 298°	to 1673°	Solid from 298° to 1673°, Liquid from 1673° to	from 1673	se to	
			2750°,		natomic 0	Ideal Monatomic Gas from 2750° to 3000°	750° to 3	000°.	
44.96		1	1	1	q	- (1,100 ° 1)-	FORMATI	FORMATION FROM REFERENCE STATE	ICE STATE
Cłw	GRAMS	-	ሪ•	H ⁰	۶ <u>-</u>	FREE ENERGY	HEAT A H ^e	FREE ENERGY Δ F	
(H [°] _{210.15} H [°] ₂) = 1,674	CAL/GFW.	*****	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GPW.	ENTROPY CAL./DEG./GPW.	CAL./DEG./ GFW.		CAL./ GFW.	LOG K
		298	5 • 28	0	41.75	41.75	82000	72235	- 52.051
E S	×	300	5.28	10	41.78	41.75	81999	72177	- 52.585
		400	5.15	530	43 . 28	41.96	81913	68913	- 37.655
ΔHm	CAL. /GFW.	000	5.08	1042	44 • 42	42.34	81807	65677	- 28.709
		200	5 • 0 3	1548	40.35	42.77	81688	62458	
9	Jie O	800	5.01	2554	46.79	43.60	81404	56092	- 15.374
	:	006	5.00	3055	47.38	43.99	81245	52940	
ДН,	CAL. /GFW.	1000	5.00	3555	47.91	44.36	81075	49805	- 10.885
]	1100	4.99	4054	48•38	44.70	80884	46685	- 9.276
		1200	4 • 66	4553	48.82	45°03	80693	43577	- 7.937
5.P.	¥	1300	4.99	5052	49.22	45.34	80492	40504	- 6.809
		1400	4•99	5551	49.59	45.63	80271	37431	- 5.843
Δ Hs	CAL. /GFW.	0061	66 • 4	6050	49 . 93	45.90	80040	34380	- 5.009
		1600	5 • 00	6550	50.25	46.16	79810	31346	- 4.281
		1700	5.01	7050	50.56	46.42	75700	28372	- 3.647
T.P.	Å	0081	60°4	7553	50.85	46.66	75403	25597	- 3.107
		0000		1008	21.12	46.88	75107	2 2 8 3 8	- 2.626
4 UP		2100	5.15	9078	51.63	47.31	74528	26002	- 2°195
		2200	5.21	9595	51.87	47.51	74245	14669	- 1.457
Ţ₽	×	2300	5 • 28	10120	52.10	47.70	73970	11962	- 1.136
		2400	5.37	10652	52.33	47.90	73702	9262	843
ΔH	CAL. / GFW.	2500	5.47	11194	52.55	48°08	73444	6594	576
		2600	5 • 59	11747	52.77	48.26	73197	3907	328
		2700	5.72	12312	52 . 98	48.42	72962	1250	- 101
Tc =	¥.	2800	5.87	12892	53.19	48.59	0	0	0
		0062	£0°0	13487	53.40	48.75	0	0	0
= °	ATM.	0000	12.0	14048	53.61	48•92	0	0	0

SCANDIUM

Publication Date: January 1, 1956 | doi: 10.1021/ba-1956-0018.ch004

SELENIUM		Se		Solid	l from 29(8° to 490	Solid from 298° to 490°, Liquid from 490° to	from 490	• to	
REFE	REFERENCE STATE	щ		958°,		Ideal Diatomic Gas from	as from 9	958° to 3000°.	00	
j j	78.96		TEMPERATURE	Co P HEAT CAPACITY	H ⁰ - H ⁰ T 296.15 HEAT CONTENT	S ⁰ T ENTROPY	-(FO-HO 200.15) FREE ENEROY	FORMATI HEAT A H ^o	FORMATION FROM REFERENCE STATE	ICE STATE LOG K
(n ⁻ 2%.15 n ⁰ / =			•	COLL/DEG/ GPR.	CALLY GPW.	CAL./DEG./ GFW.	CAL./DEG./ GFW.	CALL/GFW.	CALL/ GFW.	9
1	490		862	000 v	• =	10.15	10.15			
		4	400	6.65	650	12.02	10.40			
ΔH	T, 000	CAL. / GFW.	500	8 40	2650	16.21	10.01			
			2002	0 * • 0 8 • 4 0	4330	10.04	12.86			
B.P.	958	*	800	8.40	5170	20.16	13.70			
	6.290		006	8 • 40	6010	21.15	14.48			
^H 2	6	CAL /GFW.	1100	4 • 50	20610	35•86	17.02			
			1200	4 • 52	21060	36.25	19.70			
S.P.		¥	1300	4.53	21510	36.62	20.08			
3			1400	4 • 55	21970	36.95	21.26			
51			1600	09.4	22880	37.56	23.26			
			1700	4.62	23340	37.84	-			
T.P.		×	1800	4.65	23810	38.11				
3		M30/ 170	1900	4.67	24270	38.36	25.59			
			2100	4.71	25210	38.83	26.83			
			2200	4.73	25680	39.05	27.38			
T.P.		ж.	2300	4.75	26150	39.26	27.90			
H <		CAL /GEW	2400	4•77 4•78	26630	39.46	28.37			
			2600	4.80	27590	39.84	29.23			
			2700	4.82	28070	40.02	29.63	_		
1, i		×	2800	4.83	28550	40 • 20	30.01	_		
,			2900	4.84	29030	40.37	30.36			
" "		ATM.	3000	4 . 86	29520	40.53	30•69			

SELENIUM

SELENTIM	e.		Refe	Reference Sta	State for Calculating AH, AF,	lculating	QH [°] , QF	, and		
	200		Log _{1 O} Kp :		Solid from 298° to 490°, Liquid from	98° to 49	o°, Liqui	d from 490°	•0	
IDEAL DIATOMIC	GAS		to 6	958°, Ideal		Distomic Gas from	958°	to 3000°.		
Ghu 157.92	GRAMS		و		ę	-(F ⁰ -H ⁰ 299.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE	Π
•		TEMPERATURE		T 290.15	* +	FREE ENERGY	HEAT A H ^e	FREE ENERGY & F		
(H [°] _{211.15} H [°] ₂) = 2,570	CAL./GFW.	¥,	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GPW.	LOG K	
		298	8.47	0	60•23	60.23	34120	22214	- 16.283	83
M.P.	*	300	8.47	16	60•28	60.23	34114	22144	- 16.133	33
:		400	8.67	874	62.75	60.57	33694	18210	- 9.950	50
ΔHm	CAL. / GFW.	500	84.78	1748	02 • 70	61.21	30568	14428	- 6.306	80
		600	8.85	2630	66.31	61.93	29770	11272	- 4.106	8
		700	8•89	3516	67.68	62.66	28976	8256	- 2.577	77
B.P.	×	800	8.92	4407	68.87	63.37	28187	5347	-	00
		006	66-8	1050	69•92	64•03	27401	2543	••	• 617
2 H v	CAL /GFW.	11000	86.8	1610	71.72	04.01	00	00	00	
		1200	9.03	1997	72.50	65 . 84	00	0	0	
S.P.	*	1300	90•6	8902	73.23	66.39	0	0	0	
		1400	9.10	9810	73.90	66.90	0	0	0	
∆ H _s	CAL. /GFW.	1500	9.15	10720	74.53	61.39	0	0	0	
		1600	9.20	11640	75.12	67.85	0	0	0	
		1700	9.24	12560	75.68	68.30	0	0	0	
T.P.	×	1800	9 • 29	13490	76.21	68 •72	0	0	0	
H		1900	9•33 933	14420	76.71	69 . 13	00	00	00	
ł		2000	10.0	00001	87 • / /				, ,	
		2200	64.6	17240	78.09	70.26			0	
T.P.	×	2300	9.49	18180	78.51	70.61	0	0	0	
		2400	9.53	19130	78.92	70.95	0	0	0	
ΔH,	CAL. / GFW.	2500	9•56	20090	79.31	71.28	0	0	0	
		2600	9•60	21050	79.68	71.59	0	0	0	
		2700	9.63	22010	80.04	71.89	0	0	0	
T _c =	×	2800	9.66	22970	80.39	72.19	0	0	0	
		2900	9.68	23940	80.73	72.48	0	0	0	
P. =	ATM.	3000	9.71	24910	81.06	72.76	0	0	0	
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SELENIUM

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In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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Publication Date: January 1, 1956 doi: 10.1021/ba-1956-0018.c]	7004
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SET ENTIN	đ		Refer	ence Stat	Reference State for Calculating $\Delta H_{ m e}^{ m s},\ \Delta F_{ m e}^{ m s},$ and	culating	AH, AF	, and		
TDFAL HEYATOMIC	9.00 V V		Log ₁₀ Kp:		ld from 29	8° to 49 C)°, Liquia	Solid from 298° to 490°, Liquid from 490°	ໍ	
			to 958°.		Ideal Diatomic Gas from	Gas from	958	1500°.		
Giw 473.76	GRAMS	F	ືບ	H° – H°	e,	-(1-10 200.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE S	TATE
(H ² _{296.15} H ₀) =	CAL./GFW.	TEMPERATURE · ^o k	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL. /DEG./ GFW.	HEAT A H ^e cal/gfw.	FREE ENERGY & F	-	LOG K
.e. #	¥	298	29•00	0	110.00	110.00	35380	20739	I	15.202
ΔHm	CAL /GFW.	300	29•02	54	110.19	110.01	35368	20653	ı	15•046
		400	29•90	3000	118.67	111.17	34480	15860	I	8.666
B.P.	*	500	30.50	6030	125.40	113.34	25510	11440	•	5.000
ΔH v	CAL. /GFW.	600	30.90	9100	131.00	115.84	23540	8804	I.	3.207
S.P.	×	700	31.20	12200	135.80	118.38	21600	6508	ı	2 • 032
Δ H _s	CAL. /GFW.	800	31.40	15330	140.00	120.84	19690	4458	I	1.217
		006	31.55	18480	143.70	123.17	17800	2680	1	•650
T.P.	¥	1000	31.65	21640	147.00	125.36	- 63940	1640	1	•358
ΔH¢	CAL. /GFW.	1100	31.75	24810	150.00	127.45	- 63470	8206	t	1.630
T.P.	×	1200	31.82	27980	152.80	129.49	- 63000	14640	I	2.666
д н,	CAL. /GFW.	1300	31.88	31170	155.40	131.43	- 62510	21106	I	3 . 548
		1400	31.95	34360	157.70	133.16	- 62080	27520	I	4.296
T c =	¥.	1500	32.00	37560	159.90	134.86	- 61580	34000	I	4°624
Pc =	ATN.									

THERMODYNAMIC PROPERTIES OF THE ELEMENTS

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SELENIUM	Se		Refe	rence Sta	te for Ca	Reference State for Calculating $\Delta H_{ m P}^{ m c}$, $\Delta P_{ m c}^{ m c}$, and	AH, AF	, and		
IDEAL MONATOMIC GAS	CAS		Log ₁ to 9	Log ₁₀ Kpt Sol to 958°. Idea	1d from 2 1 Distomi	Solid from 298° to 490 Ideal Distomic Gas from	0°, Liquid from m 958° to 3000°	Solid from 298° to 490°, Liquid from 490° deal Diatomic Gas from 958° to 3000°.	•0	
	Γ							FORMATION FROM REFERENCE STATE	NCE STATE	
Giw 78.96	GRAMS	-	ზ	H ^o H ^o T 296.15	°,⊢		HEAT A N ^o			
(H [°] _{291.15} H [°] ₅) = 1,481	CAL./GFW.	tenperature ^o K	HEAT COL. A	HEAT CONTENT CAL./ GFW.	ENTROPY CAL. /DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GPV.	CALL/ GFW.	2 2 2 2 2 2	
		298	4.98	0	42.21	42.21	49400	39841	- 29•205	05
A.P.	¥	300	4 • 98	6	42.24	42.21	49398	39783	- 28,984	84
:		400	5.02	509	43.68	42.41	49259	36595	- 19.996	96
	CAL. / GFW.	500	5.11	1015	44.81	42.78	47765	59768	- 14.628	8
		600	5.23	1532	45.75	43•20	47442	30636	- 11.160	60
		100	5.35	2061	46.57	43.63	47131	27860	- 8.699	66
B.P.	*	800	5.46	2602	47.29	44.04	46832	25128	- 6.865	65
		006	5.55	3152	47.94	44.44	46542	22431	- 5.447	47
⊅ ₩ ~	CAL. /GFW.	1000	5.61	3711	48 • 53	44.82	32951	19851	- 4.338	38
		1100	50°G	4274	40.05	45.18	33064	18544	- 3.684	84
		1200	5.68	4841	49.56	45.53	33181	17209	- 3.134	34
S.P.	*	1300	5.69	5409	50.01	45 . 85	33299	15892	- 2.671	7
		1400	5.69	5978	50.43	46.16	33408	14536	- 2.269	69
∆ H₅	CAL. /GFW.	1500	5 • 68	6546	50.82	46.46	33526	13201	- 1.923	23
		1600	5.67	7113	51.19	46.75	33633	11825	- 1.615	15
		1700	5.66	7679	51.53	47.02	33739	10466	- 1.345	45
T.P.	×.	1800	5.64	8244	51.86	47.28	33834	9084	- 1.102	02
		1900	5.63	8808	52.16	47.53	33938	7718	- •887	87
Ф н ,	CAL. / GFW.	2000	2000	1371	52.45	47.77	34031	6331	ю • І	•691
		0012		26.66	21.526	48.00	34122	4953	•	15
		0022		6640T	04.40	40.42	54213	7066	•	• 354
T.P.	*			1011			94.904	C/12	•	200
		2400	00.0	11014	14.66	48.64	34384	760	ē I	•069
- Ф н ,	CAL. / GFW.	2500	5.60	12174	53.70	48 • 84	34464	- 636	•055	55
		2600	5.60	12734	53.92	49 • 03	34544	- 2064	•173	73
		2700	5.60	13295	54.13	49.21	34625	- 3472	• 5	281
Te=	×	2800	5.61	13855	54.34	49.40	34705	- 4887	ě.	381
1		2900	5.61	14416	54.53	49.56	34786	- 6278	•	473
Pc =	ATM.	3000	5•62	14977	54.72	49.73	34857	- 7713	• 5(561

SILICON	S1	-		Solid	from 298°	to 1683°	, Liquid	from 1683	Solid from 298° to 1683°, Liquid from 1683° to 3000°.	
REFEREN	REFERENCE STATE	61								
6fw 2	28.09	GRAMS	-	ບ	н ^о -н	<i>v</i> .	-(10-110,239,15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H ^o _{298.15} H ^o) =	769	CAL./GPW.	temperature °K	HEAT CAPACITY CAL./DEG/ GPW.	T ZNLIS HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CALL./DEQ./ GFW.	HEAT A H	FREE ENERGY & F f CAL./ GF.J.	х 100 к
			298	4.80	0	4.53	4.53			
М.Р.	1,683	*	300	4.81	80	4.56	4.54			
		6	400	5.34	518	6 • 02	4.73			
ΔH	11,100	CAL. / GFW.	500	5.63	1070	7.25	5.11			
			600	5.83	1640	8.29	5.56			
	10 000		700	5.98	2230	9•20	6.02			
4	())	*	800	6.11	2840	10.01	6.46			
Ĩ		CAL /GFW	006	67°0	5 4 5 4 C 6 6 4	6/ 01	06.00			
A					4000		7.72			
		ſ	1200	6.54	5370	12.57	8.10			
S.P.		¥	1300	6.64	6030	13.10	8.47			
			1400	6.74	6700	13.59	8.81			
Δ H _s		CAL. /GFW.	1500	6 • 83	7380	14.06	9.14			
			1600	6.92	8070	14.51	9.47			
			1700	7.00	19860	21.53	9°82			
T.P.		¥	1800	7.00	20560	21.93	10.51			
AH.		CAL /GFW.	1900	00.1	21200	22.31	11.68			
-			2100	7.00	22660	23.01	12.22			
			2200	7.00	23360	23.33	12.72			
T.P.		*	2300	7.00	24060	23.64	13.18			
			2400	7.00	24760	23.94	13.63			
∆H,		CAL. /GFW.	2500	7.00	25460	24.23	14.05			
			2600	7.00	26160	24.50	14.44			
			2700	7.00	26860	24.77	14.83			
T _c =		×	2800	7•00	27560	25.02	15.18			
4			2900	1.00	28260	12.62	56.61			
" "		A18	3000	1.00	28900	16.62	12.00			

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SILICON

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uary 1,	ate: Jar
	ate: Jar

SILICON	S1		Referenc	ce State 1	for Calcu	lating AH	, ∆P°, B	Reference State for Calculating $\Delta H_{f}^{\circ}, \ \Delta F_{f}^{\circ}, \ and \ Log_{10} Kpt$	3 0
IDEAL MONATOMIC GAS	C GAS		Solid fi	Solid from 298° (to 1683°,	Liquid from 1683° to 3000°	rom 1683°	to 3000°	•
_{6fw} 28.09	GRAMS	-	ບ	не - Не	95	-(F°-H° 221.11)-	FORMAT	FORMATION FROM REFERENCE STATE	KCE STATE
$(H^{0}_{2m,15},H^{0}_{2}) = 1,805$	CAL/GFW.	tenperature °K	P HEAT CAPACITY CAL./DEG/ GFW.	T 294.15 HEAT CONTENT CAL./ GPW.	T ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H	FREE ENERGY A F	т соб к К
		298	5.32	C	40-12	40.12	105000	04200	- 40 101
8	er	300	5.31	10	40.16	40.13	105002	94322	- 68.719
	2	400	5.17	533	41.66	40.33	105015	90759	- 49.592
ΔHmm	CAL. / GFW.	500	5.09	1046	42.80	40.71	104976	87201	- 38.118
		009	5.06	1553	43.73	41.15	104913	83649	- 30.471
		200	5.03	2057	44.51	41.58	104827	80110	- 25.013
B.P.	×	800	5.02	2560	45.18	41.98	104720	76584	- 20.923
		006	5.01	3061	45.77	42.37	104606		- 17.745
2H	CAL. /GFW.	1000	5.01	3562	46.30	42.74	104482		- 15.208
		1100	5.02	4064	46.78	43 • 09	104344		- 13.133
	ſ	1200	5.03	4566	47.21	43.41	104196	-	- 11.407
d y	¥	1300	5.04	5069	47.62	43.73	104039		- 9.947
	:	1400	5.06	5575	47.99	44.01	103875	55715	- 8.698
Δ H _s	CAL. /GFW.	1500	5.09	6082	48 • 34	44.29	103702	52282	- 7.618
		1600	5.11	6592	48.67	44°55	103522	48866	- 6.674
		1700	5.14	7105	48 • 98	44.81	92245	45580	- 5.859
T.P.	¥	1800	5.17	7621	49.27	45°04	92061	42849	- 5.202
	(1900	5 • 20	8139	49 • 56	45 • 28	91879	40104	- 4.612
∆ H,	CAL"/GFW.	2000	5.23	8661	49 . 82	45.49	10116		- 4.084
		2200	02.02	0213	50•08 50-08	45•71 45.01	91526	34679	- 3.609
5		2300	5.32	10243	50.56	46.11	91183	-	
÷	4	2400	5.34	10776	50.79	46.30	91016		- 2.420
Δ H.	CAL /GFW.	2500	5.36	11311	51.01	46.49	90351	23901	- 2.089
		2600	5.39	11849	51.22	46.67	90689	21217	- 1.783
		2700	5.41	12389	51.42	46.84	90529	18574	- 1.503
T.=	ж	2800	5.42	12930	51.62	47.01	90370	15890	- 1.240
		2900	5.44	13473	51.81	47.17	90213	13247	- •998
Pe =	ATM.	3000	5.45	14018	51,99	47.32	90058	10618	- •773

SILVER	ER AG			Solid	from 296	3° to 1234	Solid from 298° to 1234°, Liquid from 1234° to	l from 12	34° to	
REFE	REFERENCE STATE	67		2450°	, Ideal)	Monatom1c	2450°, Ideal Monatomic Gas from	2450° to 3000°	3000°.	
€Į≮	107.880	GRAMS	-	ۍ <u>.</u>	H ⁰ - H ⁰ T 274.15	•v-	-(F°-H° 228.15)	FORMAT US	FORMATION FROM REFERENCE STATE	CE STATE
(H ^e 298.1	°2 ^{30.15} H ⁰)= 1,373	CAL./GFW.	TEMPERATURE °K	HEAT C	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE EMERGY FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	LOG K
			298	60 •0	o	10•20	10.20			
M.P.	1.234.0	×	300	6.10	11	10.24	10.21			
			400	6.19	625	12.01	10.45			
∆Han	2, 700.	CAL. / GFW.	200	6.32 6.48	1250	13.40	10.90			
			2002	9 • • • •	2550	15.58	11.94			
8.P.	2,450.	Å	800	6.80	3220	16.48	12.46			
			006	6.76	3910	17.29	12,95			
∆H	60,960.	CAL /GFW.	1000	7.12	4610	18.03	13.42			
			1100	7.28	5330	18.72	13,88			
			1200	7.44	6060	19•35	14.30			
S.P.		¥	1300	7.50	9510	22.14	14.83			
			1400	7.50	10260	22.70	15.38			
Ω H ^e		CAL. / GFW.	1500	7.50	11010	23.21	15.87			
			1500	7.50	12510	24.15	16-80			
a +		, a	1800	7.50	13260	24.58	17.22			
:		e	1900	7.50	14010	24.99	17.62			
ΔH		CAL. /GFW.	2000	7.50	14760	25.37	17.99			
			2100	7.50	15510	25.74	19.36			
			0022		00701	60.02	13.00			
<u>:</u>		4	0042	7.50	17760	26.74	19.34			
ΔH,		CAL. /GFW.	2500	4.97	79340	51.89	20.15			
			2600	4.97	79840	52.08	21.38			
			2700	4.97	80330	52.27	22.52			
T		۴ ۲	2800	4.97	80830 81330	52•45 52•62	23•59 24.58			
" a`		ATM.	3000	4.07	81820	52.79	25.52			
			>>>>		21040	, , , ,				

SILVER

SILVER	Ag		Referen	ice State	for Calc	Reference State for Calculating $\Delta H_{\rho}^{\bullet}$, $\Delta P_{\rho}^{\bullet}$, and	H°, ΔP°,	and	
TDFAL MONATOMIC GAS	5 645		Log ₁₀ Kp		from 298	° to 1234	, Liquid	Solid from 298° to 1234°, Liquid from 1234°	4°
			to 2450°	•	Mona tom1	Ideal Monatomic Gas from	n 2450° to 3000°	o 3000°.	
. 107.880	1110	•	ę	9	ę	-(E ⁰ -H ⁰ 298.15) -	FORMAT	FORMATION FROM REFERENCE STATE	ACE STATE
		TEMPERATURE	م	T 294.15	a+	FREE ENERGY	HEAT A H ^o	FREE ENERGY & F	
(H ^o 2m. 15 H ^o) = 1 2 481	CAL./GFW.	¥•	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GPW.	CAL./ GFW.	LOG K 16 r
		298	4.97	0	41.32	41.32	68400	59122	- 43.339
A.P.	×	300	4.97	6	41.35	41.32	68398	59065	- 43.032
		400	4.97	506	42.78	41.52	68281	55973	- 30.584
∆ H	CAL. /GFW.	200	4.97	1003	43.89	41.89	68153	52908	- 23.127
		000	4.97	1500	44 . 80	42.30	68010	49872	- 18.167
	[200	4.97	1996	45.56	42.71	67846	46860	- 14.631
B.P.	*	000	10.4	5643	40.23	43.12	67673	43873	- 11.986
		005	4.97	2662	46.81	43.49	67480	40912	- 9.935
∆H√	CAL /GFW.	0001	4 • 97	3487	47.33	43 • 85	67277	37977	- 8,300
		1100	4.97	3984	47.81	44.19	67054	35055	- 6,965
		1200	4.97	4480	48 • 24	44.51	66820	32152	- 5.856
. P . 2	*	1300	4.97	4977	48.64	44°82	63867	29417	- 4.945
		1400	4.97	5474	49.01	45.10	63614	26780	- 4.180
Δ M _s	CAL. /GFW.	1500	4.97	5971	49.35	45.37	63361	24151	- 3.519
		1600	4.97	6468	49.67	45.63	63108	21556	- 2.944
		1700	4.97	6964	49.97	45 . 88	62854	18960	- 2.437
T.P.	×	1800	4.97	7461	50.25	46.11	62601	16395	- 1.990
		1900	4.97	1958	50.52	46.34	62348	13841	- 1.591
∆H,	CAL. /GFW.	2000	4.97	8455	50.78	46.56	6 2095	11275	- 1.232
		2100	4.97	8952	51.02	46.76	61842	8754	- ,911
		0022	16.4	8446	51•25	46.96	61588		619
T.P.	×	2 200	16.4	6965	51.47	47.15	51335	3720	- • 353
		2400	4.97	10442	51.68	47.33	61082		- 1111
∆H,	CAL. /GFW.	2500	4.97	10939	51.89	47.52	0	0	0
		2600	4.97	11436	52 • 08	47.69	0	0	0
		2700	4.97	11932	52.27	47.86	0	0	0
T, =	×	2800	4.97	12429	52.45	49.02	0	0	0
•		2900	4.97	12926	52.62	48.17	0	0	0
= ~	ATM.	3000	4.97	13423	52.79	48.32	0	0	0
			-			A			

SILVER

SODIUM		Na		Solid	from 298	• to 371°	Solid from 298° to 371°, Liquid from 371° to	from 371°	\$	
REF	REFERENCE STATE	E		1163	, Ideal M	ona tomi c	1163°, Ideal Monatomic Gas from 1163° to 3000°.	1163° to	3000°.	
35 5	22.991	GRAMS	F	້	¥°−+	e,	-(F°-H° 228.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H ⁰ 298.1	200.15 ⁻ H ⁰) = 1,532	1,532 CAL/GFW.	teaperature 9K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL/DEG./ GFW.	HEAT A H	FREE ENERGY & F CAL./ GFW.	۲06 K
			298	6.74	0	12.21	12.21			
Ч. Ч.	370.97	*	300 400	6•75 7•52	1355	12.25	12.21			
ΔH	621.8	CAL /GFW.	500	7.32	2096	17.65	13.46			
			000	7.10	2819	18.97	14.28			
8 9	1.163.	¥	008	06.00	4218	20.98	15.71			
			006	6.89	4909	21.80	16.35			
₩	21,280.	CAL. /GFW.	11000	0•93 7•01	1944	22.22	17.47		-	
			1200	4.97	30380	43.63	18.32			
S.P.		¥	1300	4.97	30877	44.03	20.28			
			1400	4.97	31374	44 • 40	21.99			
5∎ ⊲			1500	4.97	31871	44.74	23.50			
			1700	16.4	32864	45.36	26.03			
T.P.		*	1800	4.97	33361	45.65	27.12			
ΩH ²		CAL /GFW.	1900	4.97	33858	45.92	29.00			
-			2100	4.98	34853	46.41	29.82			
			2200	4.98	35351	46.64	30.58			
Ч.		¥	2300	4.98	35849	46.87	31.29			
ΔH,		CAL /GFW.	2400	5.00	36347	47.28	32.55			
			2600	5.01	37348	47.48	33.12			
			2700	5 • 03	37850	•	33.66			
T. = .		×	2800	5.04	38353	47.85	34.16			
" "		ATM.	3000	5.08	39365	-	35.08			
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In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956. SODIUM

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SODTUM	Na		Reference	nce State	State for Calculating AM, AP, and	ulating A	H°, ΔP°,	and		
			Log, "Kp:		from 298	° to 371°	. Liouid	Solid from 298° to 371°. Liquid from 371°		
IDEAL MONATOMIC GAS	GAS		-10 - to 1163	•	Monatomic	c Gas from	m 1163° t	1163° to 3000°.		
ei	CDAMC	•	و	10	2	-(F ⁰ -H ⁰ 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE	
]	-	مر	T 294.15	'n⊢	FREE ENERGY	HEAT A H ^o	FREE ENERCY & F		
(H [°] _{214.15} H [°] ₂) = 1,481 CA	CAL./GFW.	Ne Ne	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL. /DEG./ GPW.	CAL./DEG./ GFW.	CAL./GFW.	CAL./GFW.	° Loc	× •
		298	4.97	0	36.71	36.71	25900	18595	- 13,	13-631
M.P. **		300	4.97	0	36.74	36.71	25897	18550	- 13	3.514
		400	10.4	506	38.17	36.91	25051	16183	80	8.842
∆ Hm CA	CAL. / GFW.	500	4.97	1003	39.28	37.28	24807	13992	ۍ ۱	6.116
		600	4.97	1500	40.19	37.69	24581	-	4	4.316
		700	4.97	1996	40.95	38.10	24375		•	3.042
B.P.		800	4.97	2493	41.62	38.51	24175		- 5	2.093
		006	4.97	2990	42.20	38.88	23981	5621		1.365
		1 000	4.97	3487	42.73	39.25	23790		•	782
		1100	4.97	3984	43.20	39 ° 58	23591	1580	-	.313
	Γ	1200	4.97	4480	43.63	39.90	0	0	0	
S.P.		1300	4.97	4977	44.03	40.21	0	0	0	
		1400	4.97	5474	44.40	40.49	0	0	0	
⊂ Hs CA	CAL. /GFW.	1500	4.97	1265	44.74	40.76	0	0	0	
		1600	4.97	6468	45.06	41.02	0	0	0	
		1700	4.97	6964	45.36	41.27	Э	0	0	
T.P. %		1800	4.97	7461	45.65	41.51	0	0	0	
∆H. CA	CAL /GFW.	1900	4.97	7958	45.92	41.74	Ō	0	0	
		0012	40.08	0 4 0 5 3	19-95	51.04			00	
		2200	4 . 98	9451	46.64	42.35) C			
T.P. %		2300	4.98	6766	46.87	42.55	0	00	0	
		2400	4.99	10447	47.08	42.73	0	0	0	
\ ∆H ₁ CA	CAL. / GFW.	2500	5 • 00	10947	47.28	42.91	0	0	0	
]	2600	5.01	11448	47.48	43 . 08	0	0	0	
		2700	5.03	11950	47.67	43.25	0	0	0	
T c = %		2800	5.04	12453	47.85	43.41	0	0	0	
		2900	5.06	12958	48 • 03	43.57	0	0	0	
		3000	5 • 08	13465	48•20	43.72	0	0	0	

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SODTIM	Na		Refere	Reference State for Calculating $\Delta H_{\rho}^{\bullet}$, $\Delta F_{\rho}^{\bullet}$, and	for Calc	ulating ∆	H°, ΔP°,	and		
IDEAL DIATOMIC			Log ₁₀ Kp:		from 298 Monatom	from 298° to 371°, Monatomio Gas from	, Liquid m 1162° t	Solid from 298° to 371°, Liquid from 371° Ideal Monstomio Dae from 1162° to 1500°		
_{6fw} 45.982	GRAMS	T				-(F- H 238.15) FREE ENERGY	HEAT	A H° FREE ENERGY △ F°	. NCE ST	
(H [°] ₂₉₈ .15 H°) = 2,484	CAL./GFW.	¥.	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL/DEG./ GFW.	CAL./GFW.	CAL./GFW.		ж е е
	×	298	8•96	0	54.99	54.99	33800	24685	I	18•095
ΔHm	CAL. / GFW.	300	8•96	17	55•05	55.00	33793	24628	I	17.942
		400	9°04	816	57.64	55.35	32008	21752	•	11.885
B.P.	×	500	9.10	1825	59•66	56.01	31433	19253	I	8.416
∆н ,	CAL. /GFW.	600	9.15	2736	61•32	56.76	30898	16870	I	6.145
9.2	×	700	9.19	3655	62.74	57.52	30413	14565	I	4.547
ΔHs	CAL /GFW.	800	9•24	4580	63•98	58•26	29944	12328	I	3•368
		006	9•28	5499	65 • 06	58°82	29481	10167	I	2.469
Т.Р.	×	1000	9•32	6436	66•05	59-62	29042	8032	I	1.755
ΔH	CAL. /GFW.	1100	9•36	7361	66 • 93	60•24	28575	5970	ı	1.186
T.P.	*	1200	0**6	8304	67.75	60.83	- 18656	4756	1	.866
ΔH,	CAL. / GFW.	1300	9 • 44	9242	68 • 50	61.40	- 18712	6716	I	1.129
		1400	9.47	10186	69 • 20	61.93	- 18762	8678	I	1•354
Tc =	×	1500	9.51	11136	69 • 85	62.43	- 18806	10639	I	1•550
Pc =	ATM.				-					

SODIUM

FTOM 1043* Co 1640* Co 300 87-63 GAMS 1-043 T 900 6-31 1-043 T 900 6-31 1-043 T 900 6-31 1-043 T 900 6-31 1-045 T 900 6-31 1-045 T 900 6-31 1-045 T 1-045 T 900 9-30 900 9-30 900 9-40 900 9-40 900 9-40 900 9-40 900 9-40 10-40 14-47 10-40 14-47	STRONTIUM	Sr	Sol	1d I fro	m 298° to	862°, So	11d II fr	om 862° 1	Solid I from 298° to 862°, Solid II from 862° to 1043°, Liquid	Liquid
B7.65 GRAMS T C_{c} η_{c}	REFERENCE STA	TE	fro	m 1043°	to 1640°,	Ideal	natomic G	as from]	1640° to 3	.000
11.043 x x 1.043 x 0 12.50 12.50 1.043 x 0 12.55 12.55 200 6.65 6.60 14.44 12.55 1.043 x 11.12 12.55 13.24 200 7.00 1340 12.55 13.24 1.540 x 11.20 7.00 1340 12.55 700 7.65 2500 18.37 14.37 700 7.65 2500 18.41 14.93 700 7.65 2500 19.41 14.94 700 8.00 8.00 8.60 3580 19.41 1100 7.40 10040 21.56 15.50 7 11000 7.40 10780 24.56 7 1200 7.40 10780 25.31 862 x 11600 7.40 11520 26.86 1400 7.40 11520 26.86 19.48 1700 4.977 48.26 22.39 862 x 11400 7.40 11520 862 x 11600 5.01 49070 862 x 116		GRAMS CAL /GEV	T TEMPERATUME M	C C HEAT CAPACITY CAL ARCY CAPACITY	H ⁶ – H ⁶ T 294.15 HEAT CONTENT CALT CONTENT	S ⁰ S ¹ ENTROPY CAL, APEO, ORW	- 1 - 1 - 1 - 248.15) FREE ENEMOY FUNCTION	FORMAT HEAT \triangle H ^o cal / GeV.	ION FROM REFEREN	te state Loc k
1,043 κ 1,043 κ (2,200) c_{M}/GFN 500 7.00 1,640 κ 1,640 κ 33,200 c_{M}/GFN 33,200 c_{M}/GFN 900 8.80 9.60 900 8.80 9.60 1,0640 κ 33,200 c_{M}/GFN 900 σ 1100 7.40 9520 σ 1100 7.40 9520 24.56 κ 1200 9.520 24.56 94 σ 1400 7.40 10780 25.28 σ 1100 7.40 10780 25.63 σ 1400 7.40 10780 25.63 σ 1500 7.40 10780 25.63 σ 1500 7.40 10780 25.63 σ 1500 7.40 10780 26.93 σ 1200 7.40 10780 26.93 σ 2000 <t< th=""><th>20.12 m</th><th></th><th>208</th><th>6.30</th><th>C</th><th>12.60</th><th>12 60</th><th></th><th></th><th></th></t<>	20.12 m		208	6.30	C	12.60	12 60			
(2, 200) Cut. / GFW. 500 7.00 1340 14.40 1, 640 vt. 7.00 7.60 1340 15.92 700 7.60 7.60 1340 15.92 700 7.60 3580 19.41 33, 200 cut. / GFW. 900 8.80 4610 20.65 33, 200 cut. / GFW. 1000 9.50 5520 21.658 1100 7.40 10004 25.21 17.22 1200 7.40 10780 25.80 1200 7.40 10780 25.80 1200 7.40 10780 25.80 862 vt. 1100 7.40 11520 862 vt. 11700 7.40 11520 25.80 862 vt. 1900 5.01 47070 48.53 862 vt. 1900 5.01 47070 48.53 862 vt. 1900 5.01 47070 48.53 862 vt. 11520 27.34 50140 49.03 862 vt. 12000 5.01 49.77 49.72 862 vt. 2200 5.01 49.77			300	6.31	11	12.54	12.51			
Vulture Cut. / GFW. 500 7 = 30 7 = 30 1 = 340 1 = 5 = 92 1 = 640 % 900 8 = 00 3580 19 = 37 33 = 200 Cut. / GFW. 900 8 = 00 4610 20 = 62 33 = 200 Cut. / GFW. 900 8 = 80 4610 20 = 62 33 = 200 Cut. / GFW. 1100 7 = 40 19 = 41 20 = 65 % 11 = 100 7 = 40 10040 25 = 80 24 = 56 11 = 100 7 = 40 10780 26 = 86 27 = 34 11 = 100 7 = 40 10780 26 = 86 27 = 34 11 = 200 7 = 40 10780 26 = 86 27 = 34 12 = 26 7 = 40 10780 26 = 86 27 = 34 17 = 49 7 = 40 10780 26 = 86 27 = 34 1700 4 = 99 4 = 770 48 = 75 27 = 34 1700 5 = 01 4 = 96 2100 5 = 01 47 = 97 % 2200 5 = 01 4 = 72 4 = 75 4 = 75 % 2100 5 = 01 4 = 72 4 = 72 4 = 72 % % 5 = 01 4 = 76 4 = 72 2 = 76		4	400	6•65 -	660	14.40	12.75			
1, 640 % 33, 200 % 33, 200 % 33, 200 % 1100 7.40 800 8.80 900 8.80 900 8.80 900 8.80 900 8.80 900 8.80 900 8.80 4610 20.62 1100 7.40 900 8.80 440 10040 1300 7.440 1300 7.440 1300 7.440 1400 7.440 1500 7.440 1700 7.440 1800 7.440 1900 7.440 1900 7.440 1900 7.440 1900 7.440 1700 4.99 46570 48071 4862 48071 4862 48071 900 5.01 900 5.01 900 5.01 900 5.01 900 5.01 900 5.01 900 5.05 900 5.05 900 5.05		CAL. / GFW.		7.30	1340	17.22	13.24			
1,640 % 800 8.00 3580 19.41 33,200 cut./dFW 900 8.80 4610 20.62 33,200 cut./dFW 1000 9.50 5520 21.58 1200 % 1100 7.440 8550 24.56 1 1100 7.440 10040 25.21 11.56 25.21 1 11200 7.440 10040 25.81 1 1 1 1 862 % 1400 7.440 10780 26.35 21 1 862 % 1500 7.440 10780 25.86 27.334 1 862 % 1900 7.440 11520 27.334 1 48071 48071 48073 48073 48073 48073 48073 48073 48073 48073 48073 49.95 27.83 27.83 27.83 27.83 27.83 27.83 27.83 27.83 27.83 27.83 27.73 27.83 27.73 27.83 27.83 27.73 27.83 27.9			2007	7.65	2800	18.37	14.37			
33,200 0.00 8.80 4610 20.62 33,200 0.1 0.000 9.500 5520 21.568 1100 7.440 8550 25.21 1200 7.440 10040 25.21 1200 7.440 10040 25.21 1100 7.440 10780 26.35 1100 7.440 10780 26.35 11400 7.440 10780 25.26 11700 7.440 11520 25.86 862 % 11700 4.99 11700 7.440 11520 26.86 11700 7.440 11520 25.86 862 % 1900 5.01 47070 11700 4.99 46071 48.79 2000 5.01 47070 48.79 2100 5.01 47070 48.79 % 2200 5.0140 49.93 7 49.09 5.0140 49.65 % 2300 5.025 49650 % 2700 5.34 50140 % 2800 5.495 50.95 % 2900 5.495 50.95 %		*	800	8.00	3580	19.41	14.94			
-0.1 Loop -7.4 CFW. 11000 7.4 40 8550 24.56 -K 11200 7.4 40 10040 25.821 -K 1300 7.4 40 10780 26.35 -K 1400 7.4 40 10780 25.821 -K 1500 7.4 40 10780 25.86 -K 1500 7.4 40 11520 25.86 -K 1700 4.99 46070 27.34 -K 1700 4.99 46070 27.34 -K 1900 5.01 47070 48.79 -K 2000 5.01 47070 48.79 -K 2200 5.01 47070 48.79 -K 2300 5.05 49570 49.03 -K 2200 5.01 47070 49.03 -K 2200 5.05 49620 49.67 -K 2300 5.05 5.34 50140 49.93 -K 2600 5.495 50.15 50.35 -K 2300 5.34 50140 49.93 -K 2600 5.495 50.35 50.35 -K 2700 5.34 50140 <		:	006	8.80	4610	20.62	15.50			
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * 1300 7.440 10780 25.81 * 1500 7.440 11520 25.86 * 1600 7.440 11520 25.86 * 1900 5.01 45070 48.79 * 2000 5.01 47070 48.79 * 2000 5.01 47070 48.79 * 2200 5.01 47070 48.79 * 2200 5.01 47570 49.63 * 2200 5.01 47070 49.63 * 2300 5.02 496.73 79.94 * 2300 5.17 49620 49.65 * 2400 5.0140 49.65 714 * 2500 5.34 50140 49.65 * 2700		CAL /GFW.	1 1000	00% 2	0220	86.12	10.00			
% 1300 7.440 10040 25.80 CAL./GFW. 1500 7.440 10780 26.35 B62 % 11500 7.440 11520 26.86 B62 % 1700 4.99 46070 47.97 B62 % 1900 5.01 47700 48.79 CAL./GFW. 1900 5.01 47070 48.79 CAL./GFW. 2000 5.01 47070 48.79 % 2200 5.01 47070 48.79 % 2200 5.05 49500 49.67 % 2200 5.05 5.34 50140 % 2300 5.05 5.34 50140 % 2300 5.495 50.35 50.35 % 2800 5.495 50.36 50.35 % 29000 5.34 50140 49.95 % 2900 5.365 51300 50.35 % 2900 5.365			1200	7.40	9290	25.21	17.47			
The second se		1	1300	7.40	10040	25.80	18.08			
CAL/GFW. 1500 7.440 11520 26.86 BG2 °K 1600 7.499 46070 47.97 BG2 °K 1700 4.999 46070 48.53 CAL/GFW. 1900 5.01 47070 48.53 CAL/GFW. 2000 5.01 47070 48.53 CAL/GFW. 2000 5.01 47070 48.53 CAL/GFW. 2000 5.01 47070 48.53 CAL/GFW. 2200 5.01 47070 48.79 CAL/GFW. 2200 5.01 49090 49.27 CAL/GFW. 2200 5.17 49090 49.50 °K 2200 5.17 49090 49.73 °K 2200 5.34 50140 49.73 °K 2200 5.34 50140 49.67 °K 2800 5.466 51300 50.95 °K 2900 5.95 51300 50.95 ATM 3000 5.95 5390 50.77	2. -	¥	1400	7.40	10780	26.35	18.65			
B62 * 15600 7.40 12260 27.34 B62 * 1700 4.99 46570 47.97 1700 4.99 46570 47.97 (200) 5.01 47570 48.26 * 2000 5.01 47570 48.26 * 2000 5.01 47570 48.26 * 2000 5.01 47570 48.73 * 2200 5.01 47570 48.73 * 2200 5.01 49071 49.03 * 2200 5.17 49090 49.27 * 2300 5.25 49620 49.72 * 2300 5.25 49620 49.72 * 2300 5.25 49620 49.72 * 2300 5.260 5.17 49.99 * 2300 5.46 50680 50.15 * 2700 5.46 51800 50.56 * 3000 5.95 52390 50.77	Δ Η-	CAL. /GFW.	1500	7.40	11520	26.86	19.18			
862 * 1700 4.998 46070 47.97 862 * 1800 4.999 46570 48.26 1800 5.01 47070 48.53 1900 5.01 47070 48.79 2000 5.03 47570 48.79 2000 5.03 47570 48.79 2000 5.03 47570 48.79 2000 5.03 47570 49.79 2000 5.05 49090 49.27 2300 5.11 49090 49.27 2300 5.25 49620 49.72 2300 5.25 49620 49.72 2300 5.260 5.46 50.46 2100 5.46 5080 50.15 2700 5.46 51800 50.56 * * 2800 5.95 52390 * * 3000 6.16 50.97	•		1600	7.40	12260	27.34	19•68			
862 * 1800 4.99 46570 48.26 (200) cut./GFH 1900 5.01 47570 48.53 2000 5.03 47570 48.79 2000 5.03 47570 48.79 2100 5.01 47070 48.79 2200 5.03 47570 48.79 2200 5.01 47903 49.03 2200 5.11 49090 49.27 2200 5.11 49090 49.27 2300 5.11 49090 49.72 2300 5.17 49090 49.72 2300 5.25 49620 49.72 2300 5.260 5.34 50140 49.93 2700 5.46 50680 50.36 2800 5.76 51800 50.56 3000 5.95 52390 50.77			1700	4.98	46070	47.97	20.87			
(200) 5.01 47070 48.53 2000 5.03 47570 48.53 2100 5.03 47570 48.79 2100 5.01 49071 48.79 2100 5.03 47570 48.79 2100 5.01 49071 49.03 2100 5.01 49090 49.27 2300 5.24 50140 49.94 2300 5.34 50140 49.94 2100 5.34 50140 49.94 2100 5.46 51300 50.36 2100 5.45 51800 50.56 2100 5.95 52390 50.75 2100 5.95 52390 50.77		30	1800	66 • 7	46570	48 • 26	22.39			
Nacoustic CAL. / GFN 2200 5-00 48071 49-03 °K 22200 5-11 49580 49-27 °K 2300 5-17 49090 49-27 °K 2300 5-17 49090 49-72 °K 2300 5-17 49090 49-72 °K 2400 5-25 49620 49-72 °K 2500 5-34 50140 49-94 °K 2700 5-46 50680 50-36 °K 2700 5-46 51800 50-36 °K 2900 5-95 52390 50-36 °K 2900 5-95 52390 50-97	•	4	1 900	5•01 1002	47070	48.53	23.76			
2200 5.11 48580 49.27 * 2300 5.17 49090 49.27 * 2300 5.17 49090 49.72 * 2400 5.25 49620 49.72 * 2500 5.34 50140 49.94 * 2500 5.46 50680 50.36 * 2600 5.46 50680 50.36 * 2700 5.46 51800 50.36 * 2800 5.95 52390 50.56 * 3000 6.16 5300 50.77	-	CAL. / GFW.	2100	5.06	48071	49.03	26.14			
* 2300 5.17 49090 49.50 * 2400 5.25 49620 49.72 CAL_/GFW 2500 5.34 50140 49.94 2500 5.34 50140 49.94 2600 5.46 50680 50.36 2700 5.46 51800 50.36 * 2800 5.95 51300 50.56 * 3000 5.95 52390 50.77].	2200	5.11	48580	49.27	27.19			
K 2400 5.25 49620 49.72 CAL./GFW 2500 5.34 50140 49.94 Z500 5.34 50140 49.94 Z500 5.46 50680 50.15 Z700 5.46 50680 50.36 * 2700 5.46 51800 50.56 * 2800 5.95 52390 50.56 * 3000 5.95 52390 50.77			2300	5.17	49090	49.50	28.16			
CAL./GFW 2500 5.34 50140 49.94 49.94 2600 5.46 50680 50.15 2700 5.46 50680 50.36 20.36 2700 5.46 51800 50.36 2800 5.46 51800 50.36 40 49.94 2800 5.46 51800 50.36 16 51800 50.37 77 77 77 77 77 77 77 77 77 77 77 77 7		¥	2400	5.25	49620	49.72	29•05			
2600 5.446 50680 50.15 2700 5.60 51300 50.36 2800 5.76 51800 50.56 * 2800 5.76 51800 50.56 * 2900 5.95 52390 50.77	1	CAL /CEW	2500	5.34	50140	46°6	29.89			
•k 2700 5.60 51300 50.36 -k 2800 5.76 51800 50.56 -k 2900 5.95 52390 50.77 - ATM 3000 6.16 53000 50.97	1 11		2600	5.46	50680	50.15	30.66			
= •k 2800 5.976 51800 50.56 2900 5.95 52390 50.77 = • • • • • • • • • • • • • • • • • • •			2700	5.60	51300	50.36	31.36			
= 2900 5.95 52390 50.77	•	20	2800	5.76	51800	50.56	32.06			
= ATH. 3000 6.16 53000 50.97		4	2900	5°95	52390	50.77	32.71			
	P = 1	ATM.	3 000	6.16	53000	50.97	33.31			

STRONTIUM

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

MILLUNCHIS	2	Å	eference	State fo:	r Calcula	ting AH°,	∆P°, and	Reference State for Calculating ΔH_{ρ}^{ρ} , ΔF_{ρ}^{ρ} , and Log, ΔK_{ρ} :	
	5	Š	olid I fi	rom 298°	to 862°,	Solid II	from 862°	Solid I from 298° to 862°, Solid II from 862° to 1043°, Liquid	, Liquid
IDEAL MONATOMIC GAS	C GAS	J	from 1043°	° to 1640°	, Ideal	Monatom1c	Gas	from 1640° to	3000°.
	311183	•	۶	9	9	-(1	FORMATI	FORMATION FROM REFERENCE STATE	ACE STATE
um 87.63	GKARS	TEMPERATURE		H - H	×-	FREE ENERGY	HEAT △ H ^e	FREE ENERGY Δ F	
(H ⁶ _{206.15} H ⁶) = 1,481	CAL./GFW.	¥.	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL. /DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	f CAL./GFW.	CAL./ GFW.	LOG K 10 K
		298	4.97	0	39•32	36*35	39100	31104	- 22,800
M.P.	*	300	4.97	6	39.36	39.33	39098	31052	- 22.623
		400	4.97	506	40.78	39.52	38946	28394	- 15.515
∆ H _m	CAL. / GFW.	500	4.97	1003	41.89	39 • 83	38763		- 11.268
		600	4.97	1500	42.80	40.30	38550		- 8.452
		700	4.97	1996	43.56	40.71	38296		- 6.451
B.P.	*	800	4.97	2493	44.23	41.12	38013	18157	- 4.960
		006	4.97	2990	44.81	41.49	37480	15709	- 3.814
ФН	CAL. /GFW.	1000	4.97	3487	45.34	41.86	37067	13307	- 2,908
		1100	4.97	3984	45.81	42.19	34534	11159	- 2.217
		1200	4.97	4480	46.24	42.51	34290	9054	- 1.649
S.P.	¥	1300	4.97	4977	40.04		34037	6945	- 1.167
		1400	4.97	5474	47.01		33794		760
Δ H.	CAL. /GFW.	1500	4.97	5971	47.35		33551	~	410
		1600	4.97	6468	47.67	43.63	33308		106
		1700	4.98	9969	47.97	43.88	0	0	0
T.P.	×	1800	4.99	7465	48 • 26	44.12	0	0	0
		1900	5.01	1965	48.53	44.34	0	0	0
Ф н	CAL. /GFW.	2000	5.03	8466	48.79	44.56	-	0	0
		2100	5.06	8971	49°03	44.76	0	0	0
		2200	5.11	9480	49.27	44.97	0	0	0
T.P.	×	2300	5.17	7666	49.50	45.16	0	0	0
		2400	5.25	10515	49.72	45.34	0	0	0
₽ ₩	CAL. /GFW.	2500	5.34	11044	40°04	45°53	0	0	0
		2600	5.46	11584	50.15	45.70	0		0
		2700	5.60	12200	50.36	45 . 85	0		0
Te =	×	2800	5.76	12705	50.56	46.03	0		0
1		2900	5.95	13290	50.77	46.19	0	0	0
" "	ATM.	3000	6.16	13895	50.97	46.34	0	0	0

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STRONTIUM

SULFUR		5		Rhom	ibic Solid	Rhombic Solid from 298° to 368.6°, Monoclinic	3° to 368.	,6°, Mono	clinic	
amama anna agada	EVEN AV	2		Soli	d from 36	Solid from 368.6° to 392°, Liquid from 392° to	592°, Liqu	itd from	3 92° to	
Ngug Jgu	CE STAT	4		.717.	75°, Idea	I Diatomi	c Gas fro	m 717.75	717.75°, Ideal Diatomic Gas from 717.75° to 3000°	•
4	32.066	GRAMS	-	ຽ	H° H°	٩	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	ACE STATE
5	1,053		TEMPERATURE		T 294.15 HEAT CONTENT	ENTROPY	FREE ENERGY	HEAT △ H ^e	FREE ENERGY A F	K LOG
(H ⁰ _{296.15} H ₀) =		CAL./GFW.	¥	CAL./DEG./ GFW.	CAL./ GFW.	CAL./DEG./ GFW.	CAL./DEG./ GFW.	CAL./GFW.	CAL./GFW.	2
			298	5.40	0	7.62	7262			
ď.	392.	×	300	5.41	0	7.65	·			
	337.		400	7.54	1033	10.45	7.87			
ΔHm		CAL. /GFW.	200	8.84	1948	12.48	8.59			
			600	8 • 34	2798	14•03	9.37			
i	7 70		200	00.0	3655	15.35	10.13			
B.P.	C/ • / T/	*	008	4.37	17530	31.37	9**6			
002 0	Ę		006	4.40	17970	31.88	11.92			
	•	CAL. /GFW.	1000	4.42	18400	32.34	13.94			
			1100	4044	18850	32.76	15.63	×		
			1200	4.45	19290	33.15	17.08			
5.P.		×	1300	4.46	19740	33.51	18,33			
			1400	4.47	20190	33.84	19.42			
ΔHs		CAL. /GFW.	1500	4.48	20630	34.15	20.40			
			1600	4.49	21080	34.44	21.27			
			1700	4.50	21530	34.71	22.05			
T.P. 36	568. 6	*	1800	4.51	21980	34.97	22.76			
	S		1900	4.51	22430	35.21	23.41			
¢H,		CAL. /GFW.	2000	4.52	22880	35.44	24•00			
			2100	4.52	23330	35.67	24.57			
			2200	4 5 3	23790	35.88	25.07			
T.P.		×	2300	4 •53	24240	36.08	25•55			
			2400	4.53	24690	36.27	25.99			
ΔH,		CAL. /GFW.	2500	4.54	25150	36.46	26.40			
			2600	4.54	25600	36.63	26.79			
			2700	4.55	26050	36.80	27.16			
Te =		Å	2800	4.55	26510	36.97	27.51			
•			2900	. 4.55	26960	37.13	27.84			
= ~		ATM.	3000	4.56	27420	37.28	28.14			

SULFUR

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ana ms	v	Reference		e for Cal	culating	ΔH°, ΔP°,	and Log ₁	Kp: Rho	State for Calculating AH, AP, and Log, Kp: Rhombic Solid
		from 2	298° to 30	68.6°, Mo	noclinic	to 368.6°, Monoclinic Solid from 368.6°	m 368.6°	to 392°, Liquid	Liquid
IDEAL DIATOMIC	GAS	from 3	392° to 7:	717.75°, I	Ideal Diatomic	Gas	from 717.	from 717.75° to 3000°	00°.
						- (,)	FORMAT	FORMATION FROM REFERENCE STATE	ACE STATE
6iv 04.132	GRAMS	-	° ئ	H ⁰ H ⁰ T 294.15	°.⊢	CORE ENERGY	HEAT A H ^o	FREE ENERGY & F	
$(H^{0}_{298.15} - H^{0}_{0}) = 2,141$	CAL./GFW.	TEMPERATURE °K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./GFW.	LOG K "" "
		298	7.76	0	54.51	54.51	30840	19130	- 14.023
K.P.	٩ ۲	300	7.77	13	54.55	54.51	30835	19060	- 13,886
		400	8.14	811	56.85	54.83	29585	15205	- 8.3UB
ΔMm	CAL. /GFW.	500	8.39	1639	58.69	55.42	28583	11718	- 5.122
		600	8.54	2485	60.23	56.09	27729	8427	- 3.069
		700	8.65	3347	61.56	56.78	26877	5275	- 1.647
B.P.	×	800	8.73	4219	62.73	57.46	0	0	0
		006	8.79	5095	63.76	58.10	0	0	0
∠H√	CAL. /GFW.	1 000	8.84	5963	64 • 68	58.72	0	0	0
		1100	8.87	6857	65•52	59•29	0	0	0
		1200	8.90	7747	66.30	59 ° 82	0	0	0
.e.s.	×	1300	8.92	8636	67.01	60.37	0	0	c
:		1400	8.94	9535	67•68	60.87	0	0	0
△ H _s	CAL. /GFW.	1500	8.96	10429	68 • 30	61.35	0	0	0
		1600	8.98	11326	68 • 88	61.81	0	0	0
		1700	8.99	12224	69.42	62.23	0	0	0
T.P.	¥	1800	00.6	13124	69.94	62.65	0	0	0
1	CAL /GEW	0061	10.0	14024	10.43	CD•50	5 0	2 0	0
		2100	9.02	15828	71.33	6.9.40			
		2220	9.04	16732	71.75	64.15			
T.P.	*	2300	9.05	17637	72.16	64.50	C		c c
	,	2400	90.6	18543	72.54	64.82	0	0	0
Δ Η,	CAL. /GFW.	2500	9.07	19450	72.91	65.13	0	0	0
		2600	9 •0 8	20358	73.27	65.44	0	0	0
		2700	60•6	21266	73.61	65.74	0	0	0
Tc =	×	2800	9.10	22175	73.94	66•03	0	0	0
1	į	2900	9•11 9	23086	74•26	00.30	0	0	0
Pc =	ATM.	3000	9.12	23997	14.51	86.00	Ъ	S	0

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SULPUR SULPUR SB	S 88	Referen from 2	nce State 98° to 36	e for Cald 58.6°, Mor	culating a	∆H [°] , ∆r [°] , Solid fro	and Log ₁ n 368.6°	Reference State for Calculating ΔH_{f}° , ΔR_{f}° , and $Log_{10}Kp$: Rhombic Solid from 298° to 368.6°, Monoclinic Solid from 368.6° to 392°, Liquid	mbio Liqu	solid Solid
THATATAA THEAT		from 3	392° to 7]	17.75°, IC	leal Diat	omic Gas	from 717.	to 717.75°, Ideal Diatomic Gas from 717.75° to 1000°.	8	
64 25C C00	SWAG	-	و		ę	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE ST	ATE
8.15 H		TEMPERATURE OK	HEAT CAPACITY CAL./DEG./ GFW.	T 294.15 HEAT CONTENT CAL./ GFW.	ST ENTROPY CAL/DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H ^o cal/gfw.	FREE ENERGY & F ^o f cal/ gfw.		х , , , ,
	×	298	37.17	0	102.76	102.76	24350	11880	I	8.708
∆ H _m	CAL. / GFW.	300	37.25	68	102.99	102.77	24346	11809	I	8.603
		400	39.73	3933	114.08	104.25	20019	7827	1	4.276
ä	*	500	41.05	1983	123.13	107.17	16749	5104	ı	2.231
Δн ,	CAL. /GFW.	600	41.82	12123	130.66	110.46	14089	3037	I	1.106
e s	¥	700	42.30	16330	137.15	113.83	11440	1395	I	•435
∆ H₅	CAL. /GFW.	800	42.62	20530	142.82	117.10	- 95310	- 8798		2.403
		006	42.84	24850	147.85	120.24	- 94560	1161	ı	•464
T.P.	×	1000	43.01	29140	152.38	123•24	- 93710	12630	I	2.760
ΔH,	CAL. /GFW.									
T.P.	¥									
ΔH,	CAL. / GFW.									****
T _c =	ж.									
= °	ATM.	,								

SULFUR

298° to 368.6' 292° to 717.7' 17.7' 7 117.7' 7 117.7' 7 117.7' 7 117.7' 7 117.7' 7 117.7' 7 117.7' 7 117.7' 7 117.7' 7 5.555 5 5.27 7 5.27 7 5.23 5 5.24 7 5.21 5 5.21 5 5.21 5 5.21 5 5.21 5 5.21 5 5.21 5 5.21 5 5.10 5 5.11 5 5.11 5 5.11 5 5.11 1	from 298° from 298° × × × × × × × × × × × × × × × × × × ×	• 75° , Mon. • 75° , Id. • 75° , Id. • 10° . •	OCIINIC eal Diate s ⁶ s ⁷ s ⁶ 40.09 40.09 40.12 40.12 40.12 41.74 41.74 45.46 45.46 45.46 45.46	Solid fro omic Gas -front and fro restriction the color 40009 40009 40072 41019 41054 41054 41054 41054 41054 41054 4207 4207 4207 43233	Dm 368.6° from 717 From 717 Forwar hEAT △ H° cau.ver. 56900 56438 56438 56438 56438 56438 56438 55435 55545 55575 55545 55575 55545 55575 55575 55575 55575 55575 55575 55575 55575 55575 55575 55575 55575 55575 55575 55575 55575 555755 555755 555755 55575555 5557555555	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	Liqui 1000°.	uid
EAL MONATOMIC GAS EAL MONATOMIC GAS 32.066 RAWS 32.066 RAWS 32.066 RAWS 32.066 RAWS 32.066 RAWS 32.066 RAWS CAL/GFW CAL/GFW CAL/GFW 11000 5.12 1200 5.000 5.01 1200 5.	from 392° to The tarting Rectating 1 298 5.66 5.66 5.66 1 200 5.65 1 200 5.05 1 20	-75°, Id 	eal Dlat 7 40.09 40.09 40.012 40.012 40.012 44.74 45.46 45.46 45.46	Omic Gas -front care restriction restriction 400.09 400.09 400.72 410.19 410.64 410.64 42.68 42.	from 717 FORMAT HEAT △ H ⁶ Collocation 56900 56435 55435 55435 42083 42083 42162 42162	-75° to 30 -75° to 30 FREE BUENY D F CALL GFN 47218 47218 47218 47218 47218 47218 47218 47218 27810 34848 3	000 000 000 000 000 000 000 000	€ K 6 K 6 C 6 C 6 C 6 C 6 C 6 C 6 C 6 C
32.066 GRAMS T C a.iH)= 1,591 CAL/GFWL FEARSTANDER a.iH)= 1,591 CAL/GFWL 5,066 a.iH)= - 2,98 5,666 a.iGFWL - 700 5,044 a.iGFWL - 1000 5,017 a.iGFWL - 11000 5,011 a.iGFWL 11000 5,006 11 a.iGFWL 11000 5,006 11 a.iGFWL 11000 5,006 5,006 a.iGFWL 11000 5,006 a.iGFWL 11000 5,006 a.iGFWL 11000 5,006 a.iGFWL 11700 5,006 a.iGFWL 12000 5,006 a.iGFWL </td <td>Tareet Travers Trave Travers Travers Travers Travers Travers Trave Tra</td> <td></td> <td></td> <td>- - - - - - - - - -</td> <td>2444 2444 2444 24444</td> <td>Free Denory ∆ F⁴ FREE DEnory ∆ F⁴ CAL./ GFL CAL./ GFL 47160 4708 4708 4848 4848 4848 4848 4848 4848 4848 4848 4848 4848 4848 4848 <tr< td=""><td></td><td>€ K 613 •613 •613 •613 •613 •613 •880 •880 •137 •137 •112 •112</td></tr<></td>	Tareet Travers Trave Travers Travers Travers Travers Travers Trave Tra			- - - - - - - - - -	2444 2444 2444 24444	Free Denory ∆ F ⁴ FREE DEnory ∆ F ⁴ CAL./ GFL CAL./ GFL 47160 4708 4708 4848 4848 4848 4848 4848 4848 4848 4848 4848 4848 4848 4848 <tr< td=""><td></td><td>€ K 613 •613 •613 •613 •613 •613 •880 •880 •137 •137 •112 •112</td></tr<>		€ K 613 •613 •613 •613 •613 •613 •880 •880 •137 •137 •112 •112
52.005 GRMS TT C F.H)= 1,591 CAL/GFN FM-TACKARTY F.H0= CAL/GFN 500 5.056 F.H0= CAL/GFN 5.00 5.011 F.H0= CAL/GFN 1100 5.011 F.H0= CAL/GFN 1200 5.066 F.H0= FL 1100 5.011 F.H0= FL 1100 5.011 F.H 1100 5.010 5.066 F.H 1100 5.010 F.H 1100 5.010 F.H 1100 5.010 F.H 1100 5.010 F.H 11700 5.010 F.H 2200 5.011 F.H 2200 5.113 <	Taveranture Heat Carlos Control K K K Carlos Control K K K K K K K K K K K K K K K K K K K			PREE HALLAY PREE HARGY ALLORGANA CALLORGANA 40009 40072 40072 41019 41054 4207 4208 43023	Ξ. S.			× • 613 • 613 • 6513 • 6513 • 6513 • 6513 • 6513 • 6513 • 613 • 137 • 137 • 137 • 1122 • 112
•	Turner Horizon Construction 298 5.66 300 5.66 400 5.66 700 5.44 700 5.21 900 5.11 1100 5.11 1200 5.11 1200 5.01 1400 5.00 1500 5.00 1600 5.00 1700 5.00 1600 5.00 1700 5.00			CALL/PEC/PENT 40009 40009 40072 40072 41019 41054 4207 4207 4207 4207 4207 43023	3			к к к к к к к к к к к к к к к к к к к
* * * * * 300 * 300 * 400 5.55 * * * * * * * * * * * * * * * * * * 1100 * * * * * * * * * * * * * * * * * * * 1200 * 1300 * * 1900 * 1900 * * 1900 * * * * * * * * * *	238 300 5500 11200 11200 11200 11200 11200 11200 11200 11200 11200 11200 11200 11200 1000 1000000	0 10 1121 1121 1121 1121 1121 1022 2713 2713 2713 2713 2713 2713 2713 27	40000 4000000	40.09 40.09 40.09 40.32 40.72 41.64 41.64 42.64 42.88 43.23			~~~~~~	• 613 • 613 • 9999 • 9999 • 9499 • 9499 • 137 • 137
* * * 298 * 300 5.66 * * * * * * * * * * * * * * * * * * 1100 5.11 * * * 11200 5.01 * 11200 5.01 * * 11200 5.00 5.00 5.00 * 11200 5.00 </td <td>238 300 300 300 500 11 1200 11 1200 11 1200 11 1200 11 1000 11 1000000</td> <td>0 10 1121 1121 1121 1121 1121 1122 2713 3747 4770 4770</td> <td>40.09 40.12 41.74 42.95 42.95 45.45 45.45 45.67 45.67</td> <td>40.09 40.09 40.09 40.72 41.19 41.19 42.64 42.64 43.23</td> <td></td> <td></td> <td></td> <td>• 613 • 358 • 358 • 8999 • 849 • 880 • 880 • 112 • 112</td>	238 300 300 300 500 11 1200 11 1200 11 1200 11 1200 11 1000 11 1000000	0 10 1121 1121 1121 1121 1121 1122 2713 3747 4770 4770	40.09 40.12 41.74 42.95 42.95 45.45 45.45 45.67 45.67	40.09 40.09 40.09 40.72 41.19 41.19 42.64 42.64 43.23				• 613 • 358 • 358 • 8999 • 849 • 880 • 880 • 112 • 112
* * CAL / GFW 300 5.66 CAL / GFW 500 5.65 * 400 5.65 * 700 5.21 * 800 5.21 * 1100 5.11 * 11200 5.01 * 11200 5.01 * 11200 5.01 * 11200 5.01 * 11200 5.01 * 11700 5.01 * 11200 5.06 * 1200 5.06 * 1300 5.06 * 1300 5.06 * 1300 5.06 * 1200 5.06 * 1200 5.06 * 1200 5.06 * 1300 5.06 * 22000 5.01 * 22000 5.11 * 22000 5.13 * 2400 5.13	300 2000 2	10 571 1121 1121 1121 2713 3232 3232 4770 4770	40.12 41.74 42.95 42.95 44.76 45.46 45.46 45.46 45.62	40.09 40.32 40.72 40.72 41.64 41.64 42.64 42.88 43.23				••358 •9999 ••849 ••880 ••117 ••112
Cut. / GFW. 6FW. 500 5044 % 500 50444 500 50444 500 5034 700 5034 700 5034 700 5034 700 5017 700 5017 700 5017 1100 501 1100 500 1100 500 11000 500 1000 5000 1000 500 1000 5000 1000 5000 1000 5000 1000 5000	400 500 500 1100 11200 11200 11200 11200 11200 11200 11200 11200 11200 1000 1000000	571 1121 1660 2190 2713 3232 4770 4770	41.74 42.95 43.95 44.76 45.46 45.46 45.62 45.62	40.32 40.72 41.19 41.64 42.07 42.48 42.88 42.88				5.999 .849 .8473 .8880 .8880 .137 .112
CAL./GFW. 500 5.44 * 1000 5.34 600 5.34 600 5.34 700 5.21 700 5.11 700 5.11 700 5.11 1100 5.11 1200 5.09 700 5.01 1200 5.09 700 5.01 1200 5.01 1200 5.09 700 5.01 1200 5.01 700 5.01 1200 5.01 700 5.00 700 5.	500 6000 11000 10000 1000000	1121 1660 2713 3232 3237 4770 4770	42.95 43.95 44.76 45.46 45.60 45.62 45.62 45.62	40.72 41.19 41.64 42.07 42.48 42.88 43.23				• 849 • 773 • 773 • 880 • 117 • 112
% % 600 5.34 % 700 5.21 700 5.21 % 800 5.11 % 1000 5.14 % 1100 5.14 % 1200 5.14 % 1300 5.01 % 1300 5.07 % 1300 5.06 % 1500 5.06 % 1600 5.06 % 1700 5.06 % 1900 5.06 % 1900 5.06 % 1900 5.06 % 22000 5.01 % 23000 5.113 % 22000 5.13 CAL /GFW 25000 5.13		1660 2713 2713 3232 3247 4770 4770	43.95 44.76 45.46 45.46 45.07 45.07 47.10	41.19 41.64 42.07 42.48 42.88 43.23				3.773 9.880 1.417 1.137 1.112
* * * 700 5.27 Cult. /GFW. 800 5.21 900 5.17 900 * 11000 5.14 * 11200 5.09 * 1300 5.09 * 1700 5.00 * 11000 5.00 * 11000 5.00 * 11000 5.00 * 11700 5.00 * 11700 5.00 * 11700 5.00 * 11700 5.00 * 11700 5.01 * 1900 5.01 * 2100 5.01 * 22000 5.01 * 22000 5.11 * 22000 5.11		2190 2713 3232 3747 4250 4770	44 • 76 45 • 46 46 • 07 46 • 62 47 • 10	41.64 42.07 42.48 42.88 43.23				0.880 1.417 1.137 1.137 1.12
* 800 5.21 Cult. /GFW. 900 5.17 900 5.17 900 * 11000 5.14 * 11200 5.09 * 1300 5.008 * 1400 5.01 * 1700 5.00 * 1700 5.00 * 1700 5.00 * 1900 5.08 * 1900 5.08 * 1900 5.08 * 2100 5.01 * 2300 5.11 * 22000 5.11 * 22000 5.11		2713 3232 3747 4260 4770	45.46 46.07 46.62 47.10	42.07 42.48 42.88 43.23				•417 •137 •112
CAL /GFW. 900 5.17 ** 1000 5.14 ** 1100 5.14 1200 5.14 1300 5.08 ** 1300 5.08 CAL /GFW. 1500 5.08 CAL /GFW. 22000 5.13 ** 22000 5.13		3232 3747 4260	46.07 46.62 47.10	42•48 42•88 43•23			111	•137 •112
CAL./GFW. 1000 5.14 * 1100 5.01 * 11200 5.09 CAL./GFW. 1200 5.09 CAL./GFW. 1500 5.06 1700 5.08 CAL./GFW. 2200 5.01 2100 5.11 2200 5.11 200	x.	3747 4250 4770	46.62 47.10	42 . 88 43 . 23			ייסע ו ו	.112
CAL /GFW. 1100 5.09 *K 11200 5.09 CAL /GFW. 1500 5.08 CAL /GFW. 1500 5.06 1700 5.08 CAL /GFW. 2200 5.09 CAL /GFW. 2200 5.13 CAL /GFW. 2200 5.13	、 	4260	47.10	43 • 23	42310		ی ا	.272
* 1200 5.09 * 1300 5.09 CAL /GFW 1400 5.06 * 1400 5.06 * 1500 5.06 * 1700 5.06 * 1900 5.06 * 1900 5.06 * 22000 5.09 * 22000 5.10 * 22000 5.13 * 22000 5.13 * 22000 5.13		4770			20115	05007	י ו	
* * CuL /GFW 1300 5.08 CuL /GFW 1400 5.07 1500 5.06 * 1500 5.06 * 1700 5.06 * 1700 5.06 * 1900 5.07 * 2000 5.01 * 22000 5.11 * 22000 5.11 * 2400 5.16 * 2500 5.16		010	47.55	43.58	42380		1	4.571
CAL /GFW. 1400 5.07 CAL /GFW. 1500 5.06 % 1500 5.06 1700 5.06 1700 5.06 1700 5.08 2.000 5.01 2.100 5.11 2.2200 5.13 CAL /GFW. 2200 5.13 2.2500 5.16 2.16	к. 	0170	47.95	43.89			ה ו	978
CAL./GFW. 1500 5.06 *K 1500 5.06 1700 5.06 1700 5.06 1700 5.06 2.00 2.00 5.09 5.11 2200 5.11 2200 5.11 2210 5.11 221		5786	48.33	44.20	42496	22210	•	3.467
* 1600 5.06 * 1700 5.06 * 1700 5.06 * 1900 5.08 * 2100 5.09 * 22000 5.11 * 2300 5.11 * 2300 5.11 * 2400 5.11 * 2500 5.11		6292	48.68	44.49	42562	20767	т 1	3.025
* 1700 5.06 * 1800 5.07 CAL./GFW 1900 5.08 CAL./GFW 2100 5.09 * 22000 5.10 * 2300 5.11 * 2300 5.11 * 2400 5.11 * 2300 5.11 * 2300 5.11		6199	49.01	44.77	42619		~ I	2.637
CAL/GFW 1800 5.07 CAL/GFW 1900 5.08 CAL/GFW 22000 5.09 2100 5.10 22200 5.11 22200 5.11 22300 5.14 2400 5.16		7305	49.31	45 • 02	42675	17855	2 1	2.295
CAL/GFW 1900 5.08 2000 5.09 22000 5.10 2200 5.11 2200 5.11 2300 5.14 2400 5.14 2500 5.16		7811	49.60	45.27	42731		-	1.990
CAL / GFN. 2000 5.09 2200 5.10 2200 5.13 2300 5.13 2400 5.14 2400 5.14		8318	49.88	45.51	42788		-	1.715
2100 5.10 * 2200 5.11 2200 5.13 2400 5.14 CAL /GFW. 2500 5.16		8826	50.14	45 • 73	42846		-	.469
K 2200 5.11 K 2300 5.13 CAL/GFW 2500 5.14 2500 5.16		9335	50.39	45 . 95	-		I	1.248
CAL/GFW. 2500 5.13 CAL/GFW. 2500 5.16		9846	50.62	46.15	•	-	ı	1•045
CAL./GFW. 2400 5.14 2500 5.16		10358	50.85	46.35	-		I	•859
CAL./GFW. 2500 5.16		10871	51.07	46.55			ı	.688
		11387	51.28	46.73	_		ı	• 532
5.18		11904	51.48	46.91			1	•386
2700 5.20		12423	51.68	47.08			1	•250
5.22 1		12944	51.87	47.25	-		ł	•125
2900 5.24 1		13467	52.05	47.41	-		I	•010
re = Aitt. 3000 5.26 13992	2	13992	52.23	47.57	43472	1378		•100

Publication Date: January 1, 1956 | doi: 10.1021/ba-1956-0018.ch004

SULFUR

TANTALUM	Ta			So]	lid from	Solid from 298° to 3000°.			
REPERENCE STATE	ы								
₆₁ , 180.95	GRAMS	-	ູ້	H ⁰ - H ⁰	ۍ ۲	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
$(H^{0}_{298,15} H^{0}_{9}) = 1,358$	CAL./GFW.	TEMPERATURE 9K	HEAT CAPACITY CAL. DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H	FREE ENERGY & F cal/gfw.	רס6 ר06
		298	6.08	0	06.0	00.0			
M.P. 3,270	¥	300	6.08	11	9.94	16.91			
)		400	6.27	620	11.71	10.14			
		009	0 4 0	1900	14.30	11-14			
		2002	6.52	2550	15.30	11-66			
B.P. 5,700	×	800	6.57	3210	16.17	12.16			
		006	6.63	3870	16.95	12.65			
ΔH, 180,000	CAL. /GFW.	1000	6.67	4530	17.65	13.12			
		1100	6.72	5200	18.29	13.57			
		1200	6.76	5880	18.87	13.97			
.e.s	*	1300	6.81	6550	19.42	14.39			
		1400	6.85	7240	19.92	14.75			
ΔHs	CAL. /GFW.	1500	00.9	0601	20.40	15.12			
		1600	946 • 94	8620	20.84	15.46			
		1700	6.98	9310	21.26	15.79			
T.P.	ж.	1800	7.02	10010	21.66	16.10			
		1900	7.07	10720	22 • 0 4	16.40			
ΔH,	CAL. / GFW.	2000	7.11	11430	22.41	16.70			
		2200	7.19	12860	23.09	17.25			
a +	20	2300	7.23	13580	23.41	17.51			
	4	2400	7.28	14300	23.72	17.77			
ΔH.	CAL /GFW.	2500	7.32	15030	24.02	18.01			
		2600	7.36	15770	24.31	18.25			
		2700	7.40	16510	24.58	18.47			
T.=		2800	7.44	17250	24.85	18.69			
	:	2900	7.48	17990	25.11	18.91			
Pc =	ATM.	3000	7.53	18740	25.37	19.13			
						-		-	

TANTALUM

TANTALUM	ġ		_ 6 5	eference	State foi	Reference State for Calculating AH, AF,	ting AH [•]	۲. ۲.	
IDEAL MONATOMIC GAS	C GAS		B	and Log ₁₀ Kp:		Solid from 298° to 3000°	• to 300	0°.	
6łw 180.95	GRAMS	H	ບ	H° – H°	ړ	-(P"-H" 296.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
		TEMPERATURE	P UEAT CABACITY	T 298.15	1	FREE ENERGY	HEAT △ H ^C	FREE ENERGY \$ F	
(H ² 28.15 H ²) = 1,482	CAL_/GFW.	*	CAL./DEG./ GFW.	CAL./ GFW.	CAL./DEG./ GPW.	CAL./DEG./ GFW.	CAL./GPW.	CAL./ GFW.	
		298	4 • 99	0	44.24	44.24	186800	176561	-129.428
A.P.	¥	300	4.99	6	44.27	44.24	186798	176499	-128.590
		004	5 • 08	512	45.72	44-44	186683	173079	- 94.573
ΔHm	CAL. / GFW.	500	5.28	1029	46.87	44.82	186569	169699	- 74.180
].	600	5.54	1570	47.86	45.25	186470	166334	- 60.592
		700	5.83	2138	48.73	45•68	186388	162987	- 50.891
B.P.	×	800	6.11	2735	49. 53	46.12	186325	159637	- 43.614
		006	6.38	3359	50.26	46.53	186289	156310	- 37.959
ΔH v	CAL. /GFW.	1000	6.62	4009	50°95	46.95	186279	152979	- 33.436
]	1100	6 • 8 4	4683	51.59	47.34	186283	149653	- 29.736
	ſ	1200	7.04	5377	52.19	47.71	186297	146313	- 26.649
5.P.	¥	1300	7.22	6091	52.77	48.0 9	186341	142986	- 24.040
		1400	7.38	6821	53.31	48.44	186381	139635	- 21.799
∆ H.s	CAL. /GFW.	1500	7.51	7565	53 . 82	48.78	186435	136305	- 19.861
		1600	7.63	8322	54.31	49.11	186502	132950	- 18.159
		1700	7.73	0606	54.77	49°43	186580	129613	- 16.663
TP	ж.	1800	7.82	9867	55.22	40.74	186657	126249	- 15.327
	:	1900	7.89	10653	55.64	50.04	186733	122893	- 14.135
Δ Η,	CAL. /GFW.	2000	7.96	11446	56.05	50.33	186816	119536	- 13.061
		2100	8.02	12245	56.44	50.61	186905	116177	- 12.090
		2200	8.08	13050	56.81	50.88	186990	112806	- 11.206
T.P.	×	2300	8.13	13861	57.17	51.15	187081	109433	- 10.398
		2400	8.18	14676	57.52	51.41	187176	106056	- 9.657
ΔH,	CAL. /GFW.	2500	8.22	15496	57.86	51.67	187266	102666	- 8.975
		2600	8.26	16319	58.18	51.91	187349	99287	- 8,346
		2700	8.29	17147	58.49	52.14	187437	95880	- 7.760
T.=	×	2800	8.32	17977	58.79	52.37	187527	92495	- 7.219
9		2900	8.35	18811	50°03	52.61	187621	89079	- 6.712
Pc =	ATM.	3000	8.38	19648	59.37	52.83	187708	85708	- 6.243
						-			

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In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

TECH	TECHNETIUM 1	Лс		Solid	from 298	° to 2400	°, Liquid	from 24(Solid from 298° to 2400°, Liquid from 2400° to 3000°.	•••
BABR	REFERENCE STATE	Ш								
3- 5-	* •66	GRAMS	-	ື້	н ^о -н ^о н	e,'	-(Fr0-H ⁰ 218.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
(H [°] _{298.15} H [°])		CAL/GPW.	TEMPERATURE •K	HEAT C	T ZMLIS HEAT CONTENT CAL./ GPW.	T ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFV.	HEAT A H	FREE ENERGY & F	۲0 ۳
			298	5.80	C	8-00	8,000			
¥.P.	(2.400)	¥	300	5.80	10	8.04	8.01			
:			400	6 • 00	600	9.73	8.23			
∆Hm	(2,500)	CAL. /GFW.	500	6.20	1210	11.10	8.68			
			600	6.40	1840	12.24	9.18			
			700	6.60	2490	13.25	9.70			
8 - -	(4,900)	×	800	6.80	3160	14.14	10.19			
2			006	7.00	3850	14.95	10.68			
^u 7	(138,000)	LAL. / GFW.	1000	7.20	4560	15.70	11.14			
			1100	7.40	5290	16.40	11.60			
			1200	7.60	6040	17.05	12.02			
e,		*	1300	7.80	6810	17.67	12.44			
			1400	8 • 00	7600	18.25	12.83			
° µ ⊲		CAL /GFW.	1500	8 • 20	8410	18.81	13.21			
			1600	8 • 40	9240	19.35	13.58			
			1700	8•60	10090	19.86	13.93			
T.P.		×	1800	8•80	10960	20.36	14.28			
			1900	00•6	11850	20.84	14.61			
₽		CAL. /GFW.	2000	9.20	12760	21.31	14.93			
			2100	0**6	13690	21.76				
			2200	6 •60	14640	22.20	Ч			
		¥	2300	9•80	15630	22.63	15.84			
			2400	10.00	22120	25.35				
́н ⊲		CAL. /GFW.	2500	10.00	23120	25.76	16.52			
			2600	10.00	24120	26.15	16.88			
			2700	10.00	25120	26.52	17.22			
T. =		×	2800	10.00	26120	26.89	17.57			
			2900	10.00	27120	27.24	17.89			
" "			3000	10.00	28120	27.58	18•21			

* Isotope of Longest Known Half Life.

TECHNETIUM

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

Publication Date: January 1, 1956 | doi: 10.1021/ba-1956-0018.ch004

TECHNETIUM	Тс		Refere	ence Stat	e for Cal	culating	∆H°, ∆P°,	Reference State for Calculating AH [°] , AP [°] , and Log ₁₀ Kp:	0Kp t
IDEAL MONATOMIC GAS	C GAS		Solid	from 298	° to 2400	°, Liquid	from 240	Solid from 298° to 2400°, Liquid from 2400° to 3000°	•••
Gfw C	GRAMS	F	و	40 - 140	ą	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
* • 66		TEMPEDATINE	•ر	T 290.15	o [⊥]	FREE ENERGY	HEAT A H ^o	FREE ENERGY A F	
(H [°] _{216.15} H [°] ₀) = 1,48]	1,481 ^{CAL./GFW.}	¥	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	F CAL./ GFW.	С06 Ж
		298	4-07	0	43.25	43.25	155000	144490	-105-918
R.P.	×	300	4.97	0	43.28	43.25	154999	144427	-105.223
3	110	400	5.00	507	44.71	43.45	154907	140915	- 76.998
0 11	CAL / GPW.	500	5.11	1012	45.84	43.82	154802	137432	- 60.075
		600	5.33	1532	46.79	44.24	154692	133962	- 48.799
		700	5.66	2081	47.63	44.66	154591	130525	- 40.755
B.P.	×	800	6.06	2667	48.41	45 • 08	154507	127091	- 34.722
;		006	6.48	3294	49.15	45.49	154444	123664	- 30.031
PH.	CAL. /GFW.	1000	6.86	3961	49. 85	45.89	154401	120251	- 26.283
		1100	7.18	4664	50.52	46.28	154374	116842	- 23.216
		1200	7.42	5395	51.16	46.67	154355	113423	- 20.658
S.P.	*	1300	7.58	6146	51.76	47.04	154336	110019	- 18.497
1		1400	7.66	6069	52.33	47.40	154309	106597	- 16.641
2 us		1500	7.68	7676	52 . 85	47.74	154266	103206	- 15.038
		1600	7.65	8443	53.35	48.08	154203	99803	- 13.632
		1700	7.59	9206	53.81	48.40	154116	96401	- 12,393
T.P.	×	1800	7.50	0966	54.24	48.71	154000	93016	- 11.293
H	CA1 /CEW	1900	7.41	10706	54.65	49 . 02	153856	89617	- 10.307
		2000	7.30	11441	55•02	49.30	153681	86261	- 9.425
		2100	7.20	12166	55 • 38	49.59	153476	82874	- 8.624
		2200	2.09	12881	55.71	49.86	153241	79519	- 7.899
T.P.	*	2300	7.00	13585	56.02	50.12	152955	76158	- 7.236
		2400	6.91	14281	56.32	50.37	147161	72833	- 6.632
	CAL. /GFW.	2500	6.83	14967	56.60	50.62	146847	69747	- 6.097
		2600	6.75	15646	56.87	50 . 86	146526	66654	- 5.602
		2700	6.69	16318	57.12	51.08	146198	63578	- 5.146
T c =	×.	2800	6.63	16984	57.36	51.30	145964	60548	- 4.725
a		2900	6.58	17644	57.59	51.51	145524	57509	- 4.333
r e =	ATM.	3000	6.53	18299	57.82	51.73	145179	54459	- 3.967

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956. *Isotope of Longest Known Half Life

TECHNETIUM

TELLURIUM	Те			solid from	n 298° to	Solid from 298° to 723°, Liquid from 723° to	uid from	723° to	
REFERENCE STATE	LATE		T	1260°, Ide	sal Diaton	Ideal Diatomic Gas from 1260°	om 1260°	to 3000°.	
cłw 127.61	GRAMS	-	೮್	H ⁰ -H ⁰ T 294.15	er-	-(50-10 20115)	FORMATI HEAT A H ^C	FORMATION FROM REFERENCE STATE	CE STATE
(H [°] _{296.15} H [°] ₉) = 1463	5 CAL/GFW.	*	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GPW.	CAL./GPW.	CAL./GFW.	х° "Сос
	3	298	6.15	0	11.88	11.88			
		300	6.16 6.68	653	11.92	11.89			
∆Hm 4180	CAL /GFW.	500	7.21	1347	15.31	12.62			
		009	7.73	2094	16.67	13.18			
B.P. 1260	*	800	8•20 00•00	2894	24.86	14.91			
		006	00•6	8860	25.92	16.03			
001°71 400		1000	00.6	9760	26.87	17.11			
		1200	00.0	11560	28.51	18.88			
S.P.	¥	1300	4.47	24250	38.58	19.93			
Δ Η-	CAL /GFW.	1400	4.47	24700	38.91	21.27			
•		1500	4.47	25145	39.22	22.46			
		1600	4.47	25590	39.51 30.78	23.52			
T.P.	Å	1800	14.4	26485	40.03	25.32			
д н,	CAL /GFW.	1900	4.47	26930	40.28	26.82			
-		2100	4.47	27825	40.73	27.48			
T.P.	×	2200	4.47	28275	40.93	28.65			
:		2400	4.47	29165	41.32	29.17			
₽H	CAL. /GFW.	2500	4.47	29615	41.50	29•66			
		2600	4.47	30060	41.68	30.12			
1	;	2700	4.47	30510	41.85	30.55			
	4	2800	4.47	30955	42.01	30.96			
= ~	ATM.	2900	4.47	31400	42.17	31.35			
		3000	14.41	106916	20.24	11/010		_	

TELLURIUM

TELLURIUM	đ		E	leference	State foi	Reference State for Calculating $\Delta H^{\bullet}_{ m P}, \ \Delta F^{\bullet}_{ m P},$ and	ting AHe,	ΔF_{ρ}° , and	
	2,1		Ц	Log ₁₀ Kp:	Solid fro	om 298° to	0 723°, L:	Solid from 298° to 723°, Liquid from 723°	1 723°
LUEAL DIATOMIC GAS	C GAS		¢	to 1260°,	Ideal D18	atomic Gas	from 12	Ideal Diatomic Gas from 1260° to 3000°	0°.
255.22					•	- (", ",",")-	FORMATI	FORMATION FROM REFERENCE STATE	ICE STATE
	GRAMS	Telecolitic	Ե	H ^o -H ^o T 200.15	°-	FREE ENERGY	HEAT △ H ^e	FREE ENERGY & F	
$(H^{\circ}_{296,15} - H^{\circ}_{9}) = 2,379$	CAL./GFW.	No.	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL. /DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./GFW.	L06 K
		298	8.72	0	64.10	64-10	39600	27572	110-00 -
A.P.	×	300	8.72	16	64.16	64.11	39594	27498	
:		400	•	895	66.68	64.45	39189	23525	- 12.854
۵Mm	CAL. / GFW.	500	8.80	1775	<u>68</u> .65	65.10	38681	19666	- 8 . 596
		000	88.8	2005	70.27	65.83	38077	15919	- 5.798
8. P.	*	800	• •	0000	72-83	1000	31361	. 12279	- 3.833
		006	8.92	5335	73.86	67.96	27215	7379	
2H v	CAL. /GFW.	1000	8.92	6225	74.82	68.60	26305	5225	- 1.142
		1100	8.92	7117	75.67	69.20	25397	3144	624
		1200	8.93	8010	76.44	69.77	24490	1186	216
. P.	*	1300	8.93	£068	77.16	70.32	0	0	0
:		1400	8.93	6616	77.82	70.83	0	0	0
₽ ₩ 2	CAL /GFW.	1500	8 • 93	10690	78.44	71.32	0	0	0
		1600	8.93	11585	10.01	71.77	0	0	0
		1700	8.94	12475	19.56	72.23	0	•	с
T.P.	¥	1800	8.94	13370	80.06	72.64	0	0	0
Δ н.	CAL. / GFW.	1900	8 04 8 04	14265	80•55 81.01	73.05	00	0	00
-		2100	8.94	16050	81.45	73.81			o c
		2200	8.94	16950	81.86	74.16		• c	0
T.P.	×	2300	8.94	17840	82.26	74.51	c	c	0
		2400	8.94	18730	82.64	74.84	ò	¢	o
ΔH	CAL. / GFW.	2500	8.94	19630	83 • 00	75.15	0	0	o
ţ.		2600	8•94	20520	83•36	75.47	c	c	0
		2700	8•94	21420	83.69	75.76	• o		0
Tc =	×	2800	8 • 94	22310	84•02	76.06	0	0	0
		2900	8 • 94	23200	84.33	76.33	0	0	c
Pc =	ATM.	3000	8•94	24100	84.64	76.61	0	0	o

Publication Date: January 1, 1956 | doi: 10.1021/ba-1956-0018.ch004

TELLURIUM

TELLURIUM	. E		Å	Reference	State for	State for Calculating AH, AF, AF, and	ing AH,	∆P°, and	
THOM INCH IN THE			Å	Log ₁₀ Kp:	Solid fro	an 298° to	723°, L1	Solid from 298° to 723°, Liquid from 723°	723°
TUERL MUNATORIC GAS	C UAS		ţ	to 1260°,	Ideal Dia	Ideal Diatomic Gas		from 1260° to 3000°	٥°.
Giw 127.61	GRAMS	+	ບ	е.Н. Н.	°2,	-(10-11-2111)	FORMATI	FORMATION FROM REFERENCE STATE	ACE STATE
(H [°] _{2N.15} H°) = 1,481	CAL/GFW.	TEMPERATURE •K	HEAT O	T ZMLIS HEAT CONTENT CALL/ GPW.	T ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H	FREE ENERGY & F	LOG K
		298	4.97	0	43.64	43-64	46500	37031	- 27,145
A.P.	*	9 00 9 00 9 00	4.97	6 90 9	43.67	43.64	46498	36973	
Δ H	CAL. /GFW.	005	4.97	1003	46.21	44.21	46156	30706	- 18.4/8 - 13.422
		600	4.97	1500	47.12	44.62	45906	27636	- 10.067
	3	007	4 • 98	1997	47.88	45.03	45603	24617	- 7.686
1	 	006	4 • 99 5 • 01	2662	48•55 49•14	45.82 45.82	41035	22083	- 6.033 - 4.703
2H 2	CAL. /GFW.	1000	5.05	3409	49.67	46.18	40239	17439	- 3.811
		1100	5°06	4006	50.15	46.51	39846	15173	- 3.014
		1200	5.14	4517	50.60	46.84	39457	12949	- 2.358
S.P.	¥	1300	5 • 20	5034	51.01	47.14	27284	11125	- 1.870
ΔHs	CAL. /GFW.	1400	5.26	5557 6086	51.40	47.44	27357 27441	9871	- 1.541 - 1.257
		1600	5.38	6621	52.11	47.98	27531	7371	- 1.006
	Γ	1700	5.44	7162	52.44	48•23	27622	6100	784
T.P.	×	1800	5 • 50	1709	52.75	48.47	27724	4828	- •586
Υ Η Υ	CAL /GEW	1900	5 • 55	8261	53.05	48•71	27831	3568	- •410
		2100	5.65	6700	53.61	40.15	28056	1008	162• -
		2200	5.70	9949	53.87	49.35	28174	- 294	020
1.P.	×	2300	5.74	10521	54.13	49.56	28301	- 1599	.151
:		2400	5.78	11097	54.37	49.75	28432	- 2888	• 262
₽₩	CAL. /GFW.	2500	5.82	11677	54.61	40.04	28562	- 4213	.368
		0007	68.6	12200	54.84	50.13	28700	- 5516	• 463
		2700	989	12847	55 • 06	50.31	28837	- 6830	• 552
Tc =	¥	2900	5.94	13430	55 48	50.48 50.65	28981	- 8147	• 635 - 713
P _c =	ATM.	3 000	5.96	14624	55 . 68	50.81	29274	- 10806	.787

TELLURIUM

Publication Date: January 1, 1956 | doi: 10.1021/ba-1956-0018.ch004

TERBIUM		E.		Solic	d from 29	8° to 170	Solid from 298° to 1700°, Liquid from 1700° to	d from 1	700° to	
REFE	REFERENCE STATE	31		2800'	, Ideal	Monatom1c	2800°, Ideal Monatomic Gas from 2800° to 3000°	2800° to	3000°.	
Gfw	158.93	GRAMS	F		H ^o - H ^o T 296.15	-1 So	-(F0-H0 299.15)	FORMAT HEAT A H ^o	FORMATION FROM REFERENCE STATE Δ H ^o Free Energy Δ F ^o	
(H ⁰ _{298.15} H ₀ ⁰)	- H°) =	CAL./GFW.	er e	HEAT CAPACITY CAL/DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./GFW.	х° 9
			298	6.54	C	17.46	17.46			
A.P.	(1,700)	×	300	6.54	12	17.50	17.46			
	(- coo -)		00†	6.72	675	19.41	17.73			
∆Hm	(006 (c)	CAL /GFW.	500	06 • 90	1360	20.92	18.20			
			000	90° 1	2007 0770	22.20	18.78			
9	(2,800)	*	800	7.44	3510	24.28	19.90			
	-		006	7.62	4260	25.17	20.44			
∆H	(70,000)	CAL. /GFW.	1000	7.80	5030	25 • 98	20.95			
			1100	7.98	5820	26.74	21.45			
			1200	8.16	6630	27.44	21.92			
9.2		¥	1300	8.34	7450	28.10	22.37			
			1400	8.52	8300	28.72	22.80			
Δ H _s		CAL./GFW.	1500	8.70	9160	29.32	23.22			
			1000	8 • 88	10040	29•88	23.61			
			1700	8•00	14830	32.72	24•00			
T.P.		¥	1800	8 • 00	15630	33.17	24.49			
Ĩ		CAL /GEW	1900		17230	10.05	16.45			
			2100	8.00	18030	34.41	25.83			
			2200	8.00	18830	34.78	26.23			
d. T		*	2300	8 • 00	19630	35.14	26.61			
			2400	8 • 00	20430	35.48	26.97			
ΔH		CAL. /GFW.	2500	8•00	21230	35.80	27.31			
			2600	8.00	22030	36.12	27.65			
			2700	8•00	22830	36.42	27.97			
T _ =		×	2800	6 •00	93630	61.71	28.28			
,			2900	6.00	94230	61.91	29.42			
ື		ATM.	3 000	6 • 00	94830	62 • 12	30.51			

Publication Date: January 1, 1956 | doi: 10.1021/ba-1956-0018.ch004

TERBIUM

THALLIUM	1		Sol	1d I from	1 298° to	507°, So	lid II fro	m 507° t	Solid I from 298° to 507°, Solid II from 507° to 577°, Liquid	lqu1d
REFERENCE STATE	E STATI	ы	from	577°	to 1740°,]	Ideal Mon	Ideal Monatomic Gas from 1740°	from 17	4 0° to 3000°	0
chu 20	204.39	GRAMS	-	و .	H ⁶ - H ⁶ T 2%15	°2⊢	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H° 200. 15 H°) =	1,632	CAL./GFW.	TEMPERATURE •K	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	CAL./GPW.	CAL./ GFW.	۲06 K
			208	6.20	0	15.35	15,35			
A.P.	577	×	300	6.30	11	15.39	15.36			
	000	MO / 14	400	0°64	658	11.25	15.61			
	7,060			7.30	3170	22.03	16.75			
			700	7.30	3900	23.15	17.58			
B.P.	1,740	¥	800	7.30	4630	24.13	18.35			
			006	7.30	5360	24.99	19•04			
∆н, 38	38,740	CAL. /GFW.	1000	7.30	6090	25.76	19.67			
]	1100	7.30	0820	20.45	20.02			
			1300	000		27.67	21.31			
			1400	7.30	9010	28.21	21.78			
ΔHs		CAL. /GFW.	1500	7.30	9740	28.72	22.23			
			1600	7.30	10470	29.19	22.65			
			1700	7.30	11200	29.63	23 . 05			
T.P.	507	×	1800	5.27	50550	52.22	24.14			
			1900	5.34	51090	52.50	25.62			
₽H ⁺	8	CAL. /GFW.	2000	5.42	51620	52.78 53.04	26.97			
			2200	5.58	52720	53.30	29.34			
T.P.		¥	2300	5.67	53280	53.55	30.39			
			2400	5.75	53850	53.80	31.37			
¢H,		CAL. /GFW.	2500	5.83	54430	54.03	32.26			
			2600	591	55020	54•20	33.10			
			2700	5.98	55610	54.49	33.90			
Tc =		¥	2800	6.05	56210	54.70	34.63			
(2900	11•0	07806	24 • 34	55.65			
= ~		ATM.	3000	6.17	57440	55.13	35•99			

THALLIUM

THALLIUM	Ę	Ref	erence St	tate for	Calculati	Reference State for Calculating AH, AF, AP, and Log, Ap;	F, and L	og, "Kp :	
IDEAL MONATOMIC GAS	IC GAS	Sol	1d I fron	n 298° to	507°, So	lid IÎ Îr	om 507° t	Solid I from 298° to 507°, Solid II from 507° to 577°, Liquid	lquid
		HOJ I		T /#0	, Ideal Mon	atomic Ga	B from 17	Monatomic Gas from 1740° to 3000°	
204.39	31700	•	· १	91 	ť	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
2		Telebook T	•ر•	T 296.15	×-	FREE ENERGY	HEAT A H ^e	FREE ENERGY & F	
(H [°] ^{294.15} H [°]) = 1,481	L CAL/GFW.	No.	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.		CAL./ GFW.	LOG K
		298	4.97	0	43.23	43.23	43000	34687	- 25.427
d M	×	300	4.97	6	43.26	43.23	42998	34637	- 25.235
		400	4.97	506	44.69	43.43	42848	31872	- 17.415
ΔH	CAL. / GFW.	200	4.97	1003	45.79	43.79	42663	29153	- 12.743
		000	4 • 97	1500	46.70	44•20	41330	26528	- 9.663
		700	4.97	1996	47.47	44.62	41096	24072	- 7.516
B.P.	¥	800	4.97	2493	48.13	45.02	40863	21663	- 5,918
		006	4.97	2990	48.72	45.40	40630	19273	- 4.680
∆H ,	CAL. /GFW.	1000	4.97	3487	49.24	45.76	40397	16917	- 3.697
		1100	4 • 98	3985	49.71	46.09	40165	14579	- 2.896
		1200	5 • 00	4484	50.15	46.42	39934	12262	- 2.233
S.P.	*	1300	5.02	4985	50.55	46.72	39705	1966	- 1.674
		1400	5.05	5489	50.92	47.00	39479	7685	- 1.199
Δ Hs	CAL. /GFW.	1500	5.09	2006	51.27	47.28	39256	5431	- • 791
		1600	5.14	6508	51.60	47.54	39038	3182	434
		1700	5.20	7025	51.92	47.79	38825	932	119
T.P.	×	1800	5.27	1549	52.22	48.03	0	0	0
		1900	5.34	8079	52.50	48.25	o	0	0
ΔM	CAL. /GFW.	2000	5.42	8617	52.78	48.48	0	0	0
		2100	5.50	9164	53.04	48.68	o	0	0
		2200	5 • 58	9718	53.30	48 • 83	0	0	0
T.P.	*	2300	5.67	10280	53•55	4 9 •09	0	0	0
		2400	5.75	10851	53.80	49.28	0	0	0
ΔH	CAL. /GFW.	2500	5•83	11430	54.03	49.46	0	0	0
		2600	5.91	12017	54.26	49.64	0	0	0
		2700	5.98	12612	54.49	49.82	0	0	0
T _c =	×	2800	6.05	13214	54.70	49 • 99	0	0	0
		2900	6.11	13822	54.92	50.16	0	0	0
Pe =	ATM.	3000	6.17	14436	55.13	50.32	0	0	0
	-								

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Publication

		NCE STATE		2° K		_	_	_	_	_		_		_			_	_	_	_			_		_	_				_			
ШQ		FORMATION FROM REFERENCE STATE	FREE ENERGY $ riangle F^{\bullet}$	CAL./ GFW.								-																					
lid II fr	38° to 3000°	FORMAT	HEAT △ H ^e	CAL./GFW.																													
Solid I from 298° to 1673°, Solid II from	1673° to 1968°, Liquid from 1968°	-(1. 30 30 11)	FREE ENERGY	FUNCTION CAL./DEG./ GFW.	12.76	12.76	13.02	13.53	14.12	14.73	15.34	15.93	16.50	17.07	17.62	18.14	18.65	19.16	19.65	20.14	20.62	21.08	21.56	22.09	22•58	23.06	23.50	23.94	24.37	24.77	25.16	25.54	25.90
298° to]	°, Liquid			CAL./DEG./ GFW.	12.76	12.80	14.74	16.35	17.75	19.00	20.15	21.21	22.21	23.16	24.07	24.93	25.77	26.58	27.37	28.51	29.14	29.73	32.20	32.014	33•25	33.74	34.20	34.65	35.09	35.50	35.90	36.29	36.66
d I from	5° to 1968	1	H° H° T 296.15	HEAT CONTENT CAL./ GFW.	0	12	069	1410	2180	2990	3850	4760	5710	6700	7740	8830	0966	11130	12360	14240	15340	16440	08717	22 380	23480	24580	25680	26780	27380	28980	30080	31180	32280
Soli	1673	1		CAL./DEG./ GPW.	6.53	6.54			1.90	8.36				_				11.99						00.11	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
			TEMPERATURE	*	298	300	400	500	600	700	800	006	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900		0012	2 200	2300	2400	2500	2600	2700	2800	2900	3000
臣	VTE		GRAMS	CAL/GFW.		Υ.		CAL /GFW.			*		CAL. /GFW.			*		CAL. / GFW.			×		CAL. /GFW.			*		CAL. / GFW.			×		ATM.
MUII	REFERENCE STATE	232.05		H°)= 1,556	000	T, 300	(2 74U)				۰. ۲										L,0/2	10201	(0/0)										
THORIUM	REFE	;	25	(H ^e _{298 . 15} H ^e) =		A,	:	₩			8		∆H ^			S.P.	:	₽₽			T.P.	-	h ⊲			T.P.		ΔH			T =		" •

THORIUM

THU	L WOITOHL	Ę		Solic	1 from 29	Solid from 298° to 1900°, Liquid from 1900° to	0°, Liqui	d from 19	00° to	
REF	REFERENCE STATE	TE		2400	, Ideal	2400°, Ideal Monatomic Gas from 2400° to 3000°.	Gas from	2400° to	3000°.	
Ğ	168.94	GRAMS	-	ۍ.	H ⁰ H ⁰ T 274.15	°,-	-(F0-H0 208.15)	FORMAT MEAT A Nº	FORMATION FROM REFERENCE STATE	ICE STATE
(H ⁰ 298.1	298.15 H0) =	CAL./GFW.	TEMPERATURE °K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL. /DEG./ GFW.	CALL/GFW.	CAL./ GFW.	LOG K
			298	6+45	0	17.06	17.06			
A. P.	(1,900)	×	300	6.45	11	17.10	17.07			
→ H	(4,400)	CAL /GFW.	500 500	6•60 6•75	660 1330	18.97 20.46	17.80			
			600	6.90	2010	21.71	18.36			
			700	7.05	2710	22.78	18.91			
8.P.	(2,400)	*	800	7•20	3420	23.73	19.46			
	(c, co)		006	7.35	4150	24.59	19,98			
∆H	(000'Te)	CAL. /GFW.	1000	06.1	9890	25.37	20.48			
					000	EC 90				
		3	1300	7.95	7210	27.40	21.86			
Ľ		4	1400	8.10	8010	27.99	22.27			
∆ H₅		CAL. /GFW.	1500	8.25	8830	28.56	22.68			
			1600	8.40	9996	29 • 09	23.06			
			1700	8 • 55	10510	29.61	23.43			
đ			1800	8.70	11370	30.10	23.79			
		 4	1900	8 • 00	16650	32.89	24.13			
ΔH		CAL. /GFW.	2000	00.8	17450	33.30	24.58			
			2200	8.00	19050	34.07	25.42			
4 1		3	2300	8.00	19850	34.42	25.79			
<u>:</u>		4	2400	5.18	71220	55+83	26.16			
AH.		CAL /GFW.	2500	5 • 20	71740	56.04	27.35			
			2600	5.23	72260	56.24	28.45			
			2700	5.25	72780	56.44	29.49			
" •		×.	2800	5.28	73310	56.63	30.45			
-		•	2900	5.30	73840	56.82	31.36			
ູ		ATM.	3000	5•32	74370	57.00	32.21			

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to 2960°, Ideal Monatomic Gas from 2960° to 3000°.	• 000
	FREE BURGY FROM REFERENCE STATE HEAT \$\Delta H^0 FREE BURGY \$\Delta F^0 LOG \$\Delta H_0 \$\Delta F_0 \$\
HEAT CAL./	
-fr ² -H ² 181.11 -free versor receiver HEAT recurrence 12.029	
S	-
CALLON CALL	
H ⁰ - H ⁰ T 24L HEAT CONT CAL./ GF	
C PHEAT CARACITY CAL./PEG/ GFW. 6 • 3 0	6.30 6.31
TaretakTute	
AS / GPW.]
GRAMS	7 CAL./GFW.
	118.70 = 1,507
	Gíw (H ⁰ , ₃₈ 1 ₇ H ⁰) :

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Publication

TIN	Sn		Referen	Reference State for Ca White solid from 200°	for Calcu	Reference State for Calculating AH ^e , AF ^e , and Log ₁₀ Kp: white solid from 200° to 505° linuid from 505°	e, ∆Pe, E	nd Log ₁₀ ¹ 505°	đ	
IDEAL MONATOMIC	C GAS	-	to 2960	", Ideal	Monatomic	will'e Sully itom 250 co 500, Light 100 500 to 2960°, Ideal Monatomic Gas from 2960° to 3000°	2960° to	3000°.		
ciw 118.70	GRAMS	-	ຽ	H°H°	2	-(F°H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE	TATE
1		TEMPERATURE	_	T 298.15	•-	FREE ENERGY	HEAT A H ^o	FREE ENERGY A F		
(H [°] _{296.15} H [°] ₆) = 1,485	CAL./GFW.	٩K	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	FCAL./GFW.	f CAL./GFW.		L06 ° К
		298	5.08	0	40.24	40-24	72000	63667	1	46.671
A.P.	×	300	5.09	5	40.28	40.25	71998	63613	1	46.345
		400	5.47	535	41.79	40.46	71855	60839	1	33.243
ΔHm	CAL. / GFW.	500	6 • 0 5	1110	43.07	40.85	71710	58110	1	25.401
		600	6.66	1747	44.22	41.31	69897	55719	1	20.297
		700	7.18	2440	45 . 29	41.81	69860	53361	1	16.661
B.P.	×	800	7.57	3179	46.28	42.31	69869	50997	1	13.932
		006	7.80	3948	47.18	42.80	69908	48641	1	11.812
ΔH ,	CAL. /GFW.	1000	16•1	4735	48.01	43.28	69965	46275	1	10.114
		1100	7.92	5527	48.77	43.75	70027	43902	1	8.723
		1200	7.86	6316	49•40	44.20	70086	41514	1	7.561
S.P.	×	1300	7.75	7097	50.08	44.63	70137	39132	I	6.579
:		1400	7.62	7866	50.65	45°04	70176	36744	I	5.736
∆ H.s	CAL. /GFW.	1500	7.48	8621	51.17	45.43	70201	34366	I	5.007
		1600	7.34	9363	51.65	45.80	70213	31973	I	4.367
		1700	7.21	10090	52.09	46.16	70210	29580	ı	3.802
T.P.	*	1800	1.09	10805	52.50	46.50	70195	27193	I	3.301
		1900	6.97	11508	52.88	46.83	70168	24796	I	2.852
ΔH	CAL. / GFW.	2000	6.87	12200	53 • 23	47.13	70130	22430	I	2.450
		2100	6.78	12882	53.57	47.44	70082	20018	1	2.083
		2200	69.69	13555	53 . 88	47.72	70025	17643	1	1.752
T.P.	Υ.	2300	6.62	14221	54.18	48.00	69961	15267	1	1.450
		2400	6.55	14879	54.46	48.27	69889	12889	I	1.173
₽ ₩	CAL. / GFW.	2500	6 • 49	15532	54.72	48.51	69812	10537	I	.921
		2600	6.44	16178	54.98	48.76	69728	8134	I	•683
		2700	6.39	16820	55.22	4 9 •00	69640	5785	ı	•468
T _c =	*	2800	6.34	17456	55.45	49 . 22	69546	3410	ł	•266
		2900	6.30	18089	55.67	49.44	69449	1328	1	•100
ر = ۲	ATM.	3000	6.27	18717	55 • 89	49•66	0	C		0

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In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

TITA	TITANIUM T1	÷		01	Solid I f	rom 298°	Solid I from 298° to 1155°, Solid II from	Solid II	[from	
REFE	REFERENCE STATE	ы		-	1155° to	1950°, L1	1155° to 1950°, Liquid from 1950° to 3000°	1950° to	, 3000°.	
	47. 9N			,				FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
¥9	S •• F	GRAMS	F	ۍ .	H°H° T 296.15	s,⊢	FAFE FUEROV	HEAT A H ^o	FREE ENERGY \triangle F	
(H ^o _{296.15} H ^o) =	₅ H ⁰ = 1,150	CAL./GFW.		HEAT CAPACITY CAL. /DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./GPW.	LOG K 10 K
			298	5.98	0	7.33	7.33			
¥.P.	1,950	×	300	5.98	11	7.37	7.34			
	(002 2)		400	6.36	629	9.15	7.58			
ΩH		CAL /GFW.	200	6.62	1280	10.60	8.04			
			000	10	1950	11.82	8.57			
9	3,550	ж о	800	7.18	3355	13.84	9.65			
		:	006	7.33	4080	14.70	10.17			
∆H v	102,500	CAL. /GFW.	1000	7.47	4820	15.48	10.66			
			1100	7.60	5575	16.19	11.13			
			1200	7.72	7290	17.68	11.61			
2 		×	1300	7.84	8070	18.30	12.10			
			1400	7.95	8860	18.89	12.57			
Δ Hs		CAL. /GFW.	1500	8.06	0996	19.44	13.00			
			1600	8.16	10470	19,96	13.42			
				0.00	06711	04 0 0 0 0 0	20001			
ų. I	CCT (T	*	1900	8.46	12970	21.39	14.57			
Δ н,	950	CAL. /GFW.	2000	8.00	17500	23.71	14.96			
			2100	8.00	18300	24.10	15.39			
			2200	8•00	19100	24.47	15.79			
Ţ.		*	2300	8.00	19900	24.83	16.18			
			2400	8.00	20700	25.17	16.55			
Ъң		CAL. /GFW.	2500	8.00	21500	25.50	16.90			
-			2600	8.00	22300	25.81	17.24			
			2700	8.00	23100	26.11	17.56			
"		×	2800	8•00	23900	26.40	17.87			
• 			2900	8.00	24700	26.68	18.17			
- -		ATM.	3000	8.00	25500	26.96	18.46			
			_							

TITANIUM

ADVANCES IN CHEMISTRY SERIES

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In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

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TITANIUM	WD	됩		Refe	rence Sta	tte for Ca	Reference State for Calculating $\Delta H_{\rho,\nu}^{\circ}$		∆r°, and		
IDEAL	IDEAL MONATOMIC GAS	C GAS		Log	OKpt Sol	lid I from	Log ₁₀ Kp: Solid I from 298° to 1155°	1155°, S	Solid II		
				from	1155° to	1155° to 1950°, L	Liquid from 1950° to 3000°	m 1950° (to 3000°.		
č	47.90	20110	Þ	و	0 - F0	ę	-(51,292,294,	FORMATI	FORMATION FROM REFERENCE STATE	NCE STAT	
24			TEMPEDATINE		T 296.15	, -	T FREE ENERGY	HEAT A H	FREE ENERCY A F		
(H [°] _{216.15} H [°]) =		1,802 CAL/GFW.	Хe	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	Š	× °
			298	5.84	0	43.07	43.07	112600	101944		74.730
		×	300	5•83	11	43.10		112600	101881		74.226
		:	400	5.52		44 • 74		112548	98312	1	53.719
∆ H _m		CAL. /GFW.	500	5.34		45° 95	43.72	112439		1	41.424
			000	5.24		46.91	44.17	112298		i n	33 . 238
				5.12 1.2	2012	4/•/1	44.62	112128	87754		27.400
8.P.		¥				00.04		976111	94280		23.020
ΔH.		CAL. /GFW.	1000			49.54	45.84	111484	77424		16.922
			1100	5.11		50.03	46.20	111239	74015	ה ו	4.706
			1200	5.13		50.47		110036	70688	-	2.875
S.P.		×	1300	5.18	5241	50.98		109771	67417		11.334
			1400	5.24		51.27		109502	64170	ה י	0.018
∆ H₅		CAL. /GFW.	1500	5.31	6289	51.63	47.44	109229	60944	1	8.880
			1600		6825	51.98	47.72	108955	57723	1	7.884
			1700			52.31	47.98	108680	54535	•	7.011
J. L		*	1900	5.74	7926 8494	52•63 52•63	48•23 48-46	108396	51354		5.234
Δ Н,		CAL. / GFW.	2000			53.23	48.70	104174	45134		160.4
			2100			53 • 52	48.92	103966	42184	1	4.390
			2200	6.13		53.80	49.14	103773	39247	1	3 . 898
T.P.		×	2300	0.27		54.08	49°35	103593	36318	t	3.450
			2400	6 •41	11527	54.35	49 • 55	103427	33395	1	3.040
₽H		CAL. /GFW.	2500	6.55	12175	54.61	40.74	103275	30500	1	2.666
			2600	6.70	12837	54.87	40°04	103137	27581	1	2.318
			2700	6.84	13514	55.13	50.13	103014	24660	1	1.995
T. =		ж.	2800	6 • 9	14206	55 • 38	50.31	102906	21762	1	1.698
•			2900	7.13	14912	55.63	50.49	102812	18857	1	1.421
۳		ATM.	3000	7•28	15633	55.87	50.66	102733	16003	1	1.165

TITANIUM

TUNGSTEN	м			So	lid from	Solid from 298° to 3000°.	• • • • • •		
REFERENCE STATE	E								
6fw 183.86	GRAMS	-	υ	H° H°	8	- (1- 10 2011)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
(H [°] _{2m.15} H [°]) = 1,216	CAL./GFW.	TEMPENATURE •K	CAL A	T 294.15 HEAT CONTENT CAL./ GFW.	T ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL./DEQ./ GFW.	HEAT A H ^C cal./gfw.	FREE ENERGY & F	ж 907
		208	5.02	C	8-04	8.04			
M.P. 3.650	×	300	5.92	10	8.08	8.05			
		400	6.00	606	9.79	8.28			
△ H _m (8,420)	CAL. /GFW.	500	6.09	1211	11.14	8.72			
		000	6.17	1824	12.25	9•21 0•73			
B.P. 5.800	×	800	6•34	3075	14.05	10.21			
		006	6.42	3710	14.80	10.68			
∆H, 191,000	CAL. /GFW.	1000	6.50	4360	15.48	11.12			
		1100	6.58	5010	16.11	11.56			
		1200	6.67	5680	16.68	11.95			
S.P.	×	1300	6.75	6350	17.22	12.34			
:		1400	6.83	7030	17.72	12.70			
∆ H.ª	CAL. /GFW.	1500	6.91	7710	18.20	13.06			
		1600	7.00	8410	18.65	13.40			
		1700	7.08	9110	19.07	13.72			
T.P.	*	1800	7.16	9820	19.48	14.03			
A H	CAL /GFW	1900	7.33	11270	19.87	14.33			
		2100	7.41	12010	20.60	14.89			
		2200	7.49	12760	20.95	15.15			
T.P.	¥	2300	7.58	13510	21.29	15.42			
		2400	7.66	14270	21.61	15.67			
ΔH	CAL. / GFW.	2500	7.74	15040	21.92	15.91			
		2600	7.82	15820	22.23	16.15			
		2700	16•1	16600	22.53	16.39			
T _c =	×	2800	7.99	17400	22.81	16.60			
1		2900	8.07	18200	23.10	10.83			
ے = 1	ATA	3000	8.15	19010	23.37	17•04			

TUNGSTEN

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

TUNGSTEN	3		<u></u>	eference	State for	Reference State for Calculating $\Delta H_{f}^{\circ}, \ \Delta F_{f}^{\circ},$	tıng ∆H°,	∆r°,	
IDEAL MONATOMIC GAS	IC GAS		B	and Log ₁₀ Kp:		Solid from 298° to 3000°	° to 300	۰.	
6fw 183_86	GRAMS	+	ۍ	н <mark>о</mark> — Но	°2	-(1-40 20815)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
(H [°] _{210.15} H [°] ₀) = 1,486	CAL/GFW.	TEMPERATURE	HEAT O	T 296.15 HEAT CONTENT CAL./ GFW.	T ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ OFW.	HEAT A H	FREE ENERGY & F	, 2001 ГОС
•									
d M	×.	298	5 • 09	0 (41.55	41.55	200000	190009	-139.286
	2	400 400	5•10	9 538	41•58 43•10	41•76 41•76	199932	189949	-138•389 -101•966
∆ Hm	CAL. / GFW.	500	6.30	1128	44°4]	42.16	199917	183282	- 80.118
		600	7.25	1804	45.64	42.64	199980	179946	- 65.550
B.P.	×	700 800	8•22 9•03	2578 3442	46.83 47.99	43.16 43.69	200133200367	176599	- 55.141
ДН.	CAL /GFW.	006	9.58	4375	49.08	44.23	200665	169813	
		1000	0.80	5349	50.11	44.77	200989	160359	- 30.361
		1200	06.6	4000	51.01	45.81	201644	159368	
S.P.	¥	1300	9.57	8292	52.69	46.32	201942	155831	- 26.199
H <	CAL /CEW	1400	9.30	9236	53 . 39	46.80	202206	152268	- 23.772
F		1500	9•01	10151	54.02	47.26	202441	148711	~ .
		1600	8.72	11038	54.59	47.70	202628	145124	- 19.822
T.P.	¥	1700	8.45	11896	55•11 55•59	48.12	202786	141518	- 18.193 - 16.743
		1900	1.99	13538	56.02	48.91	202998	134313	- 15.448
с. н.	CAL. /GFW.	2000	7.80	14327	56.43	49.27	203057	130677	- 14.279
		2100	7.63	15099	56.81	49.62	203089	127048	- 13.221
a +	2	2200	7.50	15855	57.16	4 0• 00	203095	123433	- 12.261
	4	2300	7.38	16598	57.49	50.28	203088	119828	- 11.386
ΔH	CAL. /GFW.	2400	1.29	10050	08.14	50.58	203062	116206	- 10.581
		2600	7.18	18778	58.38	51.16	810002	10896801	
		2700	7.15	19494	58.65	51.43	202894	105370	- 8.528
T _c =	×	2800	7.13	20208	58.91	51.70	202808	-	- 7.939
" "	ATM.	2900	7.14	20921	59.16	51.95	202721		- 7.396
	_	3000	CI •/	21030	04.66	61•24	20202	94230	- 0.880

THERMODYNAMIC PROPERTIES OF THE ELEMENTS

TUNGSTEN

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In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

URANIUM	U MU:			Solid I	from 298	to 941	Solid II	from 94	Solid I from 298° to 941°, Solid II from 941° to 1047°,	۰°,
REFER	REFERENCE STATE			Solid II	II from 10	047° to 14	III from 1047° to 1406°, Liquid from 1406°	iid from	1406° to 3	to 3000°.
49	238.07	GRAMS	4	ზ -	H ⁰ - H ⁰ T 24415	°,	-(1	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
(H ⁰ _{216.15} H ⁰) =	H [*])= 1,559	CAL./GFW.	TEMPERATURE •K	HEAT	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FREE ENERGY FUNCTION CAL.,/DEG./ GFW.	HEAT A H	CAL./ GPW.	י ג 100 יי
1	307 -		208 200	\$9°54	10	13.03	13-03			
			400	7.08	200	14.04	12.29			
7	3,700	CAL / GFW.	200	7.61 8.25	1430	17.12	12.81			
			2002	8.97	3080	18.44	14.04			
đ.	4,200	¥	800	9.88	4020	19•70	14.68			
ΔH ,	101.000 CAL /GFW.	CAL. /GFW.	1000	11.12	5070 6810	20.93	15.96			
			1100	9•15	8860	24.72	16.67			
			1200	9.15	9770	25.52	17.38			
S.P.		*	1300	9.15	10690	26.25	18.03			
:			1400	9.15	11600	26.93	18.65			
° ∎ ⊲		CAL /GFW.	1500	9.15	1515	30.17	19.36			
		ſ	1700	9.15	18045	31.33	20.72			
T.P.	941	*	1800	9.15	18960	31.86	21.33			
1			1900	9.15	19875	32.35	21.89			
6 107	9 / 4	CAL. / GFW.	2000	9.15	20790	32.82	22.43			
			2100	9.15	21/02	33.69	22.94			
Ţ.P.	1.047	*	2300	9.15	23535	34.10	23.87			
			2400	9.15	24450	34.49	24.31			
₽₩	1,083	CAL. /GFW.	2500	9.15	25365	34.86	24.72			
			2600	9.15	26280	35.22	25.12			
			2700	9.15	27195	35.57	25.50			
1 ° =		*	2800	9.15	28110	35.90	25.87			
			2900	9.15	29025	36.22	26.22			
" "		AIR	3000	9•15	29940	36•53	26•55			

URANIUM

In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

URANTUM		Referen	ce State	for Calcu	lating AH	e, ∆Pe, 8	Reference State for Calculating AH, AP, and Log, Kp:	1 d
		Solid I	from 298'	• to 941°	, Solid I	I from 94	Solid I from 298° to 941°, Solid II from 941° to 1047°	7°,
TUKAL MONATOMIC GAS	AS [Solid I	II from 1(047° to 1	406°, Liqu	ild from	III from 1047° to 1406°, Liquid from 1406° to 3000°.	3000°.
Giv 238 07 GRAMS	#ST	ຽ	н. - н.	e.	-(F°-H° 229.15)	FORMATI	FORMATION FROM REFERENCE STATE	NCE STATE
	TEMPE		T 299.15	,	FREE ENERGY	HEAT A H ^e	FREE ENERCY & F	
(H ² 20.15 H ²) = 1,553 CAL	CAL_/GFW. •K	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.		CAL./ GPW.	Сос Тос Сос
	298		0	47.73	47.73	117160	106515	
M.P.	300		10	47.76	47.73	117158	106451	- 77.555
			582	49•40	47.95	117042	102898	- 56.225
∆Hm CAL	CAL./GFW. 500	5.66	1151	50.67	48.37	116881	99381	- 43.442
	- 000 		1714	51.70	48.85	116654	92606	- 34.936
	700		2270	52.56	49.32	116350	92466	- 28.871
B.P.	800	5.53	2823	53.30	49.78	115963	89083	- 24.338
			3378	53.95	50.20	115468	85750	- 20.824
∆H v CAL	CAL./GFW. 1000	5.65	3939	54.54	50.61	114289	82519	- 18.036
	1100		4509	55 • 08	50°05	112809	79413	- 15.779
	1200		5090	55 • 59	51.35	112480	96692	- 13.914
S.P. •K	1300	5.99	5683	56.06	51.69	112153	73400	- 12.340
	1400	6.11	6288	56.51	52.02	111848	70436	- 10.996
	LAL / GFW. 1500		6069	56.94	52.34	107850	67695	- 9.863
	1600		7533	57.34	52.64	107563	65067	- 8.887
	1700		8170	57.73	52.93	107285	62405	- 8.022
T.P. %K	1800		8816	58.10	53.21	107016	59784	- 7.258
	1900		69469	58.45	53.47	106754	57164	- 6.575
∆H, CAL	CAL./GFW. 2000	6.61	10127	58.79	53.73	106497	54557	- 5.961
	2100		10790	59.11	53.98	106245	51981	- 5.409
	2200	6.67	11455	59.42	54.22	105995	49389	- 4.906
	2300		12123	59.72	54.45	105748	46822	- 4.449
	2400	•	12792	60.00	54.67	105502	44278	- 4.031
	LAL./ WFW. 2500	•	13461	60 • 28	54.90	105256	41706	- 3.645
	2600		14130	60.53	55.10	105010	39204	- 3.295
	2700		14798	60.79	55.31	104763	36669	- 2.967
T _c = %	2800		15465	61.03	55.51	104515	34151	- 2.665
1			16130	61.27	55.71	104265	31.620	- 2.382
rc = ATM.	3000	6.63	16794	61.49	55.90	104014	29134	- 2.122

TT

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In THERMODYNAMIC PROPERTIES OF THE ELEMENTS; Advances in Chemistry; American Chemical Society: Washington, DC, 1956.

VANADIUM	٧		Sol1d	from 298°	to 2190°	, Liquid	from 2190	Solid from 298° to 2190°, Liquid from 2190° to 3000°.	•
REFERENCE STATE	TE								
_{cfw} 50.95	GRAMS	-	2	9H - 9H	2	-(F°-H° 202.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
				T 296.15	• -	FREE ENERGY	HEAT A H ^o	FREE EVERCY & F	
(H [°] , ¹¹ , ¹¹ , ¹¹) = ¹ , ¹¹ , ¹¹ , ¹¹	1,122 CAL/GFW.	X.	HEAT CAPACITY CAL./DEG./ GPW.	HEAT CONTENT CAL./ GPW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./OFW.	CAL./ GPW.	L06 7 5 7
		298	5.91	0	7-01	7-01			
2,190	2	300	5.92	11	7.05	7.02			
	4	400	6.23	620	8.78	7.23			
△ H _m (4,200)	CAL. /GFW.	500	6.43	1254	10.19	7.69			
		600	6.58	1910	11.38	8.20			
		700	6.70	2570	12.41	8.74			
B.P. 3,650	×	800	6.85	3250	13•31	9•25			
		006	7.05	3940	14.13	9.76			
<u>дн.</u> 109,600	CAL /GFW.	1000	7.30	4660	14.89	10.23			
		1100	7.55	5400	15.59	10.69			
		1200	7.83	6170	16.26	11.12			
ay		1300	8.12	6970	16.90	11.54			
		1400	8.43	7800	17.52	11.95			
ΔHs	CAL. /GFW.	1500	8.74	8650	18.11	12.35			
		1600	600	9550	18•68	12.72			
		1700	9.35	10470	19•24	13.09			
1.P.	*	1800	9.67	11430	19.79	13.44			
	:	1900	10.01	12410	20.32	13.79			
∆ H,	CAL. /GFW.	2000	10.25	13410	20.84	14.14			
		2100	10.50	14450	21.34	14.46			
	-	2200	0 9•50	19700	23.75	14.80			
T.P.	Å	2300	9•50	20650	24.17	15.20			
		2400	9.50	21600	24.57	15.57			
ΔĦ	CAL. /GFW.	2500	9.50	22550	24.96	15.94			
		2600	9•50	23500	25•33	16.30			
		2700	9•50	24450	25.69	16.64			
T.=	×	2800	6 •50	25400	26.04	16.97			
,	:	2900	05.6	26350	26.37	17.29			
Pc =	ATM.	3000	9•50	27300	26.69	17.59			

VANADIUM

VANADIUM	٨		Referen	ice State	for Calc	ulating ∆	f, AP,	Reference State for Calculating Af ^e , Af ^e , and Log ₁₀ Kp:	t dy	
IDEAL MONATOMIC GAS	C GAS		Solid f	Solid from 298°		Liquid 1	rom 2190	to 2190°, Liquid from 2190° to 3000°		
20 - 95 20 - 95		•	8	9	ą	-(5, -1, 5, 5, 1, 5)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE	
	GRAMS			H H 298.15	°-	FREE ENERGY	HEAT △ H [®]	FREE ENERGY & F		
$(H^{0}_{296,15} - H^{0}_{9}) = 1,890$	CAL./GFW.	X,	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	f CAL./GFW.	CAL./ GFW.	LOG K	
		298	6.22	0	43.55	43°25	122750	111856	- 81.996	
	×	300	6.21	12	43 • 58	43•54	122751	111792	- 81.447	
	:	400	5.89	615	45.32	43.79	122745	108129	- 59.083	
Δ H _m	CAL. / GFW.	500	5.78	1197	46.62	44.23	122693	104478		
		000	08.4	1775	47.58	44.73	122615	100835		
			0 0 0 0 0	2051	40.20	12004	122254	022/6	- 30.335	
B.P.	×			3548	50.07	46.13	122358	11000		
ZH.	CAL /GFW.	1000	6.03	4150	50.70	46.55	122240	86430		
		1100	6.04	4754	51.28	46.96	122104	82845	- 16.461	
		1200	6.03	5357	51.80	47.34	121937	79289	- 14,441	
2P	×	1300	6 • 00	5959	52 . 28	47.70	121739	75745	- 12.735	
		1400	5.97	6558	52.73	48.05	121508	72214	- 11.274	
Δ H _s	CAL. /GFW.	1500	5.94	7154	53.14	48.38	121254	68709	- 10.011	
		1600	5.91	7746	53.52	48.68	120946	65202	- 8.905	
		1700	5.89	8336	53 • 88	48.98	120616	61728	- 7.935	
T.P.	¥	1800	5.87	8924	54.22	49.27	120244	58270	- 7.074	
		1900	5•85	9510	54.53	49.53	119850	54851	- 6.308	
ΔH	CAL. /GFW.	2000	5.85	10095	54.83	49.79	119435	51455	- 5.622	
		2100	5 . 85	10679	55.12	50.04	118979	48041	- 4•999	
		2200	5.86	11264	55 •3 9	50.27	114314	44706	- 4.441	
T.P.	×	2300	5.88	11851	55.65	50.50	113951	41547	- 3.947	
		2400	5.90	12440	55.90	50.72	113590		- 3.496	
ΔH,	CAL. / GFW.	2500	5.94	13032	56.14	50.93	113232		- 3.084	
		2600	5 • 98	13628	56.38	51.14	112878	32148	- 2.702	
		2700	6 • 0 4	14229	56.60	51.33	112529	29072	- 2.353	
T. =	×	2800	6.10	14836	56.82	51.53	112186	26002	- 2.029	
و '	:	2900	6.17	15449	57.04	51.72	111849	22906	- 1.726	
Pc =	ATM.	3000	6.24	16070	57.25	51.90	111520	19840	- 1.445	
										1

XENON	I Xe	e e		Ĭ	leal Mona	tomic Gas	Ideal Monatomic Gas from 298° to 3000°.	to 3000		
REFER	REFERENCE STATE	ല								
*19 0	131.30	GRAMS	-	ະ	H° H°	\$	-(F°-H° 228.15)	FORMAT	FORMATION FROM REFERENCE STATE	ICE STATE
	00.101		TEMPERATURE		T 294.15	T T	FREE ENERGY	HEAT A H	FREE ENERGY & F	
(H [°] _{298.15} H [°] ₆) =	H\$)= 1,481	CAL./GFW.	×	CAL./DEG./ GPW.	HEAT CONTENT CAL./ GFW.	CAL./DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	LOG K
			298	4.97	C	40.53	40.53			*
A.P.	161.3	¥	300	4.97	0	40.56	40.53			
:		110, 110	400	4.97	506	41.99	40.73			
р П ш	549.	LAL. / GFW.	500	4.97	1003	43.10	41.10			
			600	4.97	1500	44.00	41.50			
			700	4.97	1996	44.77	41.92			
8.P.	165.04	÷	800	4.97	2493	45.43	42.32			
Ţ	- COO - F		006	4.97	2990	46.02	42.70			
	• 120,0		1000	4.97	3487	40.54	43°00			
			1100	4.97	3984	47.02	43.40			
1			1200	4.97	4480	47.45	43.72			
S.P.		¥	1300	4.97	4977	47.85	44•03			
		140, 170	1400	4.97	5474	48.21	44.30			
5 1		CAL. / GFW.	1500	4.97	1165	48 • 56	44.58			
			1600	4.97	6468	48 • 88				
			1700	4.97	6964	49.18	45.09			
T.P.		×	1800	4.97	7461	97 • 67				
			1900	4.97	7958	-	45.55			
1 17		LAL. / GFW.	2000	4.97	8455	-	45.77			
			2100	4.97	8952	-	45.97			
			2200	4.97	9448	50.46	46.17			
Т.Р.		*	2300	4.97	6945	-	46.36			
			2400	4.97	10442					
ΔH,		CAL. /GFW.	2500	4.97	10939					
			2600	4.97	11436	51.29	46.90			
		-	2700	4.97	11932	-	47.07			
Tc =	256.57	×	2800	4.97	12429		47.23			
			2900	4.97	12926		-			
" "	58.0	ATA	3000	4.97	13423	52.00	47.53			

XENON

YTTERBIUM	ę,	So]	lid I fro	m 298° to	1071°, S	olid II f	,1701 mor	Solid I from 298° to 1071°, Solid II from 1071° to 1097°, Liquid	, Liquid
REFERENCE STATE	STATE	fro	m 1097°	to 1800°,	Ideal Mo	natomic G	as from	from 1097° to 1800°, Ideal Monatomic Gas from 1800° to 3000°.	. 000
6tw 173.04 (H ^o 298.15 ⁻ H ^o) =	04 GRAMS CAL-/GFW.	T TEMPERATURE %	C ⁰ F HEAT CAPACITY CAL/DEG/ GFW.	H ⁰ - H ⁰ T 2015 HEAT CONTENT CALL/ GFW.	S ⁰ ENTROPY CAL./DEG./ GFW.	-(F ⁰ -H ⁰ 298.15) FREE ENERGY FUNCTION CAL./DEG./ GFW.	FORMAT HEAT A H ⁶ cal./gfw.	Definition FROM REFERENCE STATE △ H ^o FREE ENERGY △ F ^o CFN, CAL. ¹ GFN, f COL. ¹ GFN, f	ICE STATE LOG K
м.Р. 1,097 ∆н _м (2,200)	97 °K 00) cal./gfw		000 000 000 000 000 000 000 000 000 00	620 11 620 1250	15.00 15.00 16.79 18.19	15.00 15.00 15.69			
B.P. 1,800	*		7.00 000 000	3260	20.41	10°26			
_{дн} 37,100	00 CAL. /GFW.		7.50	7950	22 94 25 94	18-24 18-72		New Astern	
\$Р. Δ Н ₅	°K Cal. /GFW	·	7 • 50	9/00 9450 10200 10950	27.19 27.19 28.27	19.54 19.93 20.47 20.97 21.44			
т.е. 1,071 ∆н, (300	, 071 °K (300) call/gew	, , , , , , , , , , , , , , , , , , , ,		12450 13200 50860 51360	29.20 29.20 50.55 50.81	21.88 22.31 23.79 25.13			
Т.Р. Аң,	*K Call./GFW		4 4 7 7 7 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9	52850 53350 53350	51.28 51.50 51.72	20 20 20 20 20 20 20 20 20 20 20 20 20 2			
τα α = =	AT. CK	2200 30000 30000	5.00 5.00 5.00 5.12 5.12 5.16	54350 54860 55360 55870 56390	52.12 52.49 52.49 52.67 52.85	31.22 32.00 32.72 34.61 34.61			

Publication Date: January 1, 1956 | doi: 10.1021/ba-1956-0018.ch004

YTTERBIUM

	0I						•			,
IDEAL MONATOMIC GAS	GAS	Solid from	lid I fro m 1097°	Solid I from 298° to 1071°, Solid II from 1097° to 1800°, Ideal Monatomic	JO71', S Ideal M		from 1071 3as from	from 1071' to 1097', Liquid Gas from 1800° to 3000°.	[097°, L1qu to 3000°.	1d
6tw 173.04 0	GRAMS	-	υ	H° - H°	°2	-(F°-H° 288.15)	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE	
		TEMPERATURE	P	T 296.15	L.	FREE ENERGY	HEAT A H ^o	FREE ENERCY & F		
(H [°] _{211.15} H [°] ₂) = 1,481 (CAL./GFW.	*	CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL./DEG./GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	° LOC	× •
		298	4.97	0	41.35	41.35	42900		- 25.6	980
	×	300	4.97	6	41.38	41.35	42698			90
		400	4.97	506	42.81	41.55	42786	32378	÷ 17•691	169
∆ Hm 0	CAL. /GFW.	500	4.97	1003	43.92	41.92	42653	29788	- 13.021	21
		600	4.97	1500	44.83	42.33	42500	27230	5°6	9 • 919
		700	4.97	1900 I	45.59	42.74	42326	24700		7.712
B.P.	*	800	4.97	2493	46.26	43.15	42133	22189	- 6.062	62
		006	4.97	2990	46.84	43.52	41920	19717	1 4 1	4.788
∆H, C	CAL. /GFW.	1000	4.97	3487	47.36	43.88	41687	17267	- 3.774	74
		1100	4.97	3984	47.84	44.22	38934	74841	- 2.949	676
		1200	4.97	4480	48 • 27	44.54	38680	12664	- 2,306	006
s.P.	*	1300	4.97	4977	48.67	44 . 85	38427	10503	- 1.7	•765
		1400	4.97	5474	40°67	45.13	38174	8368	- -	•306
∆ H _s C	CAL. /GFW.	1500	4.97	5971	49.38	45.40	37921	6256	•	.011
		1600	4.97	6468	49.70	45.66	37668	4148	•	566
	ſ	1700	4.97	6965	50.00	45.91	37415	2055		•264
T.P.		1800	4.97	7461	50.28	46.14	37161	6	•	•001
		1900	4.97	1958	50.55	46.37	0	0	0	
∆H, 0	CAL. /GFW.	2000	4.97	8456	50.81	46.59	0	0	0	
		2100	4.98	8953	51.05	46.79	0	0	0	
		2200	4.98	9451	51.28	46.99	0	0	0	
T.P. •	*	2300	4.99	9950	51.50	47.18	0	0	0	
		2400	5.00	10449	51.72	47.37	0	0	0	
Δ Η, 0	CAL. /GFW.	2500	5.01	10950	51.92	47.54	0	0	0	
		2600	5.03	11452	52.12	47.72	0	0	0	
		2700	5.05	11956	52.31	47.89	0	0	0	
T _c = •	ж —	2800	5 • 08	12463	52.49	48.04	0	0	0	
		2900	5.12	12973	52.67	48.20	0	0	0	
Pc = /	ATM.	3000	5.16	13486	52 • 85	48•36	0	0	0	

YTT'R IUM	А		Solid	from 298	• to 1773	°, Liquid	from 177	Solid from 298° to 1773°, Liquid from 1773° to 3000°.	•
REFERENCE STATE	LTE								
64w 88 • 92	GRAMS	+	υ	н° – н° Н	e,	-(11-21111)-	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE
(H [°] _{2M · 15} H [°]) =	CAL/GFW.	temperature ^o K	P HEAT CAPACITY CAL./DEG./ GFW.	T 294.15 HEAT CONTENT CAL./ GFW.	T ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H ^C cal./GFW.	FREE ENERGY A F	רס6 א רס6 א
		298	6.01	0	11-00	11-00			
(1,773)		300	6.01	11	11.04	11.01			
M.P.	4	400	6.11	617	12.78	11.24			
(4°100)	CAL /GFW.	500	6.21	1233	14.15				
		000	6.31	1859	15.29	12.20			
				6642	12.01				
	*			1416	41.14	13.22			
(34,000)		1000	6.72	4465	18.61				
Δ Η •	CAL. /GFW.	1100	6.82	5142	19.26	14.59			
		1200	6.92	5829	19.86	15.01			
		1300	7.03	6527	20.41	15.39			
. P.	×	1400	7.13	7235	20.94	15.78			
- H <	CAL. /GFW.	1500	7.23	7953	21.43	16.13			
f :: 1		1600	7.33	8681	21.90	16.48			
		1700	7.43	9419	22.35	16.81			
		1800	8•00	14280	25.10	17.17			
	4	1900	8•00	15080	25.53	17.60			
ΔH,	CAL. / GFW.	2000	8•00 900	15880	25•94 26•33	18.00			
		2200	8.00	17480	26.70	18.76			
4	2	2300	8•00	18280	27.06	19.12			
<u>.</u>	4	2400	8 • 00	19080	27.40	19.45			
3	CAL /GEW.	2500	8•00	19880	27.72	19.77			
F	- 5	2600	8•00	20680	28.04	20.09			
		2700	8•00	21480	28.34	20.39			
Tc =	*	2800 2900	88000	22280 23080	28.63 28.91	20•68 20•96			
	ATM	3 0 0 0	8 • 00	23880	29.18	21.22			
U									

l956-0018.ch004
10.1021/ba-
.956 doi:
: January 1, 1
Publication Date

YTTRIUM	λ		Refere	ence State	e for Cal	culating /	M ^e , Δ ^e ,	Reference State for Calculating AH, AP, and Log ₁₀ Kp:	,Kp :
IDEAL MONATOMIC GAS	C GAS		Solld	from 298		to 1773°, Liquid	from 177	from 1773° to 3000°	•••
_{6fw} 88.92	GRAMS	-	ະ	H° H°	°2	-(1-42 -11-0-11-	FORMAT	FORMATION FROM REFERENCE STATE	NCE STATE
(H [°] _{211.15} H [°] ₂) = 1,639	-	TEMPERATURE %K	CAL D	T 294.15 HEAT CONTENT CAL./ GFW.	T ENTROPY CAL./DEG./GFW.	FREE ENERGY FUNCTION CAL./DEG./ GFW.	HEAT A H ^e cal/gfw.	FREE ENERGY A F	го6 К
		208	ALIA	C	47.87	79.64	102000	20400	
2	20	300	6.18). 11	42.91	42.88	102000	92439	- 67.347
	e	400	6.04	625	44.67	43.11	102008	89252	- 48.769
∆ H _m	CAL. /GFW.	500	5 . 83	1218	46.00	43.57	101985	86060	- 37.619
		000	5.64	1791	47.04	44°06	101932	82882	- 30.192
		00/	0.49	2347	47.90	44°55	101852	11227	
B.P.	¥		0 0 0 0 0	1697	40°04	20°C4	04/101	86401	
H<	CAL /GFW	1000	5.25	3953	18.04	45.86	101488	70288	- 15.362
A		1100	5.20	4476	50.31	46.25	101334	67179	- 13.348
		1200	5.17	4004	50.76	46.60	101165	64085	- 11.672
S.P.	*	1300	5.14	5510	51.17	46.94	100083	60095	- 10.255
		1400	5.13	6023	51.56	47.26	100788	57920	- 9.042
∆ H₅	CAL. /GFW.	1500	5.12	6535	51.91	47.56	100582	54862	- 7,993
		1700	5.13	7559	52.55	47.84	100140	51822	- 7.078 - 6.273
a +	*	1800	5.15	8074	52.84	48.36	95794	45862	- 5.568
•	4	1900	5.19	8590	53.12	48.60	95510	43089	- 4.956
ΔH	CAL. /GFW.	2000	5.24	1116	53.39	48.84	95231	40331	- 4.406
		2100	5.30	9638	53.65	49.07	94958	37586	- 3.911
		0022	55.0	7/101	06.54	49.28	20440	34852	- 3.462
	*	0062	5 4 1 7 4 1	10714	54.14	67°07	94434	32150	- 3.054
∆H,	CAL. /GFW.	2500	5.71	11831	54.60	49.87	19966	26751	- 2.338
		2600	5.86	12410	54.83	50.06	93730	24076	- 2.023
		2700	6.02	13004	55.05	50.24	93524	21407	- 1.732
Tc =	¥	2800	6.20	13614	55.27	50.41	93334	18742	- 1.462
		2900	6°33	14243	55.50	50.59	03163	16052	- 1.209
Pc =	ATM.	3000	6•59	14892	55•72	50.76	93012	13392	- •975

YTTRIUM

EFFRENCE STATE IIB1 [•] , Ideal Monatomic Gas from S5.38 GAMS T C m_{min} from m_{min} from m_{min} from 65.38 GAMS T C m_{min} from m_{min} from m_{min} from 65.38 GAMS The mean from m_{min} from m_{min} from m_{min} from 692.7 m 592.7 m m_{min} from m_{min} from m_{min} from m_{min} from 692.7 m 1,349 CAL/GPR m_{min} from m_{min} from m_{min} from 692.7 m 1,765 CL/GPR m_{min} from m_{min} from m_{min} from 692.7 m 1,765 CL/GPR m_{min} from m_{min} from m_{min} from 700 6.91 19.00 19.01 10.03 11.07 10.05 700 7.05 5150 19.02 11.07 10.05 10.05 700 7.05 5150 19.03 11.07 10.05 10.05 1,1810 700	ZINC	Zn			Solid fro	m 298° to	692.7°,	Liquid f	Solid from 298° to 692.7°, Liquid from 692.7° to	ţ
65.38 GRAMS T $C_{\rm e}^{\rm e}$ $W_{\rm e}^{\rm e}$ 1, 765 C.L./GFW 2300 6.07 11000 7.50 1200 11.75 11.75 11.75 11.75 11.75 11.75 11.75 11.75 11.75 11.75 11.75 11.75 11.75 11.75 11.	REFER	ENCE STATE			1181°, Id	eal Monat	omic Gas	from 118)	1° to 3000	•
Light Lunder Current Current Current Current Current Current		35.38 1.349	T TEMPERATURE		H ⁰ – H ⁰ T 2015 HEAT CONTENT	S ⁰ T ENTROPY	-(F"-H" 28115) FREE ENERGY FUNCTION	FORMAT HEAT \bigtriangleup_{i}^{0}	FORMATION FROM REFERENCE STATE	NCE STATE LOG K
692.7 % 298 6.07 0 9.99 1, 765. cut./cfw. 300 6.31 11.76 1, 765. cut./cfw. 500 6.31 1270 13.20 1, 765. cut./cfw. 500 6.31 10400 14.41 27,560. cut./cfw. 600 6.79 1940 18.03 27,560. cut./cfw. 1000 7.50 5150 1940 18.03 27,560. cut./cfw. 1000 7.50 5150 19.03 27,560. cut./cfw. 11000 7.50 5157 19.03 12100 4.97 36157 45.77 47.01 12100 4.97 36157 45.77 45.77 12100 4.97 36157 45.77 45.77 12100 4.97 36157 45.47 46.14 12100 4.97 36157 45.47 46.14 1300 4.97 36157 45.77 47.69 1700 4.97 361647 46.86	(M ^{200,15} M		4	CAL./DEG./ GFW.	CALLY GFW.	CAL. /DEG./ GFW.	CAL./DEG./ GFW.	CALL/GPV.	CAL./ GFW.	2
1,765. cut./Grw. 400 6.31 630 11.76 1,181. vx 500 6.55 1270 13.20 700 7.50 5150 14.41 700 7.50 5150 19.03 27,560. cut./Grw. 900 7.50 5150 19.03 11000 7.50 5500 20.71 1200 7.50 5500 20.71 1200 7.50 5500 21.42 1200 7.50 5560 20.71 1200 7.50 5560 20.71 1200 7.50 5560 46.14 1200 4.97 3654 46.14 1200 4.97 3654 46.14 1200 4.97 3654 47.05 1200 4.97 3654 47.16 vx 1500 4.97 38144 47.01 vx 1900 4.97 39138 47.65 vx 1900 4.97 39134 47.05 vx 1900 4.97 39144 47.01 vx 1900 4.97 39138 47.065 vx 22000 4.97 40628 48.01 <t< th=""><th>4</th><th>692.7 °K</th><th>298 300</th><th>6.07 6.07</th><th>11</th><th>9•95 9•99</th><th>9•95 9•96</th><th></th><th></th><th></th></t<>	4	692.7 °K	298 300	6.07 6.07	11	9•95 9•99	9•95 9•96			
1,181. % 600 6.79 1940 14.41 700 7.50 5500 19.03 27,560. cut./drw. 800 7.50 5150 19.03 27,560. cut./drw. 10000 7.50 5150 19.92 1200 7.50 5500 20.71 % 11000 7.50 5650 20.71 % 1200 4.97 35654 46.14 % 1300 4.97 3654 46.14 % 1400 4.97 3654 46.14 % 1300 4.97 36157 45.37 % 1300 4.97 36157 45.14 % 1500 4.97 36157 45.14 % 1500 4.97 36157 45.14 % 1500 4.97 36157 45.15 % 1500 4.97 36157 45.16 % 1500 4.97 36157 45.14 % 1500 4.97 36157 45.16 % 1500 4.97 36144 477.65 % 1900 4.97 39138 477.65 % 22000 4.97 <td< th=""><th>⊿ H</th><th></th><th>400 500</th><th>6.31 6.55</th><th>630 1270</th><th>11•76 13•20</th><th>10.19</th><th></th><th></th><th></th></td<>	⊿ H		400 500	6.31 6.55	630 1270	11•76 13•20	10.19			
1,181. * 700 7.50 4400 18.03 27,560. cut./defu. 800 7.50 5900 19.03 * 1100 7.50 5900 19.03 * 1100 7.50 5900 21.45 * 1100 7.50 5650 21.45 * 1100 7.50 5650 21.45 * 1200 4.97 35660 45.37 * 1300 4.97 35654 46.14 * 1500 4.97 36157 45.17 * 1700 4.97 36157 45.17 * 1500 4.97 36157 45.14 * 1500 4.97 36157 45.17 * 1500 4.97 36157 45.16 * 1500 4.97 36157 45.16 * 1500 4.97 36157 45.16 * 1500 4.97 36157 45.16 * 1600 4.97 36141 47.65 * 1700 4.97 39138 477.65 * 1900 4.97 39641 477.91 * 2200 4.			600	6.79	1940	14.41	11.18			
27,560. Cul. /GFW. 900 7.50 5900 19.92 27,560. Cul. /GFW. 10000 7.50 5900 19.92 21 % 11200 7.50 5560 45.37 1200 4.97 35560 45.37 1200 4.97 35561 45.47 1200 4.97 35654 45.48 1200 4.97 37150 45.61 % 1500 4.97 37150 45.48 % 1500 4.97 37150 45.48 % 1500 4.97 37150 45.48 % 1700 4.97 38144 47.010 % 1900 4.97 38641 47.05 % 1900 4.97 39138 477.65 % 1900 4.97 39138 477.65 % 22000 4.97 39138 477.65 % 22000 4.97 488.38 % 2300 4.97 491312 % 2300 4.97 41622 % 2300 4.97 499.75 % 2500 4.97 49125 % 4.97 </th <th>4</th> <th></th> <th>700 800</th> <th>7.50</th> <th>4400 5150</th> <th>18•03 19•03</th> <th>11.75</th> <th></th> <th></th> <th></th>	4		700 800	7.50	4400 5150	18•03 19•03	11.75			
-1,000 C,000 C,000 C,000 20.071 -x -x 1100 7.50 7400 21.42 -x 1300 4.97 35157 45.37 -x 1300 4.97 35157 45.37 -x 1300 4.97 35157 45.37 -x 1400 7.650 45.97 36547 -x 1500 4.97 36541 47.10 -x 1700 4.97 37150 45.47 -x 1700 4.97 37150 45.48 -x 1700 4.97 37150 45.47 -x 1700 4.97 37150 45.47 -x 1700 4.97 37150 45.47 -x 1700 4.97 37150 477.65 -x 1700 4.97 39634 477.65 -x 22000 4.97 40131 477.91 -x 22000 4.97 40628 48.15 -x 22000 4.97 40121 477.91 -x 2200 4.97 40125 48.81 -x 2200 4.97 41125 49.40 -x </th <th></th> <th></th> <th>006</th> <th>7.50</th> <th>2005</th> <th>19.92</th> <th>13.37</th> <th></th> <th></th> <th></th>			006	7.50	2005	19.92	13.37			
*x 1200 4.97 35660 45.37 *x 1300 4.97 36157 45.37 Cull / GFW. 1300 4.97 36157 45.77 1400 4.97 36157 45.77 *x 1500 4.97 36157 45.77 *x 1500 4.97 36157 45.77 *x 1500 4.97 36144 47.010 1700 4.97 38641 47.055 *x 1900 4.97 39634 47.055 *x 1900 4.97 39138 47.055 *x 22000 4.97 39634 47.055 *x 22000 4.97 39634 47.055 *x 22000 4.97 48.15 48.05 *x 22000 4.97 41052 48.05 *x 27000 4.97 411225 49.022 *x 22000 4.97 411225 49.022 *x 22000 4.97 42615 49.022 *x 22000 4.97 42615 49.022 *x 22000 4.97 42615 499.075 *x 22000 <td< th=""><th>~н⊽</th><td></td><td>1000</td><td>7.50</td><td>6650 7400</td><td>20•71 21•42</td><td>14.06</td><td></td><td></td><td></td></td<>	~ н⊽		1000	7.50	6650 7400	20•71 21•42	14.06			
•x 1300 4.97 36157 45.77 CAL./GFW. 1400 4.97 3654 46.14 I.500 4.97 3654 46.14 •x 1600 4.97 37647 46.80 •x 1700 4.97 37647 46.80 •x 1700 4.97 37647 46.80 •x 1900 4.97 38641 47.10 •x 1900 4.97 39634 47.65 •x 1900 4.97 39634 47.65 •x 22000 4.97 39634 47.65 •x 23000 4.97 39634 47.65 •x 22000 4.97 48.15 48.60 •x 22000 4.97 49131 48.95 •x 22000 4.97 41052 48.60 •x 27000 4.97 41125 49.92 •x 2700 4.97 42118 49.92 •x 2800 4.97 49.75 49.75 •x 2700 4.97 49.75 49.75 •x 2700 4.97 49.75 49.75 •x 2800 4.97			1200	4.97	35660	45.37	15.66			
CAL /GFW. 1400 4.97 36554 46.14 0x 0x 4.97 37150 46.48 0x 1500 4.97 37150 46.48 0x 11600 4.97 37150 46.48 0x 11700 4.97 38644 47.10 0x 1900 4.97 39144 47.10 0x 1900 4.97 39138 47.65 0x 2000 4.97 39138 47.65 0x 22000 4.97 48.15 48.60 0x 22000 4.97 40228 48.60 0x 23000 4.97 41125 48.60 0x 0x 4.97 4.0128 49.021 0x 0x 4.97 4.99 4.99 0x 0x 4.97 4.91 4.99 0x 0x 4.97 4.94 0x 0x 4.97 4.94 0x 4.97 4.94 4.94 <	S.P.	*	1300	4.97	36157	45.77	17.96			
	:		1400	4.97	36654	46.14	19.96			
•x 1700 4.97 38144 47.010 •x 1800 4.97 39134 47.031 •x 1900 4.97 39134 47.031 •x 1900 4.97 39534 47.055 •x 2000 4.97 39534 47.055 •x 2100 4.97 39534 47.055 •x 2200 4.97 49131 48.15 •x 2200 4.97 40131 48.38 •x 2200 4.97 40131 48.38 •x 22400 4.97 41125 48.60 •x 25500 4.97 42118 49.02 •x 2700 4.97 41122 49.92 •x 2800 4.97 42615 49.62 •x 2800 4.97 42615 49.65 •x 2800 4.97 42615 49.75 •x 2800 4.97 42615 49.75	51		0091	4.91	001/6	40•40 46.80	21.012			
•K 1800 4.97 38641 47.38 CAL./GFN 2000 4.97 39138 47.65 CAL./GFN 2000 4.97 39138 47.65 2100 4.97 39138 47.65 * 2100 4.97 39138 47.65 * 2100 4.97 40131 48.15 * 2200 4.97 40131 48.38 * 2200 4.97 41125 48.60 * 22400 4.97 41122 48.60 * 2500 4.97 41122 49.02 * 2500 4.97 42118 49.02 * 2700 4.97 411622 49.61 * 2700 4.97 42615 49.62 * 2800 4.97 41162 49.75 * 2700 4.97 44105 49.75			1700	4.97	38144	47.10	24.67			
CAL /GFW. 1900 4.97 39138 47.65 CAL /GFW. 2000 4.97 39634 47.91 2100 4.97 39634 47.91 * 2100 4.97 39634 47.91 * 2200 4.97 39634 47.91 * 2200 4.97 40628 48.93 * 2300 4.97 41125 48.68 CAL /GFW. 2500 4.97 411622 48.81 * 2500 4.97 41125 48.61 * 2500 4.97 42118 49.02 * 2500 4.97 42118 49.02 * 2700 4.97 42112 49.40 * 2700 4.97 42112 49.40 * 2700 4.97 42112 49.40 * * 2700 4.97 49.75 * * 4.97 44105 49.75	T.P.	*	1800	4.97	38641	47.38	25.92			
2100 4.97 40131 48.15 * 2200 4.97 40131 48.15 * 2200 4.97 40131 48.36 * 2300 4.97 41125 48.60 * 2400 4.97 41622 48.81 CAL/GFW 2500 4.97 41125 48.81 2500 4.97 41622 48.81 * 2500 4.97 42118 49.02 * 2700 4.97 42118 49.21 * 2700 4.97 42112 49.40 * 2800 4.97 44105 49.58	ΔH.	CAL /GFW.	1900	4.97	39138	47 . 65 47 . 91	28.10			
x 2200 4.97 40628 48.38 x 2300 4.97 41125 48.60 x 2400 4.97 41125 48.60 cul/GFN 2400 4.97 41125 48.60 2400 4.97 41125 48.81 cul/GFN 2500 4.97 41622 48.81 2500 4.97 42615 49.02 x 2500 4.97 42615 49.61 x 2700 4.97 42615 49.61 x 2700 4.97 42615 49.65 x 2800 4.97 42615 49.65 x 2800 4.97 49.65	-		2100	4.97	40131	48.15	29.04			
•K 2300 4.97 41125 48.60 CAL/GFN 2400 4.97 41125 48.60 CAL/GFN 2500 4.97 41622 48.81 2500 4.97 42118 49.02 2500 4.97 42118 49.02 2500 4.97 42615 49.21 •K 2700 4.97 42112 49.40 2700 4.97 42615 49.40 •K 2800 4.97 42112 49.40 •K 2800 4.97 43112 49.40 •K 2800 4.97 49.658			2200	4.97	40628	48•38	29.92			
CAL./GFW 2500 4.97 42118 49.02 2500 4.97 42615 49.02 2700 4.97 42615 49.21 2700 4.97 42615 49.40 2700 4.97 42609 49.58 49.40 49.75 2800 4.97 44105 49.75	Ţ.P.	*	2300	4 • 97 4 • 97	41125	48 • 60 48 • 81	30.72			
2600 4.97 42615 49.21 2700 4.97 42112 49.40 2800 4.97 43112 49.40 2800 4.97 43169 49.58 2800 4.97 44106 49.75 2900 4.97 44106 49.75	ДH,	CAL /GFW.	2500	4.97	42118	49.02	32.18			
= •k 2700 4.97 43112 49.40 = •k 2800 4.97 43105 49.58 2900 4.97 44106 49.75 40.07 4.602 49.05			2600	4.97	42615	49.21	32.82			
= •k 2800 4.97 43609 49.58 2900 4.97 44106 49.75 40.00 4.97 44502 49.05			2700	4.97	43112	49.40	33.44			
	T. =	*	2800	4.97	43609	49•58	34•01			
	•		2900	4.97	44106	49.75	34.55			
	۳ ۳	ATM.	3000	4•97	44602	49.92	35•06			

ZINC	Zu			Reference	State fo	r Calcula	ting AH [°] ,	Reference State for Calculating ΔH_{r}° , ΔF_{r}° , and $Log_{10}Kpt$	Log ₁₀ Kp:
IDEAL MONATOMIC GAS	C GAS			Solid fro 1181°, Id	rom 298° to 692. Ideal Monatomic	692.7°, omic Gas	Liquid fro from 1181°	Solid from 298° to 692.7°, Liquid from 692.7° to 1181°, Ideal Monatomic Gas from 1181° to 3000°.	° to
		TEMPERATURE	C ⁰ F HEAT CAPACITY	M ⁰ – M ⁰ T 291.15 HEAT CONTENT	S ⁰ T Entropy	-(F°-H° 281.15) FREE ENERGY FUNCTION	FORMATI HEAT \$\Delta H_1	FORMATION FROM REFERENCE STATE	ICE STATE LOG K
(H ² _{241.15} H ₀) = -9 -0-	CAL/GFW.	*	CAL./DEG./ GFW.	CAL./ GFW.	CAL./DEG./ GFW.	CAL./DEG./ OFW.	CAL./GFW.	CAL./ GPW.	2
		300	4.97	00	38.45	38.45	31190	22682	- 16.627
A.P.	*	400	4.97	506	39.91	38.65	31056		- 10.488 - 10.816
∆ M	CAL /GFW.	500	4.97	1003	41.02	39 • 02	30913	17003	- 7.432
		000	4.97	1500	41.93	39.43	30740	14228	
a a	¥	800	16.4	2493	42.09	40.24	28523	9067	- 2.477
		006	4.97	2990	43 . 94	40.62	28270	6652	- 1.615
ФН,	CAL. /GFW.	1000	4.97	3487	44 • 46	40.98	28017	4267	- •932
		0011	10.4	9986	44 • 94	41.32	27764	1892	- •375
	8	1300	4 97	4480	45.37	41.64	00	00	00
	4	1400	4.97	5474	46.14	42.23			
ΔHs	CAL. /GFW.	1500	4.97	5971	46.48	42.50	0	0	00
		1600	4.97	6468	46.80	42.76	0	0	0
		1700	4.97	69.64	47.10	43 . 01	00	0	0
1.P.	*	1900	4.97	1041	47.65	43.47		D C	o c
ΔH	CAL. / GFW.	2000	4.97	8455	47.91	43.69	0	0	0
		2100	4.97	8952 0448	48•15 48•28	43.89	00	00	00
TP	*	2300	4.97	5766	48.60	44.28	00	00	00
	:	2400	4.97	10442	48.81	44.46	0	0	0
∆H,	CAL. /GFW.	2500	4.97	10939	49 • 0 2	44.65	0	0	0
]	2600	4.97	11032	49.21	44.82	00	00	00
•	3	2800	4.97	12429	49.58	45.15	00		bo
= 3	4	2900	4.97	12926	49.75	45.30	0	0	00
Pc =	ATM.	3000	4.97	13423	49 •92	45.45	0	0	0

ZINC

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ZIRCONIUM	1 Zr			Solid	I from 29	8° to 114	Solid I from 298° to 1143°, Solid II from	II from			
REFERENCE	STATE			1143°	to 2125°,	Liquid 1	to 2125°, Liquid from 2125°	to 3000°.	•		
5	91 . 22	CDAMC	•	۲	91	2	-(F°-H° 298.15)	FORMAT	FORMATION FROM REFERENCE STATE	CE STATE	
	1	CHAND	TEMBERATTING		T 296.15	×-	FREE ENERGY	HEAT A H ^o	FREE ENERGY & F		
(H ^o _{298.15} H ^o) =	1,313	CAL./GFW.	Жe	HEAT CAPACITY CAL./DEG./ GFW.	HEAT CONTENT CAL./ GFW.	ENTROPY CAL. /DEG./ GFW.	FUNCTION CAL./DEG./ GFW.	CAL./GFW.	CAL./ GFW.	гос 8 8	
			208	6 ° U I	o	0, 20	00.00				r
M.P. 2,125	25	×	300	6.01	11	9.33	9.30				
× H (4	(4,000)	AL /CEW	400	6.36	630	11-11	9.54				
			500	6.63	1280	12.56	10.00				
			600	6 • 88	1960	13.79	10.53				
B.P. 4.	4.650	×	200	7.12	2660	14.87	11.62				
					4125	16.71	12.13				
∆H, 139,000	800	CAL. /GFW.	1000	7.79	0685	17.52	12.63				
			1100	8.01	5680	18.28	13.12				
			1200	6.79	7450	19•86	13.66				
S.P. 1,	1,143	*	1300	6.95	8140	20.41	14.15				
:			1400	7.11	8840	20.93	14.62				
⊂ H° T ,	1,040	CAL. /GFW.	1500	7.27	9560	21.42	15.05				
			1600	7.43	10300	21.90	15.47				
		Γ	1700	7.59	11050	22.35	15.85				
T.P.		*	1800	7.75	11820	22.79	16.23				
∆H,		CAL. / GFW.	0007	8.07	13400	23.62	16.92				
			2100	8.23	14220	24.02	17.25				
			2200	8 • 00	19000	26.27	17.64				
T.P.		*	2300	8 • 00	19800	26.62	18.02				
			2400	8 • 00	20600	26.96	18.38				
ΔH,		CAL. /GFW.	2500	8 • 00	21400	27.29	18.73				2
			2600	8.00	22200	27.60	19•07				JR
			2700	8 • 00	23000	27.91	19.40				
Tc =		*	2800	8•00	23800	28•20	19.70				DN
1			2900	8 • 00	24600	28.48	20.00				NU
= °		ATA	3000	8•00	25400	28.75	20•29				M

doi: 10.1021/ba-1956-0018.ch004
1956
1,
January
Date:
Publication

IDEAL MONATOMIC GAS T Giv 91.22 GRAMS Giv 91.22 GRAMS $(H^0_{280,15}-H^0_5) = 1_5629$ CAL/GFW Temeson M.P. *K 300 M.P. *K 300 D.H. CAL/GFW 500 D.H. CAL/GFW 10000 D.H. CAL/GFW 11000 D.H. CAL/GFW 12000 D.H. CAL/GFW 2500 D.H. CAL/GFW 2500	91 91 92		I from 2 125°, L1q 5°, L1q 43°, L1q 43°	(uid from -fe ^{-f} unul rest entror rest en	Solid I from 298° to 1143°, Solid II to 2125°, Liquid from 2125° to 3000 to 2120 to 2120 <thto 2120<="" th=""> to 2120</thto>	Solid II • to 3000°. Forwartow Frow Reference state or A ^H Presentence		TATE Loc k 99.587 98.932 772.338 772.338 772.338 772.338 28.019 28.019 224.462 224.462
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CAL./GFW. CAL./GFW. CAL./GFW.		6968	53.19	48.22	144128	98964	1	15.450
°K CAL./GFW. °K CAL./GFW.		7617	53.63	48.56	144057	95742	I	13.950
°K C.A.L. /GFW. V C.A.L. /GFW.		8277	54.06	48.89	143977	92521	I	12.637
°K C.A.L. /GFW. V C.A.L. /GFW.		8948	54.47	49.21	143898	89294	1	11.479
CAL./GFW. *K CAL./GFW.		9629	54.86	49.52	143809	86083	I	10.451
CAL./GFW.		10320	55.23	49.80	143720	82882	1	9 . 533
°K CAL./GFW.		11020	55.59	50.08	143620	79680	•	8.706
°K CAL./GFW.	2100 7.13	11730	55.94	50.36	143510	76478	1	7.959
°K CAL. / GFW.		12450	56.27	50.62	139450	73450	I	7.296
CAL. / GFW.		13170	56.59	50.87	139370	70439	1	6.693
CAL. / GFW.	2400 7.34	13900	56.90	51.11	139300	67444	1	6.141
-		14640	57.20	51.35	139240	64465	1	5.635
560	2600 7.48	15380	57.49	51.58	139180	61466	I	5.166
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Pc = ATM. 300	3000 7.75	18430	58 • 58	52.44	139030	49540	I	3.608

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Arsenic	11	44	Nitrogen	24	139
Astatine	11	48	Osmium	24	141
Barium	11	51	Oxygen	25	143
Beryllium	12	53	Palladium	25	145
Bismuth	12	55	Phosphorus	25	147
Boron	12	58	Platinum	26	15 2
Bromine	13	60	Polonium	26	154
Cadmium	13	63	Potassium	27	157
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