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HYDROLYSIS, FORMATION AND IONIZATION
CONSTANTS AT 25°C, AND AT HIGH
TEMPERATURE-HIGH IONIC STRENGTH*

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DISCLAIMER

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ABSTRACT

Thermochemical data for nuclear waste disposal are compiled. The resulting computerized database consists of critically evaluated data on Gibbs energy of formation, enthalpy of formation, entropy and heat capacity of selected substances for about 16 elements at 25⁰ C and zero ionic strength. Elements covered are Am, As, Br, C, Cl, F, I, Mo, Np, N, O, P, Pu, Si, Sr, S and U. Values of these thermodynamic properties were used to calculate equilibrium quotients for hydrolysis, complexation and ionization reactions up to 300⁰ C and 3 ionic strength, for selected chemical reactions.

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Attachment I. Properties of Water

Appendix I. Thermodynamic Data

Americium

Arsenic

Bromine

Carbon

Chlorine

Fluorine

Iodine

Molybdenum

Neptunium

Nitrogen

Oxygen

Phosphorus

Plutonium

Silicon

Strontium

Sulfur

Uranium

Appendix II. Equilibrium Values for Selected
Chemical reactions

INTRODUCTION

Thermochemical data are basic to computer codes and other calculations on solubility and speciation of radionuclides in site-specific waters. Ideally, values of thermodynamic properties for all likely aqueous substances are known, together with an uncertainty in each value. The resulting database then permits calculation of equilibrium quotients for important chemical reactions such as hydrolysis and complexation, to high temperatures and in saline natural waters.

This report compiles critically evaluated thermochemical data for calculations applicable to the disposal of nuclear wastes. The objective is mainly to provide values of equilibrium quotients at temperatures and ionic strengths representative of natural waters associated with prospective waste repositories. For waters associated with sites such as basalt, tuff and granite, ionic strength is 0.01; saline waters for salt repositories are about 5 ionic strength⁽¹⁾. These natural waters include F^- , OH^- , HCO_3^- , CO_3^{--} , HSO_4^- and SO_4^{--} as principal anions. See Table 1. Thus, this compilation for use in calculating solubility and speciation of radionuclides in natural waters includes stability constants of metals such as Pu, Am and Np with these and other ligands. Besides metals, I_2 and C are important nonmetals, and are also included. Attachment II lists proposed rules published in the Federal Register by the U.S. Environmental Protection Agency on nuclear waste disposal, as well as proposed criteria for radionuclides such as C and Cs. Management Plan for high-level wastes is given in Attachment III.

In summary, a database for nuclear waste disposal consisting of critically evaluated thermochemical data is described. The database is developed around intrinsic equilibrium constants at 25⁰ C and zero ionic strength; and mathematical equations which permit estimations of equilibrium quotients to 300⁰ C and up to 3 ionic strength. Where available, the intrinsic data are compiled from other critical evaluations such as National Bureau of Standards and Lemire and Tremaine. Other important data have been calculated in this work. Besides equilibrium constants, values for the following thermochemical properties are compiled or are calculated: Gibbs energy of formation, enthalpy of formation, entropy and heat capacity for individual substances. From these basic data, we calculate the magnitudes of thermodynamics of reaction, for example enthalpy change, for hydrolysis and other reactions. These values are also tabulated.

Table 1. Compositions of Ground Water in Potential Repositories
(Reference 11, Table 14)

Constituent	Concentration, mg/L				
	Salt				
	A*	B**	Granite†	Basalt††	Tuff††
Lithium	20	---	---	---	0.05
Sodium	42,000	115,000	125	250	51
Potassium	30,000	15	0.4	1.9	4.9
Rubidium	20	1	---	---	---
Cesium	1	1	---	---	---
Magnesium	35,000	10	0.5	0.04	2.1
Calcium	600	900	59	1.3	14
Strontium	5	15	---	---	0.05
Iron	2	2	0.02	---	0.04
Silica	---	---	11	92	61
Fluoride	---	---	3.7	37	2.2
Chloride	190,000	175,000	283	148	7.5
Bromide	400	400	---	---	---
Iodide	10	10	---	---	---
Carbonate	---	---	3	25	---
Bicarbonate	700	10	13	21	120
Sulfate	3,500	3,500	19	108	22
Borate	---	10	---	---	---
Nitrate	---	---	---	---	5.6
<hr/>					
pH	6.5	6.5	9.0	9.7	7.1
Eh (Volts)	Mildly Oxidizing	Mildly Oxidizing	+0.17	-0.50	Mildly Reducing

* Based on analysis of brine inclusions in the Salado formation near Los Medanos, New Mexico (see Reference 14).

** Based on solution results from water saturated with WIPP salt.

† Based on results from Stripa mine in Sweden (see Reference 21).
pH value taken from Reference 12.

†† Based on data of Reference 12.

THERMOCHEMICAL DATA

Data are given here in two formats: first as thermodynamic properties of individual substances to include values of Gibbs energy and enthalpy of formation, entropy and heat capacity in Appendix I. The second format consists of values of equilibrium quotients to 300⁰ C, and ionic strength mainly up to 3 for selected chemical reactions in Appendix II. Tabulated also in Appendix II are values of $\Delta_f H^0$, ΔS^0 , ΔC_p^0 calculated from data in Appendix I and Debye-Huckel parameters for the reactions selected.

Equilibrium Constants

The database centers on values of equilibrium constants, $\log K^0$, at 25⁰ C and zero ionic strength. The chemical equilibria are mostly hydrolysis, complexation and ionization reactions. These intrinsic data are calculated from the equations

$$\Delta_r G^0 = \Delta_r H^0 - T\Delta S^0 \quad (1)$$

$$\log K^0 = \frac{-\Delta_r G^0}{(2.303)RT} \quad (2)$$

Values of $\Delta_r H^0$ and ΔS^0 for each chemical reaction are calculated from the sum of the $\Delta_f H^0$ and S^0 of the products, minus this sum for the reactant..

Temperature Effects

Equilibrium quotients are computed from 25-300⁰ C based on the following equation

$$R \ln Q = \Delta S^0 - \frac{\Delta_r H^0}{T} + \Delta C_p^0 \left[\frac{\theta}{T} - 1 + \ln \left(\frac{T}{\theta} \right) \right] \quad (3)$$

where $\theta = 298.15^\circ \text{C}$

$T = 273.15 + ^\circ \text{C}$

$Q = \text{equilibrium quotient}$

$R = 8.3143 \text{ J mol}^{-1} \text{ K}^{-1}$

$\Delta S^0 = \text{entropy change at } 25^\circ \text{C, J mol}^{-1} \text{ K}^{-1}$

$\Delta_r H^0 = \text{enthalpy difference at } 25^\circ \text{C, J mol}^{-1}$

$\Delta C_p^0 = \text{change in heat capacity at } 25^\circ \text{C,}$
 $\text{J mol}^{-1} \text{ K}^{-1}$

Equation 3 assumes heat capacity change is constant over the temperature range of interest; this assumption is certainly not valid above perhaps 100°C for the majority of reactions. However, if chemical reactions are written such that both sides of a chemical equation have an equal number of like charges, then constancy of ΔC_p^0 is a more tenable assumption^(3,4,5). This "balanced like charges" approach and eq 3 are used in this database to the extent possible. Lemire⁽¹²⁾ and Lemire and Tremaine⁽¹³⁾ assign $C_p^0 = 0$ for uncharged aqueous substances such as $\text{U}(\text{OH})_4(\text{aq})$. In absence of other data, this assumption is used for this database.

Effect of Ionic Strength

Variations in $\log Q$ with ionic strength are calculated using an extended Debye-Huckel equation.

$$\log Q = \log K^0 + \frac{A_y \Delta z^2 I^{1/2}}{1 + (89) I^{1/2}} + bI \quad (4)$$

- K^0 = intrinsic equilibrium constant at 25° C and zero ionic strength
 A_γ = Debye-Huckel slope, $(\text{kg mol}^{-1})^{1/2}$; 0.510 at 25° C
 ΔZ^2 = difference in sum of the squares of the charges of the products of the reaction, and reactants
 I = ionic strength, mol kg^{-1}
 b = coefficient, kg mol^{-1}
 $(B9) = 1$, usually

Equation 4 is used over the range $0 < I < 3$. Values of the parameters A_γ , ΔZ^2 , $(B9)$ and b are found in reference 2 for many reactions. Otherwise these data were obtained from sources such as Baes and Mesmer⁽⁶⁾, and Turner, Whitfield and Dickson⁽⁷⁾.

UNCERTAINTIES OF RECOMMENDED VALUES

Generally, uncertainties given here for thermodynamic properties are those given in the referenced publications for 25⁰ C, and zero ionic strength. Data from the National Bureau of Standards have values "tabulated in general so that the overall uncertainty lies between 8 and 80 units of the last (rightmost) digit...."⁽⁹⁾. An excellent paper on uncertainties was published by IUPAC Commission I.2 of the International Union of Pure and Applied Chemistry, in the Journal of Chemical Thermodynamics⁽¹⁰⁾.

Uncertainties in the recommended values are given in Appendix I as the number immediately below this value. These are to be interpreted as a "+-" range about the recommended value. Data referenced as obtained from the National Bureau of Standards have an uncertainty described in the above paragraph. Otherwise, an uncertainty is not assigned to the best value. A $\log K^0$ calculated from the thermodynamic data will most often have a maximum uncertainty of ± 0.1 unit of $\log K^0$.

An uncertainty is not given for $\log Q$ at high ionic strength. The reader should refer to Baes and Mesmer⁽⁶⁾ for uncertainties in hydrolysis quotients for metals, usually over the range $0 < I < 3$. Reference 2 has values of uncertainties for many complexation reactions, such as formation of fluorides, sulfates and carbonates.

Uncertainties are not given for high temperature data, partly due to the large uncertainty in values of C_p^0 ; and, partly because of the lack of experimental data. The dependence of uncertainties in $\log Q$ for each equilibrium reaction is difficult to predict. However, for eq 3 we find that uncertainty in ΔS^0 has a larger effect on $\log Q$ than $\Delta_r H^0$ for the

complexation reaction $\text{Pu}^{4+} + \text{SO}_4^{2-} = \text{PuSO}_4^{2+}$ (Table 2). As shown in Table 2, a change in ΔS^0 of $\pm 20 \text{ J mol}^{-1} \text{ K}^{-1}$ causes a change of ± 1.0 units for $\log Q$ from 25-350° C. On the other hand, changing $\Delta_r H^0$ by $\pm 900 \text{ J mol}^{-1}$ affects $\log Q$ by about ± 0.1 unit over the same temperature interval. An uncertainty in ΔC_p^0 of $\pm 100 \text{ J mol}^{-1} \text{ K}^{-1}$ results in a nonlinear effect on $\log Q$; the change varies from 0 to ± 1 log unit. See Figure 1. The nonlinearity is due to the nonlinear nature of the temperature dependence of ΔC_p^0 as shown in Figure 2. A lucid and useful discussion of uncertainties in values of $\log K^0$ for neptunium was published recently by Lemire⁽¹²⁾.

INCONSISTENCIES IN CALCULATED EQUILIBRIA

Equilibrium constants at 25°C and I = 0 should be identical when calculated from eq 1 and eq 2, as well as from Gibbs energy data:

$$\Delta_r G^0 = \sum \Delta_f G^0 \quad (5)$$

Table 2. Effect of uncertainty in ΔS^0 and $\Delta_r H^0$ on $\log Q$ for the reaction
 $\text{Pu}^{4+} + \text{SO}_4^{2-} = \text{PuSO}_4^{2+}$

T/C	$\log Q$ at ΔS^0 shown ($\text{J mol}^{-1} \text{K}^{-1}$)		
	132	152	172
25	5.79	6.83	7.88
50	5.93	6.97	8.02
75	6.14	7.19	8.23
100	6.41	7.45	8.49
150	7.05	8.09	9.14
200	7.77	8.82	9.86
250	8.53	9.57	10.62
300	9.29	10.31	11.38
350	10.06	11.10	12.15

$\sigma = \pm 1.05$ units of $\log Q$

Effect of uncertainty in $\Delta_r H^0$

T/C	$\log Q$ at $\Delta_r H^0$ shown (J mol^{-1})		
	5420	6320	7220
25	6.99	6.83	6.67
50	7.12	6.97	6.83
75	7.32	7.19	7.05
100	7.58	7.45	7.35
150	8.21	8.09	7.99
200	8.91	8.82	8.72
250	9.66	9.57	9.48
300	10.42	10.34	10.26
350	11.18	11.10	11.03

$\sigma = \pm 0.1$ units of $\log Q$

Figure 1. Effect of uncertainty in heat capacity change on equilibrium quotient for reaction:

Figure 2. Variation in heat capacity function versus temperature.

However, values of thermodynamic properties for individual substances were obtained from numerous sources such as other compilations and research publications. These are combined to give values of changes in thermodynamics of reactions, thereby introducing possible inconsistencies in values of $\log K^0$. Any inconsistencies are removed as these tables are revised: the reader is urged to communicate inconsistent data found in this report to the authors for subsequent revision of the tables.

Certain substances in the database have equivalent aqueous forms with one or more H_2O as a link. For example, $CO_2(aq) + H_2O = H_2CO_3(aq)$; $AsO_2^- + 2H_2O = As(OH)_4^-$; $Mo_7O_{24}^{-----} + 4H_2O = H_8(MoO_4)_7^{-----}$. For these substances, thermodynamics of reaction within the constraints of uncertainty in values for each property are zero:

$$\Delta_r G^0 = \Delta_r H^0 = \Delta S^0 = \Delta C_p^0 = 0$$

A typical maximum difference from zero due to uncertainty for $\Delta_r G^0$ and $\Delta_r H^0$ is about 5 kJ mol^{-1} in this database.

RELIABILITY OF TABULATED DATA

By reliability we mean the closeness with which values of equilibrium quotients reproduce the most reliable experimental data. Such data are obtained from experimental measurements; either directly from published research results, or from other compilations and critical evaluations. It is not possible to compare all calculated equilibrium quotients at high temperatures and ionic strengths with experimental or other data. This is partly due to the lack of experimental data, and partly because of the enormous amount of time required. Thus the scope of the database excludes detailed comparison of computed equilibrium values with other work.

SYMBOLS, UNITS AND CONVERSION FACTORS

$\Delta_f G^\circ$	=	Gibbs energy of formation, 25 ⁰ C, I = 0; kJ mol ⁻¹
$\Delta_f H^\circ$	=	Enthalpy of formation, 25 ⁰ C, I = 0; kJ mol ⁻¹
S°	=	Entropy, 25 ⁰ C, I = 0; J mol ⁻¹ K ⁻¹
C_p°	=	Heat capacity, 25 ⁰ C; J mol ⁻¹ K ⁻¹
$\Delta_r G^\circ$	=	Gibbs energy of reaction, 25 ⁰ C, I = 0; J mol ⁻¹
$\Delta_r H^\circ$	=	Enthalpy of reaction, 25 ⁰ C, I = 0; J mol ⁻¹
ΔS°	=	Entropy change for reaction, 25 ⁰ C, I = 0; J mol ⁻¹ K ⁻¹
ΔC_p°	=	Heat capacity change for reaction, 25 ⁰ C, I = 0; J mol ⁻¹ K ⁻¹
J	=	joules; cal = calories
kJ	=	kilojoules = 1000 joules
I	=	ionic strength, mol kg ⁻¹
K	=	273.15 + ⁰ C, C = celsius
mol	=	gram molecular weight
Q	=	equilibrium quotient, or product
K°	=	intrinsic equilibrium constant, 25 ⁰ C, I = 0
R	=	gas constant: 8.3143 J mol ⁻¹ K ⁻¹ ; 1.987 cal mol ⁻¹ K ⁻¹
g	=	gaseous form
s	=	solid form
am	=	amorphous form
aq	=	aqueous form
l	=	liquid form

SYMBOLS, UNITS AND CONVERSION FACTORS (cont.)

$$\text{molal} = \frac{(1000) (\text{molarity})}{(1000) (\text{density}) - (\text{molarity}) (\text{molecular weight of salt})}$$

$$\text{molarity} = \frac{(1000) (\text{density}) (\text{molality})}{1000 + (\text{molecular weight of salt}) (\text{molality})}$$

$$\text{cal} = 4.184 \text{ J}$$

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ATTACHMENT I

Selected thermochemical properties of water as a function of temperature at zero ionic strength; and of ionic strength at 25°C.

Selected Properties of H₂O(l)

T(°C)	P(bar)	logK _w ^o	Dielectric	Density
0	----	-14.938	87.81	----
25	.032	-13.995	78.46	0.9971
50	.123	-13.275	69.91	0.9880
75	.386	-12.712	62.24	0.9747
100	1.013	-12.265	55.39	0.9583
150	4.758	-11.638	43.89	0.9170
200	15.538	-11.289	34.59	0.8647
250	39.73	-11.191	26.75	0.7992
300	85.81	-11.406	19.66	0.7125
325	----	-11.71	16.19	0.6544
350	165.13	-12.30	12.61	0.5746
360	186.51	-13.33	11.22	0.5284
370	210.3	-14.85	9.74	0.4519
372.1	215.4	-15.27	9.37	0.4196
374.1	220.9	-15.74	9.07	0.3169

FIGURES

Figure 3. Variation in ionization product of water as a function of ionic strength at 25°C in NaClO_4 solutions. Experimental data are from Baes and Mesmer (Reference 6).

Figure 4. Plot of ion product of water versus temperature at zero ionic strength based on data calculated from Marshall and Franck (Reference 14).

Figure 5. Effect of temperature on dielectric constant of water at saturation vapor pressures, calculated from Akerlof and Oshry (Reference 15).

Figure 6. Effect of temperature on formation of $\text{UO}_2\text{F}_2(\text{aq})$.

Note almost linear plot obtained for eqB, where charges equal 2+ on both sides of the chemical equation.

Figure 3. Variation in ion product of H_2O as a function of ionic strength at 25°C .

Figure 4. Plot of ion product of H_2O versus temperature at zero ionic strength.

Figure 5. Effect of temperature on dielectric constant of water at saturation vapor pressure.

Figure 6. Effect of temperature on formation of $\text{UO}_2\text{F}_2(\text{aq})$.

Linearity is improved by writing eq 3 in the following form, when plotting values of $\log Q$ as a function of $1000/T(K)$

$$\log K^{\circ}(T) + \frac{\Delta_r C_p^{\circ}}{2.303 R} \left[\ln\left(\frac{298.15}{T(K)}\right) + 1 \right] = A + \frac{B}{T(K)} \quad (5)$$

$$A = \frac{\Delta_r S^{\circ}}{2.303 R}$$

$$B = - \frac{1}{2.303 R} \left[\Delta_r H^{\circ} - 298.15 \Delta_r C_p^{\circ} \right]$$

See Figure 7 and Figure 8. Because of the improved linearity, extrapolation can be made to higher temperature with more confidence with eq 5; this equation should be used whenever data are available on heat capacity of chemical reactions at 25°C.

Figure 7. Temperature function, $F(\log Q, \Delta_r C_p^\circ)$ equal to

$$\log K^\circ(T) + \frac{\Delta_r C_p^\circ}{2.303 R} \left[\ln\left(\frac{298.15}{T(K)}\right) + 1 \right]$$

versus $1000/T(K)$. From slope and intercept, $\Delta_r H^\circ = -31.6 \text{ kJ/mol}$; $\Delta_r S^\circ = -58.2 \text{ J/mol/K}$.

Figure 8. Temperature function, $F(\log Q, \Delta_r C_p^\circ)$ equal to

$$\log K^\circ(T) + \frac{\Delta_r C_p^\circ}{2.303 R} \left[\ln\left(\frac{298.15}{T(K)}\right) + 1 \right]$$

versus $1000/T(K)$. From slope and intercept, $\Delta_r H^\circ = -3.113 \text{ kJ/mol}$; $\Delta_r S^\circ = 158 \text{ J/mol/K}$.

Figure 9. Effect of ionic strength on first hydrolysis constant of Am^{+++} (data are for Nd^{+++}). Note linear change for range 1 to 3 in ionic strength.

Figure 10. Effect of change in ionic strength for formation constant of AmOH^{++} (data for NdOH^{++}).

Figure 11. Ionic strength function versus ionic strength for hydrolysis of Am^{+++} to form AmOH^{++} .

Figure 12. Ionic strength function versus ionic strength for formation of AmOH^{++} .

Figure 7. Temperature function, $F(\log Q, \Delta_r C_p^\circ)$ versus $1000/T(K)$. From slope and intercept, $\Delta_r H^\circ = -31.6 \text{ kJ/mol}$; $\Delta_r S^\circ = -58.2 \text{ J/mol/K}$.

Figure 8. Temperature function, $F(\log Q, \Delta_r C_p^\circ)$ versus $1000/T(K)$. From slope and intercept, $\Delta_r H^\circ = -31.13 \text{ kJ/mol}$; $\Delta_r S^\circ = 159 \text{ J/mol/K}$.

Figure 9. Effect of ionic strength on first hydrolysis constant of Am^{+++} (data are for Nd^{+++}). Note linear change for range 1 to 3 ionic strength.

Figure 10. Effect of change in ionic strength for formation constant of AmOH^{++} (data for NdOH^{++}).

Rewriting eq 4 as follows

$$\log K^{\circ}(I) - \frac{A_{\gamma} \Delta z^2 I^{1/2}}{1 + (B\gamma) I^{1/2}} = \log K^{\circ} + bI \quad (6)$$

gives eq 6 which predicts a linear relation when plotting the left hand side versus ionic strength (I). The intercept is the intrinsic equilibrium constant, $\log K^{\circ}$, and slope is the parameter, b. Equation 6 is plotted in Figure 11 and in Figure 12 for formation of AmOH^{++} , and for hydrolysis of Am^{+++} . See also Reference 2, where eq 6 is used for other reactions, but with $(B\gamma) = 1.6$.

Ionic Strength
Figure 11. Ionic strength function versus ionic strength for hydrolysis of Am^{+++} to form AmOH^{++} .

Ionic Strength
Figure 12. Ionic strength function versus ionic strength for formation of AmOH^{++} .

APPENDIX I

Appendix is a tabulation of values for the following thermodynamic properties at 25°C and zero ionic strength:

Gibbs energy of formation, $\Delta_f G^\circ$ ($\sim fG_o$)

Enthalpy of formation, $\Delta_f H^\circ$ ($\sim fH_o$)

Entropy, S° (S_o)

Heat capacity, C_p° (C_{p_o})

Immediately beneath each value is the uncertainty. The form of the substance is given with the chemical formula:

(g) = gaseous

(s) = solid

(am) = amorphous

(aq) = aqueous

+ or - refer to the number of charges

Examples:

Am^{+++} is Am^{+++}

$H_5IO_6(aq)$ is $H_5IO_6(aq)$

$(UO_2)_2(OH)_2^{++}$ is $(UO_2)_2(OH)_2^{++}$

References to the sources of the data are given for each element, immediately following the printout of the data.

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 Solids;
 Aqueous Species
 September 1984

PROPERTIES OF ELEMENTAL AMERICIUM:

Atomic Number: 95
 Formula Mass: 241.06
 Electronic Configuration: 5f7 7s2
 Electronegativity:
 Hydration Number:
 Ionic Radius: 0.975 angstrom
 Selected Average for Soils:
 Concentration in Natural Waters:

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$	S° J mol ⁻¹ K ⁻¹	C_p° K ⁻¹	Ref.
Am (s)	0.000	0.000	54.47 2.70	25.86 1.3	1,19
AmO2 (s)	- 883.660	- 932.200 2.5	95.60		2,5
Am2O3 (s)	-1605.900 20.0	-1692.000 15.0	127.00		17,22
Am (OH)4 (s)	-1299.900				2
Am (OH)3 (s)	-1210.590 3.0				14
AmF4 (s)	-1627.576	-1719.600 26.0	148.50 4.00		21
AmF3 (s)	-1523.394	-1588.300 8.0	127.60 4.00		21
AmCl3 (s)	- 910.857	- 977.800 1.3	164.80 6.30		5,21
AmBr3 (s)	- 786.592	- 809.600 7.0	205.00 16.70		21
AmI3 (s)	- 613.793	- 612.000 7.0	234.30 20.90		21
AmOCl (s)	- 904.162	- 953.500 2.5	102.50 7.10		5,21
AmOBr (s)	- 862.741	- 898.000 7.0	117.10 16.70		5,21
Am2(CO3)3 (s)	-2996.160				20
Am (OH) (CO3) (s)	-1412.000				20
Am++++	- 373.200 10.0	- 432.200 11.0	-406.00 21.00		1
Am+++	- 599.100 3.8	- 616.700 3.8	-201.00 13.00		1

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$	S° J mol ⁻¹ K ⁻¹	C_p°	Ref.
AmOH ⁺	- 790.560 10.0	- 831.820	- 47.10		10, 11
Am(OH) 2 ⁺	- 976.885 10.0				10, 11
Am(OH) 3 (aq)	-1159.215 10.0				10, 11
AmF ⁺⁺	- 911.246 2.1		-108.40		7, 20
AmF2 ⁺	-1204.843 2.2				10
AmF3 (aq)	-1504.860 2.4				10
AmCl ⁺⁺	- 737.410				10
AmCl2 ⁺	- 870.650				20
AmSO4 ⁺	-1367.200 2.0				4
Am(SO4) 2-	-2119.400 2.4				10
AmHCO3 ⁺⁺	-1217.550 1.4				8
Am(HCO3) 2 ⁺	-1826.410 1.5				8
AmCO3 ⁺	-1164.100 2.0				9
Am(CO3) 2-	-1734.700 2.0				9

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22. S° by analogy with $\text{Pu}_2\text{O}_3(\text{s})$.

 * Aqueous *
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ARSENIC
 Solids;
 Aqueous Species
 September 1984

PROPERTIES OF ELEMENTAL ARSENIC:

Atomic Number: 33
 Formula Mass: 74.9216
 Electronic Configuration: 3s2 3p6 3d10 4s2 4p3
 Electronegativity: 2.0
 Hydration Number:
 Ionic Radius: Covalent radius = 1.21 angstrom
 Selected Average for Soils: 5 mg/kg
 Concentration in Natural Waters:

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	^o fG ₀ kJ mol ⁻¹	^o fH ₀	S ₀ J mol ⁻¹ K ⁻¹	C _{p0} K ⁻¹	Ref.
As (s)	0.000	0.000	35.69 0.42	24.64	2,8
KAsO3 (s)		- 858.300 4.5			12
As2O5 (s)	- 782.300	- 924.870	105.40	116.52	2
As4O6 (s)	-1152.430	-1313.940	214.20	191.29	2
As2O3 (s)	- 575.964	- 656.970	107.41	95.65	1
alpha-As4S4 (s)	- 131.500 6.8	- 138.100 6.7	247.70 2.50	188.10	8
beta-As4S4 (s)	- 129.800 6.8	- 134.600 6.7	254.00 2.50	188.10	8
As2S3 (s)	- 90.700 5.0	- 91.600 4.8	163.70 4.20	115.60	8
As2O5 (aq)		- 951.400			2
AsO2-	- 349.980	- 429.030	40.60	-100.80	2
HAsO2 (aq)	- 402.660	- 456.500	125.90		2
AsO4---	- 648.410	- 888.140	-162.80	-489.10	2,3
HAsO4--	- 714.600	- 906.340	- 5.40	-284.10	2,3
H2AsO4-	- 753.170	- 909.560	117.00	- 54.80	2,3
H3AsO4 (aq)	- 766.000	- 902.500	184.00	211.70	2,3
As (OH) 4-	- 830.110	-1006.820	179.58	49.80	5,7
AsO3---	- 447.700 21.0	- 663.790	-186.60	-475.30	3
HAsO3--	- 524.300 21.0	- 689.100 12.0	- 15.10	-277.80	3
H2AsO3-	- 593.330 1.3	- 720.990 1.3	110.90	- 50.20	3
H3AsO3 (aq)	- 646.010 1.3	- 748.520 1.3	195.20	204.60	3

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$ kJ mol ⁻¹	S° J mol ⁻¹ K ⁻¹	C_p° J mol ⁻¹ K ⁻¹	Ref.
CH ₃ AsO(OH) ₂ (aq)					5
(CH ₃) ₂ AsO(OH) (aq)					5

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BROMINE
Solids;
Aqueous Species
September 1984

Atomic Number: 35
Formula Mass: 79.9090
Electronic Configuration: 3s2 3p6 3d10 4s2 4p5
Electronegativity: 2.8
Hydration Number:
Ionic Radius: 1.94 angstrom
Selected Average for Soils: 5 mg/kg (ppm)
Concentration in Natural Waters: < 1 mg/L in drinking
water; brines 400 mg/L

Substance	$\Delta_f H^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$ kJ mol ⁻¹	S° J mol ⁻¹ K ⁻¹	C_p° J mol ⁻¹ K ⁻¹	Ref.
Br-	-103.960	-121.500 0.2	82.84 0.20	-141.80	1,8

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CHLORINE
 Solids;
 Aqueous Species
 September 1984

PROPERTIES OF ELEMENTAL CHLORINE:

Atomic Number: 17
 Formula Mass: 35.4530
 Electronic Configuration: 2s2 2p6 3s2 3p5
 Electronegativity: 3.0
 Hydration Number:
 Ionic Radius: 1.83 angstrom
 Selected Average for Soils: 100 mg/kg
 Concentration in Natural Waters: 0.15 to 1000 mg/L. Brines 180,000 mg/L

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$	S° J mol ⁻¹ K ⁻¹	C_p°	Ref.
Cl-	- 131.228	- 167.080 0.1	56.73 0.16	-126.00	2,8,10

 * Aqueous *
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FLUORINE
 Solids:
 Aqueous Species
 September 1984

PROPERTIES OF ELEMENTAL FLUORINE:

Atomic Number: 9
 Formula Mass: 18.9984
 Electronic Configuration: 1s² 2s² 2p⁵
 Electronegativity: 3.95
 Hydration Number:
 Ionic Radius: 1.35 angstrom
 Selected Average for Soils: 200 mg/kg
 Concentration in Natural Waters: 2-37 mg/L in Basalt,
 tuff, granite waters

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$ kJ mol ⁻¹	S° J mol ⁻¹ K ⁻¹	C_p° J mol ⁻¹ K ⁻¹	Ref.
F-	- 281.750	- 335.350 0.7	- 13.18 0.54	-122.00	8,11
HF (g)	- 273.200	- 273.300 0.7	173.67 0.04	29.13	1,8
HF (aq)	- 299.930 0.5	- 321.282 0.7	94.98 0.50	39.30	11,12

BROMINE, CHLORINE, FLUORINE
References
June 1984

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 * Aqueous *
 * Solutions *
 * Database *

CARBON
 Solids;
 Aqueous Species
 September 1984

PROPERTIES OF ELEMENTAL CARBON:

Atomic Number: 6
 Formula Mass: 12.011
 Electronic Configuration: 1s² 2s² 2p²
 Electronegativity: 2.5
 Hydration Number: 2(HCO₃⁻); 15(CO₃⁻⁻)
 Ionic Radius: 0.77 angstrom covalent radius
 Selected Average for Soils: 20,000 mg/kg
 Concentration in Natural Waters: < 10 mg/L CO₂ (surface waters);

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$	S° J mol ⁻¹ K ⁻¹	C_p° K ⁻¹	Ref.
C(s)	0.000	0.000	5.74 0.12	8.53	10, 18
CO ₂ (g)	- 394.359	- 393.510 0.1	213.68 0.04	37.11	10, 18
CO ₂ (aq)	- 385.980	- 413.800	117.60	243.00 10.0	7, 10
CO ₃ ⁻⁻	- 527.810	- 677.140	- 56.90	-302.00 4.0	10, 32
HCO ₃ ⁻	- 586.770	- 691.990	91.20	- 53.00 4.0	7, 10
H ₂ CO ₃ (aq)	- 623.080	- 699.650	187.40	318.00	10
CaHCO ₃ ⁺	-1241.100		67.40	173.30	16
MgHCO ₃ ⁺	-1219.900	-1155.600	-110.00	160.80	16
CaCO ₃ (aq)	-1081.390	-1219.970	-110.00		10
MgCO ₃ (aq)	-1002.500				9

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 * Aqueous *
 * Solutions *
 * Database *

IODINE
 Solids;
 Aqueous Species
 September 1984

PROPERTIES OF ELEMENTAL IODINE:

Atomic Number: 53
 Formula Mass: 126.905
 Electronic Configuration: 4s2 4p6 4d10 5s2 5p5
 Electronegativity: 2.55
 Hydration Number: 2
 Ionic Radius: 0.222 nm (I-)
 Selected Average for Soils: 0.1 to 40 mg/kg
 Concentration in Natural Waters: 1.23 mg/L (1.0% water); 10 mg/L (brine)

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$ kJ mol ⁻¹	S ₀ J mol ⁻¹ K ⁻¹	C _{p0} J mol ⁻¹ K ⁻¹	Ref.
I2(g)	19.327	62.421 0.1	260.57 0.06	36.90	10, 18
HIO(g)	- 85.800	- 98.300	187.40		31, 38
CH3I(g)	14.700	13.000	254.12	44.10	10
I2O5(s)	- 7.887 10.0	- 158.070	115.00 30.00	129.00 50.0	10, 47
HIO3(s)		- 231.840 0.4			48
Ba(IO3)2(s)	- 864.700	- 1027.200	249.40	187.40	10
AgIO3(s)	- 93.740	- 171.100	149.40	102.92	10
Bi5(IO6)2(s)		- 3945.960			49
Sr5(IO6)2(s)		- 3975.140			49
AgI(s)	- 66.190	- 61.840	115.50	56.82	10
HgI2(s)	- 101.700	- 105.400	180.00		10
I2(s)	0.000	0.000	116.14 0.80	54.44	10, 18
I2(aq)	16.400	22.600	137.20	330.00	5, 10
IO4-	- 58.500	- 151.500	222.00		10
H3IO6--	- 486.230	- 756.000	95.30		10, 11
H4IO6-	- 524.420 0.5	- 759.400 4.6	212.00 16.70		10, 51
H5IO6(aq)	- 541.550 1.0	- 759.400	268.90		10, 11
IO3-	- 132.960 1.1	- 224.680 2.2	118.40	- 74.00	10, 24, 40
HIO3(aq)	- 137.550 1.0	- 217.030 1.0	159.40 1.30	- 40.00	10, 42
IO-	- 38.500	- 107.500	- 5.40	90.00	8, 10, 47
HIO(aq)	- 99.100	- 138.100	95.40	133.90	5, 10

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$	S° J mol ⁻¹ K ⁻¹	C_p°	Ref.
I ₂ O--	- 82.220 0.2				2
I ₂ O _H -	- 164.870 0.2	- 209.330	201.40	161.00	1,2
H ₂ IO+	- 107.790 1.1	- 193.940	- 62.80	358.00	1
I-	- 51.570	- 56.900 0.8	106.70 0.20	-142.30	10,18
I ₃ -	- 51.400	- 51.900 1.9	239.30	166.70 8.0	10,46
AgI (aq)	25.520	50.380	184.10	-120.50	10
HgI ₂ (aq)	- 75.300	- 79.500	176.00		10

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Equivalent Aqueous Substances of Molybdenum

Certain aqueous molybdenum substances are equivalent; differing only by one or more molecules of H_2O in the formulas. Values of $\log Q$ are identical for reactions involving these equivalent substances. These include the following:

For each of these equivalent formulations, the values of changes in thermodynamic properties for the "reactions" shown is zero, within the uncertainties of the thermodynamic data.

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 Solids;
 Aqueous Species
 September 1984

PROPERTIES OF ELEMENTAL MOLYBDENUM:

Atomic Number: 42
 Formula Mass: 95.9400
 Electronic Configuration:
 Electronegativity: 2.1
 Hydration Number:
 Ionic Radius:
 Selected Average for Soils: 2 mg/kg (2 ppm)
 Concentration in Natural Waters:

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$	S° J mol ⁻¹ K ⁻¹	C_p° K ⁻¹	Ref.
Mo (s)	0.000	0.000	28.66	24.06	4
MoO ₃ (s)	- 667.970	- 745.090	77.74	74.98	4
alpha-MoO ₃ .H ₂ O (s)		-1037.800			12
		0.9			
MoO ₄ --	- 838.500	- 997.000	38.00	-30 ^o .60	2,4,14
HMoO ₄ --	- 862.475	- 978.935	181.00		5,14
	6.0	1.8	9.00		
H ₂ MoO ₄ (aq)	- 890.846	-1007.500	178.35		4,14
	6.0				
H ₃ MoO ₄ +	- 883.180	-1001.500	173.30		5,17
	0.9	2.4	8.00		
MoO ₃ (aq)	- 653.720	- 721.700	108.40		4
	6.0	6.0			
HMoO ₃ +	- 650.121	- 735.285	62.30		5,11
	2.0	3.0			
HMo ₂ O ₆ +	-1313.370				5
	5.0				
H ₂ Mo ₂ O ₆ ++	-1317.195				11,17
	5.0				
H ₃ Mo ₂ O ₆ +++	-1313.655				11
	5.0				
HMo ₂ O ₇ --	- 819.020				3
Mo ₇ O ₂₄ -----	-5208.350	-6029.125	301.00		2
	8.0				
HMo ₇ O ₂₄ -----	-5250.304	-6035.000	422.00		3
	6.0	8.0			
H ₂ Mo ₇ O ₂₄ ----	-5283.700	-6044.545	501.00		3
	7.0				
H ₃ Mo ₇ O ₂₄ ----	-5307.050	-6055.430	543.00		3
	7.0				

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$ kJ mol ⁻¹	S° J mol ⁻¹ K ⁻¹	C_p° J mol ⁻¹ K ⁻¹	Ref.
MoO ₂ ----	-5711.650 15.0	-6477.000 10.0			3,9,17
HMoO ₂ ----		-6527.755 10.0			8
H ₄ MoO ₂ (aq)		-6530.740 10.0			8
HMoO ₂ -----	-6094.228 10.0				3
H ₃ (MoO ₄) 2-	-1767.540 10.0				3
H ₅ (MoO ₄) 2+	-1782.035 8.0				3
H ₈ (MoO ₄) 7-----	-6156.690 10.0	-7172.445	580.60		3,18
H ₉ (MoO ₄) 7-----	-6198.935 10.0	-7178.320	701.60		3,18
H ₁₀ (MoO ₄) 7----	-6231.475 10.0	-7187.865	780.60		3,18
H ₁₁ (MoO ₄) 7---	-6256.530 10.0	-7198.750	822.60		3,18
H ₁₂ (MoO ₄) 8----	-7132.880 10.0	-8191.980			3,18
H ₉ (MoO ₄) 8-----	-7042.745 10.0				3,18
Mo (OH) 6 (aq)	-1359.472 1.5	-1599.850 3.0	232.00 9.00		5,6
Mo (OH) 5 (H ₂ O) +	-1364.304 2.0	-1592.775 4.0	272.00 10.00		5
MoO (OH) 5-	-1336.740 6.0	-1550.600 6.0	319.00		6
Mo ₂ O (OH) 7 (H ₂ O) 3+++	-2499.300 5.0				11
Mo ₂ O (OH) 8 (H ₂ O) 2++	-2502.839 5.0				11
Mo ₂ O (OH) 9 (H ₂ O) +	-2499.014 5.0				11

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 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 Solids;
 Aqueous Species
 September 1984

PROPERTIES OF ELEMENTAL NEPTUNIUM:

Atomic Number: 93
 Formula Mass: 237.05
 Electronic Configuration: 5f5 7s2
 Electronegativity: 1.1
 Hydration Number:
 Ionic Radius: 1.012 angstrom (Np⁺⁺); 0.91 angstrom (Np⁺⁺⁺)
 Selected Average for Soils:
 Concentration in Natural Waters:

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$	So J mol ⁻¹ K ⁻¹	Cp K ⁻¹	Ref.
Np (s)	0.000	0.000	50.62 1.00	29.62 0.6	15,20
Np2O5 (s)	-2013.000 14.0	-2148.250 15.0	163.00 23.00	129.00	22
NpO2 (s)	-1021.800 2.5	-1074.000 2.5	80.30 0.30	66.21	12,13,22
NpO3.H2O (s)	-1247.000 8.0	-1379.000 4.6	146.00 33.00		21
NpO2 (OH) 2 (s)	-1236.000 12.0	-1377.010 12.0	118.00 20.00	112.00	22
NpO2 (OH) (am)	-1128.000 5.5	-1224.580 6.0	101.00 8.00	86.00	22
Np (OH) 4 (s)	-1447.000 20.0	-1621.365 20.0	139.00 25.00	131.00	22
NpF4 (s)	-1783.630	-1874.000 13.0	152.72 4.10	116.06	12,19
NpF3 (s)	-1460.310	-1528.830 5.0	124.68 4.00	98.32	12,19
NpCl4 (s)	- 896.208	- 984.100 1.7	201.67 4.10	120.46	12,19
NpCl3 (s)	- 831.699	- 898.500 2.5	161.50 8.40	104.39	12,19
NpBr4 (s)	- 737.644	771.100 1.7	242.67 12.50	128.62	12,19
NpBr3 (s)	- 706.031	- 730.500 2.1	196.65 17.00	109.24	12,19
NpO2 (NO3) 2 (s)		-1209.000			21
NpO2 (NO3) 2.H2O (s)		-1527.000			21
NpO2 (NO3) 2.6H2O (s)	-2429.200 5.4	-3009.100 5.0	516.30 4.60		21

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$ kJ mol ⁻¹	S° J mol ⁻¹ K ⁻¹	C_p° J mol ⁻¹ K ⁻¹	Ref.
NpOCl ₂ (s)		-1037.600 13.0	141.00 8.40		19
Na ₂ NpO ₂ CO ₃ ·3.5H ₂ O (s)	-2601.000 10.0		314.00 50.00	269.00	22
Np(C ₂ O ₄) ₂ (s)	-1975.000 21.0				21
Np(HPO ₄) ₂ (s)	-2858.000 14.0		200.00 20.00	224.00	22
Na ₂ Np ₂ O ₇ (s)		-2887.000 1.2			13
NpO ₂ ++	-795.800 5.4	-860.600 4.6	-92.90 8.00	10.00	1,12,22
NpO ₂ +	-915.000 5.4	-978.200 4.6	-20.90 8.00	92.00	1,12,22
Np+++	-502.900 7.5	-556.100 4.2	-389.10 21.00	-55.00	1,12,16
Np++	-517.100 3.3	-527.200 2.1	-179.10 6.40	-60.00	1,12,22
NpO ₂ OH+	-1003.530 5.0	-1102.990 6.0	24.00 60.00	64.00	3,22
(NpO ₂) ₂ (OH) ₂ ++	-2029.380 10.0	-2247.240 10.0	-14.00 50.00	-32.00	3,22
(NpO ₂) ₃ (OH) ₅ +	-3473.200 17.0	-3897.550 17.0	116.00 50.00	16.00	3,22
NpO ₂ OH(aq)	-1101.610 5.0		25.00 60.00	0.00	3,22
NpOH+++	-731.520 10.0	-797.160 50.00	-197.00 50.00	-18.00	3,16
Np(OH) ₂ ++	-961.000 15.0	-1050.400 15.0	-44.00 80.00	-15.00	22
Np(OH) ₃ +	-1181.000 20.0	-1313.705 20.0	44.00 110.00	55.00	22
Np(OH) ₄ (aq)	-1397.000 20.0		75.00 130.00	0.00	22
Np(OH) ₅ -	-1607.000 40.0		96.00 170.00	-67.00	22
NpO ₂ F+	-1100.800 7.0	-1191.715 7.0	-14.00 80.00	86.00	7,22
NpO ₂ F ₂ (aq)	-1403.250 6.0	-1527.735 6.0	40.00 80.00	0.00	7,22
NpO ₂ F(aq)	-1202.000 7.0	-1278.825 9.0	100.00 100.00	0.00	9,22
NpF+++	-824.220 8.0	-888.270 8.0	-247.00 50.00	-20.00	5,22
NpO ₂ Cl+	-925.310 5.0	-1015.180 5.0	0.00 150.00	432.00	8,22
NpO ₂ Cl ₂ (aq)	-1053.700			0.00	8
NpO ₂ Cl(aq)	-1044.000 10.0	-1129.892 10.0	80.00	0.00	22
NpCl+++	-636.000 9.0	-703.475 9.0	-260.00 150.00	273.00	22
NpO ₂ SO ₄ -	-1658.950 10.0	-1866.892 10.0	70.00 50.00	-281.00	7,22

Substance	$^{-f}G_0$ kJ mol $^{-1}$	$^{-f}H_0$	S_0 J mol $^{-1}$ K $^{-1}$	C_{p0} K $^{-1}$	Ref.
NpO ₂ SO ₄ (aq)	-1559.000 6.0	-1749.792 6.0	57.00 100.00	0.00	17,22
NpCl ₂ ++	-765.000 9.0	-795.795 10.0	40.00 200.00	-63.00	22
NpSO ₄ ++	-1279.000 10.0	-1444.790 10.0	-195.00 50.00	71.00	7,22
Np (SO ₄) ₂ (aq)	-2048.000 10.0		-27.00 70.00	0.00	22
NpO ₂ HCO ₃ (aq)	-1514.000 10.0			0.00	10
NpO ₂ (HCO ₃) ₂ -	-2109.400 10.0				10
NpO ₂ (CO ₃) ₂ --	-1933.000 11.0	-2184.050 14.0	170.00 130.00	-382.00	22
NpO ₂ (CO ₃) ₃ -----	-2494.500 10.0	-2925.220 10.0	12.00 50.00	134.00	11,22
NpO ₂ CO ₃ -	-1476.500 8.0	-1606.205 8.0	200.00 200.00	-20.00	11,22
NpO ₂ (CO ₃) ₂ ---	-2011.200 8.0	-2300.100 9.0	110.00 200.00	149.00	11,22
NpO ₂ (CO ₃) ₃ -----	-2547.100 8.0	-2977.315 9.0	80.00 50.00	438.00	11,22
Np (CO ₃) ₅ -----	-3361.000 14.0	-3912.310 15.0	160.00 200.00	771.00	22
NpO ₂ HPO ₄ (aq)	-1932.000 8.0		10.00 200.00	0.00	22
NpO ₂ H ₂ P ₂ O ₄ +	-1940.000 8.0		-50.00 200.00	106.00	22
NpO ₂ HPO ₄ -	-2025.000 6.0		180.00 200.00	266.00	22
NpO ₂ H ₂ P ₂ O ₄ (aq)	-2049.000 6.0		20.00 200.00	0.00	22
NpH ₂ P ₂ O ₄ ++	-1661.000 10.0		-146.00 200.00	42.00	22
Np (H ₂ P ₂ O ₄) ₂ +	-2799.000 10.0		-180.00 200.00	182.00	22
Np (H ₂ P ₂ O ₄) ₃ (aq)	-3941.000 20.0		-245.00 200.00	0.00	22
NpHPO ₄ ++	-1666.000 20.0		-150.00 200.00	45.00	22
Np (HPO ₄) ₂ (aq)	-2817.000 20.0		-120.00 200.00	0.00	22
Np (HPO ₄) ₃ --	-3962.000 20.0		0.00 200.00	-228.00	22
Np (HPO ₄) ₄ ----	-5107.000 20.0		80.00 200.00	515.00	22
Np (HPO ₄) ₅ -----	-6246.000 20.0		160.00 200.00	999.00	22

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 * Aqueous *
 * Solutions *
 * Database *

NITROGEN
 Gases:
 Aqueous Species
 September 1984

PROPERTIES OF ELEMENTAL NITROGEN:

Atomic Number: 7
 Formula Mass: 14.0067
 Electronic Configuration: 1s2 2s2 2p3
 Electronegativity: 3.0
 Hydration Number:
 Ionic Radius: 1.48 angstrom (NH4+)
 Selected Average for Soils: 1400 ug/kg (1400 ppm)
 Concentration in Natural Waters: 10-100 ug/L; 5.6 mg/L (Tuff)

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$	S° J mol ⁻¹ K ⁻¹	C_p° K ⁻¹	Ref.
NH3(g)	- 16.450	- 45.940 0.4	192.67 0.08	35.06	1,4
NH3(aq)	- 26.500	- 80.290	111.30	86.40 4.0	1,3,6
NH4OH(aq)	- 263.650	- 366.121	181.20	134.00	1
NH4+	- 79.310	- 133.260 0.3	111.17 0.75	79.90	1,2
NH2COO-	- 378.899	- 510.520	61.10	- 80.00	3

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OXYGEN
Gases;
Aqueous Species
September 1984

* Aqueous *
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PROPERTIES OF ELEMENTAL OXYGEN:

Atomic Number: 8
Formula Mass: 15.9994 for O
Electronic Configuration: 1s2 2s2 2p4
Electronegativity: 3.5
Hydration Number: 6.1 for OH-
Ionic Radius:
Selected Average for Soils: 490,000 mg/kg
Concentration in Natural Waters:

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$	S° J mol ⁻¹ K ⁻¹	C_p° K ⁻¹	Ref.
O2 (g)	0.000	0.000	205.04 0.03	29.36	10,18
O2 (aq)	16.400	- 12.000 0.1	110.90	205.00 2.0	5,10,37
H2O (g)	- 228.572	- 241.818	188.83	33.58	10
H2O (l)	- 237.129	- 285.830	69.91	75.29	10
OH-	- 157.244	- 230.025 0.0	- 10.71 0.20	-138.00	10,18,31

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 * Aqueous *
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PHOSPHORUS
 Solids
 Aqueous
 September 1984

PROPERTIES OF ELEMENTAL PHOSPHORUS:

Atomic Number: 15
 Formula Mass: 30.9738
 Electronic Configuration: 3s² 3p³
 Electronegativity: 2.1
 Hydration Number:
 Ionic Radius:
 Selected Average for Soils: 600 mg/kg
 Concentration in Natural Waters:

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$	S° J mol ⁻¹ K ⁻¹	C_p° K ⁻¹	Ref.
P (s)	0.000	0.000	41.09 0.25	23.84	2,3
PO ₄ ---	-1018.700	-1277.400 4.2	-220.30 8.40	-496.00 20.0	1,7
HPO ₄ --	-1089.150	-1292.140 2.1	-36.65 1.30	-254.00 4.0	1,3,5
H ₂ PO ₄ -	-1130.280	-1296.290 2.1	90.37 1.30	-34.00 4.0	1,3,7
H ₃ PO ₄ (aq)	-1142.540	-1288.340 2.1	161.10 4.20	94.00 4.0	1,4,6

PHOSPHORUS
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September 1984

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 * Aqueous *
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PLUTONIUM
 Solids;
 Aqueous Species
 September 1984

PROPERTIES OF ELEMENTAL PLUTONIUM:

Atomic Number: 94
 Formula Mass: 239.05
 Electronic Configuration: 5f6 7s2
 Electronegativity:
 Hydration Number:
 Ionic Radius: 1.00 angstrom (Pu3+); 0.90 angstrom (Pu4+)
 Selected Average for Soils:
 Concentration in Natural Waters:

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	$^{-}fG_o$ kJ mol-1	$^{-}fH_o$	S_o J mol-1 K-1	C_{p_o} K-1	Ref.
Pu (s)	0.000	0.000	56.10 0.42	32.84 0.3	1,10
PuO2 (s)	- 998.000 0.8	-1056.192 0.8	66.13 0.25	66.25	2
Pu2O3 (s)	-1594.000 21.0	-1681.841 21.0	127.00 8.00	123.74	2
PuO2 (OH) 2 (s)	-1211.000 8.0	-1363.213 8.0	104.00 13.00	112.00	2
PuO2 (OH) (am)	-1056.000 8.0		87.00 8.00	86.00	2
Pu (OH) 4 (s)	-1426.000 29.0	-1611.096 29.0	107.00 21.00	131.00	2
Pu (OH) 3 (s)	-1162.000 7.0	-1301.745 7.0	92.00 8.00	105.00	2
PuF4 (s)	-1684.000 33.0	-1741.405 33.0	147.30 0.40	116.25	2
PuF3 (s)	-1482.000 13.0	-1555.885 13.0	126.10 0.40	92.60	2
PuO2HPO4 (s)	-1918.000 13.0		154.00 8.00	159.00	2
Pu (HPO4) 2 (s)	-2818.000 8.0		187.00 17.00	224.00	2
Pu (SO4) 2 (s)	-2012.504 41.8	-2238.440 41.8	184.10 2.00		11
PuO2++	- 756.900 7.1	- 822.200 6.7	- 88.00 8.00	11.00	1,2
PuO2+	- 849.800 7.5	- 914.600 5.9	- 21.00 8.00	98.00	1,2
Pu++++	- 481.600 3.3	- 536.400 3.3	-389.00 21.00	- 63.00	1,2

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$	S° J mol ⁻¹ K ⁻¹	C_p° K ⁻¹	Ref.
Pu+++	- 578.600 3.3	- 592.000 2.1	-184.00 6.00	- 61.00	1,2
PuO2OH+	- 961.900 8.0	-1062.600 8.0	26.00 80.00	70.00	2
(PuO2) 2 (OH) 2++	-1941.000 13.0	-2157.900 13.0	0.00 80.00	- 53.00	2
(PuO2) 3 (OH) 5+	-3333.000 21.0	-3756.300 21.0	140.00 80.00	2.00	2
PuO2OH (aq)	-1032.000 13.0	-1131.504 12.0	96.00 200.00	0.00	2
PuOH+++	- 715.900 20.0	- 774.000 20.0	-167.00 40.00	- 69.00	2
Pu (OH) 2++	- 942.700 20.0	-1033.700 20.0	- 44.00 80.00	- 16.00	2
Pu (OH) 3+	-1163.000 20.0	-1297.300 20.0	44.00 110.00	59.00	2
Pu (OH) 4 (aq)	-1376.000 20.0	-1570.600 20.0	75.00 130.00	238.00	2,5
Pu (OH) 5-	-1582.000 20.0	-1839.900 20.0	96.00 170.00	- 66.00	2
PuOH++	- 770.300 4.2	- 824.600 4.2	- 88.00 40.00	9.00	2
PuO2F+	-1071.000 8.0	-1162.800 8.0	- 10.00 80.00	91.00	2
PuO2F2 (aq)	-1383.000 8.0	-1534.600 8.0	- 44.00 80.00	0.00	2,10
PuO2F3-	-1693.000 8.0	-1857.700 8.0	79.00 80.00	-273.00	2
PuO2F4--	-1991.000 8.0	-2203.600 8.0	85.00 80.00	- 75.00	2
PuF+++	- 808.800 8.0	- 866.802 8.0	-167.00 130.00	- 69.00	2
PuO2Cl+	- 887.000 8.0	- 978.100 8.0	4.00 130.00	436.00	2
PuCl+++	- 618.000 4.0	- 686.300 4.0	-257.00 130.00	266.00	2
PuCl2SO4 (aq)	-1520.000 9.0	-1711.600 9.0	61.00 100.00	360.00	2
PuSO4++	-1259.000 8.0	-1433.500 8.0	-218.00 30.00	88.00	2
PuSO4+	-1343.000 5.0	-1487.200 5.0	- 50.00 30.00	113.00	2
PuO2 (CO3) 2--	-1898.000 13.0	-2149.500 13.0	175.00 130.00	-379.00	2
PuCO3++	-1242.000 21.0	-1400.500 21.0	-233.00 200.00	134.00	2

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SILICON
 Solids:
 Aqueous Species
 September 1984

PROPERTIES OF ELEMENTAL SILICON:

Atomic Number: 14
 Formula Mass: 28.0855
 Electronic Configuration: 3s² 3p²
 Electronegativity: 1.8
 Hydration Number:
 Ionic Radius: 1.17 angstrom covalent
 Selected Average for Soils: 320,000 mg/kg
 Concentration in Natural Waters: 11-92 mg/L in tuff,
 basalt, granite waters

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	⁻ fGo kJ mol ⁻¹	⁻ fHo	So J mol ⁻¹ K ⁻¹	Cpo K ⁻¹	Ref.
SiO2(quartz)	- 856.281 1.0	- 910.700 1.0	41.46 0.20	44.51	8,9
SiO2(cristobalite)	- 854.019	- 907.864	43.36	44.89	9
SiO2(tridymite)	- 853.812 2.4	- 907.488 2.4	43.93 0.42	44.60	3
SiO2(stishovite)	- 802.827 22.1	- 861.318 2.1	27.78 0.42	42.97	3
SiO2(amorphous)	- 849.233	- 901.554	48.48	44.06	9,11
SiO2(silica glass)	- 850.559 2.1	- 903.200 2.1	47.40	37.94	3,11
SiO2(coesite)	- 850.850 2.1	- 905.584 2.1	40.36 0.42	45.40	3
SiO2(soil)	- 851.438				11
H2SiO3(aq)	-1079.400	-1182.800	109.00		1
Si(OH)4(aq)	-1308.000 1.7	-1460.000 1.7	180.00 4.20	215.00	2,3,10
SiO(OH)3-	-1251.900 1.7	-1434.400 1.7	77.84 4.00	51.10 11.0	5
SiO2(OH)2--	-1176.820	-1396.620	- 12.90	-280.00	2,11
SiO3(OH)---	-1120.477				11
SiO4----	-1045.700	-1352.700	-402.00		2,11
Si4O6(OH)6--	-4207.447				11
Si4O8(OH)4----	-4081.820				12

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 * Aqueous *
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STRONTIUM
 Solids;
 Aqueous Species
 November 1984

PROPERTIES OF ELEMENTAL STRONTIUM:

Atomic Number: 38
 Formula Mass: 87.62
 Electronic Configuration: 5s2
 Electronegativity: 1.0
 Hydration Number:
 Ionic Radius: 1.27 angstrom (Sr++)
 Selected Average for Soils: 200 mg/kg
 Concentration in Natural Waters: 5-15 mg/L in brines; 0.05 mg/L (Tuff)

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$	So J mol ⁻¹ K ⁻¹	Cpo	Ref.
alpha-Sr (s)	0.000	0.000	52.30	26.40	1
SrO (s)	- 561.900	- 592.000	54.40	45.02	1
Sr (OH) 2 (s)	- 882.475	- 968.889	97.07	74.90	11
		9.2	8.40		
SrF2 (s)	-1164.800	-1216.300	82.13	70.00	1
alpha-SrCl2 (s)	- 781.100	- 833.700	114.85	75.60	1, 15
		1.0			
SrSO4 (s)	-1340.900	-1453.100	117.00		1
SrCO3 (s)	-1140.100	-1220.100	97.10	81.42	1
SrSiO3 (s)	-1549.700	-1633.900	96.70	88.53	1
Sr2SiO4 (s)	-2191.100	-2304.500	153.10	134.26	1
Sr++	- 559.480	- 550.700	- 47.60	- 20.90	1, 10, 15
		1.0	0.90		
SrOH+	- 721.300	- 770.770	- 9.90		1, 10
	0.8				
SrF+	- 844.210				10
	0.8				
SrCl2 (aq)	- 821.910	- 884.800	80.30		1, 15, 17
		1.0			
SrHCO3+	-1153.390	-1215.560	158.50		10, 16
	1.0	1.0	5.10		
Sr (HCO3) 2 (aq)		-1928.000			1
SrSO4 (aq)	-1315.990	-1449.970	44.80		10
SrCO3 (aq)	-1109.670	-1208.050	35.50		10

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 * Aqueous *
 * Solutions *
 * Database *

SULFUR
 Solids;
 Aqueous Species
 September 1984

PROPERTIES OF ELEMENTAL SULFUR:

Atomic Number: 16
 Formula Mass: 32.06
 Electronic Configuration: 3s² 3p⁴
 Electronegativity: 2.44 (6)
 Hydration Number:
 Ionic Radius: 1.90 angstrom (S²⁻); 2.40 (SO₄²⁻)
 Selected Average for Soils: 700 mg/kg (ppm) (7)
 Concentration in Natural Waters: 19-108 mg/L SO₄²⁻ in
 Tuff, Basalt, Granite waters

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	^o fG ₀ kJ mol ⁻¹	^o fH ₀	S ₀ J mol ⁻¹ K ⁻¹	C _{p0} K ⁻¹	Ref.
S(s)	0.000	0.000	31.80	22.64	1
H ₂ S(g)	- 33.560	- 20.630	205.79	34.24	1,4
				0.0	
H ₂ S(aq)	- 27.830	- 39.700	121.00	178.50	1,4
				1.9	
HS ⁻	12.080	- 17.600	62.80	- 92.00	1,4
				1.0	
S ²⁻	85.800	33.100	- 14.60	-400.40	1,2
SO ₂ (g)	- 300.194	- 296.810	248.11	39.87	1,11
		0.2	0.06		
SO ₂ (aq)	- 300.676	- 322.980	161.90	195.00	1,5
				10.0	
SO ₃ ²⁻	- 486.500	- 635.500	- 29.00	-268.20	1,2
HSO ₃ ⁻	- 527.730	- 626.220	139.70	- 10.00	1,5
				4.0	
H ₂ SO ₃ (aq)	- 537.810	- 608.810	232.20	293.00	1,2
SO ₄ ²⁻	- 744.530	- 909.600	18.83	-278.00	1,3,11
		0.4	0.50	4.0	
HSO ₄ ⁻	- 755.910	- 887.340	134.31	22.00	1,3,12
			1.30	8.0	

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENATES
 rc = AS4
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{AsO}_4(\text{aq}) + \text{OH}^- = \text{H}_2\text{AsO}_4^- + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 62865
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 13.62
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ : - 53.21
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ :
 $\log K_0$: 11.72

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	11.72	10.86	10.11	9.45	8.32	7.39	6.62	5.96
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES:

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 Solids;
 Aqueous Species
 September 1984

PROPERTIES OF ELEMENTAL URANIUM:

Atomic Number: 92
 Formula Mass: 238.0290 for U
 Electronic Configuration: 5f3 6s2 6p6 6d1 7s2
 Electronegativity: U++++ = 1.4; UO2++ = 1.9
 Hydration Number: UO2++ = 7.35
 Ionic Radius: 1.025 angstrom (U+++); 0.93 angstrom (U++++)
 Selected Average for Soils:
 Concentration in Natural Waters: 3.3 ug/L in sea water

THERMODYNAMIC PROPERTIES OF SUBSTANCES: 25 C; I=0

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$ kJ mol ⁻¹	So J mol ⁻¹ K ⁻¹	Cpo K ⁻¹	Ref.
U (s)	0.000	0.000	50.21 0.13	27.67 0.0	10, 51
UO2 (s)	-1031.700 1.0	-1084.900 1.0	77.03 0.20	63.60	10, 18
alpha-U3O8 (s)	-3369.700 3.0	-3574.800 2.5	282.59 0.50	238.36	10, 18
gamma-UO3 (s)	-1145.900 20.0	-1223.800 2.0	96.11 0.40	81.67	10, 18
UO3.2H2O (s)	-1633.900 2.9	-1827.200 2.1	176.00 8.00	200.20	10, 50
U4O9 (s)	-4275.100	-4510.400	334.13	293.34	10
beta-UO2(OH) 2 (s)	-1394.000 4.0	-1534.700 4.0	141.80	85.79	4, 9
UO2 (OH) 2. H2O (s)	-1633.400	-1825.900	178.20		12
UF6 (s)	-2068.500	-2197.000	227.60 1.7 1.30	166.77 0.2	10, 51
UF4 (s)	-1823.300	-1914.200 4.1	151.67 0.17 0.1	116.02 0.1	10, 51
UF4 2.5H2O (s)	-2408.000 13.0	-5262.490 15.0	289.00 25.00	263.70	4
UC16 (s)	- 962.000	-1092.000 13.0	285.80 1.70	175.70 4.1	10, 51
UC12 (s)	- 996.200	-1066.900 2.5	138.32 0.20	95.06 0.4	10, 51
UO2CO3 (s)	-1562.600 2.0	-1691.200 8.00	138.10 8.00	125.50	4, 50
beta-UO2SO4 (s)	-1685.915 2.5	-1845.100 0.8	163.17 8.00	144.90	50
U (SO4) 2 (s)	-2084.900 14.6	-2309.600 12.6	180.00 21.00		50

Substance	$^{\circ}\text{fGo}$ kJ mol ⁻¹	$^{\circ}\text{fHo}$	So J mol ⁻¹ K ⁻¹	Cpo	Ref.
(UO ₂) 3 (PO ₄) 2 (s)	-5167.000 17.0	-6008.200 17.0	406.00 21.00	357.00	4,9,12
(UO ₂) 2 (HPO ₄) 2 (s)	-4218.000 13.0	-4577.300 13.0	331.00 17.00	298.00	4,12
U (HPO ₄) 2.4H ₂ O (s)	-3811.000 3.0	-4305.300 3.0	356.00 17.00	460.00	4,12
USiO ₄ (s)	-1891.200	-1999.900	117.10		12
(NH ₄) 2 (UO ₂) 2 (PO ₄) 2 (s)	-4397.400	-4899.500	439.30		12
Na ₂ (UO ₂) 2 (PO ₄) 2 (s)	-4736.300	-5071.000	393.30		12
K ₂ (UO ₂) 2 (PO ₄) 2 (s)	-4782.300	-5121.200	405.80		12
Mg (UO ₂) 2 (PO ₄) 2 (s)	-4648.400	-4974.800	343.10		12
Ca (UO ₂) 2 (PO ₄) 2 (s)	-4748.800	-5075.200	351.50		12
Sr (UO ₂) 2 (PO ₄) 2 (s)	-4757.200	-5083.600	364.00		12
Ba (UO ₂) 2 (PO ₄) 2 (s)	-4757.200	-5087.700	368.20		12
Fe (UO ₂) 2 (PO ₄) 2 (s)	-4276.000	-4598.200	355.60		12
Cu (UO ₂) 2 (PO ₄) 2 (s)	-4133.800	-4460.100	355.60		12
Pb (UO ₂) 2 (PO ₄) 2 (s)	-4220.700	-4548.000	376.60		12
K ₂ (UO ₂) 2 (VO ₄) 2 (s)	-4589.800	-4912.000	439.30		12
Ca (UO ₂) 2 (VO ₄) 2 (s)	-4560.600	-4870.100	384.90		12
alpha-Na ₂ U ₂ O ₇ (s)	-3002.400	-3194.700	275.86		15
		1.4	0.83		
Cs ₂ U ₂ O ₇ (s)	-3003.300 5.0	-3220.200 1.8	332.00 8.00		15,50
Li ₂ UO ₄ (s)	-1847.200 2.9	-1971.900 1.7	133.00 6.00		15
alpha-Na ₂ UO ₄ (s)	-1778.300	-1897.000	166.02		15
		1.0			
beta-Na ₂ UO ₄ (s)		-1886.000			15
		1.0			
K ₂ UO ₄ (s)	-1789.100 2.5	-1921.300 1.7	180.0 6.30		15,50
Cs ₂ UO ₄ (s)	-1803.801 4.2	-1926.314 4.2	219.66 0.46	152.76	50
Li ₄ UO ₅ (s)		-2641.000			15
beta-Na ₄ UO ₅ (s)		-2451.000			15
MgU ₃ O ₁₀ (s)			338.50		15
Ca ₂ U ₂ O ₇ (s)		-3335.000			15
Sr ₂ U ₂ O ₇ (s)		-5239.000			15
MgUO ₄ (s)	-1749.213 1.3	-1856.900 1.3	131.90	128.10	15,50
CaUO ₄ (s)	-1895.043 3.3	-2001.626 2.1	144.35 8.00	129.56	50
alpha-SrUO ₄ (s)		-1987.000			15
beta-SrUO ₄ (s)		-1988.000			15
BaUO ₄ (s)	-1883.690 3.3	-1986.237 2.1	174.47 8.00	133.50	50
Sr ₂ UO ₅ (s)		-2630.000			15
		2.5			
Ca ₃ UO ₆ (s)		-3302.000			15
		3.0			
Sr ₃ UO ₆ (s)		-3260.000			15
		4.0			
Ba ₃ UO ₆ (s)		-3210.600			15
		4.1			

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$ kJ mol ⁻¹	S° J mol ⁻¹ K ⁻¹	C_p° J mol ⁻¹ K ⁻¹	Ref.
Ba ₂ HgUO ₆ (s)		-3245.300 4.8			15
Ba ₂ CaUO ₆ (s)		-3294.000 5.0			15
NiU ₃ O ₈ (s)	358.000	-3942.000			15
LiUO ₃ (s)		-1522.100 1.7			15
NaUO ₃ (s)	-1412.200	-1494.600 1.6	132.84 0.13		15
KUO ₃ (s)		-1522.900 1.6			15
RbUO ₃ (s)		-1520.900 1.7			15
Na ₃ UO ₄ (s)	-1897.965 2.5	-2022.127 2.5	198.20 0.42	173.01	50
CaU ₂ O ₆ (s)		-3210.000			15
KUO ₂ PO ₄ · 3H ₂ O (s)	-3102.000 8.0				9
UO ₂ ++	- 952.700 2.1	-1019.600 1.7	- 97.10 3.80	5.00	3,4
UO ₂ +	- 968.600 5.4	-1032.600 5.9	- 25.00 8.00	98.00	3,4
U+++	- 530.900 2.1	- 591.200 2.1	-414.00 21.00	- 48.00	3,4
U++	- 480.700 4.6	- 489.100 3.8	-174.90 6.40	- 64.00	3,4
UO ₂ (OH)+	-1157.000 3.0	-1259.040 3.0	16.00 25.00	64.00	4,12
UO ₂ (OH) 2 (aq)	-1359.000 5.0	-1515.000 17.00	59.00	0.00	4,12
(UO ₂) 2 (OH) 2++	-2348.000 5.0	-2568.700 5.0	- 19.00 17.00	- 42.00	4,12,50
(UO ₂) 3 (OH) 5+	-3955.000 7.0	-4381.000 7.0	111.00 17.00	7.00	4,12,50
(UO ₂) 3 (OH) 7-	-4343.000 20.0		299.00 80.00	840.00	4
UOH+++	- 764.000 8.0	- 828.000 8.0	-192.00 40.00	- 54.00	4,12
U (OH) 2++	- 992.000 20.0	-1088.700 20.0	- 69.00 40.00	- 1.00	4,12
U (OH) 3+	-1214.000 20.0	-1353.900 20.0	19.00 40.00	74.00	4,12
U (OH) 4 (aq)	-1430.000 20.0	-1630.900 20.0	50.00 40.00	0.00	4
U (OH) 5-	-1642.000 8.0	-1904.900 8.0	71.00 40.00	-169.00	4,12
UO ₂ F+	-1264.000 3.0	-1357.300 3.0	- 19.00 20.00	85.00	4
UO ₂ F ₂ (aq)	-1567.000 3.0	-1693.300 3.0	35.00 20.00	0.00	4,12
UO ₂ F ₃ -	-1868.000 3.0	-2028.400 3.0	69.00 20.00	-255.00	4,12
UO ₂ F ₄ --	-2151.000 3.0	-2364.700 3.0	76.00 20.00	- 56.00	4,12

Substance	$\Delta_f G^\circ$ kJ mol ⁻¹	$\Delta_f H^\circ$ kJ mol ⁻¹	S° J mol ⁻¹ K ⁻¹	C_p° J mol ⁻¹ K ⁻¹	Ref.
UF ⁺⁺	- 862.000 8.0	- 907.010 8.0	-192.00 80.00	- 54.00	4,12
UF ₂ ⁺⁺	-1177.000 8.0	-1233.300 8.0	- 63.00 200.00	- 4.00	4,12
UF ₃ ⁺	-1485.000 13.0	-1567.300 13.0	13.00 200.00	78.00	4,12
UF ₄ (aq)	-1793.000 13.0	-1914.900 13.0	50.00 200.00	101.00	4,12
UF ₅ ⁻	-2084.000 17.0	-2249.600 17.0	71.00 200.00	-125.00	4,12
UF ₆ ⁻⁻	-2379.000 17.0	-2589.500 17.0	84.00 200.00	14.00	4,12
UO ₂ Cl ⁺	-1094.000 8.0	-1186.500 8.0	- 6.00 80.00	427.00	4
UCl ⁺⁺⁺	- 677.000 8.0	- 751.000 8.0	-283.00 80.00	287.00	4,12
UO ₂ SO ₄ (aq)	-1714.000 4.0	-1907.200 4.0	52.00 60.00	354.00	4,12
UO ₂ (SO ₄) ₂ ⁻⁻	-2466.000	-2812.500	106.30		12
U (SO ₄) ₂ (aq)	-2076.000 17.0	-2378.600 17.0	-110.00 50.00	158.00	4,12
UO ₂ CO ₃ (aq)	-1538.000 3.0	-1708.400 3.0	0.00 60.00	496.00	4,50
UO ₂ (CO ₃) ₂ ⁻⁻	-2106.000 2.0	-2359.300 2.0	166.00 80.00	-387.00	4,12
UO ₂ (CO ₃) ₃ ⁻⁻⁻⁻	-2659.000 2.0	-3086.900 2.0	7.00 8.00	294.00	4,12
(UO ₂) ₂ CO ₃ (OH) ₂ ⁻					41
UO ₂ H ₂ PO ₄ (aq)	-2090.000 42.0	-2304.900 42.0	50.00 200.00	0.00	4,12
UO ₂ (HPO ₄) ₂ ⁻⁻	-3237.000 42.0	-3622.900 42.0	126.00 200.00	354.00	4,12
UO ₂ H ₂ PO ₄ ⁺	-2100.000 3.0	-2311.700 3.0	63.00 200.00	36.00	4,12
UO ₂ (H ₂ PO ₄) ₂ (aq)	-3245.000 4.0	-3242.600 4.0	84.00 200.00	0.00	4,12
UO ₂ (H ₂ PO ₄) ₃ ⁻	-4385.000 4.0	-4970.600 4.0	105.00 200.00	43.00	4,12
UHPH ₄ ⁺⁺	-1689.000 21.0	-1837.200 21.0	- 63.00 200.00	- 4.00	4,12
U (HPO ₄) ₂ (aq)	-2835.000 21.0	-3138.800 21.0	63.00 200.00	0.00	4,12
U (HPO ₄) ₃ ⁻⁻	-3774.000 21.0	-4455.900 21.0	105.00 200.00	194.00	4,12
U (HPO ₄) ₄ ⁻⁻⁻⁻	-5109.000 21.0	-5811.600 21.0	21.00 200.00	302.00	4,12
UO ₂ SiO ₃ (OH) ₂ ³⁺	-2246.800				12

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APPENDIX II

Appendix II tabulates thermochemical data for selected chemical reactions, mainly for application to nuclear waste disposal. Data given are as follows:

Enthalpy change for reaction, $\Delta_r H^\circ$ ($^{\circ}\text{rHo}$)

Entropy of reaction, $\Delta_r S^\circ$ ($^{\circ}\text{So}$)

Heat capacity of reaction, $\Delta_r C_p^\circ$ ($^{\circ}\text{Cpo}$)

Debye-Huckel factor for the reaction, $A \Delta z^2$ ($\text{Ay}^{\wedge}22$)

Intrinsic equilibrium constant, $\log K^\circ$ ($\log\text{Ko}$)

b, coefficient of bI term in Debye-Huckel equation

(B9) coefficient of $(1 + (\text{B9}) I^{1/2})$ term in Debye-Huckel equation

Q, equilibrium quotient, at value of I, T shown

T, temperature, $^{\circ}\text{C}$

I, ionic strength

The elements are in alphabetical order; references are given at the end of each printout, for each element.

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 HYDROXIDES
 rc = AM1
 September 1984

EQUILIBRIUM REACTION: $\text{Am}^{+++} + \text{H}_2\text{O} = \text{AmOH}^{++} + \text{H}^+$

THEMOCHEMICAL PROPERTIES:

$^{\circ}\text{H}_0$, J mol⁻¹ : 70710
 $^{\circ}\text{S}_0$, J mol⁻¹ K⁻¹ : 83.99
 $^{\circ}\text{C}_p$, J mol⁻¹ K⁻¹ :
 $\Delta_f^{\circ} \text{z}_2$, (kg mol⁻¹)^{1/2} : - 2.04
 b , kg mol⁻¹ : -0.25
 $\log K_0$: - 8.00
 $B_9 = 3.22$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 8.00	- 7.04						
0.01	- 8.16							
0.10	- 8.34							
0.20	- 8.42							
0.50	- 8.57							
1.00	- 8.73							
2.00	- 9.02							
3.00	- 9.29							

REFERENCES: 10;11;14;15;16

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 HYDROXIDES
 rc = AM2
 September 1984

EQUILIBRIUM REACTION: $\text{Am}^{+++} + \text{OH}^- = \text{AmOH}^{++}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 14905
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 164.65
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ :
 $\Delta_f H_o$, (kg mol⁻¹) 1/2 : - 3.06
 b , kg mol⁻¹ : 0.38
 $\log K_o$: 5.99

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	5.99	6.23						
0.01	5.72							
0.10	5.29							
0.20	5.12							
0.50	4.91							
1.00	4.84							
2.00	4.96							
3.00	5.19							

REFERENCES: 1;2;10

COMMENTS: Values are for NdOH⁺⁺, see Reference 11, p.191.

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 HYDROXIDES
 rc = AM16
 November 1984

EQUILIBRIUM REACTION: $\text{Am}^{+++} + 2\text{H}_2\text{O} = \text{Am}(\text{OH})_2^+ + 2\text{H}^+$

THEMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ :
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 $\Delta_f G^\circ$, kg mol⁻¹ :
 log K_o : -16.90

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-16.90							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 14

COMMENTS: Based on value for $\text{Md}(\text{OH})_2^+$.

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 HYDROXIDES
 IC = AM17
 November 1984

EQUILIBRIUM REACTION: $\text{Am}^{+++} + 3\text{H}_2\text{O} = \text{Am}(\text{OH})_3(\text{aq}) + 3\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ :
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: -26.50

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	-26.50							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 14

COMMENTS: Based on $\text{Nd}(\text{OH})_3(\text{aq})$.

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 FLUORIDES
 IC = AN3
 September 1984

EQUILIBRIUM REACTION: $\text{Am}^{++} + \text{HF}(\text{aq}) = \text{AmF}^{+} + \text{H}^{+}$

THERMOCHEMICAL PROPERTIES:

ΔH_f° , J mol⁻¹ :
 ΔS_f° , J mol⁻¹ K⁻¹ :
 ΔC_p° , J mol⁻¹ K⁻¹ :
 $\Delta y^\circ z_2$, (kg mol⁻¹)^{1/2} : - 2.04
 b , kg mol⁻¹ : -1.56
 $\log K_o$: 2.14

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	2.14							
0.01	1.94							
0.10	1.49							
0.20	1.20							
0.50	0.52							
1.00	- 0.44	- 0.40	- 0.30	- 0.20	0.20	0.70	1.30	1.80
2.00	- 2.18							
3.00	- 3.83							

REFERENCES: 7;10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 FLUORIDES
 IC = 184
 September 1984

EQUILIBRIUM REACTION: $\text{Am}^{3+} + \text{F}^- = \text{AmF}^{2+}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ :
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f^\circ \text{X}_2$, (kg mol⁻¹)^{1/2} : - 3.06
 b , kg mol⁻¹ : -1.26
 $\log K_o$: 5.29

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	5.29							
0.01	5.00							
0.10	4.43							
0.20	4.09							
0.50	3.39							
1.00	2.50	2.71	2.97	3.25	3.88	4.55	5.23	5.90
2.00	0.98							
5.00	- 0.43							

REFERENCES: 10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 FLUORIDES
 CC = AM5
 September 1984

EQUILIBRIUM REACTION: $\text{Am}^{+++} + 2\text{F}^- = \text{AmF}_2^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ :
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ :
 $\Delta_f \Delta_2$, (kg mol⁻¹)^{1/2} : - 5.10
 b , kg mol⁻¹ :
 $\log K_o$: 7.40

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	7.40							
0.01								
0.10								
0.20								
0.50	6.11							
1.00								
2.00								
3.00								

REFERENCES: 10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 FLUORIDES
 rc = AN6
 September 1988

EQUILIBRIUM REACTION: $\text{Am}^{3+} + 3\text{F}^- = \text{AmF}_3(\text{ag})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ :
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : - 6.12
 b , kg mol⁻¹ :
 $\log K_o$: 10.60

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	10.60							
0.01								
0.10								
0.20								
0.50	9.00							
1.00								
2.00								
5.00								

REFERENCES: 10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 CHLORIDES
 rc = AN7
 September 1984

EQUILIBRIUM REACTION: $\text{Am}^{3+} + \text{Cl}^- = \text{AmCl}^{2+}$

TERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ :
 ΔS_o , J mol⁻¹ K⁻¹ :
 ΔG_o , J mol⁻¹ K⁻¹ :
 $\Delta G^{\circ} z_2$, (kg mol⁻¹)^{1/2} : - 3.06
 b , kg mol⁻¹ : 0.43
 $\log K_o$: 1.24

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	1.24							
0.01	0.97							
0.10	0.55							
0.20	0.38							
0.50	0.19							
1.00	0.14							
2.00	0.31							
3.00	0.59							

REFERENCES: 10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 SULFATES
 rc = AM12
 September 1984

EQUILIBRIUM REACTION: $\text{Am}^{3+} + \text{SO}_4^{--} = \text{AmSO}_4^+$

THERMOCHEMICAL PROPERTIES:

ΔH_f , J mol⁻¹ :
 ΔS_f , J mol⁻¹ K⁻¹ :
 ΔC_p , J mol⁻¹ K⁻¹ :
 $\Delta_f^\circ \text{Z}_2$, (kg mol⁻¹)^{1/2} : - 6.12
 b, kg mol⁻¹ : 0.43
 log K_o : 4.20

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	4.20							
0.01	3.65							
0.10	2.77							
0.20	2.39							
0.50	1.88							
1.00	1.57							
2.00	1.47							
∞.00	1.61							

REFERENCES: 10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 SULFATES
 IC = AM13
 September 1984

EQUILIBRIUM REACTION: $\text{Am}^{+++} + 2\text{SO}_4^{--} = \text{Am}(\text{SO}_4)_2^-$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ :
 ΔS_o , J mol⁻¹ K⁻¹ :
 ΔC_{po} , J mol⁻¹ K⁻¹ :
 $\Delta_f \Delta Z_2$, (kg mol⁻¹)^{1/2} : - 8.16
 b , kg mol⁻¹ : 1.26
 $\log K_o$: 5.48

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	5.48							
0.01	4.75							
0.10	3.65							
0.20	3.21							
0.50	2.73							
1.00	2.66							
2.00	3.22							
3.00	4.09							

REFERENCES: 10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 BICARBONATES
 IC = 188
 September 1984

EQUILIBRIUM REACTION: $\text{Am}^{3+} + \text{HCO}_3^- = \text{AmHCO}_3^{2+}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ :
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f H^\circ$, (kg mol⁻¹) ^{1/2} = - 3.06
 $\Delta_f S^\circ$, (kg mol⁻¹) ^{1/2} :
 $\log K_0$: 5.55

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	5.55							
0.01								
0.10								
0.20	4.79							
0.50								
1.00								
2.00								
3.00								

REFERENCES: 8;9;10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 DICARBONATES
 rc = AM9
 September 1984

EQUILIBRIUM REACTION: $\text{Am}^{+++} + 2\text{HCO}_3^- = \text{Am}(\text{HCO}_3)_2^+$

THEρμοCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ :
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : - 5.10
 b , kg mol⁻¹ :
 $\log K_o$: 9.42

EQUILIBRIUM QUOTIENTS: I =ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	9.42							
0.01								
0.10								
0.20	8.15							
0.50								
1.00								
2.00								
3.00								

REFERENCES: 8;9;10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 CARBOXYTES
 rc = AN10
 September 1984

EQUILIBRIUM REACTION: $\text{Am}^{+++} + \text{CO}_3^{--} = \text{AmCO}_3^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ :
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} : - 6.12
 $\Delta_f G^\circ$, kg mol⁻¹ :
 log K_o : 6.50

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	6.50							
0.01								
0.10								
0.20								
0.50								
1.00	5.81							
2.00								
3.00								

REFERENCES: 9;10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 CARBONATES
 IC = AM11
 September 1984

EQUILIBRIUM REACTION: $\text{Am}^{3+} + 2\text{CO}_3^{--} = \text{Am}(\text{CO}_3)_2^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ :
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ :
 $\Delta_f \Delta_r z^2$, (kg mol⁻¹)^{1/2} : - 8.16
 b , kg mol⁻¹ : -0.21
 $\log K_o$: 14.01

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	14.01							
0.01	13.27							
0.10	12.03							
0.20	11.45							
0.50	10.53							
1.00	9.72							
2.00	8.81							
3.00	8.21							

REFERENCES: 8;9;10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 SOLIDS
 rc = AM14
 September 1984

EQUILIBRIUM REACTION: $\text{Am}(\text{OH})_3(\text{s}) + 3\text{H}^+ = \text{Am}^{+++} + 3\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_{\text{f}}H^\circ$, J mol⁻¹ :
 $\Delta_{\text{f}}S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_{\text{f}}G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f z^2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_0$: 17.50

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	17.50							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 14

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 HYDROXIDES
 rc = AM15
 September 1984

EQUILIBRIUM REACTION: $\text{Am}(\text{OH})_3(\text{s}) = \text{Am}(\text{OH})_3(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\bar{r}\text{Ho}$, J mol⁻¹ :
 $\bar{r}\text{So}$, J mol⁻¹ K⁻¹ :
 $\bar{r}\text{Cpo}$, J mol⁻¹ K⁻¹ :
 $\Delta\bar{y}^{\circ}_f$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: - 9.00

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q						
	25 C	50 C	75 C	100 C	150 C	200 C	300 C
0.00	- 9.00						
0.01							
0.10							
0.20							
0.50							
1.00							
2.00							
3.00							

REFERENCES: 14

COMMENTS: Used data from Ref. 14 to calculate $\bar{r}\text{fGo}$ ($\text{Am}(\text{OH})_3(\text{aq})$)

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 IONS
 rc = AM30
 November 1984

EQUILIBRIUM REACTION: $4\text{Am(s)} + 3\text{O}_2(\text{g}) + 12\text{H}^+ = 4\text{Am}^{3+} + 6\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

ΔH°_f , J mol⁻¹ :
 ΔS°_f , J mol⁻¹ K⁻¹ :
 ΔC_p° , J mol⁻¹ K⁻¹ :
 $\Delta_f^\circ z^2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;19.

COMMENTS: $\log K_o = 577.66$ at 25 C and I=0

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 OXIDES
 rc = AM31
 November 1984

EQUILIBRIUM REACTION: $4\text{AmO}_2(\text{s}) + 12\text{H}^+ = 4\text{Am}^{3+} + \text{O}_2(\text{g}) + 6\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ :
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f \alpha^\circ$, (kg mol⁻¹)^{1/2} :
 $\Delta_f b^\circ$, kg mol⁻¹ :
 $\log K_o$: 49.89

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;5.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 OXIDES
 EC = AH32
 November 1984

EQUILIBRIUM REACTION: $4\text{AmO}_2(\text{s}) + 12\text{H}^+ = 4\text{Am}^{3+} + \text{O}_2(\text{aq}) + 6\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

ΔH_f° , J mol⁻¹ :
 ΔS_f° , J mol⁻¹ K⁻¹ :
 ΔC_{p0}° , J mol⁻¹ K⁻¹ :
 $\Delta y^\circ z^2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 47.01

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;5.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 OXIDES
 rc = AM18
 October 1984

EQUILIBRIUM REACTION: $\text{AmO}_2(\text{s}) + 4\text{H}^+ = \text{Am}^{4+} + 2\text{H}_2\text{O}$

THEMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 71660
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ :
 $\Delta_f \Delta Z^2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: - 6.34

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q						
	25 C	50 C	75 C	100 C	150 C	200 C	300 C
0.00	- 6.34						
0.01							
0.10							
0.20							
0.50							
1.00							
2.00							
3.00							

REFERENCES: 2;5.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 OXIDES
 PC = AM79
 January 1985

EQUILIBRIUM REACTION: $\text{Am2O3(s)} + 6\text{H}^+ = 2\text{Am}^{+++} + 3\text{H2O}$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : -398890
 ΔS_o , J mol⁻¹ K⁻¹ : -319.30
 ΔC_{po} , J mol⁻¹ K⁻¹ :
 $\Delta y^{\sim} z^2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 53.20

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	53.20							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;17.

COMMENTS: $\Delta fG_o[\text{Am2O3(s)}]$ changed to -1605.900 kJ mol⁻¹, 01/15/85 from -1415.500 for consistency with $\Delta rG = \Delta rH - T\Delta rS$.

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 HYDROXIDES
 IC = 1527
 November 1984

EQUILIBRIUM REACTION: $\text{Am}(\text{OH})_4(\text{s}) = \text{Am}^{4++} + 4\text{OH}^-$

THERMOCHEMICAL PROPERTIES:

ΔH_f° , J mol⁻¹ :
 ΔH_o° , J mol⁻¹ K⁻¹ :
 $\Delta C_{p,o}^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta f^\circ_{\text{Z}_2}$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: -52.15

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 HYDROXIDES
 rc = AM28
 November 1984

EQUILIBRIUM REACTION: $\text{Am}(\text{OH})_3(\text{s}) = \text{Am}^{+++} + 3\text{OH}^-$

THERMOCHEMICAL PROPERTIES:

Δ_{rHo} , J mol⁻¹ :
 Δ_{So} , J mol⁻¹ K⁻¹ :
 Δ_{Cpo} , J mol⁻¹ K⁻¹ :
 Δ_{y}^{-22} , (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_0$: -24.48

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 14.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 FLUORIDES
 rc = AM24
 October 1984

EQUILIBRIUM REACTION: $\text{AmF}_3(\text{s}) = \text{Am}^{3+} + 3\text{F}^-$

THEMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 34750
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -368.10
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_0$: -13.85

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	-13.85							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 5.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 CHLORIDES
 xc = AM23
 October 1984

EQUILIBRIUM REACTION: $\text{AmCl}_3(\text{s}) = \text{Am}^{+++} + 3\text{Cl}^-$

THEMOCHEMICAL PROPERTIES:

ΔH_f , J mol⁻¹ : -140140
 ΔS_f , J mol⁻¹ K⁻¹ : -195.60
 ΔC_p , J mol⁻¹ K⁻¹ :
 $\Delta \bar{v}_2^2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 14.35

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	14.35							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 5.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 BROMIDES
 IC = AX22
 October 1984

EQUILIBRIUM REACTION: $\text{AmBr}_3(\text{s}) = \text{Am}^{3+} + 3\text{Br}^-$

THERMOCHEMICAL PROPERTIES:

ΔH_f , J mol⁻¹ : -170200
 ΔS_f , J mol⁻¹ K⁻¹ : -157.50
 ΔC_p , J mol⁻¹ K⁻¹ :
 $\Delta \chi^2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 21.79

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	21.79							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 5.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 CARBONATES
 IC = AM21
 January 1985

EQUILIBRIUM REACTION: $\text{Am}_2(\text{CO}_3)_3(\text{s}) = 2\text{Am}^{++} + 3\text{CO}_3^{--}$

THERMOCHEMICAL PROPERTIES:

ΔH_f , J mol⁻¹ :
 ΔS_f , J mol⁻¹ K⁻¹ :
 ΔG_f , J mol⁻¹ K⁻¹ :
 $\Delta_f^\circ \text{Am}^{++}$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: -37.58

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-37.58							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 20.

COMMENTS: Formula for $\text{Am}_2(\text{CO}_3)_3(\text{s})$ corrected; was $\text{Am}_2(\text{CO}_3)(\text{s})$.

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 CARBONATES
 rc = AM20
 October 1984

EQUILIBRIUM REACTION: $\text{Am}(\text{OH})(\text{CO}_3)(\text{s}) + 2\text{H}^+ = \text{Am}^{3+} + \text{HCO}_3^- + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

ΔH° , J mol⁻¹ :
 ΔS° , J mol⁻¹ K⁻¹ :
 ΔC_p° , J mol⁻¹ K⁻¹ :
 $\Delta \gamma^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 1.88

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	1.88							
0.01								
0.10	2.74							
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 20.

COMMENTS: $\log K_o$ (I=0) calculated using Davies equation.

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 OXIDES
 TC = AM26
 December 1984

EQUILIBRIUM REACTION: $2\text{Am}_2\text{O}_3(\text{s}) + 16\text{H}^+ + \text{O}_2(\text{g}) = 4\text{Am}^{++} + 8\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

ΔH°_f , J mol⁻¹ : -631440
 ΔS°_f , J mol⁻¹ K⁻¹ :
 ΔC°_p , J mol⁻¹ K⁻¹ :
 $\Delta Y^\circ_{\text{Z}_2}$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 31.19

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	31.19							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES:

COMMENTS: $\Delta S^\circ_f = -1524$ for 25 C, I=0.

 * Aqueous *
 * Solutions *
 * Database *

AMERICIUM
 IONS
 IC = AM29
 November 1984

EQUILIBRIUM REACTION: $4Am(s) + 3O_2(g) + 12H^+ = 4Am^{3+} + 6H_2O$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ :
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f \alpha^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;19.

COMMENTS: $\log K_o = 669.04$ at 25 C and I=0.

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22. S° by analogy with $\text{Pu}_2\text{O}_3(\text{s})$.

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSEATES
 rc = AS3
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{AsO}_4(\text{aq}) = \text{H}_2\text{AsO}_4^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 7060
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 67.00
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 266.50
 $\Delta_f^\circ Z$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ : -0.08
 $\log K_o$: - 2.26
 $B_9 = 1.31$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol. kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 2.26	- 2.40	- 2.60	- 2.84	- 3.39	- 4.00	- 4.63	- 5.27
0.01	- 2.17							
0.10	- 2.04							
0.20	- 1.99							
0.50	- 1.93							
1.00	- 1.90							
2.00	- 1.91							
3.00	- 1.96							

REFERENCES: 1;2;3;4;5;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENATES
 rc = AS4
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{AsO}_4(\text{aq}) + \text{OH}^- = \text{H}_2\text{AsO}_4^- + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 62865
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 13.62
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 53.21
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ :
 $\log K_0$: 11.72

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	11.72	10.86	10.11	9.45	8.32	7.39	6.62	5.96
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES:

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENATES
 PC = AS6
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{AsO}_4(\text{aq}) = \text{HAsO}_4^{--} + 2\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 3840
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : -189.40
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ : - 495.80
 $\Delta_f \Delta_z^2$, (kg mol⁻¹)^{1/2} : 3.06
 b , kg mol⁻¹ : -0.13
 $\log K_o$: - 9.22
 $B_9 = 1.57$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 9.22	- 9.35	- 9.61	- 9.96	-10.84	-11.85	-12.93	-14.04
0.01	- 8.96							
0.10	- 8.59							
0.20	- 8.44							
0.50	- 8.26							
1.00	- 8.16							
2.00	- 8.14							
3.00	- 8.18							

REFERENCES: 1;2;3;4;5;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENATES
 rc = 155
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{AsO}_4(\text{aq}) + 2\text{OH}^- = \text{HAsO}_4^{--} + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : -115450
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 28.16
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 69.22
 $\Delta_f \bar{z}_2$, (kg mol⁻¹)^{1/2} : 1.02
 b, kg mol⁻¹ :
 log K_o : 18.75

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	18.75	17.18	15.81	14.60	12.58	10.94	9.58	8.42
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES:

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENATES
 PC = AS7
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{AsO}_4(\text{aq}) = \text{AsO}_4^{---} + 3\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 14360
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : -346.80
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : - 700.80
 $\Delta_f \Delta_z^2$, (kg mol⁻¹)^{1/2} : - 6.12
 b , kg mol⁻¹ : -0.26
 $\log K_o$: -20.63
 $B_9 = 1.52$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-20.63	-20.55	-20.69	-20.98	-21.89	-23.06	-24.39	-25.78
0.01	-21.16							
0.10	-21.96							
0.20	-22.31							
0.50	-22.85							
1.00	-23.32							
2.00	-23.90							
3.00	-24.33							

REFERENCES: 1;2;3;4;5;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENATES
 IC = AS8
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{AsO}_4(\text{aq}) + 3\text{OH}^- = \text{AsO}_4^{3-} + 3\text{H}_2\text{O}$

THEMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : -153055
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -104.94
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 60.93
 $\Delta_f^\circ \text{As}_2\text{O}_3$, (kg mol⁻¹)^{1/2} : 3.06
 b , kg mol⁻¹ :
 $\log K_o$: 21.33

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q						
	25 C	50 C	75 C	100 C	150 C	200 C	300 C
0.00	21.33	19.25	17.44	15.87	13.24	11.12	9.38
0.01							
0.10							
0.20							
0.50							
1.00							
2.00							
3.00							

REFERENCES:

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENITES
 IC = AS2
 September 1984

EQUILIBRIUM REACTION: $\text{As}(\text{OH})_3(\text{aq}) + \text{OH}^- = \text{As}(\text{OH})_4^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 28275
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 4.91
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 16.80
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ :
 $\log K_0$: 4.69

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	4.69	4.31	3.97	3.68	3.49	2.78	2.45	2.17
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES:

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENITES
 RC = ASV
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{AsO}_3(\text{aq}) + \text{H}_2\text{O} = \text{As}(\text{OH})_4^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 27530
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 85.53
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : - 230.09
 Δ_f° , (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ : -0.31
 $\log K_o$: - 9.29

EQUILIBRIUM QUOTIENTS: I =ionic strength, mol kg⁻¹

$I/\text{mol kg}^{-1}$	$\log Q$							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 9.29	- 8.95	- 8.73	- 8.60	- 8.52	- 8.61	- 8.80	- 9.06
0.01	- 9.20							
0.10	- 9.08							
0.20	- 9.04							
0.50	- 9.02							
1.00	- 9.09							
2.00	- 9.31							
3.00	- 9.57							

REFERENCES: 4;5;7

COMMENTS: $\Delta_r G^\circ$ from that of $\text{B}(\text{OH})_3(\text{aq})$ reaction. See Reference 5, p.367.

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENITES
 IC = AS9
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{AsO}_3(\text{aq}) = \text{H}_2\text{AsO}_3^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 27530
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : - 84.30
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 254.80
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ :
 $\log K_o$: - 9.23

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 9.23	- 8.89	- 8.69	- 8.57	- 8.53	- 8.67	- 8.91	- 9.22
0.01								
0.10	- 9.13							
0.20								
0.50	- 9.09							
1.00								
2.00								
3.00								

REFERENCES: 2;3;10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENITES
 IC = AS10
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{AsO}_3(\text{aq}) = \text{HAsO}_3^{--} + 2\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\bar{r}H_o$, J mol⁻¹ : 59420
 $\bar{r}S_o$, J mol⁻¹ K⁻¹ : -210.30
 $\bar{r}Cp_o$, J mol⁻¹ K⁻¹ : - 482.40
 $\Delta_f \bar{r}z^2$, (kg mol⁻¹)^{1/2} : 3.06
 b , kg mol⁻¹ :
 $\log K_o$: -21.39

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	-21.39	-20.67	-20.19	-19.89	-19.70	-19.86	-20.25	-20.78
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 3

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENITES
 rc = AS11
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{AsO}_3(\text{aq}) = \text{AsO}_3^{---} + 3\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 84730
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : -381.80
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 679.90
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} : 6.12
 b , kg mol⁻¹ :
 $\log K_o$: -34.78

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	-34.78	-33.75	-33.06	-32.63	-32.34	-32.56	-33.09	-33.83
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 3

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENATES
 rc = AS13
 September 1984

EQUILIBRIUM REACTION: $\text{As}_2\text{O}_5(\text{s}) + 3\text{H}_2\text{O} = 2\text{H}_3\text{AsO}_4(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 22640
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 52.87
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : 81.02
 $\Delta_f \Delta Z_2$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : 6.73

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q						
	25 C	50 C	75 C	100 C	150 C	200 C	300 C
0.00	6.73	6.43	6.21	6.03	5.79	5.65	5.56
0.01							
0.10							
0.20							
0.50							
1.00							
2.00							
3.00							

REFERENCES: 2;3

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 THIOARSENITES
 rc = AS14
 September 1984

EQUILIBRIUM REACTION: $\text{As}_2\text{S}_3(\text{s}) + 6\text{H}_2\text{O} = 2\text{H}_3\text{AsO}_3(\text{aq}) + 3\text{HS}^- + 3\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 256740
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 4.36
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : - 434.14
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 $\Delta_f H^\circ$, kg mol⁻¹ :
 $\log K_0$: 45.21

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-45.21	-41.79	-39.00	-36.69	-33.16	-30.65	-28.86	-27.56
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 8.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENITES
 rc = AS12
 September 1984

EQUILIBRIUM REACTION: $\text{As}_4\text{O}_6(\text{s}) + 6\text{H}_2\text{O}(\text{l}) = 4\text{H}_3\text{AsO}_3(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 34840
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : 147.14
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ : 175.37
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ :
 $\log K_o$: 1.58

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	1.58	2.08	2.56	3.02	3.89	4.68	5.42	6.10
0.01								
0.10								
0.20								
0.50								
1.00 - 0.68								
2.00								
3.00								

REFERENCES: 2;3;5

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 PHREEQE
 rc = AS15
 September 1984

EQUILIBRIUM REACTION: $\text{H3AsO3(aq)} + \text{H2O} = \text{H3AsO4(aq)} + 2\text{H}^+ + 2\text{e}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 125583
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ :
 $\Delta_f Z$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: -19.44

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-19.44							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 11

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ARSENATES
 rc = AS16
 September 1984

EQUILIBRIUM REACTION: $\text{FeAsO}_4 \cdot 2\text{H}_2\text{O} = \text{Fe}^{+++} + \text{AsO}_4^{---} + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

Δ_{rHo} , J mol⁻¹ :
 Δ_{So} , J mol⁻¹ K⁻¹ :
 Δ_{Cpo} , J mol⁻¹ K⁻¹ :
 $\Delta_{\text{y}^{\text{z}2}}$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_0$: -20.25

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	-20.25							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 11

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ORGANIC
 rc = AS17
 September 1984

EQUILIBRIUM REACTION: $(\text{CH}_3)_2\text{AsO}(\text{OH}) (\text{aq}) = (\text{CH}_3)_2\text{AsO}_2^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ :
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: - 6.20

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	- 6.20							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 5

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

ARSENIC
 ORGANIC
 rc = AS18
 September 1984

EQUILIBRIUM REACTION: $\text{CH}_3\text{AsO}(\text{OH})_2(\text{aq}) = \text{CH}_3\text{AsO}_2\text{OH}^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ :
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f^\circ \text{Z}_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: - 3.60

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

1/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00 - 3.60								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 5

COMMENTS:

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 * Aqueous *
 * Solutions *
 * Database *

CARBON
 GASES
 IC = C5
 September 1984

EQUILIBRIUM REACTION: $\text{CO}_2(\text{g}) = \text{CO}_2(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\bar{r}\text{Ho}$, J mol⁻¹ : - 20290
 $\bar{r}\text{So}$, J mol⁻¹ K⁻¹ : - 96.08
 $\bar{r}\text{Cpo}$, J mol⁻¹ K⁻¹ : 205.89
 $\Delta\bar{y}^{\sim}\text{z}_2, (\text{kg mol}^{-1})^{1/2}$: 0.00
 b , kg mol⁻¹ :
 $\log K_o$: - 1.47

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	- 1.47	- 1.71	- 1.85	- 1.93	- 1.93	- 1.79	- 1.57	- 1.30
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 5;7;9;10;18

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

CARBON
 BICARBONATES
 rc = Cl
 September 1984

EQUILIBRIUM REACTION: $\text{CO}_2(\text{ag}) + \text{OH}^- = \text{HCO}_3^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 48165
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 15.65
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : - 158.00
 $\Delta_f H^\circ_{\text{aq}}$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ : 0.07
 $\log K_o$: 7.62

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	7.62	6.94	6.31	5.73	4.67	3.74	2.89	2.14
0.01	7.63							
0.10	7.64							
0.20	7.64							
0.50	7.67							
1.00	7.70							
2.00	7.77							
3.00	7.84							

REFERENCES: 5;7;9;10;18;32

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

CARBON
 BICARBONATES
 IC = C8
 September 1984

EQUILIBRIUM REACTION: $\text{CO}_2(\text{aq}) + \text{H}_2\text{O} = \text{HCO}_3^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

ΔH°_f , J mol⁻¹ : 9060
 ΔS°_f , J mol⁻¹ K⁻¹ : - 91.20
 ΔC°_p , J mol⁻¹ K⁻¹ : - 338.00
 $\Delta_f^\circ z_2$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ :
 $\log K_o$: - 6.35

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 6.35	- 6.28	- 6.31	- 6.40	- 6.72	- 7.19	- 7.78	- 8.50
0.01								
0.10	- 6.12	- 6.04	- 6.05	- 6.12	- 6.40	- 6.80	- 7.31	- 7.86
0.20								
0.50	- 5.98	- 5.90	- 5.90	- 5.95	- 6.18	- 6.53	- 6.94	- 7.36
1.00	- 5.94	- 5.85	- 5.84	- 5.89	- 6.09	- 6.38	- 6.73	- 7.05
2.00								
3.00	- 5.96	- 5.87	- 5.85	- 5.87	- 5.98	- 6.14	- 6.29	- 6.36

REFERENCES: 3;7;10

COMMENTS: These are smoothed values; see Ref. 1,33.

 * Aqueous *
 * Solutions *
 * Database *

CARBON
 BICARBONATES
 rc = C9
 September 1984

EQUILIBRIUM REACTION: $\text{CO}_2(\text{aq}) + \text{H}_2\text{O} = \text{HCO}_3^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 7640
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 96.31
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : - 371.29
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ : -0.18
 $\log K_o$: - 6.37

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 6.37	- 6.33	- 6.40	- 6.55	- 7.03	- 7.66	- 8.36	- 9.10
0.01	- 6.28							
0.10	- 6.14							
0.20	- 6.09							
0.50	- 6.04							
1.00	- 6.04							
2.00	- 6.13							
3.00	- 6.26							

REFERENCES: 5;9;10;20;21

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

CARBON
 BICARBONATES
 rc = C3
 September 1984

EQUILIBRIUM REACTION: $\text{H}_2\text{CO}_3(\text{aq}) + \text{OH}^- = \text{HCO}_3^- + \text{H}_2\text{O}$

THEMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 48145
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : - 15.58
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : - 157.71
 $\Delta_f \Delta^{\circ} z_2$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ : 0.07
 $\log K_o$: 7.63

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/m	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	7.63	6.94	6.31	5.73	4.68	3.74	2.90	2.14
0.01	7.63							
0.10	7.64							
0.20	7.64							
0.50	7.67							
1.00	7.70							
2.00	7.77							
3.00	7.84							

REFERENCES: 5;9;10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

CARBON
 CARBOATES
 rc = C2
 September 1984

EQUILIBRIUM REACTION: $\text{HCO}_3^- + \text{OH}^- = \text{CO}_3^{--} + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 40955
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : - 67.48
 $\Delta_r G_o$, J mol⁻¹ K⁻¹ : - 35.71
 $\Delta_f \Delta^2$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ : 0.15
 $\log K_o$: 3.66

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	3.66	3.09	2.59	2.16	1.43	0.82	0.32	- 0.12
0.01	3.75							
0.10	3.92							
0.20	4.01							
0.50	4.16							
1.00	4.32							
2.00	4.56							
3.00	4.76							

REFERENCES: 5;7;9;10;32

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

CARBON
 CARBONATES
 PC = C4
 September 1984

EQUILIBRIUM REACTION: $\text{HCO}_3^- = \text{CO}_3^{--} + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : 14850
 ΔS_o , J mol⁻¹ K⁻¹ : -148.10
 ΔC_p , J mol⁻¹ K⁻¹ : - 249.00
 $\Delta \gamma_{\text{z}_2}$, (kg mol⁻¹)^{1/2} : 2.04
 b , kg mol⁻¹ : -0.13
 $\log K_o$: -10.34

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-10.34	-10.18	-10.11	-10.12	-10.28	-10.57	-10.94	-11.35
0.01	-10.16							
0.10	- 9.86							
0.20	- 9.74							
0.50	- 9.56							
1.00	- 9.45							
2.00	- 9.40							
3.00	- 9.44							

REFERENCES: 5;9;10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

CARBON
 BICARBONATES
 rc = C6
 September 1984

EQUILIBRIUM REACTION: $\text{Ca}^{++} + \text{H}_2\text{CO}_3(\text{aq}) = \text{CaHCO}_3^+ + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 1380
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : - 66.90
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ : - 145.50
 $\Delta_f A^\circ_{T=298.15}$, (kg mol⁻¹)^{1/2} : - 1.02
 b , kg mol⁻¹ :
 $\log K_o$: - 3.74

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 3.74	- 3.74	- 3.79	- 3.87	- 4.08	- 4.35	- 4.64	- 4.94
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 5;9;10;16

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

CARBON
 DICARBONATES
 IC = C7
 September 1984

EQUILIBRIUM REACTION: $\text{Ca}^{++} + \text{HCO}_3^- = \text{CaHCO}_3^+$

THEMOCHEMICAL PROPERTIES:

^{-}rHo , J mol $^{-1}$: - 6280
 ^{-}So , J mol $^{-1}$ K $^{-1}$: 29.30
 ^{-}Cpo , J mol $^{-1}$ K $^{-1}$: 225.50
 $\Delta\gamma^{\sim}2$, (kg mol $^{-1}$) $^{1/2}$: - 2.04
 b , kg mol $^{-1}$:
 $\log \gamma_o$: 2.63

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg $^{-1}$

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	2.63	2.58	2.61	2.68	2.95			
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 10;16

COMMENTS:

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 * Aqueous *
 * Solutions *
 * Database *

FLUORINE
 FLUORIDES
 rc = F1
 September 1984

EQUILIBRIUM REACTION: $\text{HF(aq)} = \text{F}^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 14068
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -108.16
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 161.30
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ : -0.20
 $\log K_0$: - 3.18

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 3.18	- 3.50	- 3.63	- 3.68	- 4.37	- 4.87	- 5.36	- 5.83
0.01	- 3.09							
0.10	- 2.95							
0.20	- 2.90							
0.50	- 2.86							
1.00	- 2.87	- 3.14	- 3.29	- 3.42	- 3.64	- 3.82	- 3.98	- 4.12
2.00	- 2.98							
3.00	- 3.13							

REFERENCES: 2;3;4;7;8;11;12.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

FLUORINE
 FLUORIDES
 rc = F2
 September 1984

EQUILIBRIUM REACTION: $\text{HF(aq)} + \text{OH}^- = \text{F}^- + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_{\text{f}}H^\circ$, J mol⁻¹ : - 69873
 $\Delta_{\text{f}}S^\circ$, J mol⁻¹ K⁻¹ : - 27.54
 $\Delta_{\text{f}}G^\circ$, J mol⁻¹ K⁻¹ : 51.99
 $\Delta_f^\circ z_2$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ : 0.02
 $\log K_0$: 10.87

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	10.87	9.86	9.07	8.40	7.33	6.52	5.99	5.40
0.01	10.87							
0.10	10.87							
0.20	10.87							
0.50	10.88							
1.00	10.89							
2.00	10.91							
3.00	10.93							

REFERENCES: 1;2;3;4;6

COMMENTS:

BROMINE, CHLORINE, FLUORINE

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June 1984

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 * Aqueous *
 * Solutions *
 * Database *

IODINE
 IODINES
 rc = I2
 September 1984

EQUILIBRIUM REACTION: $I_2(g) = I_2(aq)$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 39821
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : -123.37
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : 293.10
 $\Delta_f \Delta_z^2$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : 0.53

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	0.53	0.04	- 0.30	- 0.52	- 0.69	- 0.64	- 0.45	- 0.16
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 5;10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 IODINES
 rc = I3
 September 1984

EQUILIBRIUM REACTION: $I_2(s) = I_2(g)$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 62421
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 144.43
 $\Delta_r C_{po}$, J mol⁻¹ K⁻¹ : - 17.54
 $\Delta_f \Delta_z^2$, (kJ mol⁻¹) ^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: - 3.39

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.10	- 3.39	- 2.54	- 1.83	- 1.21	- 0.21	0.57	1.20	1.70
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 5;9;10;18

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 IODINES
 rc = I1
 September 1984

EQUILIBRIUM REACTION: $I_2(s) = I_2(aq)$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 22600
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 21.06
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : 275.56
 $\Delta_f \bar{z}_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: - 2.86

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 2.86	- 2.50	- 2.13	- 1.73	- 0.90	- 0.07	0.75	1.55
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;5;9;10;15;18

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 IODATES
 IC = I4
 September 1984

EQUILIBRIUM REACTION: $3I_2(aq) + 6OH^- = IO_3^- + 5I^- + 3H_2O$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 54320
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 514.29
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 721.63
 $\Delta_f \Delta^\circ$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ :
 $\log K_o$: 36.37

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	36.37	35.52	34.58	33.58	31.50	29.39	27.30	25.26
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;9;10;40

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 IODATES
 rc = 15
 September 1984

EQUILIBRIUM REACTION: $3\text{I}_2(\text{aq}) + 3\text{H}_2\text{O} = \text{IO}_3^- + 5\text{I}^- + 6\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 280510
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 30.57
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : -2001.37
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} : 6.12
 b , kg mol⁻¹ :
 $\log K_o$: -47.55

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-47.55	-44.08	-41.69	-40.12	-38.75	-38.99	-40.23	-42.13
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;9;10;40

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 IODATES
 IC = I6
 September 1984

EQUILIBRIUM REACTION: $\text{HIO}_3(\text{aq}) + \text{OH}^- = \text{IO}_3^- + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 63455
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 39.62
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 179.29
 $\Delta_f z_2$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ :
 $\log K_0$: 13.19

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	13.19	12.35	11.69	11.17	10.41	9.93	9.64	9.48
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 5;9;10;16;40

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 IODATES
 IC = 17
 September 1984

EQUILIBRIUM REACTION: $\text{HIO}_3(\text{aq}) = \text{IO}_3^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 7650
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : - 41.00
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 34.00
 $\Delta_f z^\circ$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ : -0.25
 $\log K_0$: - 0.78
 $B_9 = 0.37$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00 - 0.78	- 0.88	- 0.99	- 1.09	- 1.27	- 1.44	- 1.59	- 1.74	
0.01 - 0.69								
0.10 - 0.57								
0.20 - 0.54								
0.50 - 0.60								
1.00 - 0.82								
2.00 - 1.39								
3.00 - 2.04								

REFERENCES: 5;9;10;16;40

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 PERIODATES
 rc = 115
 November 1984

EQUILIBRIUM REACTION: $\text{HIO}_6^{--} + \text{H}^+ = \text{H}_2\text{IO}_6^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 3400
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 116.70
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f \alpha^\circ$, (kg mol⁻¹)^{1/2} :
 $\Delta_f b$, kg mol⁻¹ :
 $\log K_o$: 6.69

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q						
	25 C	50 C	75 C	100 C	150 C	200 C	300 C
0.00	6.69						
0.01							
0.10							
0.20							
0.50							
1.00							
2.00							
3.00							

REFERENCES: 10;11;51.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 PERIODATES
 IC = I16
 November 1984

EQUILIBRIUM REACTION: $\text{H4IO6}^- + \text{H}^+ = \text{H5IO6}(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 0
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 56.90
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f \alpha^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_0$: 2.89

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	2.89							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 10;11;51.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 PERIODATES
 rc = I17
 November 1984

EQUILIBRIUM REACTION: $\text{H4IO6}^- = \text{IO4}^- + 2\text{H2O}$

THEMOCHEMICAL PROPERTIES:

$\bar{r}_{\text{Ho}}$, J mol⁻¹ : 36240
 $\bar{r}_{\text{So}}$, J mol⁻¹ K⁻¹ : 149.82
 $\bar{r}_{\text{Cpo}}$, J mol⁻¹ K⁻¹ :
 $\Delta \bar{y}^{\circ 22}$, (kg mol⁻¹)^{1/2} :
 h , kg mol⁻¹ :
 $\log a_0$: 1.46

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	1.46							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 10;11;51

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 OXYIODIDES
 rc = I8
 September 1984

EQUILIBRIUM REACTION: $I_2(aq) + H_2O = HIO(aq) + H^+ + I^-$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : 68230
 ΔS_o , J mol⁻¹ K⁻¹ : - 5.01
 ΔC_{po} , J mol⁻¹ K⁻¹ : - 413.69
 $\Delta Y^{\sim}z_2$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ :
 $\log K_o$: -12.22

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-12.22	-11.36	-10.75	-10.32	- 9.87	- 9.78	- 9.93	-10.23
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2;10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 OXYIODIDES
 rc = I9
 September 1984

EQUILIBRIUM REACTION: $\text{HIO(aq)} + \text{OH}^- = \text{IO}^- + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 25205
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : - 20.18
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : 169.39
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ :
 $\log K_o$: 3.37

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/1	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	3.37	3.05	2.83	2.68	2.54	2.54	2.63	2.78
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2;10

COMMENTS: Cpo of IO⁻ calculated from data in Reference 8.

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 OXYIODIDES
 rc = I10
 September 1986

EQUILIBRIUM REACTION: $I^- + IO^- = IO_2^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ :
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ :
 $\Delta_f H_o$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ :
 $\log K_o$: - 1.34

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	- 1.34							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 OXIIONIDES
 rc = I11
 September 1984

EQUILIBRIUM REACTION: $\text{IO}^- + \text{I}^- + \text{H}_2\text{O} = \text{I}_2\text{O}_2^- + \text{OH}^-$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : 10875
 ΔS_o , J mol⁻¹ K⁻¹ : 19.48
 ΔC_{po} , J mol⁻¹ K⁻¹ : 0.01
 $\Delta y^{\sim} z_2$, (kg mol⁻¹)^{1/2} : 0.00
 b, kg mol⁻¹ :
 log K_o : - 0.89

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 0.89	- 0.74	- 0.61	- 0.50	- 0.32	- 0.18	- 0.07	0.03
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2

COMMENTS: Used ΔfG_o for I_2O_2^- = -165.0; calculated from Reference 2.

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 IODIDES
 rc = 113
 September 1984

EQUILIBRIUM REACTION: $\text{IO}^- + 2\text{I}^- + \text{H}_2\text{O} = \text{I}_3^- + 2\text{OH}^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 4820
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 60.03
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 10.01
 $\Delta_f Z_2$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ :
 $\log K_0$: - 2.29

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 2.29	- 2.35	- 2.41	- 2.45	- 2.51	- 2.55	- 2.58	- 2.60
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 IODIDES
 rc = 112
 September 1984

EQUILIBRIUM REACTION: $I_2(aq) + I^- = I_3^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 17600
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 4.60
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 21.00
 $\Delta_f z_2$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ :
 $\log K_o$: 2.84

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	2.84	2.60	2.39	2.19	1.87	1.60	1.37	1.17
0.01	2.87							
0.10	2.87							
0.20	2.87							
0.50	2.86							
1.00	2.86							
2.00	2.87							
3.00	2.88							

REFERENCES: 1;5;52.

COMMENTS: logQ(I) interpolated from data in Ref. 52.

 * Aqueous *
 * Solutions *
 * Database *

IODINE
 OXIDES
 rc = 114
 October 1984

EQUILIBRIUM REACTION: $\text{I}_2\text{O}_5(\text{s}) + \text{H}_2\text{O} = 2\text{HIO}_3(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 9840
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 133.89
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ : - 284.29
 $\Delta_f \alpha^\circ$, (kg mol⁻¹)^{1/2} :
 $\log K_0$: 5.27

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	5.27	5.35	5.35	5.27	4.96	4.54	4.08	3.51
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: This work.

COMMENTS: C_p of $\text{I}_2\text{O}_5(\text{s})$ based on $\text{As}_2\text{O}_5(\text{s})$, $\text{P}_2\text{O}_5(\text{s})$, $\text{V}_2\text{O}_5(\text{s})$, $\text{Ta}_2\text{O}_5(\text{s})$.

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 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 MOLYBDATE
 cc = M01
 September 1984

EQUILIBRIUM REACTION: $\text{MoO}_4^{--} + \text{H}^+ = \text{HMoO}_4^-$

THERMOCHEMICAL PROPERTIES:

$\bar{r}\text{H}_0$, J mol⁻¹ : 18064
 $\bar{S}_0$, J mol⁻¹ K⁻¹ : 141.00
 $\bar{C}_{\text{po}}$, J mol⁻¹ K⁻¹ :
 $\Delta_f \bar{z}_2$, (kg mol⁻¹)^{1/2} : - 2.04
 $\bar{L}$, kg mol⁻¹ : 0.29
 log K_0 : 4.20

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	4.20							
0.01	4.02							
0.10	3.74							
0.20	3.63							
0.50	3.50							
1.00	3.47							
2.00	3.58							
3.00	3.78							

REFERENCES: 1;2;3;15

COMMENTS: For I=0.1: $\bar{r}\text{H}_0=20,000$; $\bar{S}_0=140$. For I=1.0: $\bar{r}\text{H}_0=22500$;
 $\bar{S}_0=141$.

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 MOLYBDATES
 rc = MO2
 September 1984

EQUILIBRIUM REACTION: $\text{MoO}_4^{--} + 2\text{H}^+ = \text{H}_2\text{MoO}_4(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 10500
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 140.35
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} : - 3.06
 b , kg mol⁻¹ : 0.09
 $\log K_o$: 9.17

EQUILIBRIUM QUOTIENTS. I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	9.17							
0.01	8.89							
0.10	8.44							
0.20	8.24							
0.50	7.95							
1.00	7.73							
2.00	7.56							
3.00	7.50							

REFERENCES: 1;2;3;15

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 MOLYBDATES
 IC = M08
 November 1984

EQUILIBRIUM REACTION: $\text{MoO}_4^{--} + 3\text{H}^+ = \text{H}_3\text{MoO}_4^+$

THEMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 4500
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 135.30
 $\Delta_r C_{po}$, J mol⁻¹ K⁻¹ :
 $\Delta_f^\circ z_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 7.83

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	7.83							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 5;17

COMMENTS: H_3MoO_4^+ is equivalent to $\text{Mo}(\text{OH})_5(\text{H}_2\text{O})^+$.

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOLYBDATES
 rc = MC16
 November 1984

EQUILIBRIUM REACTION: $2\text{MoO}_4^{--} + 3\text{H}^+ = \text{H}_3(\text{MoO}_4)_2^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r\text{H}^\circ$, J mol⁻¹ :
 $\Delta_r\text{S}^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_r\text{Cp}^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f\text{H}^\circ_{\text{Z2}}$, (kg mol⁻¹)^{1/2} : - 5.10
 b , kg mol⁻¹ :
 $\log K_o$: 15.86

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00								
0.01								
0.10								
0.20								
0.50								
1.00	14.84							
2.00								
3.00								

REFERENCES: 3;18.

COMMENTS: $\text{H}_3(\text{MoO}_4)_2^-$ is equivalent to HMo_2O_7^- .

 * Aqueous *
 * Solutions *
 * Database *

NOLYBDENUM
 POLYNOLYBATES
 rc = MO3
 September 1984

EQUILIBRIUM REACTION: $7\text{MoO}_4^{--} + 8\text{H}^+ = \text{Mo}_7\text{O}_{24}^{-----} + 4\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : -193446
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 314.60
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ : 2.47
 $\log K_o$: 50.34

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	50.34							
0.01	50.36							
0.10	50.59							
0.20	50.83							
0.50	51.57							
1.00	52.81							
2.00	55.28							
3.00	57.74							

REFERENCES: 1;2;3;7;8

COMMENTS: From Ref.3,8,9: $\Delta_r H^\circ(I=3) = -230538, -234304, -199000.$

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOLYBDATES
 rc = MO4
 September 1984

EQUILIBRIUM REACTION: $7\text{MoO}_4^{--} + 9\text{H}^+ = \text{H}_2\text{Mo}_7\text{O}_{24}^{--} + 4\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : -199320
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 435.64
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : - 6.12
 $\ln K$, kg mol⁻¹ : 2.77
 $\log K$: 57.69

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	57.69							
0.01	57.16							
0.10	56.49							
0.20	56.35							
0.50	56.54							
1.00	57.39							
2.00	59.64							
3.00	62.10							

REFERENCES: 1;2;3;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOXIDES
 cc = 805
 September 1984

EQUILIBRIUM REACTION: $7\text{H}_2\text{O}_4^{--} + 10\text{H}^+ = \text{H}_2\text{Mo}_7\text{O}_{24}^{----} + 4\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f\text{H}^\circ$, J mol⁻¹ : -208865
 $\Delta_f\text{S}^\circ$, J mol⁻¹ K⁻¹ : 514.64
 $\Delta_f\text{Cp}^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f\text{y}^\circ\text{z}_2$, (kg mol⁻¹)^{1/2} : -11.22
 b , kg mol⁻¹ : 3.09
 $\log K_0$: 63.54

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	63.54							
0.01	62.55							
0.10	61.15							
0.20	60.69							
0.50	60.44							
1.00	61.02							
2.00	63.15							
3.00	65.70							

REFERENCES: 1;2;3;7

COMMENTS: From Ref. 8: $\Delta_f\text{H}^\circ(\text{I}=3) = -213802.$

 * Aqueous *
 * Solutions *
 * Database *

NOLYBDENUM
 POLYNOLYBATES
 rc = MO6
 September 1984

EQUILIBRIUM REACTION: $7\text{MoO}_4^{--} + 11\text{H}^+ = \text{H}_3\text{Mo}_7\text{O}_{24}^{---} + 4\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$: -219750
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : 556.64
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f H^\circ$, (kJ mol⁻¹)^{1/2} : -15.30
 b , kg mol⁻¹ : 3.43
 $\log K_o$: 67.63

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	67.63							
0.01	66.27							
0.10	64.30							
0.20	63.59							
0.50	63.01							
1.00	63.40							
2.00	65.53							
3.00	68.20							

REFERENCES: 1;2;3;7

COMMENTS: $\text{H}_3\text{Mo}_7\text{O}_{24}^{---}$ is equivalent to $\text{H}_{11}(\text{MoO}_4)_7^{---}$.

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOLYBDATE
 rc = H017
 November 1984

EQUILIBRIUM REACTION: $7\text{H}_2\text{O}_4^{--} + 8\text{H}^+ = \text{H}_8(\text{H}_2\text{O}_4)_7^{--}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r\text{H}_0$, J mol⁻¹ :
 $\Delta_r\text{S}_0$, J mol⁻¹ K⁻¹ :
 $\Delta_r\text{C}_p$, J mol⁻¹ K⁻¹ :
 $\Delta_f\text{H}_0^{\text{z}}$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ : 2.47
 $\log K_0$: 50.31

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	50.31							
0.01	50.33							
0.10	50.56							
0.20	50.80							
0.50	51.55							
1.00	52.79							
2.00	55.25							
3.00	57.74							

REFERENCES: 3;18.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOYBDATES
 EC = MO18
 November 1984

EQUILIBRIUM REACTION: $7\text{MoO}_4^{--} + 9\text{H}^+ = \text{H}_9(\text{MoO}_4)_7^{--}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ :
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f H^\circ$, (kJ mol⁻¹)^{1/2} : - 6.12
 $\Delta_f S^\circ$, kJ mol⁻¹ : 2.77
 $\log K_o$: 57.71

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	57.71							
0.01	57.18							
0.10	56.52							
0.20	56.37							
0.50	56.56							
1.00	57.42							
2.00	59.66							
3.00	62.14							

REFERENCES: 3;18

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYOLYSDATES
 IC = 8019
 November 1984

EQUILIBRIUM REACTION: $7\text{MoO}_4^{--} + 10\text{H}^+ = \text{H}_2(\text{MoO}_4)_7$ ----

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ :
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : -11.22
 b , kg mol⁻¹ : 3.13
 $\log K_o$: 63.41

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/M	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	63.41							
0.01	62.42							
0.10	61.03							
0.20	60.57							
0.50	60.33							
1.00	60.93							
2.00	63.09							
3.00	65.68							

REFERENCES: 3;18.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOLYBDATES
 rc = H020
 November 1984

EQUILIBRIUM REACTION: $7\text{MoO}_4^{--} + 11\text{H}^+ = \text{H}_7(\text{MoO}_4)_7^{--}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ :
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : -15.30
 b , kg mol⁻¹ : 3.37
 $\log K_o$: 67.80

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	67.80							
0.01	66.44							
0.10	64.46							
0.20	63.75							
0.50	63.15							
1.00	63.52							
2.00	65.58							
3.00	68.21							

REFERENCES: J;18.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOLYBDATE
 IC = M022
 November 1984

EQUILIBRIUM REACTION: $8\text{MoO}_4^{--} + 9\text{H}^+ = \text{H}_9(\text{MoO}_4)_8$ -----

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ :
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ :
 $\Delta_r G_o$, J mol⁻¹ K⁻¹ :
 $\Delta_f \Delta^2$, (kg mol⁻¹)^{1/2} : 4.08
 b , kg mol⁻¹ :
 $\log K_o$: 58.64

EQUILIBRIUM QUOTIENTS: I =ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300
0.00								
0.01								
0.10								
0.20								
0.50								
1.00	59.46							
2.00								
3.00								

REFERENCES: 3;18.

COMMENTS: Assumed Davies equation valid up to $I=1.00$; estimated uncertainty in $\log K_o$ is 3 units of $\log K_o$.

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOLYBDATES
 PC = 7021
 November 1984

EQUILIBRIUM REACTION: $8\text{MoO}_4^{--} + 12\text{H}^+ = \text{H}_{12}(\text{MoO}_4)_8^{--}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ :
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : -14.28
 b , kg mol⁻¹ :
 $\log K_o$: 74.43

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00								
0.01								
0.10								
0.20								
0.50								
1.00	71.57							
2.00								
3.00								

REFERENCES: 3;18.

COMMENTS: log K_o calculated by assuming validity of Davies equation at I=1.00; uncertainty estimated at 3 units of log K_o.

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOLYBDATES
 IC = M015
 November 1984

EQUILIBRIUM REACTION: $8\text{MoO}_4^{--} + 12\text{H}^+ = \text{Mo}_8\text{O}_{26}^{----} + 6\text{H}_2\text{O}$

THEMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : -216000
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ :
 $\Delta_f \bar{z}_2$, (kg mol⁻¹)^{1/2} : -14.28
 b , kg mol⁻¹ :
 $\log K_o$: 74.70

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	74.70							
0.01								
0.10								
0.20								
0.50								
1.00	71.70							
2.00								
3.00								

REFERENCES: 3;9;17

COMMENTS: From Ref. 9: $\Delta_r H_o = -216000$.

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 MOLYBDATE
 rc = M028
 November 1984

EQUILIBRIUM REACTION: $\text{MoO}_4^{--} + 2\text{H}^+ + 2\text{H}_2\text{O} = \text{Mo}(\text{OH})_6(\text{ag})$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 31190
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 54.18
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : - 3.06
 b , kg mol⁻¹ : 0.30
 $\log K_o$: 8.54

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	8.54							
0.01	8.26							
0.10	7.83							
0.20	7.65							
0.50	7.42							
1.00	7.31							
2.00	7.35							
3.00	7.50							

REFERENCES:

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 MOLYBDATES
 rc = H09
 November 1984

EQUILIBRIUM REACTION: $\text{HMoO}_4^- + \text{H}^+ + 2\text{H}_2\text{O} = \text{Mo}(\text{OH})_6(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\Delta_f \text{H}^\circ$, J mol⁻¹ : - 49255
 $\Delta_f \text{S}^\circ$, J mol⁻¹ K⁻¹ : - 89.00
 $\Delta_f \text{Cp}^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f \text{H}^\circ_{\text{aq}}$, (kg mol⁻¹)^{1/2} : - 1.02
 b , kg mol⁻¹ : 0.27
 $\log K_o$: 3.98

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	3.98							
0.01	3.89							
0.10	3.76							
0.20	3.72							
0.50	3.69							
1.00	3.74							
2.00	3.92							
3.00	4.14							

REFERENCES: 5;6

COMMENTS: $\Delta_f \text{H}^\circ(\text{I}=1) = -46500$; $\Delta_f \text{S}^\circ(\text{I}=1) = -85$.

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 MOLYBDATES
 rc = M029
 November 1984

EQUILIBRIUM REACTION: $\text{MoO}_4^{--} + \text{H}^+ + 2\text{H}_2\text{O} = \text{Mo}(\text{OH})_5(\text{H}_2\text{O})^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 24115
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 94.18
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} :
 $\Delta_f G^\circ$, kg mol⁻¹ :
 log K_o : 9.03

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	9.03							
0.01								
0.10								
0.20								
0.50								
1.00	8.27							
2.00								
3.00								

REFERENCES: 5;17.

COMMENTS: $\text{Mo}(\text{OH})_5(\text{H}_2\text{O})^+$ is equivalent to H_3MoO_4^+ .

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 MOLYBDATES
 CC = M010
 November 1984

EQUILIBRIUM REACTION: $\text{Mo}(\text{OH})_6(\text{aq}) + \text{H}^+ = \text{Mo}(\text{OH})_5(\text{H}_2\text{O})^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 7074
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 40.00
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f \gamma^\circ$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ : 0.06
 $\log K_0$: 0.85

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	0.85							
0.01	0.85							
0.10	0.86							
0.20	0.86							
0.50	0.88							
1.00	0.91							
2.00	0.97							
3.00	1.03							

REFERENCES: 5;6

COMMENTS: For I=3: $\Delta_f H^\circ = 6000$; $\Delta_f S^\circ = 40$.

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 MOLYBDATES
 rc = M030
 November 1984

EQUILIBRIUM REACTION: $\text{MoO}_4^{--} + \text{H}^+ + 2\text{H}_2\text{O} = \text{MoO}(\text{OH})_5^-$

THERMOCHEMICAL PROPERTIES:

$\Delta^\circ\text{Ho}$, J mol⁻¹ : 18060
 $\Delta^\circ\text{So}$, J mol⁻¹ K⁻¹ : 141.00
 $\Delta^\circ\text{Cpo}$, J mol⁻¹ K⁻¹ :
 $\Delta^\circ\text{fz}_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 4.20

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	4.20							
0.01								
0.10								
0.20								
0.50								
1.00	3.71							
2.00								
3.00								

REFERENCES: This work.

COMMENTS: $\text{MoO}(\text{OH})_5^-$ is equivalent to HMoO_4^- .

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 DINERS
 rc = H011
 November 1984

EQUILIBRIUM REACTION: $2\text{HMoO}_3^+ = \text{H}_2\text{Mo}_2\text{O}_6^{++}$

THERMOCHEMICAL PROPERTIES:

$\bar{r}_{\text{Ho}}$, J mol⁻¹ :
 $\bar{r}_{\text{So}}$, J mol⁻¹ K⁻¹ :
 $\bar{r}_{\text{Cpo}}$, J mol⁻¹ K⁻¹ :
 $\text{Ay}^{\sim}z_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00	1.99							

REFERENCES: 11;17.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 DINERS
 rc = 8012
 November 1984

EQUILIBRIUM REACTION: $\text{HMoO}_4^- + \text{H}^+ = \text{H}_2\text{MoO}_4$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ :
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00	0.67							

REFERENCES: 11.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 DINERS
 CC = H013
 November 1984

EQUILIBRIUM REACTION: $\text{H}_2\text{MoO}_6^{++} + \text{H}^+ = \text{H}_3\text{MoO}_6^{+++}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ :
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ :
 $\Delta_f \bar{z}_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00 - 0.62								

REFERENCES: 11.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 DINERS
 rc = M031
 November 1984

EQUILIBRIUM REACTION: $2\text{Mo}(\text{OH})_5(\text{H}_2\text{O})^+ = \text{Mo}_2\text{O}(\text{OH})_8(\text{H}_2\text{O})^{2++} + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\hat{r}_{\text{Mo}}$, J mol⁻¹ :
 $\hat{r}_{\text{So}}$, J mol⁻¹ K⁻¹ :
 $\hat{r}_{\text{Cpo}}$, J mol⁻¹ K⁻¹ :
 $\Delta \hat{y}^{\text{z}2}$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 1.99

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	1.99							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 11.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLEBDENUM
 DIHERS
 rc = M032
 November 1984

EQUILIBRIUM REACTION: $\text{Mo}_2\text{O}(\text{OH})_9(\text{H}_2\text{O}) + \text{H}^+ = \text{Mo}_2\text{O}(\text{OH})_8(\text{H}_2\text{O})_2^{++}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ :
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 0.67

EQUILIBRIUM QUOTIENTS: I =ionic strength, mol kg⁻¹

	log q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	0.67							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 11.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 DIERS
 rc = H033
 November 1984

EQUILIBRIUM REACTION: $\text{Mo}_2\text{O}(\text{OH})_8(\text{H}_2\text{O})_{2++} + \text{H}^+ = \text{Mo}_2\text{O}(\text{OH})_7(\text{H}_2\text{O})_{3++}$

THEMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ :
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ :
 $\Delta_r y^{\circ} z_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: - 0.62

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	- 0.62							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 11.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOLYBDATE
 TC = H026
 November 1984

EQUILIBRIUM REACTION: $\text{Mo7O24} \rightleftharpoons 7 \text{H}^+ + \text{HMo7O24}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 5875
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 121.00
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f \gamma_{\pm}^2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_0$: 7.35

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	7.35							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00	4.41							

REFERENCES: 1

COMMENTS: From Ref.1: $\Delta_r H^\circ(I=3) = 10878$; $\Delta_r S^\circ(I=3) = 121$.

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOLYBDATE
 rc = M025
 November 1984

EQUILIBRIUM REACTION: $\text{HMo7O24}^{7-} + \text{H}^+ = \text{H2Mo7O24}^{6-}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 9545
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 75.00
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 $\ln K$, kg mol⁻¹ :
 $\log K$: 5.85

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	5.85							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00	3.57							

REFERENCES: 1

COMMENTS: From Ref. 1: $\Delta_r H^\circ(I=3) = 3347$; $\Delta_r S^\circ(I=3) = 79.5$.

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOLYBDATEs
 rc = 8027
 October 1984

EQUILIBRIUM REACTION: $\text{H2Mo7O24}^{---} + \text{H}^+ = \text{H3Mo7O24}^{---}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 10826
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 42.00
 $\Delta_r C_p_o$, J mol⁻¹ K⁻¹ :
 $\Delta_f \bar{G}^{\circ}_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log \bar{K}_o$: 4.09

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	4.09							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00	2.62							

REFERENCES: 1.

COMMENTS: From Ref.1: $\Delta_r H_o(I=3) = -2510$; $\Delta_r S_o(I=3) = 41.8$.

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOLYBDATES
 rc = #02J
 November 1984

EQUILIBRIUM REACTION: $\text{MoO}_2\text{O}_4\text{-----} + 8\text{OH}^- = 7\text{MoO}_4^{--} + 4\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : -252995
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 61.61

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	61.61							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 8.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 POLYMOLYBDATES
 rc = MO24
 November 1984

EQUILIBRIUM REACTION: $7\text{HMo8O26}^{---} + 11\text{OH}^- = 8\text{H2Mo7O24}^{----} + \text{H2O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ :
 $\Delta_s H_o$, J mol⁻¹ K⁻¹ :
 Δ_{cpo} , J mol⁻¹ K⁻¹ :
 $\Delta_f H_o$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 8.

COMMENTS: $\Delta_r H_o(I=1) = -515470$ (Ref.8).

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 MOLYBDATES
 EC = 2014
 November 1984

EQUILIBRIUM REACTION: $\text{H}_4\text{Mo}_8\text{O}_{26}(\text{aq}) + 3\text{OH}^- = \text{H}_2\text{Mo}_8\text{O}_{26}^{--} + 3\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : -164431
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ :
 $A_y^{\text{z}2}$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I =ionic strength, mol kg⁻¹

	log Q							
I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 8.

COMMENTS: $\Delta_r H^\circ (I=1) = -164431$.

 * Aqueous *
 * Solutions *
 * Database *

MOLYBDENUM
 OXIDES
 rc = M07
 September 1984

EQUILIBRIUM REACTION: $\text{MoO}_4^{--} + 2\text{H}^+ = \text{MoO}_3(\text{s}) + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 33920
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 109.65
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 459.87
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : 11.67

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	11.67	11.29	11.09	11.04	11.23	11.68	12.29	12.99
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;16

COMMENTS: From Ref. 9: $\Delta_r H^\circ = -31700$.

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 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 HYDROXIDES
 FC = NP1
 September 1984

EQUILIBRIUM REACTION: $\text{NpO}_2^{++} + \text{H}_2\text{O} = \text{NpO}_2\text{OH}^+ + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

ΔH° , J mol⁻¹ : 43439
 ΔS° , J mol⁻¹ K⁻¹ : 46.99
 ΔC_p° , J mol⁻¹ K⁻¹ : - 21.29
 $\Delta \gamma^\circ_{\text{H}_2\text{O}}$, (kg mol⁻¹)^{1/2} : - 1.02
 b , kg mol⁻¹ : 1.74
 $\log K_0$: - 5.15

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 5.15	- 4.57	- 4.07	- 3.65	- 2.97	- 2.44	- 2.03	- 1.69
0.01	- 5.23							
0.10	- 5.22							
0.20	- 5.12							
0.50	- 4.70							
1.00	- 3.92							
2.00	- 2.27							
3.00	- 0.58							

REFERENCES: 3;6;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 HYDROXIDES
 rc = NP2
 September 1984

EQUILIBRIUM REACTION: $2\text{NpO}_2^{++} + 2\text{H}_2\text{O} = (\text{NpO}_2)_2(\text{OH})_2^{++} + 2\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 45620
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 31.98
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 202.58
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : - 1.02
 b , kg mol⁻¹ : 0.01
 $\log K_o$: - 6.39

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 6.39	- 5.73	- 5.29	- 4.96	- 4.54	- 4.34	- 4.28	- 4.33
0.01	- 6.48							
0.10	- 6.63							
0.20	- 6.70							
0.50	- 6.81							
1.00	- 6.89							
2.00	- 6.97							
3.00	- 7.01							

REFERENCES: 3;6;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 HYDROXIDES
 EG = NE3
 September 1984

EQUILIBRIUM REACTION: $3\text{NpO}_2^{++} + 5\text{H}_2\text{O} = (\text{NpO}_2)_3(\text{OH})_5^+ + 5\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 113396
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 45.15
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 390.45
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} : - 3.07
 b , kg mol⁻¹ : 0.17
 $\log K_o$: -17.49

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-17.49	-16.03	-14.89	-13.99	-12.75	-12.03	-11.66	-11.52
0.01	-17.77							
0.10	-18.21							
0.20	-18.40							
0.50	-18.68							
1.00	-18.86							
2.00	-18.95							
3.00	-18.93							

REFERENCES: 3;6;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 HYDROXIDES
 rc = NP4
 September 1984

EQUILIBRIUM REACTION: $\text{NpO}_2^+ + \text{H}_2\text{O} = \text{NpO}_2\text{OH}(\text{aq}) + \text{H}^+$

THEMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 43360
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : - 24.01
 $\Delta_r G_o$, J mol⁻¹ K⁻¹ : - 176.00
 $\Delta_f Z_2$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ : -0.24
 $\log K_o$: - 8.87

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 8.87	- 8.29	- 7.86	- 7.53	- 7.11	- 6.89	- 6.80	- 6.80
0.01	- 8.87							
0.10	- 8.89							
0.20	- 8.92							
0.50	- 8.99							
1.00	- 9.11							
2.00	- 9.35							
3.00	- 9.59							

REFERENCES: 3

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 HYDROXIDES
 cc = NP5
 September 1984

EQUILIBRIUM REACTION: $\text{Np}^{++++} + \text{H}_2\text{O} = \text{NpOH}^{+++} + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : 44770
 ΔS_o , J mol⁻¹ K⁻¹ : 122.19
 ΔC_p , J mol⁻¹ K⁻¹ : - 38.29
 $\Delta Y^{\sim} z_2$, (kg mol⁻¹)^{1/2} : - 3.07
 b , kg mol⁻¹ : 0.12
 $\log K_o$: - 1.46

EQUILIBRIUM QUOTIENTS: I =ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 1.46	- 0.86	- 0.36	0.07	0.75	1.26	1.65	1.96
0.01	- 1.74							
0.10	- 2.19							
0.20	- 2.38							
0.50	- 2.67							
1.00	- 2.88							
2.00	- 3.02							
3.00	- 3.05							

REFERENCES: 1;3;6;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 FLUORIDES
 rc = NP6
 September 1984

EQUILIBRIUM REACTION: $\text{NpO}_2^{++} + \text{F}^- = \text{NpO}_2\text{F}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 4234
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 92.08
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : 198.00
 $\Delta_f^\circ \text{Z}_2$, (kg mol⁻¹)^{1/2} : - 2.05
 b , kg mol⁻¹ : 0.43
 $\log K_o$: 4.07

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	4.07	4.16	4.29	4.46	4.85	5.29	5.75	6.22
0.01	3.89							
0.10	3.62							
0.20	3.52							
0.50	3.43							
1.00	3.47							
2.00	3.73							
3.00	4.06							

REFERENCES: 7;17

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 FLUORIDES
 IC = NP7
 September 1984

EQUILIBRIUM REACTION: $\text{NpO}_2^{++} + 2\text{F}^- = \text{NpO}_2\text{F}_2(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 3563
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 159.26
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ : 0.00
 $\Delta_f \Delta Z_2$, (kg mol⁻¹)^{1/2} : - 3.07
 b , kg mol⁻¹ : 0.93
 $\log K_o$: 7.70

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	$\log Q$							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	7.70	7.78	7.92	8.10	8.55	9.05	9.58	10.11
0.01	7.43							
0.10	7.06							
0.20	6.94							
0.50	6.89							
1.00	7.10							
2.00	7.76							
3.00	8.54							

REFERENCES: 7;17

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 FLUORIDES
 rc = NP8
 September 1984

EQUILIBRIUM REACTION: $\text{NpO}_2^+ + \text{F}^- = \text{NpO}_2\text{F}(\text{aq})$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : 34725
 ΔS_o , J mol⁻¹ K⁻¹ : 134.08
 ΔC_{po} , J mol⁻¹ K⁻¹ : 112.00
 $\Delta \gamma_{\text{z}2}$, (kg mol⁻¹)^{1/2} : - 1.02
 b , kg mol⁻¹ :
 $\log K_o$: 0.92

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	0.92	1.41	1.86	2.28	3.04	3.71		
0.01								
0.10								
0.20								
0.50								
1.00								
2.00	0.28							
3.00								

REFERENCES: 17

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 FLUORIDES
 rc = NP9
 September 1984

EQUILIBRIUM REACTION: $\text{Np}^{+++} + \text{F}^- = \text{NpF}^{++}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 3180
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 155.42
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 157.00
 $\Delta_f \Delta^\circ$, (kg mol⁻¹)^{1/2} : - 4.08
 b , kg mol⁻¹ :
 $\log K_0$: 7.55

EQUILIBRIUM QUOTIENTS: I =ionic strength, mol kg⁻¹

	log Q							
$1/T$	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	7.55	7.62	7.73	7.86	8.17	8.51		
0.01								
0.10								
0.20								
0.50								
1.00	7.45							
2.00								
3.00								

REFERENCES: 1;5

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 CHLORIDES
 rc = NP10
 September 1984

EQUILIBRIUM REACTION: $\text{NpO}_2^{++} + \text{Cl}^- = \text{NpO}_2\text{Cl}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 12502
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 36.17
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : 548.00
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} : - 2.05
 b , kg mol⁻¹ : 0.26
 $\log K_o$: - 0.30

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 0.30	- 0.04	0.34	0.81	1.91	3.14		
0.01	- 0.48							
0.10	- 0.77							
0.20	- 0.88							
0.50	- 1.02							
1.00	- 1.07							
2.00	- 0.98							
3.00	- 0.82							

REFERENCES: 7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 CHLORIDES
 rc = NP11
 September 1984

EQUILIBRIUM REACTION: $\text{NpO}_2^+ + \text{Cl}^- = \text{NpO}_2\text{Cl(aq)}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ :
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} : 1.02
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 $\log K_o$: - 0.40

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	- 0.40			0.00	0.00			
0.01								
0.10								
0.20								
0.50								
1.00								
2.00	0.38							
3.00								

REFERENCES: 17

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 CHLORIDES
 rc = NP12
 September 1984

EQUILIBRIUM REACTION: $\text{Np}^{++++} + \text{Cl}^- = \text{NpCl}^{+++}$

THERMOCHEMICAL PROPERTIES:

ΔH° , J mol⁻¹ : 19705
 ΔS° , J mol⁻¹ K⁻¹ : 72.37
 ΔC_p° , J mol⁻¹ K⁻¹ : 454.00
 $\Delta_f \Delta Z_2$, (kg mol⁻¹)^{1/2} : - 4.08
 b , kg mol⁻¹ :
 $\log K_o$: 0.33

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	0.33	0.67	1.09	1.57	2.64	3.78		
0.01								
0.10								
0.20								
0.50								
1.00 - 0.04								
2.00								
3.00								

REFERENCES: 17

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 SULFATES
 IC = NP13
 September 1984

EQUILIBRIUM REACTION: $\text{NpO}_2^{++} + \text{SO}_4^{--} = \text{NpO}_2\text{SO}_4\{\text{aq}\}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 20499
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 131.07
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ : 627.00
 $\Delta_f \Delta_r Z_2$, (kg mol⁻¹)^{1/2} : - 4.09
 b , kg mol⁻¹ : -0.38
 $\log K_o$: 3.28

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	3.28	3.65	4.15	4.75	6.11	7.60		
0.01	2.90							
0.10	2.26							
0.20	1.94							
0.50	1.40							
1.00	0.86							
2.00	0.12							
3.00	- 0.45							

REFERENCES: 7;17

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 SULFATES
 rc = NP14
 September 1984

EQUILIBRIUM REACTION: $\text{NpO}_2^+ + \text{SO}_4^{--} = \text{NpO}_2\text{SO}_4^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 20908
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 72.07
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : - 95.00
 $\Delta_f \Delta^\circ$, (kg mol⁻¹)^{1/2} : - 2.04
 b , kg mol⁻¹ : 0.41
 $\log K_o$: 0.10

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	0.10	0.37	0.57	0.72	0.91	1.00		
0.01 - 0.08								
0.10 - 0.35								
0.20 - 0.44								
0.50 - 0.54								
1.00 - 0.51								
2.00 - 0.27								
3.00 0.04								

REFERENCES: 4;17

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 SULFATES
 rc = NP15
 September 1984

EQUILIBRIUM REACTION: $\text{Np}^{++++} + \text{SO}_4^{--} = \text{NpSO}_4^{++}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 20910
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 175.27
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : 404.00
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : - 8.16
 b , kg mol⁻¹ : 0.34
 $\log K_o$: 5.49

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	5.49	5.84	6.26	6.72	7.73	8.79		
0.01	4.75							
0.10	3.56							
0.20	3.04							
0.50	2.28							
1.00	1.75							
2.00	1.39							
3.00	1.34							

REFERENCES: 4;7;17

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 CARBONATES
 rc = NP16
 September 1984

EQUILIBRIUM REACTION: $\text{NpO}_2^{++} + \text{CO}_3^{--} = \text{NpO}_2\text{CO}_3(\text{aq})$

THERMOCHEMICAL PROPERTIES:

ΔH_f° , J mol⁻¹ :
 ΔS_f° , J mol⁻¹ K⁻¹ :
 ΔC_p° , J mol⁻¹ K⁻¹ :
 Δ_f° , (kg mol⁻¹)^{1/2} : - 4.08
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES:

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 CARBONATES
 rc = NP20
 November 1984

EQUILIBRIUM REACTION: $\text{NpO}_2^{++} + 2\text{CO}_3^{--} = \text{NpO}_2(\text{CO}_3)_2^{--}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 30830
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 376.70
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : 212.00
 $\Delta_f \Delta_r G^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 14.27

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	14.27	14.73	15.18	15.62	16.48	17.29		
0.01								
0.10								
0.20								
0.50								
1.00	16.51							
2.00								
3.00								

REFERENCES: 18.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 CARBONATES
 rc = NP17
 September 1984

EQUILIBRIUM REACTION: $\text{NpO}_2^{++} + 3\text{CO}_3^{--} = \text{NpO}_2(\text{CO}_3)_3^{----}$

THEMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 33200
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 275.60
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 1030.00
 $\Delta_f^\circ \text{Z}_2$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ :
 $\log K_o$: 20.21

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	20.21	19.93	19.99	20.29	21.43	23.01		
0.01								
0.10								
0.20								
0.50								
1.00	20.20							
2.00								
3.00								

REFERENCES: 11;18;22;23.

COMMENTS: $\Delta_r H^\circ(I=1.6) = -50000$ (Ref.23).

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 CARBONATES
 rc = NP18
 September 1984

EQUILIBRIUM REACTION: $\text{NpO}_2^+ + \text{CO}_3^{--} = \text{NpO}_2\text{CO}_3^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 49135
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 277.80
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 190.00
 $\Delta_f \Delta^\circ$, (kg mol⁻¹)^{1/2} : - 2.04
 $\Delta_f h^\circ$, kg mol⁻¹ : -0.39
 $\log K_o$: 5.90

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	5.90	6.59	7.25	7.86	8.99	9.99		
0.01	5.71							
0.10	5.37							
0.20	5.19							
0.50	4.86							
1.00	4.49							
2.00	3.92							
3.00	3.44							

REFERENCES: 11;17

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 CARBONATES
 rc = NP19
 October 1984

EQUILIBRIUM REACTION: $2\text{NpO}_2^{++} + \text{CO}_2(\text{ag}) + 4\text{H}_2\text{O} = (\text{NpO}_2)_2\text{CO}_3(\text{OH})_3 + 5\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ :
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ :
 $\Delta_f Z_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00								
0.01								
0.10								
0.20								
0.50								
1.00	-18.60							
2.00								
3.00								

REFERENCES: 18.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 OXIDES
 rc = NP22
 December 1984

EQUILIBRIUM REACTION: $2\text{NpO}_2(\text{s}) + 4\text{H}^+ + \text{O}_2(\text{g}) = 2\text{NpO}_2^{++} + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\bar{r}\text{H}_0$, J mol⁻¹ : -144860
 $\bar{S}_0$, J mol⁻¹ K⁻¹ : -411.62
 $\bar{C}_{\text{po}}$, J mol⁻¹ K⁻¹ : 8.80
 $\Delta\bar{Y}^{\text{sz}2}$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_0 : 3.88

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	3.88	1.92	0.24	- 1.21	- 3.59	- 5.47	- 6.98	- 8.22
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS:

NEPTUNIUM
OXIDES
rc = NP21
October 1984

* Aqueous *
* Solutions *
* Database *

EQUILIBRIUM REACTION: $4\text{NpO}_2(\text{s}) + 4\text{H}^+ + \text{O}_2(\text{g}) = 4\text{NpO}_2^+ + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta^\circ\text{H}_\text{f}$, J mol⁻¹ : -188460
 $\Delta^\circ\text{S}_\text{f}$, J mol⁻¹ K⁻¹ : -470.02
 $\Delta^\circ\text{C}_\text{p}$, J mol⁻¹ K⁻¹ : 224.38
 $\Delta^\circ\text{f}^\circ\text{z}_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_\text{o}$: 8.47

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	8.47	5.95	3.86	2.10	- 0.65	- 2.67	- 4.18	- 5.34
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 OXIDES
 rc = NP23
 December 1984

EQUILIBRIUM REACTION: $\text{NpO}_2(\text{s}) + 4\text{H}^+ = \text{Np}^{4+} + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 53760
 $\Delta_f H^\circ$, J mol⁻¹ K⁻¹ : -329.58
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : 29.37
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} :
 $\Delta_f b$, kg mol⁻¹ :
 $\log K_o$: - 7.80

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 7.80	- 8.52	- 9.13	- 9.65	-10.49	-11.14	-11.64	-12.05
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 IONS
 rc = NP24
 December 1984

EQUILIBRIUM REACTION: $2\text{NpO}_2^+ + 4\text{H}^+ = 2\text{Np}^{4+} + \text{O}_2(\text{g}) + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 330340
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 28.66
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 124.06
 $\Delta_f \Delta Z^2$, (kg mol⁻¹) ^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: -56.37

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-56.37	-51.92	-48.13	-44.89	-39.63	-35.56	-32.34	-29.73
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 IONS
 IC = NP25
 December 1984

EQUILIBRIUM REACTION: $4\text{HPO}_2^+ + 12\text{H}^+ = 4\text{H}_2\text{P}^{+++} + \text{O}_2(\text{g}) + 6\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$^{\circ}\text{rHo}$, J mol⁻¹ : - 26580
 $^{\circ}\text{So}$, J mol⁻¹ K⁻¹ : -848.30
 $^{\circ}\text{Cpo}$, J mol⁻¹ K⁻¹ : - 106.89
 $\Delta\gamma^{\circ}\text{z}_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log \text{Ko}$: -39.65

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-39.65	-40.03	-40.38	-40.72	-41.33	-41.89	-42.39	-42.85
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 IONS
 IC = NF26
 December 1984

EQUILIBRIUM REACTION: $4\text{NpO}_2 + 4\text{H}^+ + \text{O}_2(\text{g}) = 4\text{NpO}_2^{++} + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : -101260
 ΔS_o , J mol⁻¹ K⁻¹ : -353.22
 ΔC_{po} , J mol⁻¹ K⁻¹ : - 206.78
 $\Delta_f \Delta Z$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: - 0.71

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 0.71	- 2.12	- 3.38	- 4.53	- 6.54	- 8.26	- 9.77	-11.10
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 OXIDES
 IC = NP27
 December 1984

EQUILIBRIUM REACTION: $2\text{NpO}_2(\text{s}) + \text{O}_2(\text{g}) + 2\text{H}_2\text{O} = 2\text{NpO}_2(\text{OH})_2(\text{s})$

THERMOCHEMICAL PROPERTIES:

ΔH°_f , J mol⁻¹ : - 34360
 ΔS°_f , J mol⁻¹ K⁻¹ : -269.46
 ΔG°_f , J mol⁻¹ K⁻¹ : - 88.36
 ΔY°_{Z2} , (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: - 8.05

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/I	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 8.05	- 8.53	- 8.97	- 9.37	-10.09	-10.71	-11.25	-11.74
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 OXIDES
 rc = WP28
 December 1984

EQUILIBRIUM REACTION: $4\text{NpO}_2(\text{s}) + \text{O}_2(\text{g}) + 2\text{H}_2\text{O} = 4\text{NpO}_2(\text{OH})(\text{am})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 30660
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : -262.06
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ : - 42.06
 $\Delta_f \bar{z}_2$, (kg mol⁻¹) ^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: - 8.32

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 8.32	- 8.74	- 9.11	- 9.45	-10.02	-10.50	-10.92	-11.28
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 OXIDES
 rc = WP29
 December 1984

EQUILIBRIUM REACTION: $4\text{NpO}_2(\text{s}) + \text{O}_2(\text{g}) = 2\text{Np}_2\text{O}_5(\text{s})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 500
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -200.24
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 36.20
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\lg K_o$: -10.37

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-10.37	-10.38	-10.41	-10.43	-10.50	-10.58	-10.66	-10.74
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 OXIDES
 rc = NP30
 December 1984

EQUILIBRIUM REACTION: $\text{NpO}_2(\text{s}) + 2\text{H}_2\text{O} = \text{Np}(\text{OH})_4(\text{s})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 24872
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 81.12
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : - 85.79
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : - 8.59

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 8.59	- 8.27	- 8.02	- 7.82	- 7.55	- 7.39	- 7.31	- 7.28
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 OXIDES
 EC = NP31
 December 1984

EQUILIBRIUM REACTION: $\text{Mp(s)} + \text{O}_2(\text{g}) = \text{MpO}_2(\text{s})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ :
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 0.32
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ : 7.23
 $\Delta_f \Delta^2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00								97.95
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS: $\Delta_r H_o = -1074000$; $\log K_o = 188.16(25c)$; $173.60(50c)$;
 $161.14(75c)$; $150.35(100c)$; $132.60(150c)$; $118.61(200c)$;
 $107.29(250c)$;

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 OXIDES
 rc = W232
 December 1984

EQUILIBRIUM REACTION: $4\text{NpO}_2(\text{s}) + 12\text{H}^+ = 4\text{Np}^{+++} + \text{O}_2(\text{g}) + 6\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 472220
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -412.70
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 23.73
 $\Delta_f \gamma^{\sim 2}_2$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o :

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q						
	25 C	50 C	75 C	100 C	150 C	200 C	300 C
0.00		-97.88	-92.41	-87.68	-79.91	-73.80	-64.80
0.01							
0.10							
0.20							
0.50							
1.00							
2.00							
3.00							

REFERENCES: 22;

COMMENTS: Log K_o = -104.28 (25c) ;

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 HYDROXIDES
 rc = NP33
 December 1984

EQUILIBRIUM REACTION: $\text{Np}(\text{OH})_4(\text{s}) + 4\text{H}^+ = \text{Np}^{4+} + 4\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 78055
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -248.46
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 115.16
 $\Delta_f^\circ \text{Z}_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 0.70

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	0.70	- 0.34	- 1.20	- 1.91	- 3.01	- 3.81	- 4.39	- 4.82
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 OXIDES
 rc = NP34
 December 1984

EQUILIBRIUM REACTION: $\text{Np2O5(s)} + 2\text{H}^+ = 2\text{NpO2}^+ + \text{H2O}$

THERMOCHEMICAL PROPERTIES:

Δ_{fH}° , J mol⁻¹ : - 93980
 Δ_{fS}° , J mol⁻¹ K⁻¹ : -134.89
 Δ_{fG}° , J mol⁻¹ K⁻¹ : 130.29
 Δ_f° , (kg mol⁻¹)^{1/2} :
 L, kg mol⁻¹ :
 log K_o : 9.42

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	9.42	8.17	7.13	6.27	4.93	3.95	3.24	2.70
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 HYDROXIDES
 rc = NP35
 December 1984

EQUILIBRIUM REACTION: $\text{NpO}_2(\text{OH}) (\text{am}) + \text{H}^+ = \text{NpO}_2^+ + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 39450
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : - 51.99
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : 81.29
 $\Delta_f A^\circ$, (kJ mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 4.20

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	4.20	3.67	3.25	2.91	2.39	2.03	1.78	1.62
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NEPTUNIUM
 HYDROXIDES
 IC = NP36
 December 1984

EQUILIBRIUM REACTION: $\text{NpO}_2(\text{OH})_2(\text{s}) + 2\text{H}^+ = \text{NpO}_2^{++} + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 55250
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 71.08
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 48.58
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 $\log K_o$: 5.97

EQUILIBRIUM QUOTIENTS: Ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	5.97	5.23	4.61	4.08	3.25	2.62	2.14	1.76
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 22;

COMMENTS:

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 * Aqueous *
 * Solutions *
 * Database *

NITROGEN
 AMMONIA
 rc = N1
 September 1984

EQUILIBRIUM REACTION: $\text{NH}_3(\text{g}) = \text{NH}_3(\text{aq})$

THERMOCHEMICAL PROPERTIES:

^{-}rHo , J mol $^{-1}$: - 34350
 ^{-}So , J mol $^{-1}$ K $^{-1}$: - 81.37
 ^{-}Cpo , J mol $^{-1}$ K $^{-1}$: 51.34
 Ay^{-}z_2 , (kg mol $^{-1}$) $^{1/2}$:
 b , kg mol $^{-1}$:
 $\log \text{Ko}$: 1.77

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg $^{-1}$

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	1.77	1.31	0.93	0.62	0.14	- 0.21	- 0.47	- 0.65
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NITROGEN
 AMMONIA
 rc = N2
 September 1984

EQUILIBRIUM REACTION: $\text{NH}_3(\text{aq}) + \text{H}^+ = \text{NH}_4^+$

THERMOCHEMICAL PROPERTIES:

$\bar{r}\text{Ho}$, J mol⁻¹ : - 52970
 $\bar{r}\text{So}$, J mol⁻¹ K⁻¹ : - 0.13
 $\bar{r}\text{Cpo}$, J mol⁻¹ K⁻¹ : - 6.50
 $\Delta\bar{y}^{\sim}z_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 9.27

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	9.27	8.55	7.93	7.39	6.51	5.81	5.24	4.76
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

NITROGEN
 AMMONIA
 EC = H3
 November 1984

EQUILIBRIUM REACTION: $\text{NH}_3(\text{aq}) + \text{HCO}_3^- = \text{H}_2\text{NCOO}^- + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 24070
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : - 71.49
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : - 38.11
 $\Delta_f \gamma^{\sim} z_2$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ :
 $\log K_o$: 0.49

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	0.48	0.15	- 0.15	- 0.41	- 0.87	- 1.26	- 1.59	- 1.89
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 3

COMMENTS: $\Delta_r H_o$, $\Delta_r S_o$, $\Delta_r C_{p,o}$ estimated from data in Reference 8.

 * Aqueous *
 * Solutions *
 * Database *

NITROGEN
 AMMONIA
 TC = NH₄
 November 1984

EQUILIBRIUM REACTION: $\text{NH}_3(\text{aq}) + \text{CO}_2(\text{aq}) + \text{H}_2\text{O} = \text{NH}_4^+ + \text{HCO}_3^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 45330
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : - 96.44
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ : - 377.79
 $\Delta_f z_2$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ :
 log K_0 : 2.89

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	2.89	2.23	1.54	0.85	- 0.52	- 1.84	- 3.12	- 4.33
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 8

COMMENTS:

NITROGEN
References
June 1984

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 * Aqueous *
 * Solutions *
 * Database *

OXYGEN
 GASES
 rc = 01
 September 1984

EQUILIBRIUM REACTION: $O_2(g) = O_2(aq)$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 12000
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : - 94.14
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : 175.64
 $\Delta_f \bar{h}^{\circ}_{22}$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : - 2.81

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/1	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 2.81	- 2.95	- 3.01	- 3.02	- 2.93	- 2.75	- 2.51	- 2.23
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 5;9;10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

OXYGEN
 WATER
 rc = 02
 September 1984

EQUILIBRIUM REACTION: $\text{H}_2\text{O} = \text{OH}^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\bar{h}_\text{Ho}$, J mol⁻¹ : 55805
 $\bar{h}_\text{So}$, J mol⁻¹ K⁻¹ : - 80.62
 $\bar{c}_\text{po}$, J mol⁻¹ K⁻¹ : - 213.29
 $\text{A}_\text{y}^{\text{z}2}$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ : -0.29
 $\log K_\text{o}$: -13.99

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-13.99	-13.27	-12.71	-12.28	-11.71			
0.01	-13.90							
0.10	-13.77							
0.20	-13.73							
0.50	-13.71							
1.00	-13.77							
2.00	-13.97							
3.00	-14.21							

REFERENCES: 5;10;18;22;23;24;25;26;31;21

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

OXYGEN
 WATER
 rc = 03
 September 1984

EQUILIBRIUM REACTION: $\text{H}_2\text{O} = \text{OH}^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 55815
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : - 86.67
 $\Delta_r C_p o$, J mol⁻¹ K⁻¹ : - 231.40
 $\Delta_f \bar{z}_2$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ :
 $\log K_o$: -13.99

EQUILIBRIUM QUOTIENTS: I =ionic strength, mol kg⁻¹

I/m	$\log Q$							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	-13.99	-13.28	-12.71	-12.27	-11.64	-11.29	-11.19	-11.41
0.01	-13.91							
0.10	-13.78	-13.05	-12.47	-12.00	-11.33	-10.93	-10.72	-10.65
0.20								
0.50	-13.72	-12.97	-12.38	-11.90	-11.19	-10.73	-10.43	-10.19
1.00	-13.75	-13.00	-12.40	-11.92	-11.18	-10.68	-10.32	- 9.98
2.00								
3.00	-14.01	-13.23	-12.60	-12.07	-11.26	-10.66	-10.16	- 9.57

REFERENCES: 2;19;33

COMMENTS: $\log Q = -12.30$ (350 C); -15.74 (374.1 C). These are all smoothed values.

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 * Aqueous *
 * Solutions *
 * Database *

PHOSPHORUS
 PHOSPHATES
 rc = P1
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{PO}_4(\text{aq}) = \text{H}_2\text{PO}_4^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 7950
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : - 70.73
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ : - 128.00
 $\Delta_f Z_2$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ : -0.15
 $\log K_o$: - 2.30

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 2.30	- 2.43	- 2.58	- 2.74	- 3.08	- 3.43	- 3.78	- 4.13
0.01	- 2.21							
0.10	- 2.07							
0.20	- 2.01							
0.50	- 1.95							
1.00	- 1.94							
2.00	- 2.00							
3.00	- 2.10							

REFERENCES: 1;5;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PHOSPHORUS
 PHOSPHATES
 rc = P2
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{PO}_4(\text{aq}) + \text{OH}^- = \text{H}_2\text{PO}_4^- + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 63755
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 9.89
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 85.29
 $\Delta_f Z^\circ$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ : 0.14
 $\log K_o$: 11.69

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	11.69	10.83	10.13	9.54	8.63	7.96	7.47	7.10
0.01	11.69							
0.10	11.70							
0.20	11.72							
0.50	11.76							
1.00	11.83							
2.00	11.97							
3.00	12.11							

REFERENCES: 1;3;6;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PHOSPHORUS
 PHOSPHATES
 rc = P3
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{PO}_4(\text{aq}) = \text{HPO}_4^{--} + 2\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\bar{r}\text{Ho}$, J mol⁻¹ : - 3800
 $\bar{r}\text{So}$, J mol⁻¹ K⁻¹ : -197.75
 $\bar{r}\text{Cpo}$, J mol⁻¹ K⁻¹ : - 348.00
 $\Delta\bar{y}^{\sim}z_2$, (kg mol⁻¹)^{1/2} : 3.06
 b , kg mol⁻¹ :
 $\log K_o$: - 9.66

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 9.66	- 9.77	- 9.97	-10.22	-10.85	-11.58	-12.35	-13.14
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;3;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PHOSPHORUS
 PHOSPHATES
 rc = P4
 September 1984

EQUILIBRIUM REACTION: $\text{H}_3\text{PO}_4(\text{aq}) = \text{PO}_4^{3-} + 3\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 10940
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -381.40
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : -590.00
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : 6.12
 $\Delta_f H^\circ$, kJ mol⁻¹ :
 log K₀ : -21.84

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-21.84	-21.79	-21.91	-22.17	-22.96	-23.96	-25.09	-26.27
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;6;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PHOSPHORUS
 PHOSPHATES
 rc = P5
 September 1984

EQUILIBRIUM REACTION: $\text{H}_2\text{PO}_4^- = \text{HPO}_4^{--} + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 4150
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -127.00
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : -220.00
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} : 2.04
 b , kg mol⁻¹ : -0.04
 $\log K_o$: -7.36
 $B_9 = 2.01$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 7.36	- 7.34	- 7.39	- 7.48	- 7.78	- 8.15	- 8.57	- 9.01
0.01	- 7.20							
0.10	- 6.98							
0.20	- 6.89							
0.50	- 6.79							
1.00	- 6.73							
2.00	- 6.69							
3.00	- 6.70							

REFERENCES: 1;5;7;8

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PHOSPHORUS
 PHOSPHATES
 rc = P6
 September 1984

EQUILIBRIUM REACTION: $\text{H}_2\text{PO}_4^- + \text{OH}^- = \text{HPO}_4^{--} + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 51655
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : - 46.36
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 6.71
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : 1.02
 b, kg mol⁻¹ :
 log K_o : 6.63

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	6.63	5.92	5.32	4.79	3.93	3.25	2.69	2.22
0.01	6.70							
0.10	6.79							
0.20	6.84							
0.50	6.92							
1.00	7.04							
2.00	7.28							
3.00	7.51							

REFERENCES: 1;5;7

COMMENTS: logQ(I) calculated from logK_w and ionization constants at 25C for H₂PO₄⁻.

 * Aqueous *
 * Solutions *
 * Database *

PHOSPHORUS
 PHOSPHATES
 rc = P7
 September 1984

EQUILIBRIUM REACTION: $\text{HPO}_4^{2-} = \text{PO}_4^{3-} + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 14740
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -183.70
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 242.00
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : 3.06
 b , kg mol⁻¹ : -0.12
 $\log K_0$: -12.17
 $B_9 = 1.96$

EQUILIBRIUM QUOTIENTS: I =ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-12.17	-12.01	-11.95	-11.95	-12.10	-12.38	-12.73	-13.13
0.01	-11.91							
0.10	-11.58							
0.20	-11.46							
0.50	-11.32							
1.00	-11.26							
2.00	-11.26							
3.00	-11.32							

REFERENCES: 1;5;7;8

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PHOSPHORUS
 PHOSPHATES
 rc = PB
 September 1984

EQUILIBRIUM REACTION: $\text{HPO}_4^{--} + \text{OH}^- = \text{PO}_4^{---} + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 41065
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : -103.03
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 28.71
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : 2.04
 b , kg mol⁻¹ :
 $\log K_o$: 1.82

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	1.82	1.25	0.76	0.33	- 0.39	- 0.99	- 1.48	- 1.89
0.01	1.99							
0.10	2.19							
0.20	2.27							
0.50	2.39							
1.00	2.51							
2.00	2.81							
3.00	2.89							

REFERENCES: 1;3;7;d

COMMENTS: logQ(I) calculated from logKw and ionization constants of
 HPO_4^{--} at 25C.

PHOSPHORUS
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September 1984

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 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 HYDROXIDES
 rc = PU1
 September 1984

EQUILIBRIUM REACTION: $\text{PuO}_2^{++} + \text{H}_2\text{O} \rightleftharpoons \text{PuO}_2\text{OH}^+ + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 45430
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 44.09
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 16.29
 $\Delta_f \gamma_{\text{Z}_2}$, (kg mol⁻¹)^{1/2} : - 1.02
 Δ_f , kg mol⁻¹ : -0.06
 $\log K_0$: - 5.66

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 5.66	- 5.04	- 4.52	- 4.08	- 3.35	- 2.79	- 2.35	- 1.99
0.01	- 5.75							
0.10	- 5.91							
0.20	- 5.99							
0.50	- 6.11							
1.00	- 6.23							
2.00	- 6.38							
3.00	- 6.49							

REFERENCES: 1;2;4;5;9

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 HYDROXIDES
 PC = PU2
 September 1984

EQUILIBRIUM REACTION: $2\text{PuO}_2^{++} + 2\text{H}_2\text{O} = (\text{PuO}_2)_2(\text{OH})_2^{++} + 2\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$^{-r}H_o$, J mol⁻¹ : 58160
 $^{-S}_o$, J mol⁻¹ K⁻¹ : 36.18
 $^{-C}_{p_o}$, J mol⁻¹ K⁻¹ : - 225.58
 $\Delta y^{\sim 2}_2$, (kg mol⁻¹)^{1/2} : - 1.02
 b , kg mol⁻¹ : 0.21
 $\log K_o$: - 8.30

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 8.30	- 7.55	- 6.97	- 6.53	- 5.93	- 5.61	- 5.47	- 5.46
0.01	- 8.39							
0.10	- 8.52							
0.20	- 8.57							
0.50	- 8.62							
1.00	- 8.60							
2.00	- 8.48							
3.00	- 8.32							

REFERENCES: 1;2;4;5;9

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 HYDROXIDES
 rc = PU3
 September 1984

EQUILIBRIUM REACTION: $3\text{PuO}_2^{++} + 5\text{H}_2\text{O} = (\text{PuO}_2)_3(\text{OH})_5 + 5\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 139450
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 54.45
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : -407.46
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} : -3.06
 t , kg mol⁻¹ : 0.30
 $\log K_0$: -21.59

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/I	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-21.59	-19.76	-18.32	-17.17	-15.53	-14.51	-13.89	-13.56
0.01	-21.87							
0.10	-22.30							
0.20	-22.48							
0.50	-22.71							
1.00	-22.82							
2.00	-22.78							
3.00	-22.63							

REFERENCES: 1;2;4;5;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 HYDROXIDES
 rc = P04
 September 1984

EQUILIBRIUM REACTION: $\text{Pu}^{4+} + \text{H}_2\text{O} = \text{PuOH}^{3+} + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

ΔH° , J mol⁻¹ : 48230
 ΔS° , J mol⁻¹ K⁻¹ : 152.09
 ΔC_p° , J mol⁻¹ K⁻¹ : - 81.29
 $\Delta y^\circ_{\text{H}_2\text{O}}$, (kg mol⁻¹)^{1/2} : - 3.06
 b , kg mol⁻¹ : 0.27
 $\log K_o$: - 0.51

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/I	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00 - 0.51	0.14	0.66	1.09	1.76	2.23	2.57	2.81	
0.01 - 0.79								
0.10 - 1.22								
0.20 - 1.40								
0.50 - 1.64								
1.00 - 1.77								
2.00 - 1.76								
3.00 - 1.64								

REFERENCES: 1;2;4;5;9

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 HYDROXIDES
 rc = PU5
 September 1984

EQUILIBRIUM REACTION: $\text{Pu}^{4+} + 2\text{H}_2\text{O} = \text{Pu}(\text{OH})_2^{2+} + 2\text{H}^+$

THERMOCHEMICAL PROPERTIES:

ΔH_f° , J mol⁻¹ : 74360
 ΔS_f° , J mol⁻¹ K⁻¹ : 205.18
 ΔC_p° , J mol⁻¹ K⁻¹ : - 103.58
 ΔG_f° , (kg mol⁻¹)^{1/2} : - 5.10
 b , kg mol⁻¹ :
 $\log K_o$: - 2.31

EQU. LIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 2.31	- 1.32	- 0.50	0.18	1.24	2.01	2.58	3.00
0.01								
0.10								
0.20								
0.50								
1.00	- 2.89							
2.00								
3.00								

REFERENCES: 1;2;4

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 HYDROXIDES
 PC = PU6
 September 1984

EQUILIBRIUM REACTION: $\text{Pu}^{++++} + 3\text{H}_2\text{O} = \text{Pu}(\text{OH})_3 + 3\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 96590
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 223.27
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 103.87
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} : - 6.12
 b , kg mol⁻¹ :
 $\log K_o$: - 5.26

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 5.26	- 3.97	- 2.89	- 1.99	- 0.56	0.50	1.30	1.92
0.01								
0.10								
0.20								
0.50								
1.00	- 6.51							
2.00	- 7.08							
3.00								

REFERENCES: 1;2;4

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 HYDROXIDES
 rc = PU7
 September 1984

EQUILIBRIUM REACTION: $\text{Pu}^{4+} + 4\text{H}_2\text{O} = \text{Pu}(\text{OH})_4(\text{aq}) + 4\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 109120
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 184.35
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 0.16
 $\Delta_f \Delta_r Z^\circ$, (kg mol⁻¹)^{1/2} : - 6.12
 b , kg mol⁻¹ :
 $\log K_o$: - 9.50

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 9.50	- 8.91	- 6.74	- 5.64	- 3.84	- 2.42	- 1.27	- 0.32
0.01								
0.10								
0.20								
0.50								
1.00	-10.77							
2.00	-11.31							
3.00								

REFERENCES: 1;2;4

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 HYDROXIDES
 rc = PU8
 September 1984

EQUILIBRIUM REACTION: $\text{Pu}^{4+} + 5\text{H}_2\text{O} = \text{Pu}(\text{OH})_5^- + 5\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 125650
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 135.45
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 379.46
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : - 5.10
 b , kg mol⁻¹ :
 $\log K_0$: -14.94

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-14.94	-13.30	-12.00	-10.98	- 9.52	- 8.62	- 8.09	- 7.82
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2;4

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 HYDROXIDES
 rc = PU9
 September 1984

EQUILIBRIUM REACTION: $\text{Pu}^{+++} + \text{H}_2\text{O} = \text{PuOH}^{++} + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_{\text{f}}\text{H}^\circ$, J mol⁻¹ : 53230
 $\Delta_{\text{f}}\text{S}^\circ$, J mol⁻¹ K⁻¹ : 26.09
 $\Delta_{\text{f}}\text{G}^\circ$, J mol⁻¹ K⁻¹ : - 5.29
 $\Delta_{\text{f}}\text{G}^\circ$, (kg mol⁻¹)^{1/2} : - 2.04
 $\Delta_{\text{f}}\text{G}^\circ$, kg mol⁻¹ :
 log K_o : - 7.96

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 7.96	- 7.24	- 6.63	- 6.09	- 5.22	- 4.54	- 3.99	- 3.54
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 FLUORIDES
 PC = PU10
 September 1984

EQUILIBRIUM REACTION: $\text{PuO}_2^{++} + \text{F}^- = \text{PuO}_2\text{F}^+$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : - 5250
 ΔS_o , J mol⁻¹ K⁻¹ : 91.18
 ΔC_p , J mol⁻¹ K⁻¹ : 202.00
 Δy^{zz}_2 , (kg mol⁻¹)^{1/2} : - 2.04
 E , kg mol⁻¹ :
 $\log K_o$: 5.68

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	5.68	5.64	5.67	5.74	5.99	6.31	6.68	7.07
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2;9

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 FLUORIDES
 rc = P011
 September 1984

EQUILIBRIUM REACTION: $\text{PuO}_2^{++} + 2\text{F}^- = \text{PuO}_2\text{F}_2(\text{aq})$

THEMOCHEMICAL PROPERTIES:

ΔH°_f , J mol⁻¹ : - 41700
 ΔS°_f , J mol⁻¹ K⁻¹ : 70.36
 ΔC°_p , J mol⁻¹ K⁻¹ : 233.00
 $\Delta y^\circ_{\text{z}2}$, (kg mol⁻¹)^{1/2} : - 3.06
 b , kg mol⁻¹ :
 $\log K_o$: 10.98

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	10.98	10.45	10.07	9.79	9.49	9.39	9.45	9.59
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 FLUORIDES
 rc = PU12
 September 1984

EQUILIBRIUM REACTION: $\text{PuO}_2^{++} + 3\text{F}^- = \text{PuO}_2\text{F}_3^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 29450
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 206.54
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : 82.00
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : - 3.06
 b , kg mol⁻¹ :
 $\log K_o$: 15.95

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

1/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	15.95	15.56	15.25	15.01	14.66	14.43	14.29	14.21
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 FLUORIDES
 FC = PU13
 September 1984

EQUILIBRIUM REACTION: $\text{PuO}_2^{++} + 4\text{F}^- = \text{PuO}_2\text{F}_4^{--}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 40000
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 225.72
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : 402.00
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : - 2.04
 b , kg mol⁻¹ :
 $\log K_o$: 18.79

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	18.79	18.32	18.03	17.88	17.87	18.13	18.56	19.08
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 CHLORIDES
 rc = P014
 September 1984

EQUILIBRIUM REACTION: $\text{PuO}_2^{++} + \text{Cl}^- = \text{PuO}_2\text{Cl}^+$

THERMOCHEMICAL PROPERTIES:

ΔH_f° , J mol⁻¹ : 11180
 ΔS_f° , J mol⁻¹ K⁻¹ : 35.27
 ΔC_p° , J mol⁻¹ K⁻¹ : 551.00
 $\Delta y^\circ_{\text{z2}}$, (kg mol⁻¹)^{1/2} : - 2.04
 b , kg mol⁻¹ :
 $\log K_o$: - 0.12

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 0.12	0.13	0.49	0.95	2.04	3.25	4.53	5.82
0.01								
0.10								
0.20								
0.50								
1.00								
2.00	- 0.90							
3.00								

REFERENCES: 1;2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 CHLORIDES
 rc = PU15
 September 1984

EQUILIBRIUM REACTION: $\text{Pu}^{4+} + \text{Cl}^- = \text{PuCl}^{3+}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 17180
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 75.27
 $\Delta_r C_p_o$, J mol⁻¹ K⁻¹ : 455.00
 $\Delta_f Z$, (kg mol⁻¹)^{1/2} : - 4.08
 b , kg mol⁻¹ :
 $\log K_o$: 0.92

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	0.92	1.23	1.63	2.08	3.11	4.22	5.36	6.49
0.01								
0.10								
0.20								
0.50								
1.00 - 0.30								
2.00								
3.00								

REFERENCES: 1;2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 SULFATES
 rc = PU18
 September 1984

EQUILIBRIUM REACTION: $\text{PuO}_2^{++} + \text{SO}_4^{--} = \text{PuO}_2\text{SO}_4(\text{ag})$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 20200
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 130.17
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : 627.00
 $\Delta_f Z$, (kg mol⁻¹)^{1/2} : - 4.08
 b , kg mol⁻¹ :
 $\log K_o$: 3.25

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	3.25	3.64	4.14	4.74	6.09	7.58	9.11	10.65
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 SULFATES
 rc = PU19
 September 1984

EQUILIBRIUM REACTION: $\text{Pu}^{+++} + \text{SO}_4^{--} = \text{PuSO}_4^{+}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 12500
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 152.17
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 429.00
 $\Delta_f \Delta_r Z_2$, (kg mol⁻¹)^{1/2} : - 8.16
 b , kg mol⁻¹ :
 $\log K_o$: 5.75

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	5.75	5.99	6.33	6.72	7.63	8.63	9.66	10.70
0.01								
0.10								
0.20								
0.50								
1.00								
2.00	2.70							
3.00								

REFERENCES: 1;2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 SULFATES
 rc = PU20
 September 1984

EQUILIBRIUM REACTION: $\text{Pu}^{++} + \text{SO}_4^{--} = \text{PuSO}_4^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 14400
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 115.17
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : 452.00
 $\Delta_f \gamma^{-1/2}$, (kg mol⁻¹)^{1/2} : - 6.12
 E , kJ mol⁻¹ :
 $\log K_o$: 3.48

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	3.48	3.76	4.12	4.55	5.53	6.59	7.69	8.80
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 CARBONATES
 rc = PU16
 September 1984

EQUILIBRIUM REACTION: $\text{PuO}_2^{++} + 2\text{CO}_3^{--} = \text{PuO}_2(\text{CO}_3)_2^{--}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 26980
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 376.80
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : 214.00
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : - 4.08
 $\Delta_f G^\circ$, kg mol⁻¹ :
 log K_o : 14.95

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	14.95	15.35	15.76	16.17	16.96	17.73	18.46	19.16
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 CARBONATES
 rc = P017
 September 1984

EQUILIBRIUM REACTION: $\text{Pu}^{++++} + \text{CO}_3^{--} = \text{PuCO}_3^{++}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : -186960
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 152.90
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 499.00
 $\Delta_f^\circ \text{Z}_2$, (kg mol⁻¹)^{1/2} : - 8.16
 b , kg mol⁻¹ :
 $\log K_o$: 40.74

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	40.74	38.29	36.33	34.76	32.49	31.02	30.10	29.55
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 IONS
 rc = P034
 December 1984

EQUILIBRIUM REACTION: $4\text{PuO}_2 + 2\text{H}_2\text{O} = 4\text{PuO}_2 + 4\text{H}^+ + \text{O}_2(\text{g})$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : 202060
 ΔS_o , J mol⁻¹ K⁻¹ : 333.22
 ΔC_{po} , J mol⁻¹ K⁻¹ : 226.78
 Δy_{z2} , (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : -17.99

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-17.99	-15.22	-12.77	-10.60	- 6.89	- 3.81	- 1.20	1.05
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 IONS
 IC = PU33
 December 1984

EQUILIBRIUM REACTION: $2\text{PuO}_2^{++} + 4\text{H}^+ = 2\text{Pu}^{+++} + 2\text{H}_2\text{O} + \text{O}_2(\text{g})$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : - 60
 ΔS_o , J mol⁻¹ K⁻¹ : -257.14
 ΔC_p , J mol⁻¹ K⁻¹ : 31.94
 $\Delta \gamma^{\sim} z_2$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : -13.42

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	-13.42	-13.42	-13.40	-13.38	-13.33	-13.27	-13.20	-13.13
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

PLUTONIUM
IONS
rc = PU32
December 1984

* Aqueous *
* Solutions *
* Database *

EQUILIBRIUM REACTION: $4\text{PuO}_2^{++} + 4\text{H}^+ = 4\text{Pu}^{++} + 2\text{H}_2\text{O} + 3\text{O}_2(\text{g})$

THERMOCHEMICAL PROPERTIES:

ΔH° , J mol⁻¹ : 349140
 ΔS° , J mol⁻¹ K⁻¹ : 370.94
 ΔC_p° , J mol⁻¹ K⁻¹ : - 49.34
 $\Delta y^\circ_{\text{Z}_2}$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_0$: -41.79

EQUILIBRIUM QUOTIENTS: μ =ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-41.79	-37.06	-33.03	-29.56	-23.86	-19.40	-15.82	-12.89
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 OXIDES
 PC = PU25
 December 1984

EQUILIBRIUM REACTION: $2\text{PuO}_2(\text{s}) + 4\text{H}^+ + \text{O}_2(\text{g}) = 2\text{PuO}_2^{++} + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

ΔH°_f , J mol⁻¹ : -103411
 ΔS°_f , J mol⁻¹ K⁻¹ : -373.48
 ΔG°_f , J mol⁻¹ K⁻¹ : 10.72
 $\Delta \gamma^{-2} 2, (\text{kg mol}^{-1})^{1/2}$:
 b , kg mol⁻¹ :
 $\log K_o$: - 1.39

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 1.39	- 2.79	- 3.99	- 5.02	- 6.71	- 8.04	- 9.11	- 9.94
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 OXIDES
 rc = PU39
 December 1984

EQUILIBRIUM REACTION: $2\text{PuO}_2(\text{s}) + \text{O}_2(\text{g}) + 2\text{H}_2\text{O} = 2\text{PuO}_2(\text{OH})_2(\text{s})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 54395
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : -344.30
 $\Delta_r C_p o$, J mol⁻¹ K⁻¹ : 62.38
 $\Delta_f \Delta Z_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: - 8.46

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 8.46	- 9.19	- 9.79	-10.30	-11.10	-11.69	-12.13	-12.47
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 OXIDES
 PC = PU24
 December 1984

EQUILIBRIUM REACTION: $4\text{PuO}_2(\text{s}) + 4\text{H}^+ + \text{O}_2(\text{g}) = 4\text{PuO}_2^+ + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : - 4815
 ΔS_o , J mol⁻¹ K⁻¹ : -413.74
 ΔC_{po} , J mol⁻¹ K⁻¹ : 248.22
 Δy_{z2} , (kg mol⁻¹)^{1/2} :
 h , kg mol⁻¹ :
 $\log K_o$: -20.77

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-20.77	-20.79	-20.74	-20.63	-20.31	-19.89	-19.42	-18.92
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 OXIDES
 rc = PU38
 December 1984

EQUILIBRIUM REACTION: $4\text{PuO}_2(\text{s}) + \text{O}_2(\text{g}) + 2\text{H}_2\text{O} = 4\text{PuO}_2(\text{OH})(\text{s})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 164328
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : -261.38
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : - 100.94
 $\Delta_f \Delta_z^2$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : -42.44

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-42.44	-40.23	-38.36	-36.78	-34.22	-32.28	-30.75	-29.54
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 OXIDES
 rc = PU29
 December 1984

EQUILIBRIUM REACTION: $\text{PuO}_2(\text{s}) + 4\text{H}^+ = \text{Pu}^{4+} + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 51868
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : -315.31
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : 21.33
 $\Delta_f \Delta_z^2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: - 7.38

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 7.38	- 8.08	- 8.67	- 9.18	-10.01	-10.64	-11.14	-11.55
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 OXIDES
 rc = PU23
 December 1984

EQUILIBRIUM REACTION: $4\text{PuO}_2(\text{s}) + 12\text{H}^+ = 4\text{Pu}^{++} + 6\text{H}_2\text{O} + \text{O}_2(\text{g})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 142716
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -376.02
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 27.89
 $\Delta_f^\circ Z_2$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : -44.64

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
2.71	-44.64	-42.71	-41.07	-39.65	-37.33	-35.53	-34.08	-32.90
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 OXIDES
 rc = PU36
 December 1984

EQUILIBRIUM REACTION: $\text{PuO}_2(\text{s}) + 2\text{H}_2\text{O} = \text{Pu}(\text{OH})_4(\text{s})$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 16756
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : - 98.95
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ : - 85.83
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} :
 $\Delta_f B^\circ$, kg mol⁻¹ :
 $\log K_0$: - 8.10

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 6.10	- 7.89	- 7.73	- 7.62	- 7.48	- 7.43	- 7.43	- 7.47
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 OXIDES
 rc = PU37
 December 1984

EQUILIBRIUM REACTION: $4\text{PuO}_2(\text{s}) = 2\text{Pu}_2\text{O}_3(\text{s}) + \text{O}_2(\text{g})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 861996
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 194.52
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 11.84
 $\Delta_f Z^\circ$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o :

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q						
	25 C	50 C	75 C	100 C	150 C	200 C	300 C
0.00					-96.20	-84.94	-75.82
0.01							
0.10							
0.20							
0.50							
1.00							
2.00							
3.00							

REFERENCES: 2;

COMMENTS: log K_o = -140.84 (25c) ; -129.16 (50c) ; -119.15 (75c) ;
 -110.48 (100c) ;

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 OXIDES
 rc = P035
 December 1984

EQUILIBRIUM REACTION: $4\text{PuO}_2(\text{s}) + 6\text{H}_2\text{O} = 4\text{Pu}(\text{OH})_3(\text{s}) + \text{O}_2(\text{g})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 733697
 $\Delta_f H^\circ$, J mol⁻¹ K⁻¹ : -110.94
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 667.39
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/I	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00					-98.26	-89.99	-83.65	-78.71
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS: $\log K_o = -134.32(25\text{c}) ; -124.49(50\text{c}) ; -116.26(75\text{c}) ;$
 $-109.30(100\text{c}) ;$

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 OXIDES
 rc = p028
 December 1984

EQUILIBRIUM REACTION: $\text{Pu2O3(s)} + 6\text{H}^+ = 2\text{Pu}^{++} + 3\text{H2O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : -359640
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -285.27
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : -19.87
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : 48.10

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	48.10	43.22	39.04	35.41	29.43	24.70	20.87	17.69
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 HYDROXIDES
 rc = PU31
 December 1984

EQUILIBRIUM REACTION: $\text{PuO}_2(\text{OH})_2(\text{s}) + 2\text{H}^+ = \text{PuO}_2^{++} + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

ΔH_f° , J mol⁻¹ : - 35715
 ΔS_f° , J mol⁻¹ K⁻¹ : - 52.18
 ΔC_p° , J mol⁻¹ K⁻¹ : 49.56
 $\Delta y_{\text{Z}_2}^\circ$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : 3.53

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	3.53	3.06	2.66	2.33	1.82	1.46	1.18	0.98
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 HYDROXIDES
 PC = PU30
 December 1984

EQUILIBRIUM REACTION: $\text{PuO}_2(\text{OH}) (\text{s}) + \text{H}^+ = \text{PuO}_2 + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 42286
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 38.09
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : 87.29
 $\Delta_f^\circ \text{Z}_2$, (kg mol⁻¹)^{1/2} :
 $\bar{v}$, kg mol⁻¹ :
 log K₀ : 5.42

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	5.42	4.86	4.41	4.04	3.48	3.10	2.83	2.66
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 HYDROXIDES
 EC = PU27
 December 1984

EQUILIBRIUM REACTION: $\text{Pu}(\text{OH})_4(\text{s}) + 4\text{H}^+ = \text{Pu}^{4+} + 4\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 68624
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : -216.36
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : 107.16
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 0.72

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	0.72	- 0.19	- 0.94	- 1.56	- 2.52	- 3.21	- 3.71	- 4.07
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 HYDROXIDES
 rc = PU26
 December 1984

EQUILIBRIUM REACTION: $\text{Pu}(\text{OH})_3(\text{s}) + 3\text{H}^+ = \text{Pu}^{3+} + 3\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : -147745
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 66.27
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 59.87
 $\Delta_f^\circ Z_2$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : 22.42

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	22.42	20.43	18.74	17.29	14.95	13.14	11.70	10.55
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 FLUORIDES
 rc = P022
 December 1984

EQUILIBRIUM REACTION: $\text{PuF}_4(\text{s}) = \text{Pu}^{++++} + 4\text{F}^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : -100216
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : -589.02
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : - 667.25
 $\Delta_f \Delta_z^2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: -13.21

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-13.21	-14.68	-16.13	-17.55	-20.30	-22.91	-25.37	-27.69
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

PLUTONIUM
 FLUORIDES
 rc = PU21
 December 1984

EQUILIBRIUM REACTION: $\text{PuF}_3(\text{s}) = \text{Pu}^{+++} + 3\text{F}^-$

THERMOCHEMICAL PROPERTIES:

ΔH_f° , J mol⁻¹ : - 46095
 ΔS_f° , J mol⁻¹ K⁻¹ : -349.64
 ΔC_p° , J mol⁻¹ K⁻¹ : - 519.60
 $\Delta_f^\circ \text{Z}_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: -10.19

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-10.19	-10.90	-11.66	-12.44	-14.06	-15.67	-17.25	-18.78
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 2;

COMMENTS:

PLUTONIUM
References
June 1984

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 * Aqueous *
 * Solutions *
 * Database *

SILICON
 ACIDS
 rc = SI1
 September 1984

EQUILIBRIUM REACTION: $\text{Si}(\text{OH})_4(\text{aq}) = \text{SiO}(\text{OH})_3^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 25630
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -102.16
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : -174.42
 $\Delta_f H^\circ$, (kJ mol⁻¹)^{1/2} : 1.02
 b , J mol⁻¹ : -0.06
 $\log K_0$: -9.83

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-9.83	-9.51	-9.28	-9.14	-9.00	-9.00	-9.10	-9.25
0.01	-9.74							
0.10	-9.59	-9.24	-8.99	-8.80	-8.55	-8.45	-8.47	-8.57
0.20	-9.53							
0.50	-9.44							
1.00	-9.38	-9.01	-8.74	-8.52	-8.20	-8.00	-7.88	-7.78
2.00	-9.35							
3.00	-9.36	-9.05	-8.77	-8.53	-8.13	-7.82	-7.55	-7.24

REFERENCES: 5

COMMENTS: Smoothed values from Ref. 5.

 * Aqueous *
 * Solutions *
 * Database *

SILICON
 ACIDS
 rc = SI2
 September 1984

EQUILIBRIUM REACTION: $\text{Si}(\text{OH})_4(\text{aq}) + \text{OH}^- = \text{SiO}(\text{OH})_3^- + \text{H}_2\text{O}$

THEMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 30175
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 21.54
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 38.87
 $\Delta_f^\circ \text{H}_2$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ :
 $\log K_0$: 4.17

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	4.17	3.77	3.44	3.17	2.75	2.45	2.23	2.08
0.01								
0.10								
0.20								
0.50	4.29	3.89	3.56	3.29	2.86	2.56	2.33	2.17
1.00	4.37	3.96	3.63	3.35	2.92	2.61	2.37	2.20
2.00								
3.00	4.57	4.15	3.81	3.52	3.06	2.72	2.45	2.24

REFERENCES: 5

COMMENTS: Smoothed values from Ref. 5.

SILICON
References
June 1984

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 * Aqueous *
 * Solutions *
 * Database *

STRONTIUM
 HYDROXIDES
 rc = SR2
 September 1984

EQUILIBRIUM REACTION: $\text{Sr}^{++} + \text{H}_2\text{O} = \text{SrOH}^+ + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 65760
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : - 32.21
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ :
 $\Delta_f \gamma_{\text{H}_2\text{O}}^{\text{aq}}$, (kg mol⁻¹)^{1/2} : - 1.02
 b , kg mol⁻¹ : 0.22
 $\log K_o$: -13.12

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-13.12							
0.01	-13.21							
0.10	-13.34							
0.20	-13.39							
0.50	-13.43							
1.00	-13.41							
2.00	-13.28							
3.00	-13.11							

REFERENCES: 1;4;6;8

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

STRONTIUM
 HYDROXIDES
 rc = SR1
 September 1984

EQUILIBRIUM REACTION: $\text{Sr}^{++} + \text{OH}^- = \text{SrOH}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 9955
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 48.41
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (J mol⁻¹)^{1/2} : - 2.04
 $\Delta_f G^\circ$, (J mol⁻¹) : 0.51
 $\log K_o$: 0.87

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	0.87							
0.01	0.69							
0.10	0.43							
0.20	0.34							
0.50	0.28							
1.00	0.36							
2.00	0.69							
3.00	1.11							

REFERENCES: 1;4;6;8

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

STRONTIUM
 FLUORIDES
 rc = SR3
 September 1984

EQUILIBRIUM REACTION: $\text{Sr}^{++} + \text{F}^- = \text{SrF}^+$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ :
 ΔS_o , J mol⁻¹ K⁻¹ :
 ΔC_{po} , J mol⁻¹ K⁻¹ :
 $\Delta \gamma_{z2}$, (kg mol⁻¹)^{1/2} : - 2.04
 b , kg mol⁻¹ : 0.08
 $\log K_o$: 1.04

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	1.04							
0.01	0.86							
0.10	0.56							
0.20	0.43							
0.50	0.24							
1.00	0.10							
2.00	0.00							
3.00	- 0.01							

REFERENCES: 1;4;6

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

STRONTIUM
 CHLORIDES
 rc = SR4
 September 1984

EQUILIBRIUM REACTION: $\text{Sr}^{++} + 2\text{Cl}^- = \text{SrCl}_2(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 60
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 14.44
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ :
 $\Delta_f \bar{z}^2$, (kg mol⁻¹)^{1/2} : - 3.06
 b, kg mol⁻¹ :
 log K_o : - 0.01

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00 - 0.01								
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;4;7

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

STRONTIUM
 SULFATES
 IC = SR7
 September 1984

EQUILIBRIUM REACTION: $\text{Sr}^{++} + \text{SO}_4^{--} = \text{SrSO}_4(\text{aq})$

THERMOCHEMICAL PROPERTIES:

ΔH_f° , J mol⁻¹ : 10330
 ΔS_f° , J mol⁻¹ K⁻¹ : 73.57
 $\Delta C_{p,f}^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f^\circ \text{z}_2$, (kg mol⁻¹) ^{1/2} : - 4.08
 b , kg mol⁻¹ : 0.56
 $\log K_o$: 2.09

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	2.09							
0.01	1.72							
0.10	1.17							
0.20	0.94							
0.50	0.68							
1.00	0.61							
2.00	0.82							
3.00	1.18							

REFERENCES: 4;6

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

STRONTIUM
 BICARBONATES
 rc = SR5
 September 1984

EQUILIBRIUM REACTION: $\text{Sr}^{++} + \text{HCO}_3^- = \text{SrHCO}_3^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ :
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ :
 $\Delta_f G^\circ$, (J mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_0$: 1.26

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	1.26							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 6

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

STRONTIUM
 CARBONATES
 rc = SR6
 September 1984

EQUILIBRIUM REACTION: $\text{Sr}^{++} + \text{CO}_3^{--} = \text{SrCO}_3(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 14890
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 125.00
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ :
 $\Delta_f \bar{z}_2$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : 3.92

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	3.92							
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 6

COMMENTS:

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 * Aqueous *
 * Solutions *
 * Database *

SULFUR
 SULFIDES
 rc = S7
 September 1984

EQUILIBRIUM REACTION: $\text{H}_2\text{S}(\text{g}) = \text{H}_2\text{S}(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 19070
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 84.79
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 144.27
 $\Delta_f^\circ Z_2$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : - 1.09

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 1.09	- 1.32	- 1.48	- 1.58	- 1.66	- 1.63	- 1.53	- 1.38
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2;4

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

SULFUR
 SULFITES
 rc = S3
 September 1984

EQUILIBRIUM REACTION: $\text{SO}_2(\text{aq}) = \text{SO}_2(\text{g})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 26150
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 86.32
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 155.13
 $\Delta_f \Delta^\circ$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : - 0.07

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 0.07	0.26	0.49	0.66	0.84	0.88	0.83	0.72
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;3

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

SULFUR
 SULFATES
 PC = S1
 September 1984

EQUILIBRIUM REACTION: $\text{HSO}_4^- + \text{OH}^- = \text{SO}_4^{--} + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 78065
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : - 34.86
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 86.71
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ :
 $\log K_o$: 11.85

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	11.85	10.78	9.83	9.00	7.57	6.38	5.37	4.51
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;3.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

SULFUR
 SULFATES
 rc = S2
 September 1984

EQUILIBRIUM REACTION: $\text{HSO}_4^- = \text{SO}_4^{--} + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 22260
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : - 15.48
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : - 300.00
 $\Delta_f \bar{z}_2$, (kg mol⁻¹)^{1/2} : 2.04
 b , kg mol⁻¹ : -0.10
 $\log K_o$: - 2.13

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 2.13	- 2.48	- 2.87	- 3.28	- 4.14	- 5.01	- 5.88	- 6.73
0.01	- 1.95							
0.10	- 1.65							
0.20	- 1.52							
0.50	- 1.33							
1.00	- 1.21							
2.00	- 1.13							
3.00	- 1.14							

REFERENCES: 1;3;10

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

SULFUR
 SULFITES
 IC = 54
 September 1984

EQUILIBRIUM REACTION: $\text{H}_2\text{O} + \text{SO}_2(\text{aq}) + \text{OH}^- = \text{HSO}_3^- + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 73215
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 11.88
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 89.71
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 $\log K_o$: 12.20

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	12.20	11.19	10.31	9.52	8.16	7.03	6.07	5.24
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2;5

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

SULFUR
 SULFITES
 rc = S12
 October 1984

EQUILIBRIUM REACTION: $\text{SO}_2(\text{aq}) + \text{H}_2\text{O} = \text{HSO}_3^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 17410
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 92.11
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 280.29
 $\Delta_f Z^\circ$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ :
 $\log K_o$: - 1.76

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 1.76	- 2.04	- 2.37	- 2.72	- 3.46	- 4.23	- 5.01	- 5.77
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 13.

COMMENTS: Ref. 13 gives $\Delta_r G^\circ = 10600$; $\Delta_r H^\circ = -17400$; $\Delta_r S^\circ = -93.9$.

 * Aqueous *
 * Solutions *
 * Database *

SULFUR
 SULFITES
 rc = S5
 September 1984

EQUILIBRIUM REACTION: $\text{HSO}_3^- + \text{OH}^- = \text{SO}_3^{--} + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 65085
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : - 88.08
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 44.91
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ :
 $\log K_o$: 6.80

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	6.80	5.91	5.14	4.45	3.30	2.37	1.59	0.92
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2;5

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

SULFUR
 SULFITES
 rc = S6
 September 1984

EQUILIBRIUM REACTION: $\text{HSO}_3^- = \text{SO}_3^{--} + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 9280
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : -168.70
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 258.20
 $\Delta_f G^\circ$, (kJ mol⁻¹) 1/2 : 2.04
 b , kg mol⁻¹ :
 $\log K_o$: - 7.19

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 7.19	- 7.35	- 7.57	- 7.83	- 8.40	- 9.03	- 9.67	-10.31
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2;5

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

SULFUR
 SULFIDES
 rc = S8
 September 1984

EQUILIBRIUM REACTION: $\text{H}_2\text{S}(\text{aq}) + \text{OH}^- = \text{HS}^- + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 33705
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 22.42
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : - 57.21
 $\Delta_f G_o$, (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ :
 $\log K_o$: 7.07

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
1/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	7.07	6.61	6.19	5.82	5.17	4.62	4.14	3.72
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2;4

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

SULFUR
 SULFIDES
 rc = S9
 September 1984

EQUILIBRIUM REACTION: $\text{H}_2\text{S}(\text{aq}) = \text{HS}^- + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 22100
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 58.20
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : - 270.50
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} : 1.02
 $\Delta_f G^\circ$, kg mol⁻¹ :
 $\log K_o$: - 6.91

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	- 6.91	- 6.66	- 6.52	- 6.46	- 6.54	- 6.78	- 7.11	- 7.51
0.01								
0.10								
0.20								
0.30								
1.00								
2.00								
3.00								

REFERENCES: 1;2;4

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

SULFUR
 SULFIDES
 rc = S10
 September 1984

EQUILIBRIUM REACTION: $\text{HS}^- + \text{OH}^- = \text{S}^{--} + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 5105
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : - 3.22
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : - 95.11
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : 1.02
 b , kg mol⁻¹ :
 $\log K_0$: 1.06

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	1.06	0.98	0.88	0.77	0.53	0.27	0.02	- 0.23
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2;4

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

SULFUR
 SULFIDES
 rc = S11
 September 1984

EQUILIBRIUM REACTION: $\text{HS}^- = \text{S}^{--} + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 50700
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : - 77.40
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : - 308.40
 $\Delta_f \Delta_z^2$, (kg mol⁻¹)^{1/2} : 2.04
 b , kg mol⁻¹ :
 $\log K_o$: -12.92

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-12.92	-12.29	-11.83	-11.52	-11.18	-11.12	-11.23	-11.46
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;2;4

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 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 HYDROXIDES
 IC = U1
 September 1984

EQUILIBRIUM REACTION: $\text{UO}_2^{++} + \text{H}_2\text{O} = \text{UO}_2\text{OH}^+ + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta^\circ \text{H}_f$, J mol⁻¹ : 46390
 $\Delta^\circ \text{S}_f$, J mol⁻¹ K⁻¹ : 43.19
 $\Delta^\circ \text{C}_p$, J mol⁻¹ K⁻¹ : - 16.29
 $\Delta^\circ \text{A}_f$, (kg mol⁻¹)^{1/2} : - 1.02
 $\log K_o$: - 5.87

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 5.87	- 5.24	- 4.71	- 4.26	- 3.52	- 2.94	- 2.49	- 2.12
0.01	- 5.96							
0.10	- 6.08							
0.20	- 6.11							
0.50	- 6.10							
1.00	- 5.99							
2.00	- 5.69							
3.00	- 5.35							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 HYDROXIDES
 rc = U2
 September 1984

EQUILIBRIUM REACTION: $2\text{UO}_2^{++} + 2\text{H}_2\text{O} = (\text{UO}_2)_2(\text{OH})_2^{++} + 2\text{H}^+$

THERMOCHEMICAL PROPERTIES:

ΔH_f° , J mol⁻¹ : 42160
 ΔS_f° , J mol⁻¹ K⁻¹ : 35.38
 ΔC_p° , J mol⁻¹ K⁻¹ : - 202.58
 Δy_{-22}° , {kg mol⁻¹}^{1/2} : - 1.02
 b , kg mol⁻¹ : 0.02
 $\log K_0$: - 5.54

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 5.54	- 5.00	- 4.60	- 4.30	- 3.94	- 3.78	- 3.76	- 3.83
0.01	- 5.63							
0.10	- 5.78							
0.20	- 5.85							
0.50	- 5.95							
1.00	- 6.03							
2.00	- 6.10							
3.00	- 6.13							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 HYDROXIDES
 rc = U3
 September 1984

EQUILIBRIUM REACTION: $3\text{UO}_2^{++} + 5\text{H}_2\text{O} = (\text{UO}_2)_3(\text{OH})_5^{+} + 5\text{H}^{+}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 106950
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 52.75
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : - 384.45
 $\Delta_f Z_2$, (kg mol⁻¹)^{1/2} : - 3.07
 b , kg mol⁻¹ : 0.01
 $\log K_0$: -15.98
 $B_9 = 1.90$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-15.98	-14.59	-13.52	-12.68	-11.54	-10.90	-10.59	-10.48
0.01	-16.24							
0.10	-16.59							
0.20	-16.72							
0.50	-16.91							
1.00	-17.03							
2.00	-17.14							
3.00	-17.19							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 HYDROXIDES
 rc = U4
 September 1984

EQUILIBRIUM REACTION: $U^{+++} + H_2O = UOH^{++} + H^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H_o$, J mol⁻¹ : 49030
 $\Delta_f S_o$, J mol⁻¹ K⁻¹ : 152.09
 $\Delta_f C_p$, J mol⁻¹ K⁻¹ : - 81.29
 $\Delta_f A^\circ_{T=2}$, (kg mol⁻¹)^{1/2} : - 3.07
 b , kg mol⁻¹ : 0.03
 $\log K_o$: - 0.65
 $B9 = 1.97$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00 - 0.65		0.01	0.54	0.98	1.66	2.14	2.49	2.74
0.01 - 0.91								
0.10 - 1.25								
0.20 - 1.37								
0.50 - 1.54								
1.00 - 1.65								
2.00 - 1.74								
3.00 - 1.77								

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 HYDROXIDES
 rc = US
 September 1984

EQUILIBRIUM REACTION: $U^{++++} + 2H_2O = U(OH)_2^{++} + 2H^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 74160
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 205.18
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : - 103.58
 $\Delta_f \Delta Z_2$, (kg mol⁻¹)^{1/2} : - 5.11
 b , kg mol⁻¹ : 1.96
 $\log K_o$: - 2.27

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

log Q

I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 2.27	- 1.29	- 0.47	0.21	1.27	2.03	2.60	3.02
0.01	- 2.71							
0.10	- 3.30							
0.20	- 3.46							
0.50	- 3.41							
1.00	- 2.87							
2.00	- 1.34							
3.00	0.37							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 HYDROXIDES
 rc = U6
 September 1984

EQUILIBRIUM REACTION: $U^{+++} + 3H_2O = U(OH)_3 + 3H^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 94790
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 223.27
 $\Delta_r C_p o$, J mol⁻¹ K⁻¹ : - 103.87
 $\Delta_f \gamma_{Z_2}$, (kg mol⁻¹)^{1/2} : - 6.13
 b , kg mol⁻¹ : 1.81
 $\log K_o$: - 4.94

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 4.94	- 3.68	- 2.62	- 1.73	- 0.34	0.70	1.48	2.08
0.01	- 5.48							
0.10	- 6.23							
0.20	- 6.47							
0.50	- 6.57							
1.00	- 6.20							
2.00	- 4.91							
3.00	- 3.40							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 HYDROXIDES
 rc = U7
 September 1984

EQUILIBRIUM REACTION: $U^{+++} + 4H_2O = U(OH)_4(aq) + 4H^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 103620
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 184.36
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ :
 $\Delta_r Z_2$, (kg mol⁻¹)^{1/2} : - 6.13
 b , kg mol⁻¹ : 1.78
 $\log K_o$: - 8.52

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 8.52			- 5.00	- 4.00	- 3.00		
0.01	- 9.06							
0.10	- 9.81							
0.20	-10.06							
0.50	-10.17							
1.00	- 9.31							
2.00	- 8.55							
3.00	- 7.07							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 HYDROXIDES
 rc = 08
 September 1984

EQUILIBRIUM REACTION: $U^{+++} + 5H_2O = U(OH)_5^- + 5H^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 115450
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 135.45
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : - 497.45
 $\Delta_f \Delta Z_2$, (kg mol⁻¹)^{1/2} : - 5.11
 b , kg mol⁻¹ : 1.45
 $\log K_o$: -13.15

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	-13.15	-11.67	-10.54	- 9.69	- 8.60	- 8.06	- 7.89	- 7.96
0.01	-13.60							
0.10	-14.23							
0.20	-14.44							
0.50	-14.54							
1.00	-14.26							
2.00	-13.24							
3.00	-12.04							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = U10
 September 1984

EQUILIBRIUM REACTION: $\text{UO}_2^{++} + \text{HF(aq)} = \text{UO}_2\text{F}^+ + \text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 16418
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 16.88
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 40.70
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : - 1.02
 b , kg mol⁻¹ :
 $\log K_o$: 1.99

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

1/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	1.99	1.72	1.61	1.47	1.26	1.13	1.04	0.98
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = 09
 September 1984

EQUILIBRIUM REACTION: $\text{UO}_2^{++} + \text{F}^- = \text{UO}_2\text{F}^+$

THERMOCHEMICAL PROPERTIES:

ΔH_f° , J mol⁻¹ : - 2350
 ΔS_f° , J mol⁻¹ K⁻¹ : 91.28
 ΔC_p° , J mol⁻¹ K⁻¹ : 202.00
 $\Delta_f^\circ Z$, (kg mol⁻¹)^{1/2} : - 2.05
 Δ_f° , kg mol⁻¹ : 0.17
 $\log K_0$: 5.18
 $B_9 = 1.57$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	5.18	5.18	5.24	5.34	5.63	5.99	6.39	6.81
0.01	5.00							
0.10	4.76							
0.20	4.67							
0.50	4.58							
1.00	4.55							
2.00	4.62							
3.00	4.73							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = U11
 September 1984

EQUILIBRIUM REACTION: $\text{UO}_2^{++} + 2\text{HF}(\text{aq}) = \text{UO}_2\text{F}_2(\text{aq}) + 2\text{H}^+$

THERMOCHEMICAL PROPERTIES:

ΔH°_f , J mol⁻¹ : - 31136
 ΔS°_f , J mol⁻¹ K⁻¹ : - 57.86
 ΔC_p° , J mol⁻¹ K⁻¹ : - 185.60
 Δy°_{z2} , (kg mol⁻¹)^{1/2} : - 1.02
 b , kg mol⁻¹ :
 $\log K_o$: 2.43

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	2.43	1.98	1.54	1.11	0.29	- 0.48	- 1.19	- 1.87
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = U12
 September 1984

EQUILIBRIUM REACTION: $\text{UO}_2^{++} + 2\text{F}^- = \text{UO}_2\text{F}_2(\text{aq})$

THERMOCHEMICAL PROPERTIES:

ΔH° , J mol⁻¹ : - 3000
 ΔS° , J mol⁻¹ K⁻¹ : 158.46
 ΔC_p° , J mol⁻¹ K⁻¹ : 137.00
 $\Delta \gamma^\circ_{\text{Z}_2}$, (kg mol⁻¹)^{1/2} : - 3.07
 b , kg mol⁻¹ : 0.34
 $\log K_o$: 8.80
 $B_9 = 1.52$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	8.80	8.78	8.81	8.86	9.04	9.23	9.52	9.79
0.01	8.54							
0.10	8.18							
0.20	8.05							
0.50	7.92							
1.00	7.92							
2.00	8.10							
3.00	8.36							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = U13
 September 1984

EQUILIBRIUM REACTION: $\text{UO}_2^{++} + 3\text{F}^- = \text{UO}_2\text{F}_3^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 2750
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 205.64
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : 106.00
 $\Delta_f^\circ \text{Z}_2$, (kg mol⁻¹)^{1/2} : - 3.07
 b , kg mol⁻¹ : 0.58
 $\log K_o$: 11.22
 $B_9 = 1.12$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	11.22	11.20	11.22	11.25	11.38	11.55	11.75	11.95
0.01	10.95							
0.10	10.56							
0.20	10.42							
0.50	10.29							
1.00	10.35							
2.00	10.69							
3.00	11.15							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = U14
 September 1984

EQUILIBRIUM REACTION: $\text{UO}_2^{++} + 4\text{F}^- = \text{UO}_2\text{F}_4^{--}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 3700
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 225.82
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : 427.00
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} : - 1.02
 b , kg mol⁻¹ : 0.47
 $\log K_o$: 12.44
 $B_9 = 3.65$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	12.44	12.46	12.60	12.83	13.47	14.25	15.11	16.00
0.01	12.37							
0.10	12.34							
0.20	12.36							
0.50	12.47							
1.00	12.69							
2.00	13.15							
3.00	13.61							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = 015
 September 1984

EQUILIBRIUM REACTION: $U^{+++} + HF(aq) = UF^{++} + H^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 5472
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 127.02
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 45.30
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} : - 3.06
 $\Delta_f S^\circ$, (kg mol⁻¹)^{1/2} :
 $\log K_0$: 5.67

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	5.67	5.74	5.79	5.81	5.83	5.81	5.77	5.72
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = U28
 November 1984

EQUILIBRIUM REACTION: $U^{+++} + F^- = UF^{++}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 19540
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 235.20
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : 100.70
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} : - 4.08
 b , kg mol⁻¹ : 0.08
 $\log K_o$: 8.86
 $B_9 = 2.16$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	8.86	9.14	9.41	9.67	10.16	10.61	11.03	11.42
0.01	8.53							
0.10	8.10							
0.20	7.95							
0.50	7.76							
1.00	7.65							
2.00	7.59							
3.00	7.61							

REFERENCES: 47.

COMMENTS: Values for Debye-Huckel equation are from Turner et al.

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = U16
 September 1984

EQUILIBRIUM REACTION: $U^{+++} + 2HF(aq) = UF_2^{++} + 2H^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 464
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 161.04
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ : - 34.60
 $\Delta_f G_o$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: 8.33

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	8.33	8.33	8.32	8.30	8.25	8.19	8.13	8.05
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = U29
 October 1984

EQUILIBRIUM REACTION: $U^{+++} + 2F^- = UF_2^{++}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 28600
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 377.40
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 288.00
 $\Delta_f \Delta_r Z$, (kg mol⁻¹)^{1/2} : - 7.14
 b , kg mol⁻¹ : 0.55
 $\log K_0$: 14.70
 $B_9 = 2.07$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	14.70	15.13	15.59	16.06	17.00	17.93	18.84	19.72
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = U17
 September 1984

EQUILIBRIUM REACTION: $U^{+++} + 3HF(aq) = UF_3 + 3H^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 12254
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 142.06
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 8.10
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} : - 6.12
 b , kg mol⁻¹ :
 $\log K_o$: 9.57

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	9.57	9.40	9.26	9.14	8.95	8.81	8.69	8.61
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = U3O
 October 1984

EQUILIBRIUM REACTION: $U^{4+} + 3F^- = UF_3$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : 29950
 ΔS_o , J mol⁻¹ K⁻¹ : 466.54
 ΔC_p , J mol⁻¹ K⁻¹ : 492.00
 Δy_{z2} , (kg mol⁻¹)^{1/2} : - 9.18
 b , kg mol⁻¹ : 1.16
 $\log K_o$: 19.12
 $R_S = 0.89$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	19.12	19.61	20.17	20.77	22.08	23.42	24.77	26.10
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 IC = 018
 September 1984

EQUILIBRIUM REACTION: $U^{++} + 4HF(aq) = UF_4(aq) + 4H^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : - 38572
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 84.08
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : - 8.20
 $\Delta_r \Delta Z_2$, (kg mol⁻¹)^{1/2} : - 6.12
 b , kg mol⁻¹ :
 $\log K_o$: 11.15

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	11.15	10.62	10.17	9.78	9.13	8.61	8.19	7.83
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = 031
 October 1984

EQUILIBRIUM REACTION: $U^{+++} + 4F^- = UF_4(aq)$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 17700
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 516.72
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : 637.00
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} : -10.20
 $\Delta_f H^\circ$, kg mol⁻¹ :
 log K₀ : 23.89

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	23.89	24.23	24.71	25.29	26.62	28.09	29.62	31.15
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 47.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = 019
 September 1984

EQUILIBRIUM REACTION: $U^{+++} + 5F^- = UF_5^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 18350
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 550.90
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ : 533.00
 $\Delta_f \Delta Z_2$, (kg mol⁻¹)^{1/2} : -10.20
 b , kg mol⁻¹ :
 log K_o : 25.56

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	25.56	25.89	26.34	26.86	28.03	29.31	30.62	31.94
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = 020
 September 1984

EQUILIBRIUM REACTION: $U^{+++} + 6F^- = UF_6^{--}$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : 13800
 ΔS_o , J mol⁻¹ K⁻¹ : 577.08
 ΔG_o , J mol⁻¹ K⁻¹ : 794.00
 $\Delta y^{\Delta z}_2$, (kg mol⁻¹)^{1/2} : - 9.18
 b, kg mol⁻¹ :
 log K_o : 27.72

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	27.72	28.04	28.54	29.18	30.71	32.43	34.24	36.09
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 CHLORIDES
 rc = U26
 September 1984

EQUILIBRIUM REACTION: $\text{UO}_2^{++} + \text{Cl}^- = \text{UO}_2\text{Cl}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 180
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : 34.37
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : 548.00
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} : - 2.05
 b , kg mol⁻¹ : 0.01
 $\log K_0$: 1.76
 $B_9 = 6.25$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	1.76	1.66	2.09	2.44	3.34	4.41	5.56	6.75
0.01	1.63							
0.10	1.54							
0.20	1.52							
0.50	1.50							
1.00	1.49							
2.00	1.49							
3.00	1.49							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 CHLORIDES
 rc = U27
 September 1984

EQUILIBRIUM REACTION: $U^{+++} + Cl^- = UCl^{++}$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : 7280
 ΔS_o , J mol⁻¹ K⁻¹ : 74.27
 ΔC_p , J mol⁻¹ K⁻¹ : 459.00
 Δy_{z2} , (kg mol⁻¹)^{1/2} : - 4.09
 b , kg mol⁻¹ : 0.08
 $\log K_o$: 2.60
 $B_9 = 2.16$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	2.60	2.78	3.06	3.42	4.29	5.28	6.32	7.38
0.01	2.26							
0.10	1.84							
0.20	1.69							
0.50	1.50							
1.00	1.39							
2.00	1.33							
3.00	1.35							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 SULFATES
 cc = U33
 October 1984

EQUILIBRIUM REACTION: $\text{UO}_2^{++} + \text{SO}_4^{--} = \text{UO}_2\text{SO}_4(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\bar{r}\text{Ho}$, J mol⁻¹ : 22000
 $\bar{r}\text{So}$, J mol⁻¹ K⁻¹ : 130.30
 $\bar{r}\text{Cpo}$, J mol⁻¹ K⁻¹ : 627.00
 $\Delta\bar{r}^2$, (kg mol⁻¹)^{1/2} : -4.08
 b , kg mol⁻¹ : -0.01
 $\log K_0$: 2.94
 $B_9 = 2.63$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	2.94	3.35	3.88	4.49	5.88	7.39	8.94	10.49
0.01	2.62							
0.10	2.23							
0.20	2.09							
0.50	1.93							
1.00	1.81							
2.00	1.69							
3.00	1.64							

REFERENCES: 47.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 SULFATES
 r0 = 034
 October 1984

EQUILIBRIUM REACTION: $U^{+++} + 2SO_4^{--} = U(SO_4)_2(aq)$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 31800
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ : 266.30
 $\Delta_r C_p$, J mol⁻¹ K⁻¹ : 619.00
 $\Delta_f H_o$, (kJ mol⁻¹) 1/2 : -12.24
 b , kg mol⁻¹ :
 $\log K_o$: 8.34

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q						
	25 C	50 C	75 C	100 C	150 C	200 C	300 C
0.00	8.34	8.87	9.51	10.22	11.75	13.37	15.01
0.01							
0.10							
0.20							
0.50							
1.00							
2.00							
3.00							

REFERENCES: 47.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 CARBONATES
 rc = 021
 September 1984

EQUILIBRIUM REACTION: $\text{UO}_2^{++} + \text{H}_2\text{CO}_3(\text{aq}) = \text{UO}_2\text{CO}_3(\text{aq}) + 2\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : 10850
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 90.30
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : 175.00
 $\Delta_f G^\circ$, (kJ mol⁻¹) 1/2 : - 1.02
 b , kg mol⁻¹ :
 $\log K_o$: - 6.62

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	- 6.62	- 6.44	- 6.24	- 6.02	- 5.56	- 5.08	- 4.61	- 4.14
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 1;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 CARBONATES
 rc = 022
 September 1984

EQUILIBRIUM REACTION: $\text{UO}_2^{++} + \text{CO}_3^{--} = \text{UO}_2\text{CO}_3(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 11660
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : 154.00
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : 793.00
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} : - 4.09
 b , kg mol⁻¹ : 0.05
 $\log K_o$: 10.09
 $B_9 = 1.63$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	10.09	10.06	10.27	10.64	11.75	13.14	14.68	16.30
0.01	9.74							
0.10	9.24							
0.20	9.04							
0.50	8.77							
1.00	8.58							
2.00	8.44							
3.00	8.39							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 CARBONATES
 rc = U23
 September 1984

EQUILIBRIUM REACTION: $\text{UO}_2^{++} + 2\text{H}_2\text{CO}_3(\text{aq}) = \text{UO}_2(\text{CO}_3)_2^{--} + 4\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : 59600
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : -111.70
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : -1028.00
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} : 2.04
 b , kg mol⁻¹ :
 $\log K_o$: -16.27

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-16.27	-15.64	-15.39	-15.43	-16.13	-17.35	-18.88	-20.59
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 CARBONATES
 FC = U24
 September 1984

EQUILIBRIUM REACTION: $UO_2^{++} + 2CO_3^{--} = UO_2(CO_3)_2^{--}$

THERMOCHEMICAL PROPERTIES:

ΔH_o , J mol⁻¹ : 14580
 ΔS_o , J mol⁻¹ K⁻¹ : 376.90
 ΔG_o , J mol⁻¹ K⁻¹ : 212.00
 $\Delta y^{\sim} z_2$, (kg mol⁻¹)^{1/2} : - 4.09
 b , kg mol⁻¹ : -0.22
 $\log K_o$: 17.13
 $B_9 = 1.61$

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/I	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	17.13	17.36	17.62	17.90	18.49	19.09	19.69	20.28
0.01	16.78							
0.10	16.25							
0.20	16.02							
0.50	15.67							
1.00	15.34							
2.00	14.92							
3.00	14.60							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 CARBONATES
 rc = 025
 September 1984

EQUILIBRIUM REACTION: $\text{UO}_2^{++} + 3\text{CO}_3^{--} = \text{UO}_2(\text{CO}_3)_3^{--}$

THERMOCHEMICAL PROPERTIES:

ΔH°_f , J mol⁻¹ : - 35880
 ΔS°_f , J mol⁻¹ K⁻¹ : 278.80
 ΔG°_f , J mol⁻¹ K⁻¹ : 1195.00
 ΔG°_f , (kg mol⁻¹)^{1/2} : 0.00
 b , kg mol⁻¹ : -1.17
 $\log K_o$: 20.64

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	20.64	20.35	20.45	20.84	22.20	24.05	26.19	28.47
0.01	20.63							
0.10	20.52							
0.20	20.41							
0.50	20.06							
1.00	19.47							
2.00	18.30							
3.00	17.13							

REFERENCES: 3;4;10;12;47

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 CARBONATES
 cc = 032
 October 1984

EQUILIBRIUM REACTION: $2\text{UO}_2^{++} + \text{CO}_2(\text{aq}) + 4\text{H}_2\text{O} = (\text{UO}_2)_2(\text{CO}_3)(\text{OH})_3^- + 5\text{H}^+$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ :
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ :
 $\Delta_f \Delta^2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00								
0.01								
0.10	-18.63							
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 41.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 OXIDES
 EC = U45
 November 1984

EQUILIBRIUM REACTION: $\gamma\text{-UO}_3(\text{s}) + 2\text{H}^+ = \text{UO}_2^{++} + \text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 81630
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -123.30
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : - 1.38
 $\Delta_f H^\circ$, (kg mol⁻¹)^{1/2} :
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 $\log K_o$: 7.86

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	7.86	6.75	5.80	4.98	3.63	2.56	1.70	0.99
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 4.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 OXIDES
 rc = U46
 November 1984

EQUILIBRIUM REACTION: $\text{UO}_3 \cdot 2\text{H}_2\text{O}(\text{s}) + 2\text{H}^+ = \text{UO}_2^{++} + 3\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 49890
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : - 63.37
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 30.67
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : 5.43

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q						
	25 C	50 C	75 C	100 C	150 C	200 C	300 C
0.00	5.43	4.76	4.19	3.71	2.93	2.34	1.88
0.01							
0.10							
0.20							
0.50							
1.00							
2.00							
3.00							

REFERENCES: 4.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 OXIDES
 rc = U44
 November 1984

EQUILIBRIUM REACTION: $2\text{UO}_2(\text{s}) + 4\text{H}^+ + \text{O}_2(\text{g}) = 2\text{UO}_2^{++} + 2\text{H}_2\text{O}$

THEMOCHEMICAL PROPERTIES:

ΔH°_f , J mol⁻¹ : -447060
 ΔS°_f , J mol⁻¹ K⁻¹ : -413.48
 ΔG°_f , J mol⁻¹ K⁻¹ : 4.02
 $\Delta_f^\circ \text{UO}_2$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : 56.72

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	56.72	50.66	45.47	40.98	33.59	27.77	23.06	19.18
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 4.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 OXIDES
 PC = U35
 November 1984

EQUILIBRIUM REACTION: $4\text{UO}_2(\text{s}) + 4\text{H}^+ + \text{O}_2(\text{g}) = 4\text{UO}_2^{2+} + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : -362460
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -473.34
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : 386.01
 $\Delta_r G^\circ$, (kJ mol⁻¹) 1/2 :
 $\Delta_r G^\circ$, (kJ mol⁻¹) :
 $\log K_0$: 38.77

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	38.77	33.32	29.88	26.48	21.12	17.14	14.13	11.81
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
1.00								

REFERENCES: 3;4;9;12.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 OXIDES
 rc = 042
 November 1984

EQUILIBRIUM REACTION: $\text{UO}_2(\text{s}) + 4\text{H}^+ = \text{U}^{4+} + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 77960
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -351.21
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : 38.98
 $\Delta_f G^\circ$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: - 4.69

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	- 4.69	- 5.74	- 6.62	- 7.38	- 8.61	- 9.55	-10.29	-10.89
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 4.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 OXIDES
 rc = U38
 November 1984

EQUILIBRIUM REACTION: $4\text{UO}_2(\text{s}) + 12\text{H}^+ = 4\text{U}^{++} + 6\text{H}_2\text{O} + \text{O}_2(\text{g})$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H_o$, J mol⁻¹ : 259820
 $\Delta_r S_o$, J mol⁻¹ K⁻¹ :
 $\Delta_r C_{p,o}$, J mol⁻¹ K⁻¹ : 34.71
 $\Delta_f \Delta Z_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00						-98.48	-95.67	-93.33
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 4.

COMMENTS: $\Delta_r S_o = -1339.62$. $\log K_o = -115.48(25\text{C})$; $-111.95(50\text{C})$;
 $-108.93(75\text{C})$; $-106.29(100\text{C})$; $-101.94(150\text{C})$.

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 OXIDES
 rc = U#1
 November 1984

EQUILIBRIUM REACTION: $2\text{U}_3\text{O}_8(\text{s}) + 12\text{H}^+ + \text{O}_2(\text{g}) = 6\text{UO}_2^{++} + 6\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : -682980
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : -933.36
 $\Delta_f G^\circ$, J mol⁻¹ K⁻¹ : 1378.82
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K₀ : 70.89

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	70.89	61.87	54.53	48.53	39.49	33.27	28.96	26.00
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 4.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 OXIDES
 PC = 043
 November 1984

EQUILIBRIUM REACTION: $2UO_2(s) + 16H^+ + 3O_2(g) = 8UO_2^{2+} + 8H_2O$

THERMOCHEMICAL PROPERTIES:

$\bar{r}H_o$, J mol⁻¹ :
 $\bar{r}S_o$, J mol⁻¹ K⁻¹ :
 $\bar{r}C_{p,o}$, J mol⁻¹ K⁻¹ : - 849.23
 $\Delta y^{\sim}z_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$:

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00					94.78	74.57	57.78	43.54
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 4.

COMMENTS: $\bar{r}H_o = -1422640$; $\bar{r}S_o = -1500.9$; $\log K_o = 170.83(25C)$;
 151.40(50C); 134.53(75C); 119.69(100C).

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 HYDROXIDES
 EC = U47
 October 1984

EQUILIBRIUM REACTION: $\text{beta-UO}_2(\text{OH})_2(\text{s}) + 2\text{H}^+ = \text{UO}_2^{++} + 2\text{H}_2\text{O}$

THERMOCHEMICAL PROPERTIES:

$\Delta_{\text{f}}H^\circ$, J mol⁻¹ : - 56560
 $\Delta_{\text{f}}S^\circ$, J mol⁻¹ K⁻¹ : - 99.08
 $\Delta_{\text{f}}G^\circ$, J mol⁻¹ K⁻¹ : 69.79
 $\Delta_f z_2$, (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_0$: 4.73

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q							
	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	4.73	3.98	3.35	2.83	2.00	1.40	0.95	0.61
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 4

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = 039
 November 1984

EQUILIBRIUM REACTION: $UF_4(s) = U^{4+} + 4F^-$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 18400
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -618.39
 $\Delta_r G^\circ$, J mol⁻¹ K⁻¹ : - 652.02
 $\Delta_f H^\circ$, (kJ mol⁻¹)^{1/2} :
 b, kJ mol⁻¹ :
 log K_o : -29.07

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	-29.07	-29.43	-29.23	-30.52	-31.89	-33.39	-34.96	-36.54
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 4.

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 FLUORIDES
 rc = U37
 January 1985

EQUILIBRIUM REACTION: $2UF_4 \cdot 2.5H_2O = 2U^{++} + 8F^- + 5H_2O$

TERMOCHEMICAL PROPERTIES:

ΔH° , J mol⁻¹ : - 31863
 ΔS° , J mol⁻¹ K⁻¹ :
 ΔC_p° , J mol⁻¹ K⁻¹ : -1955.00
 Δ_f° , (kg mol⁻¹)^{1/2} :
 b , kg mol⁻¹ :
 $\log K_o$: -55.10

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 c	50 c	75 c	100 c	150 c	200 c	250 c	300 c
0.00	-55.10	-55.86	-57.07	-58.61	-62.34	-66.56	-71.01	-75.53
0.01								
0.10								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 4

COMMENTS: $\Delta S^\circ = -1161.89$ J mol⁻¹ K⁻¹ for this reaction. Formula for $UF_4 \cdot 2.5H_2O$ corrected; was $UF_4 \cdot 2.5H_2O$.

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 CARBONATES
 rc = 036
 November 1984

EQUILIBRIUM REACTION: $\text{UO}_2\text{CO}_3(\text{s}) = \text{UO}_2^{++} + \text{CO}_3^{--}$

THERMOCHEMICAL PROPERTIES:

$\Delta_r H^\circ$, J mol⁻¹ : - 5540
 $\Delta_r S^\circ$, J mol⁻¹ K⁻¹ : -292.10
 $\Delta_r C_p^\circ$, J mol⁻¹ K⁻¹ : - 422.50
 $\Delta_f Z^\circ$, (kg mol⁻¹)^{1/2} :
 $\Delta_f G^\circ$, kg mol⁻¹ :
 log K_o : -14.29

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

	log Q							
I/T	25 C	50 C	75 C	100 C	150 C	200 C	250 C	300 C
0.00	-14.29	-14.43	-14.68	-14.99	-15.78	-16.67	-17.62	-18.59
0.01								
0.1								
0.20								
0.50								
1.00								
2.00								
3.00								

REFERENCES: 4

COMMENTS:

 * Aqueous *
 * Solutions *
 * Database *

URANIUM
 SILICATES
 rc = U40
 November 1984

EQUILIBRIUM REACTION: $\text{HSiO}_4(\text{s}) + 4\text{H}^+ = \text{U}^{++++} + \text{Si}(\text{OH})_4(\text{aq})$

THERMOCHEMICAL PROPERTIES:

$\Delta_f H^\circ$, J mol⁻¹ : - 51300
 $\Delta_f S^\circ$, J mol⁻¹ K⁻¹ : -351.00
 $\Delta_f C_p^\circ$, J mol⁻¹ K⁻¹ : 17.00
 $\Delta_f A^\circ$, (kg mol⁻¹)^{1/2} :
 b, kg mol⁻¹ :
 log K_o : - 9.35

EQUILIBRIUM QUOTIENTS: I=ionic strength, mol kg⁻¹

I/T	log Q						
	25 C	50 C	75 C	100 C	150 C	200 C	300 C
0.00	- 9.35	-10.04	-10.63	-11.13	-11.95	-12.59	-13.04
0.01							
0.10							
0.20							
0.50							
1.00							
2.00							
3.00							

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ATTACHMENT II

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CHAPTER 5 - GEOCHEMISTRY

5.1 Ground-water Composition

5.1.1 Speculations on the Chemistry of Water in the Unsaturated Zone

At present, there are no available ground-water composition data for samples from the unsaturated zone at Yucca Mountain. According to the NNWSI Program Plan (LANL, 1984), samples will be taken during construction of the exploratory shaft. It has been suggested (Ogard and Kerrisk, 1984) that water in the unsaturated zone will be similar in composition to water sampled in the saturated zone of Yucca Mountain. According to this model, the probable composition of any water at Yucca Mountain can be bounded by the compositions of water from the following wells: USW-H3 (water below the repository), UE25p-1 (water in the Paleozoic aquifer), J-13 (water in the aquifer surrounding Yucca Mountain), and snow or rain (juvenile recharge) (Figure 5-1 and Table 5-1). This hypothesis is supported by data from four types of research: 1. water chemistry studies of the saturated zone at Yucca Mountain; 2. water chemistry studies of the unsaturated zone at Rainier Mesa in the NTS; 3. experimental studies of tuff-water interactions; and 4. theoretical calculations of mineral-water equilibria and reaction pathways. Ogard and Kerrisk (1984) suggest that because no saline water has been found in the tuff layers at Yucca Mountain and because the slow dissolution of volcanic glass does not lead to high concentrations of dissolved solids, water in the pores of the unsaturated zone is similar to that sampled in the wells listed above. The chemistry of waters in these wells is dominated by the reaction of vitric tuff and rain water and the production of secondary minerals. The approximate composition of water within the unsaturated zone, therefore, may lie between the compositions of rain water and the end-member water compositions represented by the wells listed above. The exact composition of pore fluid in any particular rock unit will depend upon the degree and nature of reactions with the surrounding wall rock, and thus may differ for different rock types and ground-water ages. For example, Ogard and Kerrisk (1984) suggest that the composition of water in the pores of unsaturated vitric tuff may differ from water in unsaturated devitrified tuff. Fluids in the latter rock may be higher in relative calcium content and lower in relative sodium contents than the waters described in Table 5-1. Water in equilibrium with zeolitic or vitric tuff should be similar to the water described in these tables. Kerrisk (1984) suggests that water at Rainier Mesa provides a useful analog for the compositions of waters in fractures and matrix in the unsaturated zone at Yucca Mountain. The data obtained in the studies described above will be presented in more detail in the sections that follow.

Table 5-1. Water compositions

	J-13	UE25p-1	USW-H3
Na ⁺ (mm/l)	1.96	7.43	5.39
K ⁺ (mm/l)	0.14	0.34	0.04
Ca ²⁺ (mm/l)	0.29	2.19	0.02
Mg ²⁺ (mm/l)	0.07	1.31	0.00
SiO ₂ (aq) (mm/l)	1.07	0.62	0.60
CO ₃ ²⁻ (total) (mm/l)	2.81	16.1	4.04
Cl ⁻ (mm/l)	0.18	1.04	0.23
SO ₄ ²⁻ (mm/l)	0.19	1.34	0.32
F ⁻ (mm/l)	0.11	0.18	0.28
pH	7.0	6.7	9.4
Eh (mV)	700	360	-143
TDS (mg/l)	130.4	504.22	189.3

Table 5.1-1.
Elemental concentrations in ground waters from the vicinity of Yucca Mountain
((Ogard and Kerrisk, 1984))

Well No.	Field pH	Concentration ^a (mg/l)								
		Ca	Mg	Na	K	Li	Fe	Mn	Al	Si
USW VH-1 ^b	7.5	10	1.5	80	1.9	0.090				23
USW H-6	7.4	5.5	0.22	74	2.1	0.10	0.12	0.04	0.12	20.0
USW H-3	9.4	0.8	0.01	124	1.5	0.22	0.13	0.01	0.51	16.9
USW H-5	7.1	1.1	0.03	54	2.3	0.04	0.01	N.D.	0.17	17.4
USW G-4	7.1	9.2	0.15	56	2.5	0.08	0.04	0.02	0.02	19.6
USW H-1 ^b	7.5	6.2	<0.1	51	1.6	0.04				19
USW H-4	7.4	10.8	0.19	84	2.6	0.16	0.03	0.005	0.04	25.9
UE-25b#1 ^c	7.7	19.7	0.68	56	3.3	0.28	0.04	0.004	0.03	31.5
UE-25b#1 ^d	7.2	18.4	0.68	46	2.5	0.30	0.69	0.36	0.04	28.7
UE-25b#1 ^e	7.3	17.9	0.66	37	3.0	0.17	0.08	0.07	0.06	28.8
J-13	6.9	11.5	1.76	45	5.3	0.06	0.04	0.001	0.03	30.0
UE-29a#2	7.0	11.1	0.34	51	1.2	0.10	0.05	0.03	0.04	25.8
J-12 ^b	7.1	14	2.1	38	5.1					25
UE-25p#1	6.7	87.8	31.9	171	13.4	0.32	<0.1	<0.1	0.1	30

- a. Ionic or molecular species are not listed; concentration is based on the element.
b. Data from Benson and others (1983).
c. Integral water sample.
d. Bullfrog zone, 4th day.
e. Bullfrog zone, 28th day.

Table 5.1-2
Anion concentrations and other measurements for ground waters from the
vicinity of Yucca Mountain (Ogard and Kerrisk, 1984)

Well No.	Concentration (mg/l)								Eh ^a
	F ⁻	Cl ⁻	SO ₄ ²⁻	HCO ₃ ⁻	NO ₂ ⁻	NO ₃ ⁻	O ₂	Detergent	
USW VH-1 ^b	2.7	10	45	165					
USW H-6	4.1	7.7	27.5		N.D. ^c	5.3	5.6		395
USW H-3	5.4	8.3	31.2		<0.10	0.2	<0.1	<0.02	-143
USW H-5	1.3	5.7	14.6		N.D.	8.6	6.3	<0.005	353
USW G-4	2.4	5.5	15.7		N.D.	5.5	6.4		402
USW H-1 ^b	1.0	5.8	19	122					
USW H-4	4.5	6.2	23.9		N.D.	4.7	5.8	>2	216
UE-25b#1 ^d	1.2	7.1	20.6		N.D.	0.6	1.8		220
UE-25b#1 ^e	1.5	9.8	21.0		0.5	2.2	<0.1	2.7	-18
UE-25b#1 ^f	1.2	6.6	20.3		N.D.	4.5	1.8	0.02	160
J-13	2.1	6.4	18.1		N.D.	10.1	5.7	N.D.	
UE-29a#2	0.56	8.3	22.7		N.D.	18.7	5.7		305
J-12 ^b	2.1	7.3	22	119					
UE-25p#1	3.5	37	129		N.D.	<0.1		<0.2	360

a. mV vs. H₂ electrode.

b. Data from Benson and others (1983).

c. Not detected.

d. Integral water sample.

e. Bullfrog zone, 4th day.

f. Bullfrog zone, 28th day.

Table 5.1-3
Compositions of ground waters from Yucca Mountain wells "thief samples"
(Ogord and Kerrisk, 1984)

Well No. Depth (m)	pH	Concentration (mg/l)								
		Ca	Mg	Na	K	Li	Fe	Mn	Al	Si
USW H-1										
610	7.2	3.5	0.20	106	6.4	0.07	0.02	0.11	0.02	3.6
915	7.0	5.2	0.09	153	1.4	0.09	0.14	0.08	0.03	11.5
1220	8.0	1.7	0.07	166	1.4	0.11	0.03	0.04	0.02	12.9
1800	7.6	6.2	0.15	120	2.2	0.14	0.21	0.15	0.02	16.1
USW H-4										
628	8.7	8.0	0.35	114	4.1	0.26	0.05	0.09	0.04	11.3
683	8.6	7.3	0.21	107	3.5	0.34	0.12	0.10	0.04	26.4
721	8.6	8.3	0.23	109	3.4	0.40	0.20	0.08	0.06	26.5
792	8.4	12.4	0.25	105	3.2	0.38	0.86	0.13	0.05	26.3
869	9.6	3.9	0.14	99	3.8	0.33	0.01	<0.01	0.06	26.4
908	8.6	12.8	0.25	92	3.5	0.27	<0.05	0.08	0.08	25.9
1036	8.7	11.4	0.22	93	3.2	0.26	0.16	0.08	0.09	25.4
1187	8.6	7.7	0.16	98	3.3	0.21	<0.05	0.09	0.06	26.0
USW H-1 ^a integral	7.5	6.2	<0.1	51	1.6	0.04				19
USW H-4 ^a integral	7.4	10.8	0.19	84	2.6	0.16	0.03	0.005	0.04	25.9

a. Data from Benson and others (1983).

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APPENDIX A - TABLES FOR PART 191

TABLE 1 - CONCENTRATIONS IDENTIFYING HIGH-LEVEL RADIOACTIVE WASTES
UNDER 191.02(e)(1)

Fission Product Radionuclides	Concentration (curies per cubic meter of waste)
Carbon-14 - - - - -	8
Cesium-135 - - - - -	800
Cesium-137 - - - - -	4600
Strontium-90 - - - - -	7000
Technetium-99 - - - - -	3
Tin-126 - - - - -	1
Any other radionuclide with a half-life greater than 20 years - - - - -	700

Transuranic Radionuclides	Concentration (nanocuries per gram of waste)
Plutonium-241 - - - - -	3500
Any alpha-emitting transuranic radionuclide with a half-life - - - - -	100
greater than 20 years	

NOTE: In cases where a waste corresponding to 191.02(e)(1) contains a mixture of radionuclides, it shall be considered a high-level radioactive waste for the purposes of this Part if the sum of the ratios of the radionuclide concentrations to the concentrations in Table 1 exceeds one.

For example, if a waste containing radionuclides A, B, and C in concentrations C_a , C_b , and C_c , and if the concentration limits from Table 1 are CL_a , CL_b , and CL_c , then the waste shall be considered high-level radioactive waste if the following relationship exists:

$$\frac{C_a}{CL_a} + \frac{C_b}{CL_b} + \frac{C_c}{CL_c} \geq 1$$

TABLE 2 - RELEASE LIMITS FOR CONTAINMENT REQUIREMENTS
(Cumulative Releases to the Accessible Environment
for 10,000 Years After Disposal)

Radionuclide	Release Limit (curies)
Americium-241 - - - - -	100
Americium-243 - - - - -	100
Carbon-14 - - - - -	100
Cesium-135 - - - - -	1000
Cesium-137 - - - - -	1000
Neptunium-237 - - - - -	100
Plutonium-238 - - - - -	100
Plutonium-239 - - - - -	100
Plutonium-240 - - - - -	100
Plutonium-242 - - - - -	100
Radium-226 - - - - -	100
Strontium-90 - - - - -	1000
Technetium-99 - - - - -	10000
Tin-126 - - - - -	1000
Any other alpha-emitting radionuclide - - - - -	100
Any other radionuclide that does not emit alpha particles - - - - -	1000

NOTE 1: The Release Limits in Table 3 apply to the amount of wastes in any one of the following:

(a) an amount of spent nuclear fuel containing 1,000 metric tons of heavy metal (MTHM);

(a) the high-level wastes, as defined by 191.02(e)(1), generated from each 1,000 MTHM;

(b) each 100,000,000 curies of gamma or beta-emitting radionuclides with half-lives less than 100 years that are identified by the Commission as high-level waste in accordance with 191.02(e)(2);

(c) each 1,000,000 curies of other radionuclides (gamma or beta-emitters with half-lives greater than 100 years or any alpha-emitters) that are identified by the Commission as high-level waste in accordance with 191.02(e)(2); or

(d) an amount of transuranic (TRU) wastes, as defined by 191.02(f), containing one million curies of alpha-emitting transuranic radionuclides.

To develop Release Limits for a particular disposal system, the quantities in Table 3 shall be adjusted for the amount of wastes included in the disposal system. For example:

(a) If a particular disposal system contained the high-level wastes from 50,000 MTHM, the Release Limits for that system would be the quantities in Table 3 multiplied by 50 (50,000 MTHM divided by 1,000 MTHM).

(b) If a particular disposal system contained three million curies of alpha-emitting transuranic wastes, the Release Limits for that system would be the quantities in Table 3 multiplied by three (three million curies divided by one million curies).

(c) If a particular disposal system contained both the high-level wastes from 50,000 MTHM and 5 million curies of alpha-emitting transuranic wastes, the Release Limits for that system would be the quantities in Table 3 multiplied by 55:

$$\frac{50,000 \text{ MTHM}}{1,000 \text{ MTHM}} + \frac{5,000,000 \text{ curies TRU}}{1,000,000 \text{ curies TRU}} = 55$$

NOTE 2: In cases where a mixture of radionuclides is projected to be released, the limiting values shall be determined as follows: For each radionuclide in the mixture, determine the ratio between the cumulative release quantity projected over 10,000 years and the limit for that radionuclide as determined from Table 2 and Note 1. The sum of such ratios for all the radionuclides in the mixture may not exceed one.

For example, if radionuclides A, B, and C are projected to be released in amounts Q_a , Q_b , and Q_c , and if the applicable Release Limits are RL_a , RL_b , and RL_c , then the cumulative releases over 10,000 years shall be limited so that the following relationship exists:

$$\frac{Q_a}{RL_a} + \frac{Q_b}{RL_b} + \frac{Q_c}{RL_c} \leq 1$$

ATTACHMENT III

Attachment is from: Savannah River Operations Office, Strategy Document, "Long-Term Technology Program for Defense High-Level Waste" DOE/SR-WM-79-3, Savannah River Operations Office, Aiken, SC (May 1984). Figure 1, only.

FIGURE 1. Long-Term Technology Program for Immobilization of High-Level Wastes

* Shown for planning purposes. The exact nature of NEPA documentation (if required) would be defined in part by response to the programmatic EIS.

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