

Useful equations:

$$E_N = E_A + E_R \quad E_{total} = -\frac{A}{r} + \frac{B}{r^n} \quad A = \frac{z_1 z_2 e^2}{4\pi\epsilon_0} \quad E = \int F dr \quad F = \frac{dE}{dr}$$

$$Density = \frac{mass}{volume}; \quad \rho = \frac{nA}{V_c N_A}; \quad APF = \frac{V_{atoms}}{V_{unit cell}};$$

$$Volume of a sphere = \frac{4}{3}\pi r^3 \quad \% \text{ ionic character} = \left(1 - e^{-\frac{(X_A - X_B)^2}{4}}\right) \times 100\%$$

$$N_v = N \exp\left(-\frac{Q_v}{kT}\right); \quad N = \frac{N_A \rho}{A}; \quad J = -D \frac{dC}{dx} \quad \frac{\Delta C}{\Delta x} = \frac{C_2 - C_1}{x_2 - x_1}$$

$$D = D_0 \exp\left(-\frac{Q_d}{RT}\right); \quad \frac{\partial C}{\partial t} = D \frac{\partial^2 C}{\partial x^2}; \quad \frac{C(x,t) - C_0}{C_s - C_0} = 1 - \operatorname{erf}\left(\frac{x}{2\sqrt{Dt}}\right) \quad x \approx \sqrt{Dt}$$

$$\sigma = \frac{F}{A_0} \quad \sigma = E\epsilon \quad \epsilon = \frac{\delta}{L_0} \quad v = -\frac{\epsilon_l}{\epsilon} \quad \epsilon_L = \frac{-\delta l}{W_0} \quad U_r \approx \frac{1}{2} \sigma_y \epsilon_y \quad \tau = G \gamma$$

$$\%EL = \frac{L_f - L_o}{L_o} \times 100 \quad \%RA = \frac{A_o - A_f}{A_o} \times 100 \quad W_L = \frac{M_L}{M_L + M_\alpha} = \frac{S}{R+S} = \frac{C_\alpha - C_0}{C_\alpha - C_L} \quad W_\alpha = \frac{R}{R+S} = \frac{C_0 - C_L}{C_\alpha - C_L}$$

$$DP_n = \sum x_i n_i = \frac{\overline{M}_n}{m} \quad DP_w = \sum w_i n_i = \frac{\overline{M}_w}{m} \quad m = \sum f_i m_i \quad \rho = \frac{n'(\sum A_C + \sum A_A)}{V_C N_A}$$

$$\rho = \frac{(\# \text{ of cations/UC})(\text{atomic wt. of cation}) + (\# \text{ of anions/UC})(\text{atomic wt. of anion})}{V_C N_A}$$

$$\Delta V = V_2^\circ - V_1^\circ - \frac{RT}{nF} \ln \frac{[M_1^{n+}]}{[M_2^{n+}]} \quad \Delta V = V_2^\circ - V_1^\circ - \frac{0.0592}{n} \log \frac{[M_1^{n+}]}{[M_2^{n+}]}$$

$$CPR = \frac{KW}{\rho At} \quad J = \sigma E \quad J = ev_d n \quad v_d = \mu_e E \quad \sigma_{undoped} \propto e^{-\frac{E_{gap}}{kT}}$$

$$\sigma = n|e|\mu_e + p|e|\mu_h$$

Useful constants:

Avogadro's #: 6.023×10^{23} atoms/mol. Electronic charge: $e = -1.602 \times 10^{-19}$ C
 Boltzmann's constant: $k = 1.38 \times 10^{-23}$ J/atom-K = 8.62×10^{-5} eV/atom-K
 Planck's constant: $h = 6.625 \times 10^{-34}$ J-s Bohr Magnetron: $m_B = 9.27 \times 10^{-24}$ A-m²
 Gas Constant: $R = 8.31$ J/mol-K = 1.987 cal/mol-K
 Gravitational constant: $g = 9.81$ m/s² Faraday Constant: $F = 96,487$ C/mol

Table 17.2 The Galvanic Series

	Platinum
	Gold
	Graphite
	Titanium
	Silver
	[316 Stainless steel (passive)
	[304 Stainless steel (passive)
	[Inconel (80Ni-13Cr-7Fe) (passive)
	[Nickel (passive)
	[Monel (70Ni-30Cu)
	[Copper-nickel alloys
	[Bronzes (Cu-Sn alloys)
	[Copper
	[Brasses (Cu-Zn alloys)
	[Inconel (active)
	[Nickel (active)
	Tin
	Lead
	[316 Stainless steel (active)
	[304 Stainless steel (active)
	[Cast iron
	[Iron and steel
	Aluminum alloys
	Cadmium
	Commercially pure aluminum
	Zinc
	Magnesium and magnesium alloys

↑
Increasingly inert (cathodic)

↓
Increasingly active (anodic)

Table 17.1 The Standard emf Series

	<i>Electrode Reaction</i>	<i>Standard Electrode Potential, V⁰ (V)</i>
	$Au^{3+} + 3e^{-} \longrightarrow Au$	+1.420
	$O_2 + 4H^{+} + 4e^{-} \longrightarrow 2H_2O$	+1.229
	$Pt^{2+} + 2e^{-} \longrightarrow Pt$	~ +1.2
	$Ag^{+} + e^{-} \longrightarrow Ag$	+0.800
	$Fe^{3+} + e^{-} \longrightarrow Fe^{2+}$	+0.771
	$O_2 + 2H_2O + 4e^{-} \longrightarrow 4(OH^{-})$	+0.401
	$Cu^{2+} + 2e^{-} \longrightarrow Cu$	+0.340
	$2H^{+} + 2e^{-} \longrightarrow H_2$	0.000
	$Pb^{2+} + 2e^{-} \longrightarrow Pb$	-0.126
	$Sn^{2+} + 2e^{-} \longrightarrow Sn$	-0.136
	$Ni^{2+} + 2e^{-} \longrightarrow Ni$	-0.250
	$Co^{2+} + 2e^{-} \longrightarrow Co$	-0.277
	$Cd^{2+} + 2e^{-} \longrightarrow Cd$	-0.403
	$Fe^{2+} + 2e^{-} \longrightarrow Fe$	-0.440
	$Cr^{3+} + 3e^{-} \longrightarrow Cr$	-0.744
	$Zn^{2+} + 2e^{-} \longrightarrow Zn$	-0.763
	$Al^{3+} + 3e^{-} \longrightarrow Al$	-1.662
	$Mg^{2+} + 2e^{-} \longrightarrow Mg$	-2.363
	$Na^{+} + e^{-} \longrightarrow Na$	-2.714
	$K^{+} + e^{-} \longrightarrow K$	-2.924

↑
Increasingly inert
(cathodic)

↓
Increasingly active
(anodic)

Table 12.3 Ionic Radii for Several Cations and Anions (for a Coordination Number of 6)

Cation	Ionic Radius (nm)	Anion	Ionic Radius (nm)
Al ³⁺	0.053	Br ⁻	0.196
Ba ²⁺	0.136	Cl ⁻	0.181
Ca ²⁺	0.100	F ⁻	0.133
Cs ⁺	0.170	I ⁻	0.220
Fe ²⁺	0.077	O ²⁻	0.140
Fe ³⁺	0.069	S ²⁻	0.184
K ⁺	0.138		
Mg ²⁺	0.072		
Mn ²⁺	0.067		
Na ⁺	0.102		
Ni ²⁺	0.069		
Si ⁴⁺	0.040		
Ti ⁴⁺	0.061		

Table 5.1 Tabulation of Error Function Values

z	erf(z)	z	erf(z)	z	erf(z)
0	0	0.55	0.5633	1.3	0.9340
0.025	0.0282	0.60	0.6039	1.4	0.9523
0.05	0.0564	0.65	0.6420	1.5	0.9661
0.10	0.1125	0.70	0.6778	1.6	0.9763
0.15	0.1680	0.75	0.7112	1.7	0.9838
0.20	0.2227	0.80	0.7421	1.8	0.9891
0.25	0.2763	0.85	0.7707	1.9	0.9928
0.30	0.3286	0.90	0.7970	2.0	0.9953
0.35	0.3794	0.95	0.8209	2.2	0.9981
0.40	0.4284	1.0	0.8427	2.4	0.9993
0.45	0.4755	1.1	0.8802	2.6	0.9998
0.50	0.5205	1.2	0.9103	2.8	0.9999

Key																																			
29	←	Atomic number																																	
Cu	←	Symbol																																	
63.55	←	Atomic weight																																	
IA																	O																		
1 H 1.0080																	2 He 4.0026																		
IIA																IIIA		IVA	VIA	VIIA	VIIIA														
3 Li 6.941	4 Be 9.0122															5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.180														
IIIB		IVB	VB	VIB	VIIIB	VIII			IB	IIB	IIIA		IVA	VIA	VIIA	VIIIA																			
11 Na 22.990	12 Mg 24.305	13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.064	17 Cl 35.453	18 Ar 39.948	19 K 39.098	20 Ca 40.08	21 Sc 44.956	22 Ti 47.87	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.69	29 Cu 63.55	30 Zn 65.41	31 Ga 69.72	32 Ge 72.64	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.80										
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.30	55 Cs 132.91	56 Ba 137.33	57-71 Rare earth series	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.2	76 Os 190.23	77 Ir 192.2	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.19	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89-103 Acti-nide series	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (281)																										