



CHEMISTRY 1210

SUPPLEMENTAL INFORMATION

Useful Conversion Factors and Relationships

Length

SI unit: meter (m)

$$\begin{aligned}1 \text{ km} &= 0.62137 \text{ mi} \\1 \text{ mi} &= 5280 \text{ ft} \\&= 1.6093 \text{ km} \\1 \text{ m} &= 1.0936 \text{ yd} \\1 \text{ in.} &= 2.54 \text{ cm (exactly)} \\1 \text{ cm} &= 0.39370 \text{ in.} \\1 \text{ \AA} &= 10^{-10} \text{ m}\end{aligned}$$

Mass

SI unit: kilogram (kg)

$$\begin{aligned}1 \text{ kg} &= 2.2046 \text{ lb} \\1 \text{ lb} &= 453.59 \text{ g} \\&= 16 \text{ oz} \\1 \text{ amu} &= 1.660538782 \times 10^{-24} \text{ g}\end{aligned}$$

Temperature

SI unit: Kelvin (K)

$$\begin{aligned}0 \text{ K} &= -273.15 \text{ }^\circ\text{C} \\&= -459.67 \text{ }^\circ\text{F} \\K &= \text{ }^\circ\text{C} + 273.15 \\^\circ\text{C} &= \frac{5}{9} (\text{ }^\circ\text{F} - 32^\circ) \\^\circ\text{F} &= \frac{9}{5} \text{ }^\circ\text{C} + 32^\circ\end{aligned}$$

Energy (derived)

SI unit: Joule (J)

$$\begin{aligned}1 \text{ J} &= 1 \text{ kg}\cdot\text{m}^2/\text{s}^2 \\&= 0.2390 \text{ cal} \\&= 1 \text{ C}\cdot\text{V} \\1 \text{ cal} &= 4.184 \text{ J} \\1 \text{ eV} &= 1.602 \times 10^{-19} \text{ J}\end{aligned}$$

Pressure (derived)

SI unit: Pascal (Pa)

$$\begin{aligned}1 \text{ Pa} &= 1 \text{ N}/\text{m}^2 \\&= 1 \text{ kg}/\text{m}\cdot\text{s}^2 \\1 \text{ atm} &= 1.01325 \times 10^5 \text{ Pa} \\&= 760 \text{ torr} \\&= 14.70 \text{ lb}/\text{in}^2 \\1 \text{ bar} &= 10^5 \text{ Pa} \\1 \text{ torr} &= 1 \text{ mm Hg}\end{aligned}$$

Volume (derived)

SI unit: cubic meter (m³)

$$\begin{aligned}1 \text{ L} &= 10^{-3} \text{ m}^3 \\&= 1 \text{ dm}^3 \\&= 10^3 \text{ cm}^3 \\&= 1.0567 \text{ qt} \\1 \text{ gal} &= 4 \text{ qt} \\&= 3.7854 \text{ L} \\1 \text{ cm}^3 &= 1 \text{ mL} \\1 \text{ in}^3 &= 16.4 \text{ cm}^3\end{aligned}$$

TABLE 4.1 • Solubility Guidelines for Common Ionic Compounds in Water

Soluble Ionic Compounds		Important Exceptions
Compounds containing	NO_3^-	None
	CH_3COO^-	None
	Cl^-	Compounds of Ag^+ , Hg_2^{2+} , and Pb^{2+}
	Br^-	Compounds of Ag^+ , Hg_2^{2+} , and Pb^{2+}
	I^-	Compounds of Ag^+ , Hg_2^{2+} , and Pb^{2+}
	SO_4^{2-}	Compounds of Sr^{2+} , Ba^{2+} , Hg_2^{2+} , and Pb^{2+}
Insoluble Ionic Compounds		Important Exceptions
Compounds containing	S^{2-}	Compounds of NH_4^+ , the alkali metal cations, Ca^{2+} , Sr^{2+} , and Ba^{2+}
	CO_3^{2-}	Compounds of NH_4^+ and the alkali metal cations
	PO_4^{3-}	Compounds of NH_4^+ and the alkali metal cations
	OH^-	Compounds of NH_4^+ , the alkali metal cations, Ca^{2+} , Sr^{2+} , and Ba^{2+}

TABLE 4.5 • Activity Series of Metals in Aqueous Solution

Metal	Oxidation Reaction
Lithium	$\text{Li}(s) \longrightarrow \text{Li}^+(aq) + e^-$
Potassium	$\text{K}(s) \longrightarrow \text{K}^+(aq) + e^-$
Barium	$\text{Ba}(s) \longrightarrow \text{Ba}^{2+}(aq) + 2e^-$
Calcium	$\text{Ca}(s) \longrightarrow \text{Ca}^{2+}(aq) + 2e^-$
Sodium	$\text{Na}(s) \longrightarrow \text{Na}^+(aq) + e^-$
Magnesium	$\text{Mg}(s) \longrightarrow \text{Mg}^{2+}(aq) + 2e^-$
Aluminum	$\text{Al}(s) \longrightarrow \text{Al}^{3+}(aq) + 3e^-$
Manganese	$\text{Mn}(s) \longrightarrow \text{Mn}^{2+}(aq) + 2e^-$
Zinc	$\text{Zn}(s) \longrightarrow \text{Zn}^{2+}(aq) + 2e^-$
Chromium	$\text{Cr}(s) \longrightarrow \text{Cr}^{3+}(aq) + 3e^-$
Iron	$\text{Fe}(s) \longrightarrow \text{Fe}^{2+}(aq) + 2e^-$
Cobalt	$\text{Co}(s) \longrightarrow \text{Co}^{2+}(aq) + 2e^-$
Nickel	$\text{Ni}(s) \longrightarrow \text{Ni}^{2+}(aq) + 2e^-$
Tin	$\text{Sn}(s) \longrightarrow \text{Sn}^{2+}(aq) + 2e^-$
Lead	$\text{Pb}(s) \longrightarrow \text{Pb}^{2+}(aq) + 2e^-$
Hydrogen	$\text{H}_2(g) \longrightarrow 2\text{H}^+(aq) + 2e^-$
Copper	$\text{Cu}(s) \longrightarrow \text{Cu}^{2+}(aq) + 2e^-$
Silver	$\text{Ag}(s) \longrightarrow \text{Ag}^+(aq) + e^-$
Mercury	$\text{Hg}(l) \longrightarrow \text{Hg}^{2+}(aq) + 2e^-$
Platinum	$\text{Pt}(s) \longrightarrow \text{Pt}^{2+}(aq) + 2e^-$
Gold	$\text{Au}(s) \longrightarrow \text{Au}^{3+}(aq) + 3e^-$



Fundamental Constants*

Atomic mass unit	1 amu = 1.660538782 × 10 ⁻²⁷ kg
	1 g = 6.02214179 × 10 ²³ amu
Avogadro's number	N _A = 6.02214179 × 10 ²³ /mol
Boltzmann's constant	k = 1.3806504 × 10 ⁻²³ J/K
Electron charge	e = 1.602176487 × 10 ⁻¹⁹ C
Faraday's constant	F = 9.64853399 × 10 ⁴ C/mol
Gas constant	R = 0.082058205 L-atm/mol-K = 8.314472 J/mol-K
Mass of electron	m _e = 5.48579909 × 10 ⁻⁴ amu = 9.10938215 × 10 ⁻³¹ kg
Mass of neutron	m _n = 1.008664916 amu = 1.674927211 × 10 ⁻²⁷ kg
Mass of proton	m _p = 1.007276467 amu = 1.672621637 × 10 ⁻²⁷ kg
Pi	π = 3.1415927
Planck's constant	h = 6.62606896 × 10 ⁻³⁴ J·s
Speed of light in vacuum	c = 2.99792458 × 10 ⁸ m/s

*Fundamental constants are listed at the National Institute of Standards and Technology Web site:
<http://www.nist.gov/physlab/data/physicalconst.cfm>

© 2012 Pearson Education, Inc.

Energy states of the hydrogen atom: $E = (-2.18 \times 10^{-18} \text{ J})(1/n^2)$

$$\lambda = h/mv, E = hc/\lambda$$

$$\Delta H^\circ_{\text{rxn}} = \Sigma \Delta H^\circ_{\text{products}} - \Sigma n \Delta H^\circ_{\text{reactants}}, \Delta H^\circ_{\text{rxn}} = \Sigma \text{bonds broken} - \Sigma \text{bonds formed}$$

$$q = \text{mass} \times \text{specific heat} \times \Delta T, \text{PE of two interacting charges } E = k(Q_1 Q_2)/d$$

$$F = ma, P = F/A, KE = \frac{1}{2} mv^2$$

$$\left(P + \frac{n^2 a}{V^2} \right) (V - nb) = nRT, \text{ and for an ideal gases: } PV = nRT$$

$$v = \sqrt{\frac{3RT}{M}} \text{ where } v \text{ is rms speed}$$

$$z^2 = x^2 + y^2 \text{ (diagonal of right angle triangle), } V_{\text{box}} = l \cdot w \cdot h$$

$$S_g = k_H P_g, P_A = X_A P^\circ_A, \Delta T_b = K_f m, \Delta T_f = K_f m, \Pi = (n/V)RT$$

$$\Delta P = X_{\text{solute}} P^\circ_{\text{solvent}} \quad P_{\text{solution}} = X_{\text{solvent}} P^\circ_{\text{solvent}}$$

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_v}{R} \left(\frac{1}{T_1} - \frac{1}{T_2}\right) \quad \log\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_v}{2.303R} \left(\frac{1}{T_1} - \frac{1}{T_2}\right) \quad \ln(P) = \frac{-\Delta H_v}{R} \left(\frac{1}{T}\right) + C$$

For the general equation: $aA + bB \rightleftharpoons dD + eE$

$$\text{Rate} = -\frac{1}{a} \frac{\Delta[A]}{\Delta t} = -\frac{1}{b} \frac{\Delta[B]}{\Delta t} = \frac{1}{c} \frac{\Delta[C]}{\Delta t} = \frac{1}{d} \frac{\Delta[D]}{\Delta t} \quad Q = \frac{[D]^d [E]^e}{[A]^a [B]^b}$$

$$K_c = \frac{[D]^d [E]^e}{[A]^a [B]^b} \quad K_p = \frac{(P_D)^d (P_E)^e}{(P_A)^a (P_B)^b} \quad K_p = K_c (RT)^{\Delta n}$$

$$[A]_t = -kt + [A]_0 \quad \ln[A]_t = -kt + \ln[A]_0 \quad \frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$$

$$t_{1/2} = -\frac{\ln 1/2}{k} = \frac{0.693}{k} \quad t_{1/2} = \frac{1}{k[A]_0}$$

$$\ln k = -\frac{E_a}{RT} + \ln A$$

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2}\right) \quad \log\left(\frac{k_2}{k_1}\right) = \frac{E_a}{2.303R} \left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$$k = A e^{-E_a/RT} \quad \ln(k) = -\left(\frac{E_a}{R}\right) \left(\frac{1}{T}\right) + \ln(A)$$

$$\text{Molarity, } M = \frac{\text{moles of solute}}{\text{liters of solution}}$$

$$\text{Molality, } m = \frac{\text{moles of solute}}{\text{kilograms of solvent}}$$

$$A = \epsilon bc$$

$$\pi = \left(\frac{n}{V}\right) RT = MRT$$

$$\text{at } 25^\circ\text{C, } K_w = 1.0 \times 10^{-14}$$

$$K_c = [\text{H}_3\text{O}^+][\text{OH}^-] = K_w$$

$$K_a = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]}$$

$$\text{pH} = -\log[\text{H}^+] = -\log[\text{H}_3\text{O}^+]$$

$$K_a \times K_b = K_w \quad \text{pOH} = -\log[\text{OH}^-]$$

$$\% \text{ ionization} = \frac{[\text{H}^+]_{\text{equilibrium}}}{[\text{HA}]_{\text{initial}}} \times 100\%$$

$$\text{pH} = \text{p}K_a + \log\left(\frac{[\text{base}]}{[\text{acid}]}\right)$$

$$\text{for } ax^2 + bx + c = 0, \quad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$S = k_B \ln W$$

$$\Delta G = \Delta H - T\Delta S$$

$$\Delta G = \Delta G^\circ + RT \ln Q$$

$$\Delta G = -RT \ln K$$

$$E^\circ_{\text{cell}} = E^\circ_{\text{red}} (\text{cathode}) - E^\circ_{\text{red}} (\text{anode})$$

$$\Delta G = -nFE_{\text{cell}}$$

$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.0592V}{n} \log Q$$

$$\ln K = -\Delta H^\circ/R(1/T) + C$$

Periodic Table of the Elements

Main Group Representative Elements																		Main Group Representative Elements									
1A ^a																		1A ^a									
1																		1									
H 1.00794																		H 1.00794									
2A																		2A									
2																		2									
3																		3									
Li 6.941																		Li 6.941									
4																		4									
Be 9.012182																		Be 9.012182									
5																		5									
Na 22.989770																		Na 22.989770									
6																		6									
Mg 24.3050																		Mg 24.3050									
7																		7									
K 39.0983																		K 39.0983									
8																		8									
Ca 40.078																		Ca 40.078									
9																		9									
Sc 44.955910																		Sc 44.955910									
10																		10									
Ti 47.867																		Ti 47.867									
11																		11									
V 50.9415																		V 50.9415									
12																		12									
Cr 51.9961																		Cr 51.9961									
13																		13									
Mn 54.938049																		Mn 54.938049									
14																		14									
Fe 55.845																		Fe 55.845									
15																		15									
Co 58.933200																		Co 58.933200									
16																		16									
Ni 58.6934																		Ni 58.6934									
17																		17									
Cu 63.546																		Cu 63.546									
18																		18									
Zn 65.39																		Zn 65.39									
19																		19									
Ga 69.723																		Ga 69.723									
20																		20									
Ge 72.64																		Ge 72.64									
21																		21									
As 74.92160																		As 74.92160									
22																		22									
Se 78.96																		Se 78.96									
23																		23									
Br 79.904																		Br 79.904									
24																		24									
Kr 83.80																		Kr 83.80									
25																		25									
Rb 85.4678																		Rb 85.4678									
26																		26									
Sr 87.62																		Sr 87.62									
27																		27									
Y 88.90585																		Y 88.90585									
28																		28									
Zr 91.224																		Zr 91.224									
29																		29									
Nb 92.90638																		Nb 92.90638									
30																		30									
Mo 95.94																		Mo 95.94									
31																		31									
Tc [98]																		Tc [98]									
32																		32									
Ru 101.07																		Ru 101.07									
33																		33									
Rh 102.90550																		Rh 102.90550									
34																		34									
Pd 106.42																		Pd 106.42									
35																		35									
Ag 107.8682																		Ag 107.8682									
36																		36									
Cd 112.411																		Cd 112.411									
37																		37									
In 114.818																		In 114.818									
38																		38									
Sn 118.710																		Sn 118.710									
39																		39									
Sb 121.760																		Sb 121.760									
40																		40									
Te 127.60																		Te 127.60									
41																		41									
I 126.90447																		I 126.90447									
42																		42									
Xe 131.293																		Xe 131.293									
43																		43									
La 138.9055																		La 138.9055									
44																		44									
Ce 140.116																		Ce 140.116									
45																		45									
Pr 140.90765																		Pr 140.90765									
46																		46									
Nd 144.24																		Nd 144.24									
47																		47									
Pm [145]																		Pm [145]									
48																		48									
Sm 150.36																		Sm 150.36									
49																		49									
Eu 151.964																		Eu 151.964									
50																		50									
Gd 157.25																		Gd 157.25									
51																		51									
Tb 158.92534																		Tb 158.92534									
52																		52									
Dy 162.50																		Dy 162.50									
53																		53									
Ho 164.93032																		Ho 164.93032									
54																		54									
Er 167.259																		Er 167.259									
55																		55									
Tm 168.93421																		Tm 168.93421									
56																		56									
Yb 173.04																		Yb 173.04									
57																		57									
Lu 174.967																		Lu 174.967									
58																		58									
Hf 178.49																		Hf 178.49									
59																		59									
Ta 180.9479																		Ta 180.9479									
60																		60									
W 183.84																		W 183.84									
61																		61									
Re 186.207																		Re 186.207									
62																		62									
Os 190.23																		Os 190.23									
63																		63									
Ir 192.217																		Ir 192.217									
64																		64									
Pt 195.078																		Pt 195.078									
65																		65									
Au 196.96655																		Au 196.96655									
66																		66									
Hg 200.59																		Hg 200.59									
67																		67									
Tl 204.3833																		Tl 204.3833									
68																		68									
Pb 207.2																		Pb 207.2									
69																		69									
Bi 208.98038																		Bi 208.98038									
70																		70									
Po [209]																		Po [209]									
71																		71									
At [209.99]																		At [209.99]									
72																		72									
Rn [222.02]																		Rn [222.02]									
73																		73									
Fr [223.02]																		Fr [223.02]									
74																		74									
Ra [226.03]																		Ra [226.03]									
75																		75									
Ac [227.03]																		Ac [227.03]									
76																		76									
Th 232.0381																		Th 232.0381									
77																		77									
Pa 231.03588																		Pa 231.03588									
78																		78									
U 238.02891																		U 238.02891									
79																		79									
Np [237.05]																		Np [237.05]									
80																		80									
Pu [244.06]																		Pu [244.06]									
81																		81									
Am [243.06]																		Am [243.06]									
82																		82									
Cm [247.07]																		Cm [247.07]									
83																		83									
Bk [247.07]																		Bk [247.07]									
84																		84									
Cf [251.08]																		Cf [251.08]									
85																		85									
Es [252.08]																		Es [252.08]									
86																		86									
Fm [257.10]																		Fm [257.10]									
87																		87									
Md [258.10]																		Md [258.10]									
88																		88									
No [259.10]																		No [259.10]									

^aThe labels on top (1A, 2A, etc.) are common American usage. The labels below these (1, 2, etc.) are those recommended by the International Union of Pure and Applied Chemistry (IUPAC).

The names and symbols for elements 113 and above have not yet been decided.

Atomic weights in brackets are the names of the longest-lived or most important isotope of radioactive elements.

Further information is available at <http://www.webelements.com>

** Discovered in 2010, element 117 is currently under review by IUPAC.