

15.8: Appendix H- Standard Molar Thermodynamic Properties

The values in these tables are for a temperature of 298.15 K (25.00 °C) and the standard pressure $p^\circ = 1$ bar. Solute standard states are based on molality. A crystalline solid is denoted by cr.

Most of the values in this table come from a project of the Committee on Data for Science and Technology (CODATA) to establish a set of recommended, internally consistent values of thermodynamic properties. The values of $\Delta_f H^\circ$ and S_m° shown with uncertainties are values recommended by CODATA (J. D. Cox, D. D. Wagman, and V. A. Medvedev, *CODATA Key Values for Thermodynamics*, Hemisphere Publishing Corp., New York, 1989).

Inorganic substance	$\Delta_f H^\circ$	S_m°	$\Delta_f G^\circ$
	kJ mol^{-1}	$\text{J K}^{-1} \text{mol}^{-1}$	kJ mol^{-1}
Ag(cr)	0	42.55 ± 0.20	0
AgCl(cr)	-127.01 ± 0.05	96.25 ± 0.20	-109.77
C(cr, graphite)	0	5.74 ± 0.10	0
CO(g)	-110.53 ± 0.17	197.660 ± 0.004	-137.17
CO ₂ (g)	-393.51 ± 0.13	213.785 ± 0.010	-394.41
Ca(cr)	0	41.59 ± 0.40	0
CaCO ₃ (cr, calcite)	-1206.9	92.9	-1128.8
CaO(cr)	-634.92 ± 0.90	38.1 ± 0.4	-603.31
Cl ₂ (g)	0	223.081 ± 0.010	0
F ₂ (g)	0	202.791 ± 0.005	0
H ₂ (g)	0	130.680 ± 0.003	0
HCl(g)	-92.31 ± 0.10	186.902 ± 0.005	-95.30
HF(g)	-273.30 ± 0.70	173.779 ± 0.003	-275.40
HI(g)	26.50 ± 0.10	206.590 ± 0.004	1.70
H ₂ O(l)	-285.830 ± 0.040	69.95 ± 0.03	-237.16
H ₂ O(g)	-241.826 ± 0.040	188.835 ± 0.010	-228.58
H ₂ S(g)	-20.6 ± 0.5	205.81 ± 0.05	-33.44
Hg(l)	0	75.90 ± 0.12	0
Hg(g)	61.38 ± 0.04	174.971 ± 0.005	31.84
HgO(cr, red)	-90.79 ± 0.12	70.25 ± 0.30	-58.54
Hg ₂ Cl ₂ (cr)	-265.37 ± 0.40	191.6 ± 0.8	-210.72
I ₂ (cr)	0	116.14 ± 0.30	0
K(cr)	0	64.68 ± 0.20	0
KI(cr)	-327.90	106.37	-323.03
KOH(cr)	-424.72	78.90	-378.93
N ₂ (g)	0	191.609 ± 0.004	0
NH ₃ (g)	-45.94 ± 0.35	192.77 ± 0.05	-16.41
NO ₂ (g)	33.10	240.04	51.22
N ₂ O ₄ (g)	9.08	304.38	97.72
Na(cr)	0	51.30 ± 0.20	0
NaCl(cr)	-411.12	72.11	-384.02
O ₂ (g)	0	205.152 ± 0.005	0
O ₃ (g)	142.67	238.92	163.14
P(cr, white)	0	41.09 ± 0.25	0
S(cr, rhombic)	0	32.054 ± 0.050	0
SO ₂ (g)	-296.81 ± 0.20	248.223 ± 0.050	-300.09
Si(cr)	0	18.81 ± 0.08	0
SiF ₄ (g)	-1615.0 ± 0.8	282.76 ± 0.50	-1572.8
SiO ₂ (cr, α -quartz)	-910.7 ± 1.0	41.46 ± 0.20	-856.3
Zn(cr)	0	41.63 ± 0.15	0
ZnO(cr)	-350.46 ± 0.27	43.65 ± 0.40	-320.48

(15.8.1)

Organic compound	$\Delta_f H^\circ$	S_m°	$\Delta_f G^\circ$
	kJ mol^{-1}	$\text{J K}^{-1} \text{mol}^{-1}$	kJ mol^{-1}
$\text{CH}_4(\text{g})$	-74.87	186.25	-50.77
$\text{CH}_3\text{OH}(\text{l})$	-238.9	127.2	-166.6
$\text{CH}_3\text{CH}_2\text{OH}(\text{l})$	-277.0	159.9	-173.8
$\text{C}_2\text{H}_2(\text{g})$	226.73	200.93	209.21
$\text{C}_2\text{H}_4(\text{g})$	52.47	219.32	68.43
$\text{C}_2\text{H}_6(\text{g})$	-83.85	229.6	-32.00
$\text{C}_3\text{H}_8(\text{g})$	-104.7	270.31	-24.3
$\text{C}_6\text{H}_6(\text{l}, \text{benzene})$	49.04	173.26	124.54

(15.8.2)

Ionic solute	$\Delta_f H^\circ$	S_m°	$\Delta_f G^\circ$
	kJ mol^{-1}	$\text{J K}^{-1} \text{mol}^{-1}$	kJ mol^{-1}
$\text{Ag}^+(\text{aq})$	105.79 ± 0.08	73.45 ± 0.40	77.10
$\text{CO}_3^{2-}(\text{aq})$	-675.23 ± 0.25	-50.0 ± 1.0	-527.90
$\text{Ca}^{2+}(\text{aq})$	-543.0 ± 1.0	-56.2 ± 1.0	-552.8
$\text{Cl}^-(\text{aq})$	-167.08 ± 0.10	56.60 ± 0.20	-131.22
$\text{F}^-(\text{aq})$	-335.35 ± 0.65	-13.8 ± 0.8	-281.52
$\text{H}^+(\text{aq})$	0	0	0
$\text{HCO}_3^-(\text{aq})$	-689.93 ± 2.0	98.4 ± 0.5	-586.90
$\text{HS}^-(\text{aq})$	-16.3 ± 1.5	67 ± 5	12.2
$\text{HSO}_4^-(\text{aq})$	-886.9 ± 1.0	131.7 ± 3.0	-755.4
$\text{Hg}_2^{2+}(\text{aq})$	166.87 ± 0.50	65.74 ± 0.80	153.57
$\text{I}^-(\text{aq})$	-56.78 ± 0.05	106.45 ± 0.30	-51.72
$\text{K}^+(\text{aq})$	-252.14 ± 0.08	101.20 ± 0.20	-282.52
$\text{NH}_4^+(\text{aq})$	-133.26 ± 0.25	111.17 ± 0.40	-79.40
$\text{NO}_3^-(\text{aq})$	-206.85 ± 0.40	146.70 ± 0.40	-110.84
$\text{Na}^+(\text{aq})$	-240.34 ± 0.06	58.45 ± 0.15	-261.90
$\text{OH}^-(\text{aq})$	-230.015 ± 0.040	-10.90 ± 0.20	-157.24
$\text{S}^{2-}(\text{aq})$	33.1	-14.6	86.0
$\text{SO}_4^{2-}(\text{aq})$	-909.34 ± 0.40	18.50 ± 0.40	-744.00

(15.8.3)

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