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1 Enthalpy Tables

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Source: Atkins, Peter, Julio De Paula, and James Keeler. 2017. Atkins' Physical Chemistry. 11th ed. London, England: Oxford University Press.

All data is at normal temperature $T^\ominus = 298^\circ\text{K}$ and pressure $p^\ominus = 1\text{ bar}$. The enthalpy of formation notated, $\Delta_f H^\ominus$, is relative to the most stable form of the element in question. The most stable form is assigned a $\Delta_f H^\ominus = 0$. For example, diatomic hydrogen H_2 is the most stable form of hydrogen (at this temperature) and one has $\Delta_f H^\ominus = 0$ for this molecule, as you can find on the table

Then consider, for example, the reaction



Reading from the table the enthalpy of a mole of Hydrogen gas in its mono-atomic form is

$$\Delta_f H^\ominus|_{\text{H}(g)} = 218\text{ kJ} \quad (2)$$

This is higher than zero, which means that the more stable form (lower enthalpy) is the diatomic form. So if I have two moles of Hydrogen gas in their monoatomic form and they combine to make one mole of Hydrogen gas in its diatomic form. Then the enthalpy change in the reaction is $\Delta H = H_{\text{final}} - H_{\text{initial}}$:

$$\Delta H^\ominus = \left[\underbrace{0}_{\text{This is the enthalpy } \Delta_f H \text{ of } \text{H}_2} \right] - \left[\underbrace{2 \times 218\text{ kJ}}_{\text{enthalpy of 2 mol monoatomic H}} \right] \quad (3)$$

$$= -436\text{ kJ} \quad (4)$$

This is negative indicating an *exothermic* reaction $Q_{\text{in}} < 0$ at constant pressure.

Sometimes the ΔH for a reaction at normal temperature and pressure is denoted $\Delta_{\text{rxn}} H^\ominus$, which for this reaction is -436 kJ .

Table 2.3 Standard enthalpies of fusion and vaporization at the transition temperature, $\Delta_{\text{trs}}H^\circ/(\text{kJ mol}^{-1})$

	T_f/K	Fusion	T_b/K	Vaporization		T_f/K	Fusion	T_b/K	Vaporization
Elements					CO ₂	217.0	8.33	194.6	25.23 s
Ag	1234	11.30	2436	250.6	CS ₂	161.2	4.39	319.4	26.74
Ar	83.81	1.188	87.29	6.506	H ₂ O	273.15	6.008	373.15	40.656
Br ₂	265.9	10.57	332.4	29.45					44.016 at 298 K
Cl ₂	172.1	6.41	239.1	20.41	H ₂ S	187.6	2.377	212.8	18.67
F ₂	53.6	0.26	85.0	3.16	H ₂ SO ₄	283.5	2.56		
H ₂	13.96	0.117	20.38	0.916	NH ₃	195.4	5.652	239.7	23.35
He	3.5	0.021	4.22	0.084	Organic compounds				
Hg	234.3	2.292	629.7	59.30	CH ₄	90.68	0.941	111.7	8.18
I ₂	386.8	15.52	458.4	41.80	CCl ₄	250.3	2.5	350	30.0
N ₂	63.15	0.719	77.35	5.586	C ₂ H ₆	89.85	2.86	184.6	14.7
Na	371.0	2.601	1156	98.01	C ₆ H ₆	278.61	10.59	353.2	30.8
O ₂	54.36	0.444	90.18	6.820	C ₆ H ₁₄	178	13.08	342.1	28.85
Xe	161	2.30	165	12.6	C ₁₀ H ₈	354	18.80	490.9	51.51
K	336.4	2.35	1031	80.23	CH ₃ OH	175.2	3.16	337.2	35.27
Inorganic compounds									37.99 at 298 K
CCl ₄	250.3	2.47	349.9	30.00	C ₂ H ₅ OH	158.7	4.60	352	43.5

Data: AIP; s denotes sublimation.

Table 2.5 Thermodynamic data for organic compounds (all values are for 298 K)

	$M/(\text{g mol}^{-1})$	$\Delta_f H^\circ/(\text{kJ mol}^{-1})$	$\Delta_f G^\circ/(\text{kJ mol}^{-1})$	$S_m^\circ/(\text{J K}^{-1} \text{mol}^{-1})^\dagger$	$C_{p,m}^\circ/(\text{J K}^{-1} \text{mol}^{-1})$	$\Delta_c H^\circ/(\text{kJ mol}^{-1})$
C(s) (graphite)	12.011	0	0	5.740	8.527	−393.51
C(s) (diamond)	12.011	+1.895	+2.900	2.377	6.113	−395.40
CO ₂ (g)	44.040	−393.51	−394.36	213.74	37.11	
Hydrocarbons						
CH ₄ (g), methane	16.04	−74.81	−50.72	186.26	35.31	−890
CH ₃ (g), methyl	15.04	+145.69	+147.92	194.2	38.70	
C ₂ H ₂ (g), ethyne	26.04	+226.73	+209.20	200.94	43.93	−1300
C ₂ H ₄ (g), ethene	28.05	+52.26	+68.15	219.56	43.56	−1411
C ₂ H ₆ (g), ethane	30.07	−84.68	−32.82	229.60	52.63	−1560
C ₃ H ₆ (g), propene	42.08	+20.42	+62.78	267.05	63.89	−2058
C ₃ H ₆ (g), cyclopropane	42.08	+53.30	+104.45	237.55	55.94	−2091
C ₃ H ₈ (g), propane	44.10	−103.85	−23.49	269.91	73.5	−2220
C ₄ H ₈ (g), 1-butene	56.11	−0.13	+71.39	305.71	85.65	−2717
C ₄ H ₈ (g), <i>cis</i> -2-butene	56.11	−6.99	+65.95	300.94	78.91	−2710
C ₄ H ₈ (g), <i>trans</i> -2-butene	56.11	−11.17	+63.06	296.59	87.82	−2707
C ₄ H ₁₀ (g), butane	58.13	−126.15	−17.03	310.23	97.45	−2878
C ₅ H ₁₂ (g), pentane	72.15	−146.44	−8.20	348.40	120.2	−3537
C ₅ H ₁₂ (l)	72.15	−173.1				
C ₆ H ₆ (l), benzene	78.12	+49.0	+124.3	173.3	136.1	−3268

Table 2.5 (Continued)

	$M/(\text{g mol}^{-1})$	$\Delta_f H^\circ/(\text{kJ mol}^{-1})$	$\Delta_f G^\circ/(\text{kJ mol}^{-1})$	$S_m^\circ/(\text{J K}^{-1} \text{mol}^{-1})^\dagger$	$C_{p,m}^\circ/(\text{J K}^{-1} \text{mol}^{-1})$	$\Delta_c H^\circ/(\text{kJ mol}^{-1})$
Hydrocarbons (Continued)						
$\text{C}_6\text{H}_6(\text{g})$	78.12	+82.93	+129.72	269.31	81.67	−3302
$\text{C}_6\text{H}_{12}(\text{l})$, cyclohexane	84.16	−156	+26.8	204.4	156.5	−3920
$\text{C}_6\text{H}_{14}(\text{l})$, hexane	86.18	−198.7		204.3		−4163
$\text{C}_6\text{H}_5\text{CH}_3(\text{g})$, methylbenzene (toluene)	92.14	+50.0	+122.0	320.7	103.6	−3953
$\text{C}_7\text{H}_{16}(\text{l})$, heptane	100.21	−224.4	+1.0	328.6	224.3	
$\text{C}_8\text{H}_{18}(\text{l})$, octane	114.23	−249.9	+6.4	361.1		−5471
$\text{C}_8\text{H}_{18}(\text{l})$, iso-octane	114.23	−255.1				−5461
$\text{C}_{10}\text{H}_8(\text{s})$, naphthalene	128.18	+78.53				−5157
Alcohols and phenols						
$\text{CH}_3\text{OH}(\text{l})$, methanol	32.04	−238.66	−166.27	126.8	81.6	−726
$\text{CH}_3\text{OH}(\text{g})$	32.04	−200.66	−161.96	239.81	43.89	−764
$\text{C}_2\text{H}_5\text{OH}(\text{l})$, ethanol	46.07	−277.69	−174.78	160.7	111.46	−1368
$\text{C}_2\text{H}_5\text{OH}(\text{g})$	46.07	−235.10	−168.49	282.70	65.44	−1409
$\text{C}_6\text{H}_5\text{OH}(\text{s})$, phenol	94.12	−165.0	−50.9	146.0		−3054
Carboxylic acids, hydroxy acids, and esters						
$\text{HCOOH}(\text{l})$, formic	46.03	−424.72	−361.35	128.95	99.04	−255
$\text{CH}_3\text{COOH}(\text{l})$, acetic	60.05	−484.5	−389.9	159.8	124.3	−875
$\text{CH}_3\text{COOH}(\text{aq})$	60.05	−485.76	−396.46	178.7		
$\text{CH}_3\text{CO}_2^-(\text{aq})$	59.05	−486.01	−369.31	+86.6	−6.3	
$(\text{COOH})_2(\text{s})$, oxalic	90.04	−827.2			117	−254
$\text{C}_6\text{H}_5\text{COOH}(\text{s})$, benzoic	122.13	−385.1	−245.3	167.6	146.8	−3227
$\text{CH}_3\text{CH}(\text{OH})\text{COOH}(\text{s})$, lactic	90.08	−694.0				−1344
$\text{CH}_3\text{COOC}_2\text{H}_5(\text{l})$, ethyl acetate	88.11	−479.0	−332.7	259.4	170.1	−2231
Alkanals and alkanones						
$\text{HCHO}(\text{g})$, methanal	30.03	−108.57	−102.53	218.77	35.40	−571
$\text{CH}_3\text{CHO}(\text{l})$, ethanal	44.05	−192.30	−128.12	160.2		−1166
$\text{CH}_3\text{CHO}(\text{g})$	44.05	−166.19	−128.86	250.3	57.3	−1192
$\text{CH}_3\text{COCH}_3(\text{l})$, propanone	58.08	−248.1	−155.4	200.4	124.7	−1790
Sugars						
$\text{C}_6\text{H}_{12}\text{O}_6(\text{s})$, α -D-glucose	180.16	−1274				−2808
$\text{C}_6\text{H}_{12}\text{O}_6(\text{s})$, β -D-glucose	180.16	−1268	−910	212		
$\text{C}_6\text{H}_{12}\text{O}_6(\text{s})$, β -D-fructose	180.16	−1266				−2810
$\text{C}_{12}\text{H}_{22}\text{O}_{11}(\text{s})$, sucrose	342.30	−2222	−1543	360.2		−5645
Nitrogen compounds						
$\text{CO}(\text{NH}_2)_2(\text{s})$, urea	60.06	−333.51	−197.33	104.60	93.14	−632
$\text{CH}_3\text{NH}_2(\text{g})$, methylamine	31.06	−22.97	+32.16	243.41	53.1	−1085
$\text{C}_6\text{H}_5\text{NH}_2(\text{l})$, aniline	93.13	+31.1				−3393
$\text{CH}_2(\text{NH}_2)\text{COOH}(\text{s})$, glycine	75.07	−532.9	−373.4	103.5	99.2	−969

Data: NBS, TDOC. † Standard entropies of ions may be either positive or negative because the values are relative to the entropy of the hydrogen ion.

Table 2.7 Thermodynamic data for elements and inorganic compounds (all values relate to 298 K)

	$M/(\text{g mol}^{-1})$	$\Delta_f H^\circ/(\text{kJ mol}^{-1})$	$\Delta_f G^\circ/(\text{kJ mol}^{-1})$	$S_m^\circ/(\text{J K}^{-1} \text{mol}^{-1})^\dagger$	$C_{p,m}^\circ/(\text{J K}^{-1} \text{mol}^{-1})$
Aluminium (aluminum)					
Al(s)	26.98	0	0	28.33	24.35
Al(l)	26.98	+10.56	+7.20	39.55	24.21
Al(g)	26.98	+326.4	+285.7	164.54	21.38
Al ³⁺ (g)	26.98	+5483.17			
Al ³⁺ (aq)	26.98	−531	−485	−321.7	
Al ₂ O ₃ (s, α)	101.96	−1675.7	−1582.3	50.92	79.04
AlCl ₃ (s)	133.24	−704.2	−628.8	110.67	91.84
Argon					
Ar(g)	39.95	0	0	154.84	20.786
Antimony					
Sb(s)	121.75	0	0	45.69	25.23
SbH ₃ (g)	124.77	+145.11	+147.75	232.78	41.05
Arsenic					
As(s, α)	74.92	0	0	35.1	24.64
As(g)	74.92	+302.5	+261.0	174.21	20.79
As ₄ (g)	299.69	+143.9	+92.4	314	
AsH ₃ (g)	77.95	+66.44	+68.93	222.78	38.07
Barium					
Ba(s)	137.34	0	0	62.8	28.07
Ba(g)	137.34	+180	+146	170.24	20.79
Ba ²⁺ (aq)	137.34	−537.64	−560.77	+9.6	
BaO(s)	153.34	−553.5	−525.1	70.43	47.78
BaCl ₂ (s)	208.25	−858.6	−810.4	123.68	75.14
Beryllium					
Be(s)	9.01	0	0	9.50	16.44
Be(g)	9.01	+324.3	+286.6	136.27	20.79
Bismuth					
Bi(s)	208.98	0	0	56.74	25.52
Bi(g)	208.98	+207.1	+168.2	187.00	20.79
Bromine					
Br ₂ (l)	159.82	0	0	152.23	75.689
Br ₂ (g)	159.82	+30.907	+3.110	245.46	36.02
Br(g)	79.91	+111.88	+82.396	175.02	20.786
Br [−] (g)	79.91	−219.07			
Br [−] (aq)	79.91	−121.55	−103.96	+82.4	−141.8
HBr(g)	90.92	−36.40	−53.45	198.70	29.142
Cadmium					
Cd(s, γ)	112.40	0	0	51.76	25.98
Cd(g)	112.40	+112.01	+77.41	167.75	20.79
Cd ²⁺ (aq)	112.40	−75.90	−77.612	−73.2	

Table 2.7 (Continued)

	$M/(\text{g mol}^{-1})$	$\Delta_f H^\circ/(\text{kJ mol}^{-1})$	$\Delta_f G^\circ/(\text{kJ mol}^{-1})$	$S_m^\circ/(\text{J K}^{-1} \text{mol}^{-1})^\dagger$	$C_{p,m}^\circ/(\text{J K}^{-1} \text{mol}^{-1})$
Cadmium (Continued)					
CdO(s)	128.40	−258.2	−228.4	54.8	43.43
CdCO ₃ (s)	172.41	−750.6	−669.4	92.5	
Caesium (cesium)					
Cs(s)	132.91	0	0	85.23	32.17
Cs(g)	132.91	+76.06	+49.12	175.60	20.79
Cs ⁺ (aq)	132.91	−258.28	−292.02	+133.05	−10.5
Calcium					
Ca(s)	40.08	0	0	41.42	25.31
Ca(g)	40.08	+178.2	+144.3	154.88	20.786
Ca ²⁺ (aq)	40.08	−542.83	−553.58	−53.1	
CaO(s)	56.08	−635.09	−604.03	39.75	42.80
CaCO ₃ (s) (calcite)	100.09	−1206.9	−1128.8	92.9	81.88
CaCO ₃ (s) (aragonite)	100.09	−1207.1	−1127.8	88.7	81.25
CaF ₂ (s)	78.08	−1219.6	−1167.3	68.87	67.03
CaCl ₂ (s)	110.99	−795.8	−748.1	104.6	72.59
CaBr ₂ (s)	199.90	−682.8	−663.6	130	
Carbon (for ‘organic’ compounds of carbon, see Table 2.5)					
C(s) (graphite)	12.011	0	0	5.740	8.527
C(s) (diamond)	12.011	+1.895	+2.900	2.377	6.113
C(g)	12.011	+716.68	+671.26	158.10	20.838
C ₂ (g)	24.022	+831.90	+775.89	199.42	43.21
CO(g)	28.011	−110.53	−137.17	197.67	29.14
CO ₂ (g)	44.010	−393.51	−394.36	213.74	37.11
CO ₂ (aq)	44.010	−413.80	−385.98	117.6	
H ₂ CO ₃ (aq)	62.03	−699.65	−623.08	187.4	
HCO ₃ [−] (aq)	61.02	−691.99	−586.77	+91.2	
CO ₃ ^{2−} (aq)	60.01	−677.14	−527.81	−56.9	
CCl ₄ (l)	153.82	−135.44	−65.21	216.40	131.75
CS ₂ (l)	76.14	+89.70	+65.27	151.34	75.7
HCN(g)	27.03	+135.1	+124.7	201.78	35.86
HCN(l)	27.03	+108.87	+124.97	112.84	70.63
CN [−] (aq)	26.02	+150.6	+172.4	+94.1	
Chlorine					
Cl ₂ (g)	70.91	0	0	223.07	33.91
Cl(g)	35.45	+121.68	+105.68	165.20	21.840
Cl [−] (g)	34.45	−233.13			
Cl [−] (aq)	35.45	−167.16	−131.23	+56.5	−136.4
HCl(g)	36.46	−92.31	−95.30	186.91	29.12
HCl(aq)	36.46	−167.16	−131.23	56.5	−136.4
Chromium					
Cr(s)	52.00	0	0	23.77	23.35
Cr(g)	52.00	+396.6	+351.8	174.50	20.79

Table 2.7 (Continued)

	$M/(\text{g mol}^{-1})$	$\Delta_f H^\circ/(\text{kJ mol}^{-1})$	$\Delta_f G^\circ/(\text{kJ mol}^{-1})$	$S_m^\circ/(\text{J K}^{-1} \text{mol}^{-1})^\dagger$	$C_{p,m}^\circ/(\text{J K}^{-1} \text{mol}^{-1})$
Chromium (Continued)					
$\text{CrO}_4^{2-}(\text{aq})$	115.99	-881.15	-727.75	+50.21	
$\text{Cr}_2\text{O}_7^{2-}(\text{aq})$	215.99	-1490.3	-1301.1	+261.9	
Copper					
$\text{Cu}(\text{s})$	63.54	0	0	33.150	24.44
$\text{Cu}(\text{g})$	63.54	+338.32	+298.58	166.38	20.79
$\text{Cu}^+(\text{aq})$	63.54	+71.67	+49.98	+40.6	
$\text{Cu}^{2+}(\text{aq})$	63.54	+64.77	+65.49	-99.6	
$\text{Cu}_2\text{O}(\text{s})$	143.08	-168.6	-146.0	93.14	63.64
$\text{CuO}(\text{s})$	79.54	-157.3	-129.7	42.63	42.30
$\text{CuSO}_4(\text{s})$	159.60	-771.36	-661.8	109	100.0
$\text{CuSO}_4 \cdot \text{H}_2\text{O}(\text{s})$	177.62	-1085.8	-918.11	146.0	134
$\text{CuSO}_4 \cdot 5\text{H}_2\text{O}(\text{s})$	249.68	-2279.7	-1879.7	300.4	280
Deuterium					
$\text{D}_2(\text{g})$	4.028	0	0	144.96	29.20
$\text{HD}(\text{g})$	3.022	+0.318	-1.464	143.80	29.196
$\text{D}_2\text{O}(\text{g})$	20.028	-249.20	-234.54	198.34	34.27
$\text{D}_2\text{O}(\text{l})$	20.028	-294.60	-243.44	75.94	84.35
$\text{HDO}(\text{g})$	19.022	-245.30	-233.11	199.51	33.81
$\text{HDO}(\text{l})$	19.022	-289.89	-241.86	79.29	
Fluorine					
$\text{F}_2(\text{g})$	38.00	0	0	202.78	31.30
$\text{F}(\text{g})$	19.00	+78.99	+61.91	158.75	22.74
$\text{F}^-(\text{aq})$	19.00	-332.63	-278.79	-13.8	-106.7
$\text{HF}(\text{g})$	20.01	-271.1	-273.2	173.78	29.13
Gold					
$\text{Au}(\text{s})$	196.97	0	0	47.40	25.42
$\text{Au}(\text{g})$	196.97	+366.1	+326.3	180.50	20.79
Helium					
$\text{He}(\text{g})$	4.003	0	0	126.15	20.786
Hydrogen (see also deuterium)					
$\text{H}_2(\text{g})$	2.016	0	0	130.684	28.824
$\text{H}(\text{g})$	1.008	+217.97	+203.25	114.71	20.784
$\text{H}^+(\text{aq})$	1.008	0	0	0	0
$\text{H}^+(\text{g})$	1.008	+1536.20			
$\text{H}_2\text{O}(\text{s})$	18.015			37.99	
$\text{H}_2\text{O}(\text{l})$	18.015	-285.83	-237.13	69.91	75.291
$\text{H}_2\text{O}(\text{g})$	18.015	-241.82	-228.57	188.83	33.58
$\text{H}_2\text{O}_2(\text{l})$	34.015	-187.78	-120.35	109.6	89.1
Iodine					
$\text{I}_2(\text{s})$	253.81	0	0	116.135	54.44
$\text{I}_2(\text{g})$	253.81	+62.44	+19.33	260.69	36.90

Table 2.7 (Continued)

	$M/(\text{g mol}^{-1})$	$\Delta_f H^\circ/(\text{kJ mol}^{-1})$	$\Delta_f G^\circ/(\text{kJ mol}^{-1})$	$S_m^\circ/(\text{J K}^{-1} \text{mol}^{-1})^\dagger$	$C_{p,m}^\circ/(\text{J K}^{-1} \text{mol}^{-1})$
Iodine (Continued)					
I(g)	126.90	+106.84	+70.25	180.79	20.786
I ⁻ (aq)	126.90	-55.19	-51.57	+111.3	-142.3
HI(g)	127.91	+26.48	+1.70	206.59	29.158
Iron					
Fe(s)	55.85	0	0	27.28	25.10
Fe(g)	55.85	+416.3	+370.7	180.49	25.68
Fe ²⁺ (aq)	55.85	-89.1	-78.90	-137.7	
Fe ³⁺ (aq)	55.85	-48.5	-4.7	-315.9	
Fe ₃ O ₄ (s) (magnetite)	231.54	-1118.4	-1015.4	146.4	143.43
Fe ₂ O ₃ (s) (haematite)	159.69	-824.2	-742.2	87.40	103.85
FeS(s, α)	87.91	-100.0	-100.4	60.29	50.54
FeS ₂ (s)	119.98	-178.2	-166.9	52.93	62.17
Krypton					
Kr(g)	83.80	0	0	164.08	20.786
Lead					
Pb(s)	207.19	0	0	64.81	26.44
Pb(g)	207.19	+195.0	+161.9	175.37	20.79
Pb ²⁺ (aq)	207.19	-1.7	-24.43	+10.5	
PbO(s, yellow)	223.19	-217.32	-187.89	68.70	45.77
PbO(s, red)	223.19	-218.99	-188.93	66.5	45.81
PbO ₂ (s)	239.19	-277.4	-217.33	68.6	64.64
Lithium					
Li(s)	6.94	0	0	29.12	24.77
Li(g)	6.94	+159.37	+126.66	138.77	20.79
Li ⁺ (aq)	6.94	-278.49	-293.31	+13.4	68.6
Magnesium					
Mg(s)	24.31	0	0	32.68	24.89
Mg(g)	24.31	+147.70	+113.10	148.65	20.786
Mg ²⁺ (aq)	24.31	-466.85	-454.8	-138.1	
MgO(s)	40.31	-601.70	-569.43	26.94	37.15
MgCO ₃ (s)	84.32	-1095.8	-1012.1	65.7	75.52
MgCl ₂ (s)	95.22	-641.32	-591.79	89.62	71.38
Mercury					
Hg(l)	200.59	0	0	76.02	27.983
Hg(g)	200.59	+61.32	+31.82	174.96	20.786
Hg ²⁺ (aq)	200.59	+171.1	+164.40	-32.2	
Hg ₂ ²⁺ (aq)	401.18	+172.4	+153.52	+84.5	
HgO(s)	216.59	-90.83	-58.54	70.29	44.06
Hg ₂ Cl ₂ (s)	472.09	-265.22	-210.75	192.5	102
HgCl ₂ (s)	271.50	-224.3	-178.6	146.0	
HgS(s, black)	232.65	-53.6	-47.7	88.3	

Table 2.7 (Continued)

	$M/(\text{g mol}^{-1})$	$\Delta_f H^\circ/(\text{kJ mol}^{-1})$	$\Delta_f G^\circ/(\text{kJ mol}^{-1})$	$S_m^\circ/(\text{J K}^{-1} \text{mol}^{-1})^\dagger$	$C_{p,m}^\circ/(\text{J K}^{-1} \text{mol}^{-1})$
Neon					
Ne(g)	20.18	0	0	146.33	20.786
Nitrogen					
N ₂ (g)	28.013	0	0	191.61	29.125
N(g)	14.007	+472.70	+455.56	153.30	20.786
NO(g)	30.01	+90.25	+86.55	210.76	29.844
N ₂ O(g)	44.01	+82.05	+104.20	219.85	38.45
NO ₂ (g)	46.01	+33.18	+51.31	240.06	37.20
N ₂ O ₄ (g)	92.1	+9.16	+97.89	304.29	77.28
N ₂ O ₅ (s)	108.01	−43.1	+113.9	178.2	143.1
N ₂ O ₅ (g)	108.01	+11.3	+115.1	355.7	84.5
HNO ₃ (l)	63.01	−174.10	−80.71	155.60	109.87
HNO ₃ (aq)	63.01	−207.36	−111.25	146.4	−86.6
NO ₃ [−] (aq)	62.01	−205.0	−108.74	+146.4	−86.6
NH ₃ (g)	17.03	−46.11	−16.45	192.45	35.06
NH ₃ (aq)	17.03	−80.29	−26.50	111.3	
NH ₄ ⁺ (aq)	18.04	−132.51	−79.31	+113.4	79.9
NH ₂ OH(s)	33.03	−114.2			
HN ₃ (l)	43.03	+264.0	+327.3	140.6	43.68
HN ₃ (g)	43.03	+294.1	+328.1	238.97	98.87
N ₂ H ₄ (l)	32.05	+50.63	+149.43	121.21	139.3
NH ₄ NO ₃ (s)	80.04	−365.56	−183.87	151.08	84.1
NH ₄ Cl(s)	53.49	−314.43	−202.87	94.6	
Oxygen					
O ₂ (g)	31.999	0	0	205.138	29.355
O(g)	15.999	+249.17	+231.73	161.06	21.912
O ₃ (g)	47.998	+142.7	+163.2	238.93	39.20
OH [−] (aq)	17.007	−229.99	−157.24	−10.75	−148.5
Phosphorus					
P(s, wh)	30.97	0	0	41.09	23.840
P(g)	30.97	+314.64	+278.25	163.19	20.786
P ₂ (g)	61.95	+144.3	+103.7	218.13	32.05
P ₄ (g)	123.90	+58.91	+24.44	279.98	67.15
PH ₃ (g)	34.00	+5.4	+13.4	210.23	37.11
PCl ₃ (g)	137.33	−287.0	−267.8	311.78	71.84
PCl ₃ (l)	137.33	−319.7	−272.3	217.1	
PCl ₅ (g)	208.24	−374.9	−305.0	364.6	112.8
PCl ₅ (s)	208.24	−443.5			
H ₃ PO ₃ (s)	82.00	−964.4			
H ₃ PO ₃ (aq)	82.00	−964.8			
H ₃ PO ₄ (s)	94.97	−1279.0	−1119.1	110.50	106.06
H ₃ PO ₄ (l)	94.97	−1266.9			
H ₃ PO ₄ (aq)	94.97	−1277.4	−1018.7	−222	

Table 2.7 (Continued)

	$M/(\text{g mol}^{-1})$	$\Delta_f H^\circ/(\text{kJ mol}^{-1})$	$\Delta_f G^\circ/(\text{kJ mol}^{-1})$	$S_m^\circ/(\text{J K}^{-1} \text{mol}^{-1})^\dagger$	$C_{p,m}^\circ/(\text{J K}^{-1} \text{mol}^{-1})$
Phosphorus (Continued)					
$\text{PO}_4^{3-}(\text{aq})$	94.97	-1277.4	-1018.7	-221.8	
$\text{P}_4\text{O}_{10}(\text{s})$	283.89	-2984.0	-2697.0	228.86	211.71
$\text{P}_4\text{O}_6(\text{s})$	219.89	-1640.1			
Potassium					
$\text{K}(\text{s})$	39.10	0	0	64.18	29.58
$\text{K}(\text{g})$	39.10	+89.24	+60.59	160.336	20.786
$\text{K}^+(\text{g})$	39.10	+514.26			
$\text{K}^+(\text{aq})$	39.10	-252.38	-283.27	+102.5	21.8
$\text{KOH}(\text{s})$	56.11	-424.76	-379.08	78.9	64.9
$\text{KF}(\text{s})$	58.10	-576.27	-537.75	66.57	49.04
$\text{KCl}(\text{s})$	74.56	-436.75	-409.14	82.59	51.30
$\text{KBr}(\text{s})$	119.01	-393.80	-380.66	95.90	52.30
$\text{KI}(\text{s})$	166.01	-327.90	-324.89	106.32	52.93
Silicon					
$\text{Si}(\text{s})$	28.09	0	0	18.83	20.00
$\text{Si}(\text{g})$	28.09	+455.6	+411.3	167.97	22.25
$\text{SiO}_2(\text{s}, \alpha)$	60.09	-910.94	-856.64	41.84	44.43
Silver					
$\text{Ag}(\text{s})$	107.87	0	0	42.55	25.351
$\text{Ag}(\text{g})$	107.87	+284.55	+245.65	173.00	20.79
$\text{Ag}^+(\text{aq})$	107.87	+105.58	+77.11	+72.68	21.8
$\text{AgBr}(\text{s})$	187.78	-100.37	-96.90	107.1	52.38
$\text{AgCl}(\text{s})$	143.32	-127.07	-109.79	96.2	50.79
$\text{Ag}_2\text{O}(\text{s})$	231.74	-31.05	-11.20	121.3	65.86
$\text{AgNO}_3(\text{s})$	169.88	-129.39	-33.41	140.92	93.05
Sodium					
$\text{Na}(\text{s})$	22.99	0	0	51.21	28.24
$\text{Na}(\text{g})$	22.99	+107.32	+76.76	153.71	20.79
$\text{Na}^+(\text{aq})$	22.99	-240.12	-261.91	59.0	46.4
$\text{NaOH}(\text{s})$	40.00	-425.61	-379.49	64.46	59.54
$\text{NaCl}(\text{s})$	58.44	-411.15	-384.14	72.13	50.50
$\text{NaBr}(\text{s})$	102.90	-361.06	-348.98	86.82	51.38
$\text{NaI}(\text{s})$	149.89	-287.78	-286.06	98.53	52.09
Sulfur					
$\text{S}(\text{s}, \alpha) \text{ (rhombic)}$	32.06	0	0	31.80	22.64
$\text{S}(\text{s}, \beta) \text{ (monoclinic)}$	32.06	+0.33	+0.1	32.6	23.6
$\text{S}(\text{g})$	32.06	+278.81	+238.25	167.82	23.673
$\text{S}_2(\text{g})$	64.13	+128.37	+79.30	228.18	32.47
$\text{S}^{2-}(\text{aq})$	32.06	+33.1	+85.8	-14.6	
$\text{SO}_2(\text{g})$	64.06	-296.83	-300.19	248.22	39.87
$\text{SO}_3(\text{g})$	80.06	-395.72	-371.06	256.76	50.67