THE OHIO STATE UNIVERSITY

CHEMISTRY 1210
SUPPLEMENTAL INFORMATION

Useful Conversion Factors and Relationships

Length

SI unit: meter (m)

$1\ \text{km} = 0.62137\ \text{mi}$

$1\ \text{mi} = 5280\ \text{ft}$

$= 1.6093\ \text{km}$

$1\ \text{m} = 1.0936\ \text{yd}$

$1\ \text{in.} = 2.54\ \text{cm (exactly)}$

$1\ \text{cm} = 0.39370\ \text{in.}$

$1\ \text{Å} = 10^{-10}\ \text{m}$

Mass

SI unit: kilogram (kg)

$1\ \text{kg} = 2.2046\ \text{lb}$

$1\ \text{lb} = 453.59\ \text{g}$

$= 16\ \text{oz}$

$1\ \text{amu} = 1.660538782 \times 10^{-24}\ \text{g}$

Temperature

SI unit: Kelvin (K)

$0\ \text{K} = -273.15\ ^\circ\text{C}$

$= -459.67\ ^\circ\text{F}$

$\text{K} = {}^\circ\text{C} + 273.15$

$^\circ\text{C} = \frac{5}{9}(^\circ\text{F} - 32^\circ)$

$^\circ\text{F} = \frac{9}{5}\,^\circ\text{C} + 32^\circ$

Energy (derived)

SI unit: Joule (J)

$1\ \text{J} = 1\ \text{kg-m}^2/\text{s}^2$

$= 0.2390\ \text{cal}$

$= 1\ \text{C-V}$

$1\ \text{cal} = 4.184\ \text{J}$

$1\ \text{eV} = 1.602 \times 10^{-19}\ \text{J}$

Pressure (derived)

SI unit: Pascal (Pa)

$1\ \text{Pa} = 1\ \text{N/m}^2$

$= 1\ \text{kg/m-s}^2$

$1\ \text{atm} = 1.01325 \times 10^5\ \text{Pa}$

$= 760\ \text{torr}$

$= 14.70\ \text{lb/in}^2$

$1\ \text{bar} = 10^5\ \text{Pa}$

$1\ \text{torr} = 1\ \text{mm Hg}$

Volume (derived)

SI unit: cubic meter (m^3)

$1\ \text{L} = 10^{-3}\ \text{m}^3$

$= 1\ \text{dm}^3$

$= 10^3\ \text{cm}^3$

$= 1.0567\ \text{qt}$

$1\ \text{gal} = 4\ \text{qt}$

$= 3.7854\ \text{L}$

$1\ \text{cm}^3 = 1\ \text{mL}$

$1\ \text{in}^3 = 16.4\ \text{cm}^3$

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	$Li(s) \longrightarrow Li^+(aq) + e^-$
Potassium	$K(s) \longrightarrow K^+(aq) + e^-$
Barium	$Ba(s) \longrightarrow Ba^{2+}(aq) + 2e^-$
Calcium	$Ca(s) \longrightarrow Ca^{2+}(aq) + 2e^-$
Sodium	$Na(s) \longrightarrow Na^+(aq) + e^-$
Magnesium	$Mg(s) \longrightarrow Mg^{2+}(aq) + 2e^-$
Aluminum	$Al(s) \longrightarrow Al^{3+}(aq) + 3e^-$
Manganese	$Mn(s) \longrightarrow Mn^{2+}(aq) + 2e^-$
Zinc	$Zn(s) \longrightarrow Zn^{2+}(aq) + 2e^-$
Chromium	$Cr(s) \longrightarrow Cr^{3+}(aq) + 3e^-$
Iron	$Fe(s) \longrightarrow Fe^{2+}(aq) + 2e^-$
Cobalt	$Co(s) \longrightarrow Co^{2+}(aq) + 2e^-$
Nickel	$Ni(s) \longrightarrow Ni^{2+}(aq) + 2e^-$
Tin	$Sn(s) \longrightarrow Sn^{2+}(aq) + 2e^-$
Lead	$Pb(s) \longrightarrow Pb^{2+}(aq) + 2e^-$
Hydrogen	$H_2(g) \longrightarrow 2\,H^+(aq) + 2e^-$
Copper	$Cu(s) \longrightarrow Cu^{2+}(aq) + 2e^-$
Silver	$Ag(s) \longrightarrow Ag^+(aq) + e^-$
Mercury	$Hg(l) \longrightarrow Hg^{2+}(aq) + 2e^-$
Platinum	$Pt(s) \longrightarrow Pt^{2+}(aq) + 2e^-$
Gold	$Au(s) \longrightarrow Au^{3+}(aq) + 3e^-$

Fundamental Constants*

Atomic mass unit	1 amu	$= 1.660538782 \times 10^{-27}$ kg
	1 g	$= 6.02214179 \times 10^{23}$ amu
Avogadro's number	N_A	$= 6.02214179 \times 10^{23}$/mol
Boltzmann's constant	k	$= 1.3806504 \times 10^{-23}$ J/K
Electron charge	e	$= 1.602176487 \times 10^{-19}$ C
Faraday's constant	F	$= 9.64853399 \times 10^{4}$ C/mol
Gas constant	R	= 0.082058205 L-atm/mol-K
		= 8.314472 J/mol-K
Mass of electron	m_e	$= 5.48579909 \times 10^{-4}$ amu
		$= 9.10938215 \times 10^{-31}$ kg
Mass of neutron	m_n	= 1.008664916 amu
		$= 1.674927211 \times 10^{-27}$ kg
Mass of proton	m_p	= 1.007276467 amu
		$= 1.672621637 \times 10^{-27}$ kg
Pi	π	= 3.1415927
Planck's constant	h	$= 6.62606896 \times 10^{-34}$ J-s
Speed of light in vacuum	c	$= 2.99792458 \times 10^{8}$ m/s

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

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

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

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

q = mass x specific heat x ΔT, PE of two interacting charges $E = k(Q_1Q_2)/d$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$\text{Molarity}, M = \frac{\text{moles of solute}}{\text{liters of solution}} \qquad \text{Molality}, m = \frac{\text{moles of solute}}{\text{kilograms of solvent}}$$

$$A = \varepsilon bc$$

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

at 25°C, $K_w = 1.0 \times 10^{-14}$

$$K_c = [H_3O^+][OH^-] = K_w.$$

$$K_a = \frac{[H^+][A^-]}{[HA]} \qquad \text{pH} = -\log[H^+] = -\log[H_3O^+]. \qquad K_a \times K_b = K_w \qquad \text{pOH} = -\log[OH^-].$$

$$\%\ \text{ionization} = \frac{[H^+]_{\text{equilibrium}}}{[HA]_{\text{initial}}} \times 100\% \qquad pH = pK_a + \log\left(\frac{[base]}{[acid]}\right)$$

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

$$S = k_B \ln W$$

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

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

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

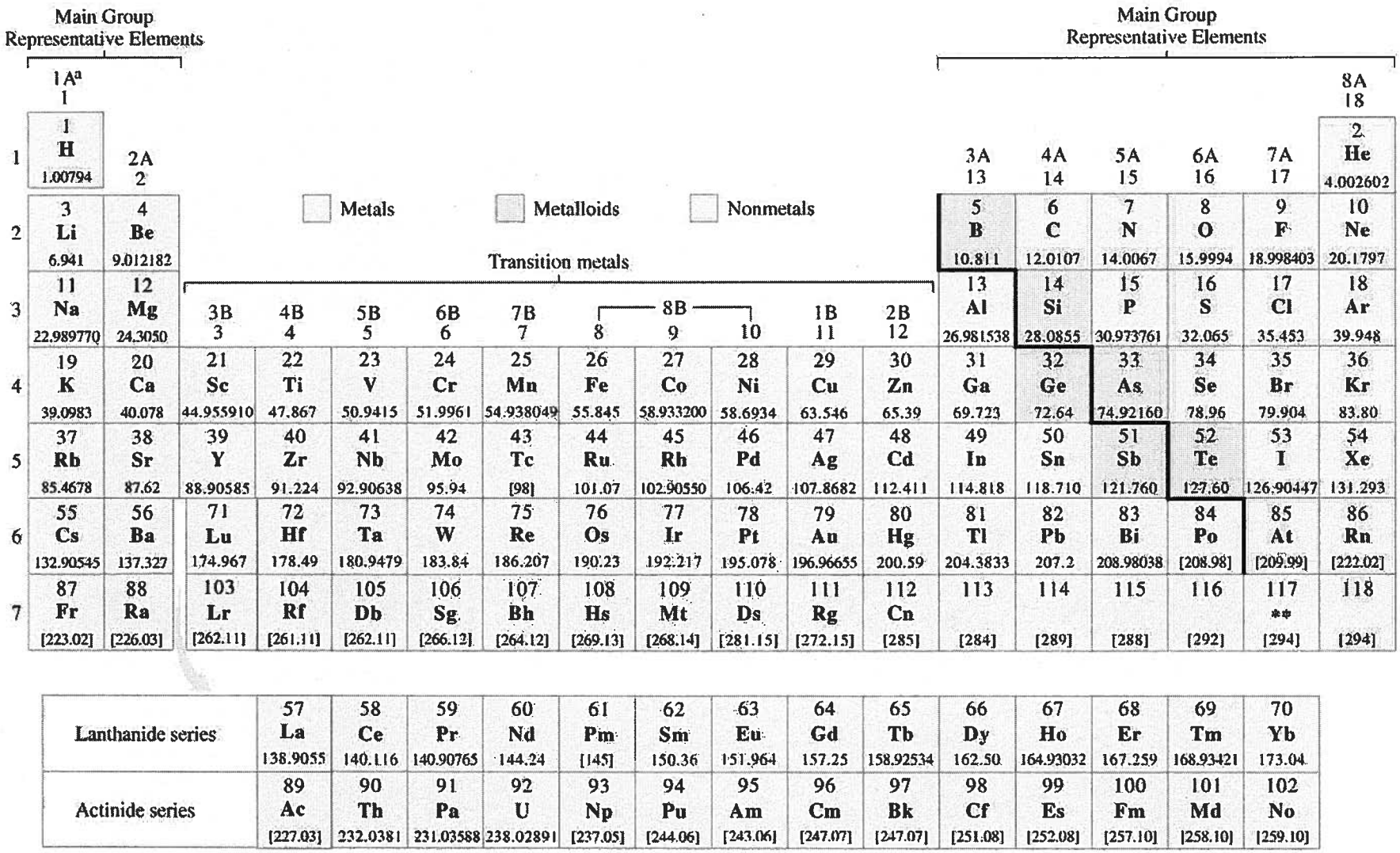
$$E^\circ_{cell} = E^\circ_{red}\,(\text{cathode}) - E^\circ_{red}\,(\text{anode})$$

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

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

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

Periodic Table of the Elements



[a]The 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.