

THERMODYNAMIC PROPERTIES

Selected Values of Standard Thermodynamic Properties at 298.15 K

Substance	ΔH_f° kJ/mol	ΔG_f° kJ/mol	S° J/mol·K
Aluminum:			
Al(<i>s</i>)	0	0	28.3
AlCl ₃ (<i>s</i>)	-704.2	-628.8	110.7
Al ₂ O ₃ (<i>s</i>)	-1676	-1582	50.92
Barium:			
Ba(<i>s</i>)	0	0	28.3
Ba ²⁺ (<i>aq</i>)	-538.36	-560.7	13
BaCO ₃ (<i>s</i>)	-1219	-1139	112
Boron:			
B(<i>s</i>)	0	0	5.86
BF ₃ (<i>g</i>)	-1137.0	-1120.3	254.12
Bromine:			
Br ₂ (<i>l</i>)	0	0	152.23
Br ₂ (<i>g</i>)	30.91	3.13	245.38
Br(<i>g</i>)	111.9	82.40	174.90
Br ¹⁻ (<i>aq</i>)	-120.9	-102.8	80.71
HBr(<i>g</i>)	-36	-53.5	198.59
Calcium:			
CaO(<i>s</i>)	-635.1	-603.5	38.2
Ca(OH) ₂ (<i>s</i>)	-986.09		
CaCO ₃ (<i>s</i>)	-1206.9	-1128.8	92.9
Carbon:			
C(<i>s</i> , graphite)	0	0	5.740
C(<i>s</i> , diamond)	1.987	2.900	2.38
C(<i>g</i>)	716.681	671.289	157.987
CO(<i>g</i>)	-110.52	-137.15	197.56
CO ₂ (<i>g</i>)	-393.51	-394.36	213.6
CO ₂ (<i>aq</i>)	-412.9	-386.2	121
CCl ₄ (<i>g</i>)	-103	-53.7	309.7
CCl ₄ (<i>l</i>)	-135.4	-68.6	216.4
HCN(<i>g</i>)	135	125	201.7
CH ₄ (<i>g</i>)	-74.9	-50.6	186.15
CS ₂ (<i>g</i>)	117.4	67.15	237.7
CS ₂ (<i>l</i>)	89.70	65.27	151.3
C ₂ H ₂ (<i>g</i>)	226.7	209.2	200.8
C ₂ H ₄ (<i>g</i>)	52.28	68.12	219.5
C ₂ H ₆ (<i>g</i>)	-84.67	-32.89	229.5

Substance	ΔH_f° kJ/mol	ΔG_f° kJ/mol	S° J/mol·K
CH ₃ OH(<i>g</i>)	-201.2	-161.9	237.6
CH ₃ OH(<i>l</i>)	-237.6	-166.23	126.8
C ₂ H ₅ OH(<i>g</i>)	-235.1	-168.6	282.6
C ₂ H ₅ OH(<i>l</i>)	-277.7	-174.76	160.7
CH ₃ COOH(<i>l</i>)	-484.5	-390	160
CH ₃ CHO(<i>g</i>)	-166	-133.7	266
C ₄ H ₁₀ (<i>g</i>)	-124.73	-15.71	310.0
C ₄ H ₁₀ (<i>l</i>)	-147.6	-15.0	231.0
C ₆ H ₆ (<i>g</i>)	82.927	129.66	269.2
C ₆ H ₆ (<i>l</i>)	49.028	124.50	172.8
C ₈ H ₁₈ (<i>l</i>)	-226		
Chlorine:			
Cl ₂ (<i>g</i>)	0	0	223.0
Cl(<i>g</i>)	121.7	105.7	165.2
Cl ¹⁻ (<i>aq</i>)	-167.2	-131.2	56.5
HCl(<i>g</i>)	-92.30	-95.31	186.80
HCl(<i>aq</i>)	-167.2	-131.2	56.5
Chromium:			
Cr ₂ O ₃ (<i>s</i>)	-1138	-1059	81.2
(NH ₄) ₂ Cr ₂ O ₇ (<i>s</i>)	-1807		
Copper:			
Cu(<i>s</i>)	0	0	33.15
CuO(<i>s</i>)	-157	-128	42.63
CuSO ₄ (<i>s</i>)	-771.36	-661.9	110
Cu ₂ S(<i>s</i>)	-79.5	-86.2	120.5
Fluorine:			
F ₂ (<i>g</i>)	0	0	202.7
F(<i>g</i>)	78.99	61.92	158.64
F ¹⁻ (<i>aq</i>)	-332.6	-278.8	-13.8
HF(<i>g</i>)	-271	-273	173.67
Hydrogen:			
H ₂ (<i>g</i>)	0	0	130.57
H(<i>g</i>)	217.97	203.26	114.60
H ¹⁺ (<i>aq</i>)	0	0	0
H ₂ O(<i>l</i>)	-285.83	-237.2	69.91
H ₂ O(<i>g</i>)	-241.82	-228.59	188.7
Iodine:			
I ₂ (<i>s</i>)	0	0	116.14
I ₂ (<i>g</i>)	62.438	19.36	260.6
I(<i>g</i>)	106.84	70.283	180.68
HI(<i>g</i>)	26.5	1.71	206.48

Substance	ΔH_f° kJ/mol	ΔG_f° kJ/mol	S° J/mol·K
Iron:			
Fe(<i>s</i>)	0	0	27.3
FeO(<i>s</i>)	-271.9	-255.2	60.75
Fe ₂ O ₃ (<i>s</i>)	-824.2	-742.2	87.40
Fe ₃ O ₄ (<i>s</i>)	-1117.1	-1014.2	146.4
Lead:			
Pb(<i>s</i>)	0	0	68.85
Pb ²⁺ (<i>aq</i>)	1.6	-24.3	21
PbBr ₂ (<i>s</i>)	-277.4	-260.7	161
PbCl ₂ (<i>s</i>)	-359	-314	136
PbO(<i>s</i>)	-219.0	-189.2	66.5
Magnesium			
Mg(<i>s</i>)	0	0	32.69
MgO(<i>s</i>)	-601.7	-569.4	26.94
MgCl ₂ (<i>s</i>)	-641.6	-592.1	89.6
Nitrogen:			
N ₂ (<i>g</i>)	0	0	191.5
N(<i>g</i>)	472.704	455.5	153.19
NH ₃ (<i>g</i>)	-46.11	-16.5	192.3
NH ₃ (<i>aq</i>)	-80.29	-26.57	111.3
NH ₄ Cl(<i>s</i>)	-314.4	-203.0	94.6
NH ₄ NO ₃ (<i>s</i>)	-365.5	-184.0	151.1
NO(<i>g</i>)	90.29	86.60	210.65
NO ₂ (<i>g</i>)	33.84	51.84	240.45
N ₂ O ₄ (<i>g</i>)	9.66	98.28	304.3
Oxygen:			
O ₂ (<i>g</i>)	0	0	205.03
O(<i>g</i>)	249.17	231.75	160.95
O ₃ (<i>g</i>)	143	163	238.82
Phosphorus:			
P ₄ (<i>s</i>)	0	0	41.08
P(<i>g</i>)	316.4	280.0	163.2
PCl ₃ (<i>g</i>)	-288.07	-269.6	311.7
PCl ₃ (<i>l</i>)	-319.6	-272.4	217
PH ₃ (<i>g</i>)	5.4	13.4	210.2
P ₄ O ₁₀ (<i>s</i>)	-1640.1		
POCl ₃ (<i>g</i>)	-542.2	-502.5	325
POCl ₃ (<i>l</i>)	-597.0	-520.9	222
H ₃ PO ₄ (<i>aq</i>)	-1288.3	-1142.6	158.2
Potassium			
K(<i>s</i>)	0	0	64.67
KCl(<i>s</i>)	-436.7	-409.2	82.59
KClO ₃ (<i>s</i>)	-397.7	-296.3	143.1

Substance	ΔH_f° kJ/mol	ΔG_f° kJ/mol	S° J/mol·K
Silicon:			
Si(<i>s</i>)	0	0	18.7
Si(<i>g</i>)	368.2	323.9	167.8
SiO ₂ (<i>s</i>)	-910.94	-856.67	41.84
SiH ₄ (<i>g</i>)	34	56.9	204.5
Silver:			
Ag(<i>s</i>)	0	0	42.55
Ag ¹⁺ (<i>aq</i>)	105.90	77.11	73.93
AgCl(<i>s</i>)	-127.0	-109.70	96.11
Ag ₂ O(<i>s</i>)	-31.05	-11.20	121.3
Ag ₂ S(<i>s</i>)	-32.6	-40.7	144.0
Sodium:			
Na(<i>s</i>)	0	0	51.45
Na ¹⁺ (<i>aq</i>)	-240.1	-261.9	59.0
NaCl(<i>s</i>)	-411.1	-384.0	72.12
Sulfur:			
S(<i>s</i> , rhombic)	0	0	31.8
SO ₂ (<i>g</i>)	-296.83	-300.19	248.1
SO ₃ (<i>g</i>)	-395.72	-371.1	256.6
S ₂ (<i>g</i>)	129	79.30	228.2
H ₂ S(<i>g</i>)	-20.6	-33.6	205.7
H ₂ SO ₄ (<i>l</i>)	-813.989	-690.101	156.90
H ₂ SO ₄ (<i>aq</i>)	-909.3	-744.6	20.08
Tin:			
Sn(<i>s</i>)	0	0	51.2
SnO(<i>s</i>)	-286	-257	56.5
SnO ₂ (<i>s</i>)	-580.7	-519.7	52.3
SnCl ₄ (<i>l</i>)	-545.2	-474.0	259
SnCl ₄ (<i>g</i>)	-471.5	-432.2	366
Titanium:			
Ti(<i>s</i>)	0	0	30.6
Ti(<i>g</i>)	468	422	180.3
TiO ₂ (<i>s</i>)	-944.7	-889.5	50.3
TiCl ₄ (<i>l</i>)	-804.2	-737.2	252.3
TiCl ₄ (<i>g</i>)	-763.2	-726.8	354
Zinc:			
Zn(<i>s</i>)	0	0	41.6
ZnO(<i>s</i>)	-348.0	-318.2	43.6
ZnCl ₂ (<i>s</i>)	-415.1	-369.4	111.5

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