

Table C.4: Standard Enthalpies and Gibbs Energies of Formation at 298.15 K[†]

Joules per mole of the substance formed

Chemical species		State (Note 2)	ΔH_{f298}° (Note 1)	ΔG_{f298}° (Note 1)
Paraffins:				
Methane	CH ₄	(g)	-74,520	-50,460
Ethane	C ₂ H ₆	(g)	-83,820	-31,855
Propane	C ₃ H ₈	(g)	-104,680	-24,290
<i>n</i> -Butane	C ₄ H ₁₀	(g)	-125,790	-16,570
<i>n</i> -Pentane	C ₅ H ₁₂	(g)	-146,760	-8,650
<i>n</i> -Hexane	C ₆ H ₁₄	(g)	-166,920	150
<i>n</i> -Heptane	C ₇ H ₁₆	(g)	-187,780	8,260
<i>n</i> -Octane	C ₈ H ₁₈	(g)	-208,750	16,260
1-Alkenes:				
Ethylene	C ₂ H ₄	(g)	52,510	68,460
Propylene	C ₃ H ₆	(g)	19,710	62,205
1-Butene	C ₄ H ₈	(g)	-540	70,340
1-Pentene	C ₅ H ₁₀	(g)	-21,280	78,410
1-Hexene	C ₆ H ₁₂	(g)	-41,950	86,830
1-Heptene	C ₇ H ₁₄	(g)	-62,760	
Miscellaneous organics:				
Acetaldehyde	C ₂ H ₄ O	(g)	-166,190	-128,860
Acetic acid	C ₂ H ₄ O ₂	(l)	-484,500	-389,900
Acetylene	C ₂ H ₂	(g)	227,480	209,970
Benzene	C ₆ H ₆	(g)	82,930	129,665
Benzene	C ₆ H ₆	(l)	49,080	124,520
1,3-Butadiene	C ₄ H ₆	(g)	109,240	149,795
Cyclohexane	C ₆ H ₁₂	(g)	-123,140	31,920
Cyclohexane	C ₆ H ₁₂	(l)	-156,230	26,850
1,2-Ethanediol	C ₂ H ₆ O ₂	(l)	-454,800	-323,080
Ethanol	C ₂ H ₆ O	(g)	-235,100	-168,490
Ethanol	C ₂ H ₆ O	(l)	-277,690	-174,780
Ethylbenzene	C ₈ H ₁₀	(g)	29,920	130,890
Ethylene oxide	C ₂ H ₄ O	(g)	-52,630	-13,010
Formaldehyde	CH ₂ O	(g)	-108,570	-102,530
Methanol	CH ₄ O	(g)	-200,660	-161,960
Methanol	CH ₄ O	(l)	-238,660	-166,270
Methylcyclohexane	C ₇ H ₁₄	(g)	-154,770	27,480
Methylcyclohexane	C ₇ H ₁₄	(l)	-190,160	20,560
Styrene	C ₈ H ₈	(g)	147,360	213,900
Toluene	C ₇ H ₈	(g)	50,170	122,050
Toluene	C ₇ H ₈	(l)	12,180	113,630

Table C.4 (Continued)

Chemical species	State (Note 2)	ΔH_{f298}° (Note 1)	ΔG_{f298}° (Note 1)
Miscellaneous inorganics:			
Ammonia	NH ₃ (g)	-46,110	-16,450
Ammonia	NH ₃ (aq)		-26,500
Calcium carbide	CaC ₂ (s)	-59,800	-64,900
Calcium carbonate	CaCO ₃ (s)	-1,206,920	-1,128,790
Calcium chloride	CaCl ₂ (s)	-795,800	-748,100
Calcium chloride	CaCl ₂ (aq)		-8,101,900
Calcium chloride	CaCl ₂ ·6H ₂ O (s)	-2,607,900	
Calcium hydroxide	Ca(OH) ₂ (s)	-986,090	-898,490
Calcium hydroxide	Ca(OH) ₂ (aq)		-868,070
Calcium oxide	CaO (s)	-635,090	-604,030
Carbon dioxide	CO ₂ (g)	-393,509	-394,359
Carbon monoxide	CO (g)	-110,525	-137,169
Hydrochloric acid	HCl (g)	-92,307	-95,299
Hydrogen cyanide	HCN (g)	135,100	124,700
Hydrogen sulfide	H ₂ S (g)	-20,630	-33,560
Iron oxide	FeO (s)	-272,000	
Iron oxide (hematite)	Fe ₂ O ₃ (s)	-824,200	-742,200
Iron oxide (magnetite)	Fe ₃ O ₄ (s)	-1,118,400	-1,015,400
Iron sulfide (pyrite)	FeS ₂ (s)	-178,200	-166,900
Lithium chloride	LiCl (s)	-408,610	
Lithium chloride	LiCl·H ₂ O (s)	-712,580	
Lithium chloride	LiCl·2H ₂ O (s)	-1,012,650	
Lithium chloride	LiCl·3H ₂ O (s)	-1,311,300	
Nitric acid	HNO ₃ (l)	-174,100	-80,710
Nitric acid	HNO ₃ (aq)		-111,250
Nitrogen oxides	NO (g)	90,250	86,550
	NO ₂ (g)	33,180	51,310
	N ₂ O (g)	82,050	104,200
	N ₂ O ₄ (g)	9,160	97,540
Sodium carbonate	Na ₂ CO ₃ (s)	-1,130,680	-1,044,440
Sodium carbonate	Na ₂ CO ₃ ·10H ₂ O (s)	-4,081,320	
Sodium chloride	NaCl (s)	-411,153	-384,138
Sodium chloride	NaCl (aq)		-393,133
Sodium hydroxide	NaOH (s)	-425,609	-379,494
Sodium hydroxide	NaOH (aq)		-419,150
Sulfur dioxide	SO ₂ (g)	-296,830	-300,194
Sulfur trioxide	SO ₃ (g)	-395,720	-371,060
Sulfur trioxide	SO ₃ (l)	-441,040	
Sulfuric acid	H ₂ SO ₄ (l)	-813,989	-690,003
Sulfuric acid	H ₂ SO ₄ (aq)		-744,530
Water	H ₂ O (g)	-241,818	-228,572
Water	H ₂ O (l)	-285,830	-237,129

†From *TRC Thermodynamic Tables—Hydrocarbons*, Thermodynamics Research Center, Texas A & M Univ. System, College Station, TX; "The NBS Tables of Chemical Thermodynamic Properties," *J. Phys. and Chem. Reference Data*, vol. 11, supp. 2, 1982.

Notes

1. The standard property changes of formation ΔH_{f298}° and ΔG_{f298}° are the changes occurring when 1 mol of the listed compound is formed from its elements with each substance in its standard state at 298.15 K (25°C).
2. Standard states: (a) Gases (g): pure ideal gas at 1 bar and 25°C. (b) Liquids (l) and solids (s): pure substance at 1 bar and 25°C. (c) Solutes in aqueous solution (aq): Hypothetical ideal 1-molal solution of solute in water at 1 bar and 25°C.