

Standard-State Thermodynamic Values at 298.15 K:
Enthalpy of Formation (ΔH_f°), Free Energy of Formation (ΔG_f°), and
Absolute Entropy (S°)

Substance	ΔH_f° (kJ/mol _{rxn})	ΔG_f° (kJ/mol _{rxn})	S° (J/mol _{rxn} ·K)
Aluminum			
Al (s)	0	0	28.33
Al ³⁺ (aq)	-531	-485	-321.7
Al ₂ O ₃ (s)	-1675.7	-1582.3	50.92
AlCl ₃ (s)	-704.2	-628.8	110.67
Barium			
Ba (s)	0	0	62.8
Ba ²⁺ (aq)	-537.64	-560.77	9.6
BaO (s)	-553.5	-525.1	70.42
Ba(OH) ₂ ·8H ₂ O (s)	-3342.2	-810.4	123.68
BaCl ₂ (s)	-871.95	-823.21	122.6
BaSO ₄ (s)	-1473.2	-1362.2	132.2
Ba(NO ₃) ₂ (s)	-992.07	-769.59	213.8
Beryllium			
Be (s)	0	0	9.50
Be ²⁺ (aq)	-382.8	-379.73	-129.7
BeO (s)	-609.6	-508.3	-129.7
BeCl ₂ (s)	-490.4	-445.6	82.68
Bismuth			
Bi (s)	0	0	56.74
Bi ₂ O ₃ (s)	-573.88	-493.7	151.5
BiCl ₃ (s)	-379.1	-315.0	177.0
Boron			
B (s)	0	0	5.86
B ₂ H ₆ (g)	35.6	86.7	232.11
Bromine			
Br ₂ (l)	0	0	152.231
Br ₂ (g)	30.907	3.110	245.463
Br ⁻ (aq)	-121.55	-103.96	82.4
HBr (g)	-36.40	-53.45	198.695
Calcium			
Ca (s)	0	0	41.42
Ca ²⁺ (aq)	-542.83	-553.58	-53.1
CaO (s)	-653.09	-604.03	39.75
Ca(OH) ₂ (s)	0986.09	-898.49	83.39
CaCl ₂ (aq)	-795.8	-748.1	104.6

CaSO ₄ (s)	-1434.11	-1321.79	106.7
CaSO ₄ ·2H ₂ O (s)	-2022.63	-1797.28	194.1
Ca(NO ₃) ₂ (s)	-938.39	-743.07	193.3
CaCO ₃ (s)	-1206.92	-1128.79	92.9
Ca ₃ (PO ₄) ₂ (s)	-4120.8	-3884.7	236.0
Carbon			
C (s, graphite)	0	0	5.74
C (s, diamond)	1.895	2.900	2.377
CO (g)	-110.525	-137.168	197.764
CO ₂ (g)	-393.509	-394.359	213.74
CH ₄ (g)	-74.81	-50.752	186.264
H ₂ CO ₃ (aq)	-699.65	-623.08	187.4
HCO ₃ ⁻ (aq)	-691.99	-586.77	91.2
CO ₃ ²⁻ (aq)	-677.14	-527.81	-56.9
CH ₃ COOH (aq)	-485.76	-396.46	178.7
CH ₃ COO ⁻ (aq)	-486.01	-369.31	86.6
Chlorine			
Cl ₂ (g)	0	0	223.066
Cl ⁻ (aq)	-167.159	-131.228	56.5
Chromium			
Cr (s)	0	0	23.77
CrO ₄ ²⁻ (aq)	-881.15	-727.75	50.21
Cr ₂ O ₇ ²⁻ (aq)	-1490.3	-1301.1	261.9
Cobalt			
Co (s)	0	0	30.04
Co ²⁺ (aq)	-58.2	-54.4	-113
Co ³⁺ (aq)	92	134	-305
Co(NH ₃) ₆ ²⁺ (aq)	-584.9	-157.0	146
Copper			
Cu (s)	0	0	33.150
Cu ⁺ (aq)	71.67	49.98	40.6
Cu ²⁺ (aq)	64.77	65.49	-99.6
CuO (s)	-157.3	-129.7	42.63
CuS (s)	-53.1	-53.6	66.5
CuSO ₄ (s)	-771.36	-66.69	109
Cu(NH ₃) ₄ ²⁺ (aq)	-384.5	-110.07	273.6
Fluorine			
F ₂ (g)	0	0	202.78
F ⁻ (aq)	-332.63	-278.79	-13.8
HF (aq)	-320.08	-296.82	88.7

Hydrogen			
H ₂ (g)	0	0	130.684
H ⁺ (aq)	0	0	0
OH ⁻ (aq)	-229.994	-157.244	-10.75
H ₂ O (l)	-285.830	-237.129	69.91
H ₂ O (g)	-241.818	-228.572	188.25
H ₂ O ₂ (aq)	-191.17	-134.03	143.9
Iodine			
I ₂ (s)	0	0	116.135
Iron			
Fe (s)	0	0	27.28
Fe ²⁺ (aq)	-89.1	-78.90	-137.7
Fe ³⁺ (aq)	-48.5	-4.7	-315.9
Fe ₂ O ₃ (s)	-824.2	-742.2	87.40
Fe ₃ O ₄ (s)	-1118.4	-1015.4	146.4
Fe(OH) ₂ (s)	-569.0	-486.5	88
Fe(OH) ₃ (s)	-823.0	-696.5	106.7
FeS ₂ (s)	-178.2	-166.9	52.93
Lead			
Pb (s)	0	0	64.81
Pb ²⁺ (aq)	-1.7	-24.43	10.5
PbO (s)	-217.32	-187.89	68.7
PbO ₂ (s)	-277.4	-217.33	68.6
PbS (s)	-100.4	-98.7	91.2
PbSO ₄ (s)	-919.94	-813.14	148.57
Lithium			
Li (s)	0	0	29.12
Li ⁺ (aq)	-278.49	-293.31	13.4
Magnesium			
Mg (s)	0	0	32.68
Mg ²⁺ (aq)	-466.85	-454.8	-138.1
Mg(OH) ₂ (s)	-924.54	-833.58	63.18
MgCO ₃ (s)	-1095.8	-1012.1	65.7
MgSO ₄ (s)	-1284.9	-1170.6	91.6
Manganese			
Mn (s)	0	0	32.01
Mn ²⁺ (aq)	-220.75	-228.1	-73.6
MnO ₂ (s)	-520.03	-465.14	53.05
KMnO ₄ (s)	-837.2	-737.6	171.76
MnS (s)	-214.2	-218.4	78.2
Mercury			

Hg (l)	0	0	76.02
Hg ²⁺ (aq)	171.1	164.40	-32.2
HgO (s)	-90.83	-58.539	70.29
HgCl ₂ (s)	-224.3	-178.6	146.0
Hg ₂ Cl ₂ (s)	-265.22	-210.745	192.5
HgS (s)	-58.2	-50.6	82.4
Nitrogen			
N ₂ (g)	0	0	191.61
NO ₃ ⁻ (aq)	-205.0	-108.74	146.4
HNO ₂ (aq)	-119.2	-50.6	135.6
NH ₃ (aq)	-80.92	-26.50	111.3
NH ₄ ⁺ (aq)	-132.51	-79.31	113.4
NH ₄ NO ₃ (s)	-365.56	-183.87	151.08
NH ₄ Cl (s)	-314.43	-203.87	94.6
Oxygen			
O ₂ (g)	0	0	205.138
Phosphorous			
P (s, white)	0	0	41.09
PO ₄ ³⁻ (aq)	-1277.4	-1018.7	-222
Potassium			
K (s)	0	0	64.18
K ⁺ (aq)	-252.38	-283.27	102.5
KOH (s)	-424.764	-379.08	78.9
KCl (s)	-436.747	-409.14	82.59
KNO ₃ (s)	-494.63	-394.86	133.05
K ₂ Cr ₂ O ₇ (s)	-2061.5	-1881.8	291.2
Silicon			
Si (s)	0	0	18.83
SiO ₂ (s)	-910.94	-856.64	41.84
Silver			
Ag (s)	0	0	42.55
Ag ⁺ (aq)	105.579	77.107	72.68
Ag(NH ₃) ₂ ⁺ (aq)	-111.29	-17.12	245.2
AgCl (s)	-127.068	-109.789	96.2
AgBr (s)	-100.37	-96.90	107.1
AgI (s)	-61.84	-66.19	-115.5
Sodium			
Na (s)	0	0	51.21
Na ⁺ (aq)	-240.13	-261.905	59.0
NaOH (s)	-425.609	-379.494	64.555
NaCl (s)	-411.153	-384.138	72.13

NaNO ₃ (s)	-467.85	-367.00	116.52
Na ₃ PO ₄ (s)	-1917.40	-1788.80	173.80
Na ₂ SO ₄ (s)	-1387.08	-1270.16	149.58
Na ₂ CO ₃ (s)	-1130.68	-1044.44	134.98
NaHCO ₃ (s)	-950.81	-851.0	101.7
NaCH ₃ COO (s)	-708.81	-607.18	123.0
Sulfur			
S ₈ (s)	0	0	31.80
S ²⁻ (aq)	33.1	85.8	-14.6
SO ₂ (g)	-296.830	-300.194	248.22
SO ₃ (g)	-395.72	-371.06	256.76
SO ₄ ²⁻ (aq)	-909.27	-744.53	20.1
SCN ⁻ (aq)	76.44	92.71	144.3
Tin			
Sn (s)	0	0	44.14
SnO (s)	-285.5	-256.9	56.5
SnO ₂ (s)	-580.7	-519.76	52.3
Zinc			
Zn (s)	0	0	41.63
Zn ²⁺ (aq)	-153.89	-147.06	-112.1
ZnO (s)	-348.28	-318.30	43.64
ZnCl ₂ (s)	-415.05	-369.39	111.46
ZnS (s)	-205.98	-201.29	57.7
ZnSO ₄ (s)	-982.8	-871.5	110.5