APPENDIX II - STANDARD STATE (298.15 K, 10^5 Pa) THERMODYNAMIC DATA

Thermodynamic data are determined by experiment and are thus subject to various types of uncertainties: (1) has the reaction achieved equilibrium, (2) have the proper corrections been applied for the activity of the ions in solution, and (3) are the phases synthesized in the experiments the same as those encountered in the natural environment. For thermodynamic values determined from experimental reactions, changes in the values for one of the reactants or products will change the values for the other species. For example, let us assume that we have determined the solubility product for a particular precipitation reaction. Newer date provides a more accurate(?) free energy value for one of the products. Since the solubility product doesn't change, the free energies of the other species involved in the reaction must be adjusted to take into account this revised value. This is often not done. When a particular thermodynamic data compilation is published the author(s) try in insure that the data are internally consistent. However, different data compilations, while internally consistent, may not agree with other compilations. CODATA values (Cox et al., 1989) represent an attempt to provide a universal reference base for thermodynamic data.

The following compilation of thermodynamic data is intended for classroom exercises. These data should not be used for research purposes without verification. Five sets of thermodynamic values are reported: the CODATA values of Cox et al. (1989), data from Drever (1997) which have been adjusted to conform with the CODATA reference values, the widely used mineralogical data base of Robie et al. (1978), the NBS values of Wagman et al. (1982) and free energy values for the transuranics and other radioactive elements from Brookins (1988). The most consistent results are obtained if all the thermodynamic data used in a calculation are taken from the same compilation.

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
Ag (silver)				
$Ag_{\ metal}$	0	0	42.6	3, 4
Ag^+	-	105.79	73.45	1
	77.1	105.8	73.4	3
	77.1	105.6	72.7	4
Ag^{2+}	269.0	268.6	88	4
$AgCl_2^-$	-215.4	-245.2	231.4	4
$Ag(OH)_2^-$	-260.2	-	-	4
$AgCl_{\ chlorargyrite}$	-109.8	-127.1	96.2	3, 4
$Ag_2S_{\ acanthite}$	-40.7	-32.6	144.0	4
$Ag_2CO_{3\ (cr)}$	-436.8	-505.8	167.4	4
$Ag_2O_{\ (cr)}$	-11.2	-31.1	121.3	4
$Ag_2SO_{4\ (cr)}$	-618.4	-715.9	200.4	4
$Ag_2SeO_{4\ (cr)}$	-334.2	-420.5	248.5	4
$AgNO_{3\ (cr)}$	-33.4	-124.4	140.9	4
Al (aluminum)				
$Al_{\ metal}$	0	0	28.3	3, 4
Al^{3+}	-	-538.4	-325	1
	-487.65	-540	-340	2
	-489.4	-531.0	-308.0	3
	-485	-531	-321.7	4
AlO_2^-	-830.9	-930.9	-36.8	4

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
$Al(OH)^{2+}$	-696.54	-778	-204	2
	-694.1	-	-	4
$Al(OH)_2^+$	-901.7	-1000	-16	2
$Al(OH)_{3\ (aq)}$	-1100.6	-1230	108	2
$Al(OH)_4^-$	-1305.8	-1487	160	2
	-1305.3	-1502.5	102.9	4
$Al_2O_{3\ corundum}$	-	-1675.7	50.92	1
	-1582.2	-1675.7	50.9	3
	-1582.3	-1675.7	50.9	4
$Al(OH)_{3\ (am)}$	-1137.6	-1276.1	-	2
$Al(OH)_{3\ gibbsite}$	-1154.86	-1293.1	68.4	2
	-1154.9	-1293.1	68.4	3
	-1155.1	-1293.3	68.4	4
$AlO(OH)_{\ boehmite}$	-913	-994	-	2
	-918.4	-993.0	48.4	3
	-915.8	-990.4	48.4	4
$AlO(OH)_{\ diaspore}$	-992.0	-1000.6	35.3	3
	-920.9	-999.4	35.3	4
$AlPO_4{\cdot}2H_2O_{\ variscite}$	-2097.8	-	-	4
$Al_2Si_2O_5(OH)_{4\ kaolinite}$	-3785.8	-4133	-	2
	-3799.4	-4120.1	203.0	3
	-3799.7	-4119.6	205.0	4
$Al_2Si_2O_5(OH)_{4\ dickite}$	-3796.3	-4118.8	197.1	3
	-3795.9	-4118.3	197.1	4
$Al_2Si_2O_5(OH)_{4\ halloysite}$	-3769.4	-4114	-	2
	-3780.7	-4101.5	203.0	3
	-3780.5	-4101.2	203.3	4
$Al_2Si_4O_{10}(OH)_{2\ pyrophyllite}$	-5273.3	-	-	2
	-5269.4	-5643.3	239.4	3
	-5268.1	-5642.0	239.4	4
Am (americium)				
Am^{3+}	-559.1	-	-	5
Am^{4+}	-373.2	-	-	5
$AmOH^{2+}$	-793.5	-	-	5
$Am(OH)_5^-$	-1529.6	-	-	5
$AmO_{2\ (cr)}$	-880.4	-	-	5
$Am_2O_{3\ (cr)}$	-1614.9	-	-	5
$Am(OH)_{3\ (cr)}$	-1168.0	-	-	5
$Am_2(CO_3)_{3\ (cr)}$	-2996.2	-	-	5
As (arsenic)				
$As_{\ (cr)}$	0	0	35.7	3
	0	0	35.1	4
AsO^+	-163.8	-	-	4
AsO_2^-	-350.0	-429.0	40.6	4
AsO_3^{3-}	-447.69	-	-	5
AsO_4^{3-}	-648.4	-888.1	-162.8	4

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
$HAsO_4^{2-}$	-714.6	-906.3	-1.7	4
$HAsO_3^{2-}$	-524.30	-	-	5
$H_2AsO_3^-$	-587.1	-714.8	110.5	4
$H_2AsO_4^-$	-753.2	-909.6	117.0	4
$H_3AsO_{3\ (aq)}$	-639.8	-742.2	195.0	4
$H_3AsO_{4\ (aq)}$	-766.0	-902.5	184.0	4
$As_2O_{3\ arsenolite}$	-576.0	-657.0	107.4	3
	-576.2	-657.0	107.1	4
$As_2O_{3\ clauderite}$	-575.6	-654.8	113.3	3
	-577.0	-654.8	117.0	4
$As_2S_{2\ realgar}$	-140.6	-142.7	127.0	3
	-	-142.7	-	4
$As_2S_{3\ orpiment}$	-168.4	-169.0	163.6	3
	-168.6	-169.0	163.6	4
Ba (barium)				
Ba^{2+}	-555.4	-532.5	8.4	2
	-560.7	-537.6	9.6	3
	-560.8	-537.6	9.6	4
$BaCl_{2\ (cr)}$	-810.4	-858.6	123.7	4
$BaF_{2\ (cr)}$	-1156.8	-1207.1	96.4	4
$BaCO_{3\ witherite}$	-1132.21	-1210.9	112.1	2
	-1132.2	-1210.8	112.1	3
	-1137.6	-1216.3	112.1	4
$BaSO_{4\ barite}$	-1362.2	-1473.2	132.2	2, 3, 4
$Ba(NO_3)_{2\ nitrobarite}$	-796.6	-992.1	213.8	3, 4
Be (beryllium)				
$Be_{\ metal}$	0	0	9.50	1, 3, 4
Be^{2+}	-379.7	-383.0	-130.0	3
	-379.7	-382.8	-129.7	4
BeO_2^{2-}	-640.1	-790.8	-159	4
$Be_3(OH)_3^{3+}$	-1801.6	-	-	4
$BeO_{\ bromellite}$	-	-609.4	13.77	1
	-580.1	-609.4	13.8	3
	-580.3	-609.6	-	4
$Be(OH)_{2\ (cr,\ \alpha)}$	-815.0	-902.5	51.9	4
$BeCl_{2\ (cr,\ \alpha)}$	-445.6	-490.4	82.7	4
$BeSO_{4\ (cr,\ tetragonal)}$	-1093.8	-1205.2	77.9	4
$BeAl_2O_{4\ chrysoberyl}$	-2178.5	-2300.8	66.3	3, 4
$Be_2SiO_{4\ phenacite}$	-	-	64.3	3
	-2032.5	-2149.3	64.3	4
C (carbon)				
$C_{\ graphite}$	0	0	5.74	1, 2
	0	0	5.7	3, 4
$C_{\ diamond}$	2.9	1.9	2.4	3, 4
$CCl_{4\ (l)}$	-65.3	-135.4	216.4	4

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
$HCN_{(aq)}$	119.7	107.1	-	4
CN-	172.4	150.6	94.1	4
$CH_{4\,(g)}$	-50.72	-74.81	186.3	2
	-50.7	-74.8	186.3	3, 4
$CH_{4\,(aq)}$	-34.3	-89.0	83.7	4
$CH_2O_{(aq)}$	-129.7	-	-	4
$C_6H_{6\,(l)}$	124.7	49.0	172	4
$HCOOH_{(l)}$	-361.4	-424.7	129.0	4
$CH_3COOH_{(aq)}$	-396.6	-485.8	159.8	4
CH_3COO-	-369.3	-486.0	86.6	4
$CO_{(g)}$	-137.17	-110.53	197.66	1, 2
	-137.2	-110.5	197.7	3, 4
$CO_{2\,(g)}$	-394.37	-393.51	213.79	1, 2
	-394.4	-393.5	213.8	3
	-394.4	-393.5	213.7	4
$CO_{2\,(aq)}$	-	-413.26	119.36	1
	-386.0	-413.8	117.6	4
$H_2CO_{3\,(aq)}$	-623.14	-699.09	189.31	2
	-623.2	-699.6	187.0	3
	-623.1	-699.6	187.4	4
HCO_3^-	-586.8	-689.93	98.4	1, 2
	-586.8	-692.0	91.2	3, 4
CO_3^{2-}	-527.9	-675.23	-50.0	1, 2
	-527.9	-677.1	-56.9	3
	-527.8	-677.1	-56.9	4
Ca (calcium)				
$Ca_{\,metal}$	-	0	41.59	1
	0	0	41.6	3
	0	0	41.4	4
Ca^{2+}	-552.8	-543.0	-56.2	1, 2
	-553.5	-542.8	-53.1	3
	-553.6	-542.8	-53.1	4
$Ca(OH)^+$	-718.4	-	-	4
$CaCO_{3\,(aq)}$	-1081.4	-1220.0	-110.0	4
$CaSO_{4\,(aq)}$	-1298.1	-1452.1	-33.1	4
$CaO_{\,lime}$	-	-634.92	38.1	1
	-603.5	-635.1	38.2	3
	-604.0	-635.1	39.8	4
$Ca(OH)_{2\,portlandite}$	-897.5	-985.2	83.4	2
	-898.4	-986.1	83.4	3
	-898.5	-986.1	83.4	4
$CaF_{2\,fluorite}$	-1176.9	-1229.3	68.9	3
	-1167.3	-1219.6	68.9	4
$CaCO_{3\,calcite}$	-1129.07	-1207.6	91.7	2
	-1128.8	-1207.4	91.7	3
	-1128.8	-1206.9	92.9	4
$CaCO_{3\,aragonite}$	-1128.3	-1206.4	93.9	2
	-1127.8	-1207.4	88.0	3

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
	-1127.8	-1207.1	88.7	4
$CaMg(CO_3)_2$ dolomite	-2161.7	-2324.5	155.2	2, 3
	-2163.4	-2326.3	155.2	4
$CaSO_4$ anhydrite	-1321.98	-1435.5	106.5	2
	-1321.7	-1434.1	106.7	3
	-1321.8	-1434.1	106.7	4
$CaSO_4 \cdot 2H_2O$ gypsum	-1797.36	-2022.92	193.9	2
	-1797.2	-2022.6	194.1	3
	-1797.3	-2022.6	194.1	4
$Ca_5(PO_4)_3OH$ hydroxyapatite	-6338.3	-6721.6	390.4	2
	-6338.4	-6721.6	390.4	3
	-6338.5	-6738.5	390.4	4
$Ca_5(PO_4)_3F$ fluroroapatite	-6508.1	-6872.2	387.9	3
	-6491.5	-6872	387.9	4
$CaAl_2Si_2O_8$ anorthite	-4002.2	-4227.8	199.3	2
	-4017.3	-4243.0	199.3	3
	-4002.3	-4227.9	199.3	4
$CaAl_2Si_4O_{12} \cdot 4H_2O$ laumontite	-6682.0	-7233.6	485.8	2
$Ca_{0.167}Al_{2.33}Si_{3.67}O_{10}(OH)_2$ Ca-beidellite	-5346	-	-	2
$CaMgSi_2O_6$ diopside	-3036.6	-3210.8	143.1	3
	-3032.0	-3206.2	142.9	4
$Ca_2Mg_5Si_8O_{22}(OH)_2$ tremolite	-11592.6	-12319.7	548.9	2
	-11627.9	-12355.1	548.9	3
	-11631	-12360	548.9	4
Cd (cadmium)				
Cd metal	0	0	51.80	1, 3, 4
Cd^{2+}	-	-75.92	-72.8	1
	-77.6	-75.9	-73.2	3, 4
CdO_2^{2-}	-284.4	-	-	4
$Cd(OH)^+$	-261.1	-	-	4
$Cd(OH)_{2\,(aq)}$	-442.6	-	-	4
$Cd(OH)_3^-$	-600.7	-	-	4
$Cd(OH)_4^{2-}$	-758.4	-	-	4
$CdCl^+$	-224.4	-240.6	43.5	4
$CdCl_3^-$	-487.0	-561.1	202.9	4
$Cd(NH_3)_4^{2+}$	-226.1	-450.2	336.4	4
CdO monteponite	-	-258.35	54.8	1
	-228.5	-258.2	54.8	3
	-228.4	-258.2	54.8	4
$Cd(OH)_{2\,(cr)}$	-473.6	-560.7	96	4
$CdCl_{2\,(cr)}$	-343.9	-391.5	115.3	4
$CdF_{2\,(cr)}$	-647.7	-400.4	77.4	4
CdS greenockite	-145.6	-149.6	70.3	3
	-156.5	-161.9	64.9	4
$CdCO_3$ otavite	-669.4	-750.6	92.5	3, 4
$CdSO_{4\,(cr)}$	-822.7	-933.3	123.0	4
$CdSO_4\ 2H_2O_{\,(cr)}$	-1068.7	-1239.6	154.0	4

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
Ce (cerium)				
Ce $_{metal}$	0	0	69.5	3
	0	0	72.0	4
Ce^{3+}	-672.0	-696.2	-205.0	3, 4
Ce^{4+}	-503.8	-537.2	-301	3, 4
Cl (chlorine)				
$Cl_{2\ (g)}$	0	0	223.1	3, 4
Cl-	-131.2	-167.08	56.60	1, 2
	-131.3	-167.1	56.7	3
	-131.2	-167.2	56.5	4
HCl $_{(g)}$	-	-92.31	186.90	1
	-95.3	-92.3	186.9	3, 4
Co (cobalt)				
Co $_{metal}$	0	0	30.0	3, 4
Co^{2+}	-54.4	-58.2	-113.0	3, 4
Co^{3+}	134.0	92.0	-305.0	3, 4
CoO $_{(cr)}$	-214.2	-237.9	53.0	3, 4
Co_3O_4 cobalt spinel	-772.6	-891.2	102.5	3
	-774	-891	102.5	4
$Co(OH)_{2\ (cr)}$	-450.1	-	-	4
Cr (chromium)				
Cr $_{metal}$	0	0	23.6	3
	0	0	23.8	4
Cr^{2+}	-	-144.0	-	3
	-	-143.5	-	4
CrO_4^{2-}	-727.8	-881.2	50.2	4
$HCrO_4^-$	-764.7	-878.2	184.1	4
$Cr_2O_7^{2-}$	-1301.1	-1490.3	261.9	4
$Cr_2O_{3\ (cr)}$	-1058.1	-1139.7	81.2	4
Cu (copper)				
Cu $_{metal}$	-	0	33.15	1
	0	0	33.2	3, 4
Cu^+	50.0	71.7	41.0	3
	50.0	71.7	40.6	4
Cu^{2+}	-	64.9	-98	1
	65.5	64.8	-99.6	3, 4
$CuCl^+$	-68.2	-	-	4
CuO_2^{2-}	-183.6	-	-	4
$Cu(OH)_{2\ (aq)}$	-249.0	-395.2	-120.9	4
$CuCl_{2\ (aq)}$	-197.9	-	-	4
$CuSO_{4\ (aq)}$	-692.2	-	-	4
CuO $_{tenorite}$	-129.6	-157.3	42.6	3

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
	-129.7	-157.3	42.6	4
Cu_2O cuprite	-146.0	-168.6	93.1	3, 4
$CuCl$ nantokite	-119.9	-137.2	86.2	4
$CuCl_{2\ (cr)}$	-175.7	-220.1	108.1	4
CuS covellite	-49.1	-48.6	66.6	3
	-53.6	-53.1	66.5	4
Cu_2S chalcocite	-86.9	-80.1	120.8	3
	-86.2	-79.5	120.9	4
$Cu_2CO_3(OH)_2$ malachite	-	-1054.0	-	3
	-893.6	-1051.4	186.2	4
$Cu_3(CO_3)_2(OH)_2$ azurite	-	-1632.2	-	3
	-1315.5	-1632.2	0	4
$CuSO_4$ chalcocyanite	-	-771.4	109.2	1
	-662.3	-771.4	109.5	3
	-661.8	-771.4	109	4
$CuSO_4 \cdot 5H_2O$ chalcanthite	-1879.8	-2279.6	300.4	3
	-1879.7	-2279.6	300.4	4
$Cu_4SO_4(OH)_6$ brochantite	-1818.0	-	-	3
	-1817.7	-	-	4
F (fluorine)				
$F_{2\ (g)}$	0	0	202.8	3, 4
F-	-281.5	-335.35	-13.8	1, 2
	-281.7	-335.4	-13.2	3
	-278.8	-332.6	-13.8	4
$HF_{\ (aq)}$	-296.8	-320.1	88.7	4
$HF_{\ (g)}$	-	-273.30	173.78	1
	-275.4	-273.3	173.8	3
	-273.2	-271.1	173.8	4
$HF_{\ (l)}$	-	-299.8	-	4
Fe (iron)				
$Fe_{\ metal}$	0	0	27.3	2, 3, 4
Fe^{2+}	-82.88	-89.0	-	2
	-78.9	-89.1	-138.0	3
	-78.9	-89.1	-137.7	4
Fe^{3+}	-8.56	-48.85	-	2
	-4.6	-48.5	-316.0	3
	-4.7	-48.5	-315.9	4
FeO_2^{2-}	-295.3	-	-	
$Fe(OH)^+$	-277.4	-324.7	-29	4
$Fe(OH)^{2+}$	-233.20	-291.2	-	2
	-229.4	-290.8	-142	4
$Fe(OH)_2^{2+}$	-450.5	-548.9	-	2
	-438.0	-	-	4
$Fe(OH)_{3\ (aq)}$	-648.3	-802.5	-	2
	-659.3	-	-	4
$Fe(OH)_4^-$	-833.83	-1058.7	-	2

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
$FeCl^{2+}$	-143.9	-180.3	-113	4
$FeSO_{4\ (aq)}$	-823.4	-998.3	-117.6	4
$FeO_{\ (cr)}$	-251.2	-272.0	59.8	3
	-251.4	-272.0	60.8	4
Fe_2O_3 hematite	-742.8	-824.7	87.7	2
	-742.7	-824.6	87.4	3
	-742.2	-824.2	87.4	4
Fe_3O_4 magnetite	-1012.9	-1116.1	146.1	2
	-1012.6	-1115.7	146.1	3
	-1015.4	-1118.4	146.4	4
$Fe(OH)_{2\ (s)}$	-486.5	-569.0	88	2, 4
$FeOOH_{\ goethite}$	-488.55	-559.3	60.4	2
	-488.6	-559.3	60.4	3
	-	-559.0	-	4
$Fe(OH)_3$ ferrihydrite	-692.07	-	-	2
	-696.5	-823.0	106.7	4
$FeCl_2$ lawrencite	-302.2	-341.6	118.0	3
	-302.3	-341.8	118.0	4
$FeCl_3$ molysite	-333.8	-399.2	142.3	3
	-334.0	-399.5	142.3	4
$FeCO_3$ siderite	-673.05	-753.8	-	2
	-666.7	-737.0	105.0	3
	-666.7	-740.6	92.9	4
$Fe_3(PO_4)_2{\cdot}8H_2O$ vivianite	-4151.6	-	-	4
$FePO_4{\cdot}2H_2O$ strengite	-1662.9	-1888.2	171.1	2
Fe_2SiO_4 fayalite	-1379.0	-1479.9	145.2	2
	-1379.4	-1479.4	148.3	3
	-1379.0	-1479.9	145.2	4
FeS_2 pyrite	-166.9	-178.2	52.9	2
	-160.2	-171.5	52.9	3
	-166.9	-178.2	52.9	4
FeS_2 marcasite	-158.4	-169.4	53.9	3
	-	-154.8	-	4
$FeS_{\ pyrrhotite}$	-100.4	-100.0	60.3	2, 4
$FeS_{\ mackinawite}$	-93.0	-	-	2
Fe_3S_4 greigite	-290	-	-	2
$FeAsS_{\ arsenopyrite}$	-50	-42	121	4
$FeSO_4{\cdot}7H_2O_{\ melanterite}$	-2509.6	-3014.4	409.2	3
	-2509.9	-3014.6	409.2	4
H (hydrogen)				
$H_{2\ (g)}$	0	0	130.57	2
	0	0	130.7	3, 4
$H_2O_{\ (g)}$	-228.58	-241.83	188.84	1, 2
	-228.6	-241.8	188.7	3, 4
$H_2O_{\ (l)}$	-237.14	-285.83	69.95	1, 2
	-237.1	-285.8	70.0	3
	-237.1	-285.8	69.9	4

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
H^+	0	0	0	1, 2, 3, 4
Hg (mercury)				
Hg_{metal}	0	0	75.9	3
	0	0	76.0	4
$Hg_{(l)}$	-	0	75.90	1
Hg^{2+}	-	170.21	-36.19	1
	164.4	171.0	-32.0	3
	164.4	171.0	-32.2	4
Hg_2^{2+}	-	166.87	65.74	1
	153.6	172.0	84.5	3
	153.5	172.4	84.5	4
$HHgO_2^{2-}$	-190.3	-	-	4
$Hg(OH)^+$	-52.3	-84.5	71	4
$HgCl^+$	-5.4	-18.8	75	4
$HgCl_4^{2-}$	-446.8	-554.0	293	4
HgS_2^{2-}	41.9	-	-	4
$HgO_{montroydite}$	-	-90.79	70.25	1
	-58.5	-90.8	70.3	3, 4
$Hg_sCl_{2\ calomel}$	-	-265.37	191.6	1
	-210.8	-265.2	192.5	3
	-210.7	-265.2	192.5	4
$HgS_{cinnabar}$	-50.6	-58.2	82.5	3
	-50.6	-58.2	82.4	4
$Hg_2SO_{4\ (cr)}$	-	-743.09	200.70	1
	-625.8	-743.1	200.7	4
K (potassium)				
K_{metal}	0	0	64.7	3
	0	0	64.2	4
K^+	-282.5	-252.14	101.2	1, 2
	-282.5	-252.2	101.0	3
	-283.3	-252.4	102.5	4
$KCl_{sylvite}$	-408.6	-436.5	82.6	2
	-408.6	-436.5	82.6	3
	-409.1	-436.7	82.6	4
$K_2SO_{4\ arcanite}$	-1319.7	-1437.7	175.6	3
	-1321.4	-1437.8	175.6	4
$KNO_{3\ niter}$	-394.5	-494.5	133.1	3
	-394.9	-494.6	133.0	4
$KAlSi_3O_{8\ microcline}$	-3742.9	-3681.1	214.2	2
	-3742.3	-3967.7	214.2	3
	-3742.9	-3968.1	214.2	4
$KAl_3Si_3O_{10}(OH)_{2\ muscovite}$	-5608.4	-5984.4	305.3	2
	-5600.7	-5976.7	306.4	3
	-5608.4	-5984.4	306.3	4
$KMg_3AlSi_3O_{10}(OH)_{2\ phlogopite}$	-	-	319.7	3
	-5831.8	-	-	4

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
La (lanthanum)				
La_{metal}	0	0	56.9	3, 4
La^{3+}	-683.7	-707.1	-217.6	4
Mg (magnesium)				
Mg_{metal}	0	0	32.7	3, 4
Mg^{2+}	-455.4	-467.0	-137	1, 2
	-454.8	-466.8	-138.0	3
	-454.8	-466.8	-138.1	4
$Mg(OH)^+$	-626.7	-	-	4
$MgSO_{4\,(aq)}$	-1212.2	-1356.0	-7.1	4
$MgO_{\ periclase}$	-569.3	-601.6	26.95	1, 2
	-269.2	-601.5	26.9	3
	-569.4	-601.7	26.9	4
$Mg(OH)_{2\ brucite}$	-833.51	-924.54	63.18	2
	-833.5	-924.5	63.2	3, 4
$MgCO_{3\ magnesite}$	-1012.1	-1095.8	65.7	2
	-1029.5	-1113.3	65.1	3
	-1012.1	-1095.8	65.7	4
$MgCO_3{\cdot}3H_2O_{\ nesquehonite}$	-1723.7	-1977.3	195.6	3
	-1726.1	-	-	4
$MgSO_4{\cdot}7H_2O_{\ epsomite}$	-2871.2	-3388.7	372.0	3
	-2871.5	-3388.7	372	4
$Mg_2SiO_{4\ forsterite}$	-2056.7	-2175.7	95.2	2
	-2051.3	-2170.4	95.2	3
	-2055.1	-2174.0	95.1	4
$MgSiO_{3\ clinoenstatite}$	-1460.9	-1547.8	67.9	3
	-1462.1	-1549.0	67.7	4
$MgSiO_{3\ enstatite}$	-1459.9	-1546.8	67.8	2
$Mg_3Si_2O_5(OH)_{4\ chrysotile}$	-4035.35	-	-	2
	-4034.0	-4361.7	221.3	3
	-4037.8	-4365.6	221.3	4
$Mg_3Si_4O_{10}(OH)_{2\ talc}$	-5527.1	-5893	260.7	2
	-5536.0	-5915.9	260.8	3
	-5523.7	-5903.3	260.8	4
$Mg_5Al_2Si_3O_{10}(OH)_{8\ chlorite}$	-8207.8	-8857.4	465.3	2
$Mg_4Si_6O_{15}(OH)_2{\cdot}6H_2O_{\ sepiolite}$	-9251.6	-10116.9	613.4	2
Mn (manganese)				
Mn_{metal}	0	0	32.0	2, 3
Mn^{2+}	-228.1	-220.79	-73.6	2, 4
	-228.0	-220.7	-73.6	3
$MnOH^+$	-405.0	-450.6	-17	4
$Mn(OH)_3^-$	-744.2	-	-	4
$MnO_{\ manganosite}$	-362.9	-385.2	59.7	3, 4
$Mn(OH)_{2\ pyrochroite}$	-616.5	-	-	2
$MnOOH_{\ manganite}$	-133.3	-	-	2

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
Mn_3O_4 hausmannite	-1283.2	-1387.8	155.6	2
	-1282.8	-1387.8	154.0	3
	-1283.2	-1387.8	155.6	4
Mn_2O_3 bixbyite	-881.1	-959.0	110.5	2, 3, 4
MnO_2 pyrolusite	-465.14	-520.3	53.1	2
	-465.1	-520.0	53.0	3, 4
MnO_2 birnessite	-453.1	-	-	2
$MnCO_3$ rhodochrosite	-816.7	-894.1	85.8	2
	-816.0	-889.3	100.0	3
	-816.7	-894.1	85.8	4
MnS alabandite	-218.0	-213.8	78.2	2
	-218.2	-213.9	78.2	3
	-218.4	-214.2	78.2	4
$MnSiO_3$ rhodonite	-1243.1	-1319.2	102.5	2
	-1243.1	-1319.4	102.5	3
	-1240.5	-1320.9	89.1	4
Mo (molybdenum)				
Mo metal	0	0	28.7	3, 4
$MoO_{4\,(aq)}$	-	-661.1	-	4
MoO_4^{2-}	-836.3	-997.9	27.2	4
$MoO_{2\,(cr)}$	-533.0	-587.8	50.0	3
	-533.0	-588.9	46.3	4
MoO_3 molybdite	-668.0	-745.2	77.7	3
	-668.0	-745.1	77.7	4
MoS_2 molybdenite	-297.4	-306.3	62.6	3
	-225.9	-235.1	62.6	4
N (nitrogen)				
$N_{2\,(g)}$	0	0	191.61	1, 2
	0	0	191.6	3, 4
NO_2^-	-32.2	-104.6	123.0	4
NO_3^-	-108.74	-206.85	146.70	1, 2
	-111.5	-207.4	146.9	3
	-108.7	-205.0	146.4	4
$NH_{3\,(g)}$	-16.45	-45.94	192.77	1, 2
	-16.4	-45.9	192.8	3
	-16.4	-46.1	192.4	4
$NH_{3\,(aq)}$	-26.5	-80.29	111.3	2
	-26.6	-80.3	111.0	3
	-26.5	-80.3	111.3	4
NH_4^+	-79.31	-133.26	111.17	1, 2
	-79.4	-133.3	111.2	3
	-79.3	-132.5	113.4	4
$NO_{(g)}$	86.6	90.2	210.8	4
$NO_{2\,(g)}$	51.2	33.1	240.1	3
	51.3	33.2	240.1	4
$N_2O_{(g)}$	104.2	82.0	219.8	4

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
$NH_{3\,(g)}$	-16.4	-45.9	192.8	3
	-16.4	-46.1	192.4	4
$(NH_4)_2SO_{4\ mascagnite}$	-901.7	-1180.8	220.1	3, 4
$NH_4NO_{3\,(cr)}$	-183.8	-365.6	151.1	3
	-183.9	-365.6	151.1	4
Na (sodium)				
$Na_{\ metal}$	0	0	51.3	3
	0	0	51.2	4
Na^+	-262.0	-240.34	58.45	1, 2
	-261.9	-240.3	58.4	3
	-261.9	-240.1	59.0	4
$NaCO_3^-$	-792.8	-935.9	-49.8	4
$NaHCO_{3\,(aq)}$	-849.7	-943.9	113.8	4
$NaSO_4^-$	-1010.6	-1144.7	108.8	4
$NaCl_{\ halite}$	-384.14	-411.15	72.1	2
	-384.2	-411.3	72.1	3
	-384.1	-411.1	72.1	4
$NaF_{\ villiaumite}$	-546.3	-576.6	51.3	3
	-543.5	-573.6	51.5	4
$Na_2CO_3{\cdot}10H_2O_{\ natron}$	-3427.7	-4081.3	562.7	4
$NaHCO_{3\ nahcolite}$	-851.9	-947.7	102.1	2
	-851.0	-950.8	101.7	4
$NaHCO_3{\cdot}Na_2CO_3{\cdot}2H_2O_{\ trona}$	-2386.6	-	-	2
	-2383.4	-2684.9	301.2	4
$Na_2SO_{4\ thenardite}$	-1269.8	-1387.8	149.6	2
	-1270.0	-1387.8	149.6	3
	-1270.2	-1387.1	149.6	4
$Na_2SO_4{\cdot}10H_2O_{\ mirabilite}$	-3646.4	-4327.1	592.0	2
	-3646.5	-4327.2	591.9	4
	-3646.8	-4327.3	592.0	4
$NaSi_7O_{13}(OH)_{3\ magadiite}$	-6651.9	-241.83	188.73	2
$NaAlSi_3O_{8\ albite}$	-3711.5	-3935.1	207.4	2
	-3711.7	-3935.1	207.4	3
	-3711.5	-3935.1	207.4	4
$NaAlSi_2O_6{\cdot}H_2O_{\ analcite}$	-3082.6	-3300.8	234.3	2
	-3091.7	-3309.8	234.4	3
	-3082.6	-3300.8	234.3	4
$Na_{0.33}Al_{2.33}Si_{3.67}O_{10}(OH)_{2\ Na\text{-}beidellite}$	-5343	-	-	2
Ni (nickel)				
$Ni_{\ metal}$	0	0	29.9	3, 4
Ni^{2+}	-45.6	-54.0	-129.0	3
	-45.6	-54.0	-128.9	4
$Ni(OH)^+$	-230.1	-	-	4
$NiO_{\ busenite}$	-211.6	-239.7	38.0	3
	-211.7	-239.7	38.0	4
$NiCO_{3\,(cr)}$	-612.5	-	-	4

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
$NiS_{\ millerite}$	-86.2	-84.9	66.1	3
	-79.5	-82.0	53.0	4
$Ni_3S_{2\ heazlewoodite}$	-197.1	-202.9	133.9	3, 4
$NiSO_{4\ (cr)}$	-759.9	-872.9	92	4
$NiSO_4\ 7H_2O_{\ morenosite}$	-2461.7	-2976.3	378.9	3
	-2461.8	-2976.3	378.9	4
Np (neptunium)				
$Np_{\ metal}$	0	0	0	5
Np^{3+}	-517.1	-	-	5
Np^{4+}	-502.9	-	-	5
$NpO_2^{\ +}$	-915.0	-	-	5
$NpO_2^{\ 2+}$	-795.8	-	-	5
$Np(OH)_5^{\ -}$	-1456.4	-	-	5
$NpO_2(OH)_2CO_3^{\ 2-}$	-1774.2	-	-	5
$NpO_{2\ (cr)}$	-1021.8	-	-	5
$Np_2O_{3\ (cr)}$	-1448.0	-	-	5
$Np_2O_{5\ (cr)}$	-2013.0	-	-	5
$NpO_2(OH)_{2\ (cr)}$	-1232.5	-	-	5
$Np(CO_3)_{2\ (cr)}$	-1630.2	-	-	5
O (oxygen)				
$O_{2\ (g)}$	-	0	205.15	1
	0	0	205.2	3
	0	0	205.1	4
$O_{2\ (aq)}$	16.4	-11.7	110.9	4
OH^-	-157.2	-230.0	-10.9	2
	-157.3	-230.0	-10.7	3
	-157.2	-230.0	-10.8	4
P (phosphorus)				
$P_{\ (g)}$	-	316.5	163.2	1
$P_{2\ (g)}$	-	144.0	218.12	1
	103.7	144.3	218.1	4
$P_{4\ (g)}$	-	58.9	280.01	1
	24.4	58.9	280.0	4
$PO_4^{\ 3-}$	-1019.0	-1277.0	-222.0	3
	-1018.7	-1277.4	-222	4
$HPO_4^{\ 2-}$	-	-1299.0	-33.5	1
	-1089.1	-1292.1	-33.5	4
$H_2PO_4^{\ -}$	-	-1302.6	92.5	1
	-1130.3	-1296.3	90.4	4
$H_3PO_{4\ (aq)}$	-1142.5	-1288.3	158.2	4
$H_3PO_{4\ (cr)}$	-1112.3	-1266.9	110.5	3
	-1119.1	-1279.0	110.5	4
Pb (lead)				
$Pb_{\ metal}$	-	0	64.80	1

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
	0	0	65.1	3
	0	0	64.8	4
Pb^{2+}	-	0.92	18.5	1
	-24.4	-1.7	10.0	3
	-24.4	-1.7	10.5	4
$HPbO_2^-$	-338.4	-	-	4
$Pb(OH)^+$	-226.3	-	-	4
$PbCl^+$	-164.8	-	-	4
$PbCl_{2\ (aq)}$	-297.2	-	-	4
$PbCl_3^-$	-426.3	-	-	4
$PbO_{\ (cr,\ red)}$	-188.9	-219.0	66.5	4
$PbO_{2\ (cr)}$	-217.3	-277.4	68.6	4
$Pb_3O_{4\ (cr)}$	-601.2	-718.4	211.3	4
$PbS_{\ galena}$	-96.1	-97.7	91.4	3
	-98.7	-100.4	91.2	4
$PbCO_{3\ cerussite}$	-625.3	-699.2	131.0	3
	-625.5	-699.1	131.0	4
$PbSO_{4\ anglesite}$	-	-919.97	148.50	1
	-813.0	-919.9	148.6	3
	-813.1	-919.9	148.6	4
Pd (palladium)				
$Pd_{\ metal}$	0	0	37.8	3
	0	0	37.6	4
Pd^{2+}	176.5	149.0	-184	4
$PdO_{\ (cr)}$	-	-85.4	-	4
$PdS_{\ (cr)}$	-67	-75	46	4
$PdS_{2\ (cr)}$	-74.5	-81.2	79	4
Pt (platinum)				
$Pt_{\ metal}$	0	0	41.6	3, 4
Pt^{2+}	254.8	-	-	4
$PtS_{\ cooperite}$	-76.9	-82.4	55.1	3
	-76.1	-81.6	55.1	4
Po (polonium)				
$Po_{\ metal}$	0	0	0	4
Po^{2+}	71.0	-	-	4
Po^{4+}	293.0	-	-	4
$Po(OH)_2^{4+}$	-473.0	-	-	4
$PoO_{2\ (cr)}$	-195.0	-	-	5
$Po(OH)_{4\ (cr)}$	-544.0	-	-	4
$PoS_{\ (cr)}$	-4.0	-	-	4
Pu (plutonium)				
$Pu_{\ metal}$	0	0	0	5
Pu^{3+}	-578.1	-	-	5
Pu^{4+}	-481.0	-	-	5
PuO_2^+	-849.8	-	-	5

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
$Pu(OH)_5^-$	-1582.0	-	-	5
$PuO_2(OH)_2CO_3^{2-}$	-1732.1	-	-	5
$PuO_{2\ (cr)}$	-998.0	-	-	5
$Pu(OH)_{4\ (cr)}$	-1426.0	-	-	5
$Pu_2(CO_3)_{3\ (cr)}$	-2918.1	-	-	5
$Pu_sS_{3\ (cr)}$	-979.0	-	-	5
Ra (radium)				
$Ra_{\ (cr)}$	0	0	71	4
Ra^{2+}	-561.5	-527.6	54	4
$RaSO_{4\ (cr)}$	-1365.6	-1471.1	138	4
Rb (rubidium)				
$Rb_{\ metal}$	-	0	79.78	1
	0	0	76.8	3, 4
Rb^+	-	-251.12	121.75	1
	-291.7	-251.1	120.5	3
	-284.0	-251.2	121.5	4
S (sulfur)				
$S_{\ (cr,\ rhombic)}$	0	0	32.05	1, 2
	0	0	31.8	3, 4
$H_2S_{\ (g)}$	-33.4	-20.6	205.81	1, 2
	-33.5	-20.6	205.8	3
	-33.6	-20.6	205.8	4
$H_2S_{\ (aq)}$	-27.7	-38.6	126	1, 2
	-27.8	-39.7	121	4
HS-	12.2	-16.3	67	1, 2
	12.1	-17.0	62.8	3
	12.1	-17.6	62.8	4
S^{2-}	85.9	34	-	2
	85.8	33.0	-15.0	3
	85.8	33.1	-14.6	4
$SO_{2\ (g)}$	-300.1	-296.81	248.22	1, 2
HSO_4^-	-755.3	-886.9	131.7	1, 2
SO_3^{2-}	-486.6	-635.6	29.0	3
	-486.5	-635.5	-29	4
SO_4^{2-}	-744.0	-909.34	18.50	1, 2
	-744.6	-909.3	20.0	3
	-744.5	-909.3	20.1	4
Sb (antimony)				
$Sb_{\ metal}$	0	0	45.5	3
	0	0	45.7	4
SbO^+	-177.1	-	-	4
SbO_2^-	-340.2	-	-	4
$Sb_2S_4^{2-}$	-49.8	-109.6	-26.2	4
$HSbO_{2\ (aq)}$	-407.5	-487.9	46.4	4

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
$Sb_2O_{4\ (cr)}$	-795.7	-907.5	127.2	4
$Sb_2O_{5\ (cr)}$	-829.2	-971.9	125.1	4
$Sb_4O_{6\ valentinite}$	-1252.7	-1417.1	246.0	3
	-1253.0	-1417.1	246.0	4
$Sb_2O_{5\ (cr)}$	-829.2	-971.9	125.1	4
$SbCl_{3\ (cr)}$	-323.7	-382.2	184.1	4
$SbF_{3\ (cr)}$	-	-915.5	-	4
$Sb_2S_{3\ stibnite}$	-173.5	-174.9	182.0	3
	-173.6	-174.9	182.0	4
Sc (scandium)				
$Sc_{\ metal}$	0	0	34.6	3, 4
Sc^{3+}	-586.6	-614.2	-255	4
$Sc(OH)^{2+}$	-801.2	-861.5	-134	4
$Sc_2O_{3\ (cr)}$	-1819.4	-1908.8	77.0	3, 4
Se (selenium)				
$Se_{\ metal}$	0	0	42.3	3
	0	0	42.4	4
Se^{2-}	129.0	-	-	3
	129.3	-	-	4
SeO_3^{2-}	-369.8	-509.2	13.0	4
SeO_4^{2-}	-441.3	-599.1	54.0	4
HSe-	44.0	15.9	79	4
$HSeO_3^-$	-411.5	-514.6	135.1	4
$HSeO_4^-$	-452.2	-581.6	149.4	4
$H_2Se_{\ (aq)}$	22.2	19.2	163.6	4
$H_2SeO_{3\ (aq)}$	-426.1	-507.5	207.9	4
$SeO_{2\ (cr)}$	-	-225.4	-	4
Si (silicon)				
$Si_{\ metal}$	0	0	18.8	3, 4
$H_4SiO_{4\ (aq)}$	-1307.9	-1457.3	180	2
	-1308.0	-1460.0	180.0	3
	-1316.6	-1468.6	180	4
$H_3SiO_4^-$	-1251.8	-1431.7	-	2
$H_2SiO_4^{2-}$	-1176.6	-1383.7	-	2
$SiO_{2\ alpha\ quartz}$	-856.3	-910.7	41.46	1, 2
	-856.3	-910.7	41.5	3
	-856.6	-910.9	41.8	4
$SiO_{2\ amorph}$	-849.1	-889.7	-	2
$SiO_{2\ cristobalite}$	-854.5	-908.3	43.4	3
	-855.4	-909.5	42.7	4
$SiO_{2\ tridymite}$	-853.8	-907.5	43.9	3
	-855.3	-909.1	43.5	4
Sn (tin)				
$Sn_{\ metal}$	0	0	51.2	3

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
	0	0	51.6	4
Sn^{2+}	-	-8.9	-16.7	1
	-27.2	-8.8	-17	4
Sn^{4+}	2.5	30.5	-117	4
$SnOH^+$	-254.8	-286.2	50	4
$SnO{\cdot}OH^+$	-474.0	-	-	4
SnO romarchite	-	-280.71	57.17	1
	-256.9	-285.8	56.5	4
SnO_2 cassiterite	-	-577.63	49.04	1
	-519.9	-580.7	52.3	3
	-580.7	-519.6	52.3	4
Sr (strontium)				
Sr metal	0	0	55.4	3
	0	0	52.3	4
Sr^{2+}	-563.83	-550.90	-35.1	2
	-559.4	-545.8	-33.0	3
	-559.5	-545.8	-32.6	4
$Sr(OH)^+$	-721.3	-	-	4
SrO (cr)	-561.9	-592.0	54.4	4
$SrCO_3$ strontianite	-1144.73	-1225.8	97.2	2
	-1137.6	-1218.7	97.1	3
	-1140.1	-1220.1	97.1	4
$SrSO_4$ celestite	-1345.7	-1456.9	-	2
	-1341.0	-1453.2	118.0	3
	-1340.9	-1453.1	117	4
Ta (tantalum)				
Ta metal	0	0	41.5	3, 4
TaO_2^+	-842.6	-	-	4
Ta_2O_5 (cr)	-1911.0	-2046.0	143.1	3
	-1911.2	-2046.0	143.1	4
Th (thorium)				
Th metal	-	0	51.8	1
	0	0	53.4	3, 4
Th^{4+}	-705.1	-769.0	-422.6	4
$Th(OH)^{3+}$	-920.5	-1030.1	-343	4
$Th(OH)_2^{2+}$	-1140.9	-1282.4	-218	4
$Th(SO_4)^{2+}$	-1480.7	-1658.5	-230	4
ThO_2 thorianite	-	-1226.4	65.23	1
	-1168.8	-1226.4	65.2	3, 4
Ti (titanium)				
Ti metal	-	0	30.72	1
	0	0	30.6	3, 4
TiO_2 rutile	-	-944.0	50.62	1
	-889.4	-944.8	50.3	3

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
	-889.5	-944.7	50.3	4
U (uranium)				
U_{metal}	-	0	50.20	1
	0	0	50.3	3
	0	0	50.2	4
U^{3+}	-520.5	-514.6	-126.0	3
	-475.4	-489.1	-192	4
U^{4+}	-579.1	-613.8	-326.0	3
	-531.0	-591.2	-410	4
UO_2^{+}	-962.7	-	-	4
UO_2^{2+}	-	-1019.0	-98.2	1
	-953.5	-1019.6	-97.5	4
	-952.5	-	-	5
$U(OH)_5^{-}$	-1630.8	-	-	5
$UO_2CO_{3\,(aq)}$	-1537.9	-	-	5
$UO_2(CO_3)_2^{2-}$	-2104.4	-	-	5
$UO_2(CO_3)_3^{4-}$	-2659.2	-	-	5
$UO_{2\ uraninite}$	-	-1085.0	77.03	1
	-1031.8	-1084.9	77.0	3
	-1031.7	-1084.9	77.0	4
$UO_{3\,(cr)}$	-	-1223.8	96.11	1
	-1146.5	-1223.8	98.6	3
	-1145.9	-1223.8	96.1	4
	-1013.9	-	-	5
$U_3O_{8\,(cr)}$	-	-3574.8	282.55	1
	-3369.6	-	-	5
$UO_2CO_{3\,(cr)}$	-1562.7	-	-	5
$USiO_{4\,(cr)}$	-1861.9	-	-	5
V (vanadium)				
V_{metal}	0	0	28.9	3, 4
VO^{2+}	-446.4	-486.6	-133.9	4
VO_2^{+}	-587.0	-649.8	-42.3	4
VO_3^{-}	-783.6	-888.3	50	4
VO_4^{3-}	-899.0	-	-	4
$V_2O_7^{4+}$	-1719	-	-	4
HVO_4^{2-}	-974.8	-1159.0	17	4
$HV_{10}O_{28}^{5-}$	-7702	-8694	222	4
$H_2VO_4^{-}$	-1020.8	-1174.0	121	4
$H_2V_{10}O_{28}^{4-}$	-7723	-	-	4
$VO_{(cr)}$	-404.2	-431.8	39.0	3, 4
$V_2O_{3\ karelianite}$	-1139.0	-1218.8	98.1	3
	-1139.3	-1218.8	98.3	4
$V_2O_{4\,(cr)}$	-1318.4	-1427.4	103.5	3
	-1318.3	-1427.2	102.5	4
$V_2O_{5\,(cr)}$	-1419.4	-1550.6	130.5	3
	-1419.5	-1550.6	131.0	4

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
W (tungsten)				
W_{metal}	0	0	32.6	3, 4
WO_4^{2-}	-	-1075.7	-	4
$WO_{2\ (cr)}$	-533.8	-589.7	50.5	3
	-533.9	-589.7	50.5	4
$WO_{3\ (cr)}$	-764.1	-842.9	75.9	3
	-764.0	-842.9	75.9	4
$WS_{2\ \text{tungstenite}}$	-297.9	95.0	298.3	3
	-	-209	-	4
Y (yttrium)				
Y_{metal}	0	0	44.4	3, 4
Y^{3+}	-693.8	-723.4	-251	4
$Y_2O_{3\ (cr)}$	-1816.6	-1905.3	99.1	3, 4
Yb (ytterbium)				
Yb_{metal}	0	0	59.8	3
	0	0	59.9	4
Yb^{2+}	-527	-	-	4
Yb^{3+}	-644.0	-674.5	-238	4
$Yb_2O_{3\ (cr)}$	-1726.8	-1814.5	133.0	3
	-1726.8	-1814.6	133.0	4
Zn (zinc)				
Zn_{metal}	-	0	41.63	1
	0	0	41.6	3, 4
Zn^{2+}	-	-153.39	-109.8	1
	-147.3	-153.4	-109.6	3
	-147.1	-153.9	-112.1	4
ZnO_2^{2-}	-384.2	-	-	4
$ZnOH^+$	-330.1	-	-	4
$HZnO_2^-$	-457.1	-	-	4
$ZnCl^+$	-275.3	-	-	4
ZnO_{zincite}	-	-350.46	43.65	1
	-320.5	-350.5	43.6	3
	-318.3	-348.3	43.6	4
$ZnS_{\text{sphalerite}}$	-202.5	-206.9	58.7	3
	-201.3	-206.0	57.7	4
$ZnSe_{\text{stilleite}}$	-163	-163	84	4
$ZnCO_{3\ \text{smithsonite}}$	-731.5	-812.8	82.4	3
	-731.5	-812.8	82.4	4
$ZnSO_{4\ \text{zinkosite}}$	-871.5	-982.8	110.5	3, 4
$Zn_2SiO_{4\ \text{willemite}}$	-1522.9	-1636.5	131.4	3
	-1523.2	-1636.7	131.4	4
Zr (zirconium)				
Zr_{metal}	0	0	39.0	3, 4

Species or Compound	ΔG_f^0 kJ mol^{-1}	ΔH_f^0 kJ mol^{-1}	S^o J mol^{-1} K^{-1}	Source
$ZrO_{2\ baddeleyite}$	-1042.8	-1100.6	50.4	3, 4
$ZrSiO_{4\ zircon}$	-1918.9	-2033.4	84.0	3
	-1919.1	-2033.4	84.1	4

*Data sources: (1) Cox et al. (1989); (2) Drever (1997); (3) Robie et al. (1978); (4) Wagman et al. (1982); (5) Brookins (1988).