Appendix A THERMODYNAMIC TABLES

7/11/12

	ΔH_f° kJ/mol	S° J/K•mol	ΔG_f° kJ/mol
Aluminum			
Al(*s*)	0	28.28	0
Al^{3+}(*aq*)	−531	−321.7	−485
$AlCl_3$(*s*)	−705.63	109.29	−630.02
AlF_3(*s*)	−1510.4	66.48	−1431.1
Al_2O_3(*s*)	−1675.7	50.95	−1582.3
Arsenic			
As(*s*)	0	35.1	0
AsH_3(*g*)	66.44	222.78	68.93
$AsCl_3$(*l*)	−305.0	216.3	−259.4
Barium			
Ba(*s*)	0	62.48	0
Ba^{2+}(*aq*)	−537.64	9.6	−560.77
$BaCO_3$(*s*)	−1216.3	112.1	−1137.6
$BaCl_2$(*s*)	−858.56	123.67	−810.29
BaO(*s*)	−548.10	72.07	−520.38
$BaSO_4$(*s*)	−1473.2	132.2	−1362.2
Boron			
B(*s*)	0	5.83	0
B_2H_6(*g*)	41.00	233.17	91.85
BF_3(*g*)	−1135.6	254.36	−1119.0
B_2O_3(*s*)	−1271.9	53.95	−1192.8
H_3BO_3(*s*)	−1094.0	88.74	−968.52
Bromine			
Br_2(*l*)	0	152.21	0
Br_2(*g*)	30.91	245.39	3.13
Br_2(*aq*)	−2.59	130.5	3.93
Br(*g*)	111.86	175.02	82.37
Br^-(*aq*)	−121.55	82.4	−103.96
HBr(*g*)	−36.44	198.70	−53.51
Calcium			
Ca(*s*)	0	41.59	0
Ca^{2+}(*aq*)	−542.83	−53.1	−553.58
$CaCO_3$(*s*)	−1206.9	92.9	−1128.8
$CaCl_2$(*s*)	−795.80	104.60	−748.07
CaO(*s*)	−635.09	38.21	−603.50
$CaSO_4$(*s*)	−1434.1	106.7	−1321.8
Carbon			
C(*graphite*)	0	5.74	0
C(*diamond*)	1.90	2.38	2.90
CCl_4(*l*)	−135.44	216.40	−65.21
$CHCl_3$(*l*)	−134.47	201.7	−73.66
Cl_2CO(*g*)	−220.08	283.80	−205.89
CH_4(*g*)	−74.87	186.25	−50.77
C_2H_2(*g*)	226.73	200.96	209.20
C_2H_4(*g*)	52.47	219.33	68.42
C_2H_6(*g*)	−84.68	229.60	−32.82
C_3H_8(*g*)	−104.70	270.31	−24.31
C_4H_{10}(*g*)	−125.60	309.91	−16.34
CO(*g*)	−110.53	197.65	−137.16
CO_2(*g*)	−393.52	213.80	−394.39
CO_2(*aq*)	−413.80	117.6	−385.98
HCO_3^-(*aq*)	−691.99	91.2	−586.77
CO_3^{2-}(*aq*)	−677.14	−56.9	−527.81
HCO_2H(*aq*)	−425.43	163	−372.3
HCO_2^-(*aq*)	−425.55	92	−351.0
H_2CO(*g*)	−115.90	218.95	−109.92
CH_3OH(*l*)	−238.66	126.8	−166.27
CH_3OH(*g*)	−200.66	239.81	−161.96
CH_3OH(*aq*)	−245.93	133.1	−175.31
CS_2(*l*)	89.70	151.34	65.27
CS_2(*g*)	116.94	237.98	66.82
CH_3CO_2H(*aq*)	−485.76	178.7	−396.46
$CH_3CO_2^-$(*aq*)	−486.01	86.6	−369.31
C_2H_5OH(*l*)	−277.69	160.7	−174.78
C_2H_5OH(*g*)	−235.10	282.70	−168.49
C_2H_5OH(*aq*)	−288.3	148.5	−181.64
HCN(*g*)	135.14	201.83	124.72
HCN(*aq*)	107.1	124.7	119.7
CN^-(*aq*)	150.6	94.1	172.4
CH_3NH_2(*g*)	−22.97	243.41	32.16
CH_3NH_2(*aq*)	−70.17	123.4	20.77
Chlorine			
Cl_2(*g*)	0	223.08	0
Cl(*g*)	121.30	165.19	105.31
Cl^-(*aq*)	−167.16	56.5	−131.23
ClO_2(*g*)	97.00	256.84	114.84
Cl_2O(*g*)	81.00	271.72	97.08
HCl(*g*)	−92.31	186.90	−95.30
HClO(*aq*)	−120.9	142	−79.9
ClO^-(*aq*)	−107.1	42	−36.8

	ΔH_f° kJ/mol	S° J/K•mol	ΔG_f° kJ/mol
Copper			
$Cu(s)$	0	33.16	0
$Cu^+(aq)$	71.67	40.6	49.98
$Cu^{2+}(aq)$	64.77	−99.6	65.49
$CuO(s)$	−156.06	42.59	−128.29
$CuS(s)$	−53.1	66.5	−53.6
$Cu_2S(s)$	−79.5	120.9	−86.2
Fluorine			
$F_2(g)$	0	202.79	0
$F(g)$	79.39	158.75	62.29
$F^-(aq)$	−332.63	−13.8	−278.79
$HF(g)$	−272.55	173.78	−274.65
$HF(aq)$	−320.08	88.7	−296.82
Hydrogen			
$H_2(g)$	0	130.68	0
$H(g)$	218.00	114.72	203.28
$H^+(aq)$	0	0	0
Iodine			
$I_2(s)$	0	116.14	0
$I_2(g)$	62.42	260.68	19.32
$I(g)$	106.76	180.79	70.17
$I^-(aq)$	−55.19	111.3	−51.57
$HI(g)$	26.36	206.59	1.56
$ICl(g)$	17.51	247.57	−5.74
Iron			
$Fe(s)$	0	27.32	0
$Fe^{2+}(aq)$	−89.1	−137.7	−78.90
$Fe^{3+}(aq)$	−48.5	−315.9	−4.7
$FeO(s)$	−272.04	60.75	−251.43
$Fe(OH)_2(s)$	−574.04	87.86	−491.97
$Fe_2O_3(s)$	−825.50	87.40	−743.52
$FeCl_2(s)$	−341.83	117.95	−302.34
Lead			
$Pb(s)$	0	64.78	0
$Pb^{2+}(aq)$	−1.7	10.5	−24.43
$PbO(s)$	−219.41	66.32	−189.28
$PbO_2(s)$	−274.47	71.80	−215.40
$PbS(s)$	−98.32	91.34	−96.68
$PbSO_4(s)$	−919.94	148.57	−813.14
Lithium			
$Li(s)$	0	29.08	0
$Li^+(aq)$	−278.49	13.4	−293.31
$LiCl(s)$	−408.27	59.30	−384.02
Magnesium			
$Mg(s)$	0	32.67	0
$Mg^{2+}(aq)$	−466.85	−138.1	−454.8
$MgCO_3(s)$	−1111.7	65.85	−1028.1
$MgCl_2(s)$	−641.62	89.63	−592.09
$MgO(s)$	−601.24	26.92	−568.94
$Mg(OH)_2(s)$	−924.66	63.24	−833.65
Mercury			
$Hg(l)$	0	76.03	0
$Hg^{2+}(aq)$	171.1	−32.2	164.40
$Hg_2^{2+}(aq)$	172.4	84.5	153.52
$HgCl_2(s)$	−230.12	144.49	−184.02
$Hg_2Cl_2(s)$	−264.93	192.54	−210.48
$HgO(s)$	−90.79	70.27	−58.49
$HgS(s)$	−58.2	82.4	−50.6
Nitrogen			
$N_2(g)$	0	191.61	0
$NH_3(g)$	−45.90	192.77	−16.37
$NH_3(aq)$	−80.29	111.3	−26.50
$NH_4^+(aq)$	−132.51	113.4	−79.31
$NH_4Cl(s)$	−314.55	94.86	−203.09
$N_2H_4(l)$	50.63	121.54	149.44
$N_2H_4(aq)$	34.31	138	128.1
$NO(g)$	90.29	210.76	86.60
$N_2O(g)$	82.05	219.96	104.18
$NO_2(g)$	33.10	240.03	51.26
$N_2O_4(s)$	−35.05	150.29	99.60
$N_2O_4(g)$	9.08	304.38	97.79
$NO_3^-(aq)$	−205.0	146.4	−108.74
$ClNO(g)$	51.71	261.68	66.10
Oxygen			
$O_2(g)$	0	205.15	0
$O_2(aq)$	−11.7	110.9	16.4
$O_3(g)$	142.67	238.93	163.18
$H_2O(l)$	−285.83	69.95	−237.14
$H_2O(g)$	−241.83	188.83	−228.58
$OH^-(aq)$	−229.99	−10.75	−157.24
$H_2O_2(aq)$	−191.17	143.9	−134.03
Phosphorus			
$P(s)$ (white)	0	41.08	0
$PH_3(g)$	5.44	210.24	7.19

	ΔH_f° kJ/mol	S° J/K•mol	ΔG_f° kJ/mol
$PCl_3(g)$	−288.70	311.68	−269.61
$PCl_5(g)$	−360.18	364.29	−290.27
$P_4O_{10}(s)$	−3009.9	228.78	−2723.3
$H_3PO_4(aq)$	−1288.3	158.2	−1142.5
$H_2PO_4^-(aq)$	−1296.3	90.4	−1130.3
$HPO_4^{2-}(aq)$	−1292.1	−33.5	−1089.2
$PO_4^{3-}(aq)$	−1277.4	−222	−1018.7
Potassium			
$K(s)$	0	64.67	0
$K(l)$	2.27	71.40	0.26
$K(g)$	89.00	160.34	60.48
$K^+(aq)$	−252.38	102.5	−283.27
$KCl(s)$	−436.68	82.55	−408.76
$KClO_3(s)$	−397.73	143.1	−296.25
$KBr(s)$	−393.80	95.94	−380.43
$KNO_3(s)$	−494.63	133.05	−394.86
$KOH(s)$	−424.72	78.91	−378.90
Selenium			
$Se(s)$	0	42.44	0
$H_2Se(g)$	29.7	219.02	15.9
Silicon			
$Si(s)$	0	18.82	0
$SiH_4(g)$	34.31	204.65	56.83
$SiF_4(g)$	−1614.94	282.76	−1572.71
$SiCl_4(g)$	−662.75	330.94	−662.78
$SiO_2(s)$	−905.49	50.05	−853.64
Silver			
$Ag(s)$	0	42.55	0
$Ag^+(aq)$	105.58	72.68	77.11
$AgCl(s)$	−127.07	96.2	−109.79
$Ag_2CO_3(s)$	−505.8	167.4	−436.8
$Ag_2O(s)$	−31.05	121.3	−11.20
Sodium			
$Na(s)$	0	51.46	0
$Na(l)$	2.41	57.86	0.50
$Na^+(aq)$	−240.12	59.0	−261.90
$NaCl(s)$	−411.12	72.12	−384.02
$NaBr(s)$	−361.41	86.82	−349.27
$NaOH(s)$	−425.93	64.44	−379.74
$Na_2CO_3(s)$	−1130.8	138.80	−1048.0
$NaHCO_3(s)$	−950.81	101.7	−851.0
$NaNO_3(s)$	−467.85	116.52	−367.00

	ΔH_f° kJ/mol	S° J/K•mol	ΔG_f° kJ/mol
Sulfur			
$S(s)$ (α)	0	32.06	0
$S^{2-}(aq)$	33.1	−14.6	85.8
$HS^-(aq)$	−17.6	62.8	12.08
$H_2S(g)$	−20.50	205.76	−33.33
$H_2S(aq)$	−39.7	121	−27.83
$SO_2(g)$	−296.84	248.21	−300.12
$SO_2(aq)$	−322.98	161.9	−300.68
$HSO_3^-(aq)$	−626.22	139.7	−527.73
$SO_3^{2-}(aq)$	−635.5	−29	−486.5
$SO_3(g)$	−395.76	256.77	−371.02
$HSO_4^-(aq)$	−887.34	131.8	−755.91
$SO_4^{2-}(aq)$	−909.27	20.1	−744.53
$SO_2Cl_2(g)$	−354.80	311.10	−310.32
$S_2Cl_2(l)$	−58.16	223.84	−39.27
Tin			
$Sn(s)$	0	51.55	0
$SnO(s)$	−285.8	56.5	−256.9
$SnO_2(s)$	−580.7	52.3	−519.6
$SnCl_4(l)$	−511.3	258.6	−440.1
Zinc			
$Zn(s)$	0	41.72	0
$Zn^{2+}(aq)$	−153.89	−112.1	−147.06
$ZnCl_2(s)$	−415.05	111.46	−369.40
$ZnO(s)$	−348.28	43.64	−318.30
$ZnS(s)$	−205.98	57.7	−201.29