

DO NOT DETACH FROM BOOK.

PERIODIC TABLE OF THE ELEMENTS

												2																							
												He 4.0026																							
1	3											9	8	7	6	5	4	3	2	1															
H 1.0079	Li 6.941	Be 9.012											F 19.00	O 16.00	N 14.007	C 12.011	B 10.811					Ne 20.179													
11	12											17	16	15	14	13					18														
Na 22.99	Mg 24.30											Cl 35.453	S 32.06	P 30.974	Si 28.09	Al 26.98					Ar 39.948														
19	20	21	22	23	24	25	26	27	28	29	30						34	33	32	31	36														
K 39.10	Ca 40.08	Sc 44.96	Ti 47.90	V 50.94	Cr 52.00	Mn 54.938	Fe 55.85	Co 58.93	Ni 58.69	Cu 63.55	Zn 65.39						Se 78.96	As 74.92	Ge 72.59	Ga 69.72			Kr 83.80												
37	38	39	40	41	42	43	44	45	46	47	48						52	51	50	49	54														
Rb 85.47	Sr 87.62	Y 88.91	Zr 91.22	Nb 92.91	Mo 95.94	Tc (98)	Ru 101.1	Rh 102.91	Pd 106.42	Ag 107.87	Cd 112.41						Te 127.60	Sb 121.75	Sn 118.71	In 114.82			Xe 131.29												
55	56	57	72	73	74	75	76	77	78	79	80						84	83	82	81	86														
Cs 132.91	Ba 137.33	*La 138.91	Hf 178.49	Ta 180.95	W 183.85	Re 186.21	Os 190.2	Ir 192.2	Pt 195.08	Au 196.97	Hg 200.59						Po (209)	Bi 208.98	Pb 207.2	Tl 204.38			Rn (222)												
87	88	89	104	105	106	107	108	109	110	111	112						(210)	(210)	(210)	(210)	(210)														
Fr (223)	Ra 226.02	†Ac 227.03	Rf (261)	Db (262)	Sg (263)	Bh (262)	Hs (265)	Mt (266)	§ (269)	§ (272)	§ (277)						(209)	(209)	(209)	(209)	(209)														
												§Not yet named																							
												66	65	64	63	62	61	60	59	58											71				
												Dy 162.50	Tb 158.93	Gd 157.25	Eu 151.97	Sm 150.4	Pm (145)	Nd 144.24	Pr 140.91	Ce 140.12											Lu 174.97				
												98	97	96	95	94	93	92	91	90											103				
												Cf (251)	Bk (247)	Cm (247)	Am (243)	Pu (244)	Np 237.05	U 238.03	Pa 231.04	Th 232.04											Lr (260)				
												*Lanthanide Series												†Actinide Series											

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STANDARD REDUCTION POTENTIALS IN AQUEOUS SOLUTION AT 25°C

Half-reaction		$E^\circ(\text{V})$
$\text{F}_2(\text{g}) + 2\text{e}^-$	$\rightarrow 2\text{F}^-$	2.87
$\text{Co}^{3+} + \text{e}^-$	$\rightarrow \text{Co}^{2+}$	1.82
$\text{Au}^{3+} + 3\text{e}^-$	$\rightarrow \text{Au}(\text{s})$	1.50
$\text{Cl}_2(\text{g}) + 2\text{e}^-$	$\rightarrow 2\text{Cl}^-$	1.36
$\text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^-$	$\rightarrow 2\text{H}_2\text{O}(\text{l})$	1.23
$\text{Br}_2(\text{l}) + 2\text{e}^-$	$\rightarrow 2\text{Br}^-$	1.07
$2\text{Hg}^{2+} + 2\text{e}^-$	$\rightarrow \text{Hg}_2^{2+}$	0.92
$\text{Hg}^{2+} + 2\text{e}^-$	$\rightarrow \text{Hg}(\text{l})$	0.85
$\text{Ag}^+ + \text{e}^-$	$\rightarrow \text{Ag}(\text{s})$	0.80
$\text{Hg}_2^{2+} + 2\text{e}^-$	$\rightarrow 2\text{Hg}(\text{l})$	0.79
$\text{Fe}^{3+} + \text{e}^-$	$\rightarrow \text{Fe}^{2+}$	0.77
$\text{I}_2(\text{s}) + 2\text{e}^-$	$\rightarrow 2\text{I}^-$	0.53
$\text{Cu}^+ + \text{e}^-$	$\rightarrow \text{Cu}(\text{s})$	0.52
$\text{Cu}^{2+} + 2\text{e}^-$	$\rightarrow \text{Cu}(\text{s})$	0.34
$\text{Cu}^{2+} + \text{e}^-$	$\rightarrow \text{Cu}^+$	0.15
$\text{Sn}^{4+} + 2\text{e}^-$	$\rightarrow \text{Sn}^{2+}$	0.15
$\text{S}(\text{s}) + 2\text{H}^+ + 2\text{e}^-$	$\rightarrow \text{H}_2\text{S}(\text{g})$	0.14
$2\text{H}^+ + 2\text{e}^-$	$\rightarrow \text{H}_2(\text{g})$	0.00
$\text{Pb}^{2+} + 2\text{e}^-$	$\rightarrow \text{Pb}(\text{s})$	-0.13
$\text{Sn}^{2+} + 2\text{e}^-$	$\rightarrow \text{Sn}(\text{s})$	-0.14
$\text{Ni}^{2+} + 2\text{e}^-$	$\rightarrow \text{Ni}(\text{s})$	-0.25
$\text{Co}^{2+} + 2\text{e}^-$	$\rightarrow \text{Co}(\text{s})$	-0.28
$\text{Cd}^{2+} + 2\text{e}^-$	$\rightarrow \text{Cd}(\text{s})$	-0.40
$\text{Cr}^{3+} + \text{e}^-$	$\rightarrow \text{Cr}^{2+}$	-0.41
$\text{Fe}^{2+} + 2\text{e}^-$	$\rightarrow \text{Fe}(\text{s})$	-0.44
$\text{Cr}^{3+} + 3\text{e}^-$	$\rightarrow \text{Cr}(\text{s})$	-0.74
$\text{Zn}^{2+} + 2\text{e}^-$	$\rightarrow \text{Zn}(\text{s})$	-0.76
$2\text{H}_2\text{O}(\text{l}) + 2\text{e}^-$	$\rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-$	-0.83
$\text{Mn}^{2+} + 2\text{e}^-$	$\rightarrow \text{Mn}(\text{s})$	-1.18
$\text{Al}^{3+} + 3\text{e}^-$	$\rightarrow \text{Al}(\text{s})$	-1.66
$\text{Be}^{2+} + 2\text{e}^-$	$\rightarrow \text{Be}(\text{s})$	-1.70
$\text{Mg}^{2+} + 2\text{e}^-$	$\rightarrow \text{Mg}(\text{s})$	-2.37
$\text{Na}^+ + \text{e}^-$	$\rightarrow \text{Na}(\text{s})$	-2.71
$\text{Ca}^{2+} + 2\text{e}^-$	$\rightarrow \text{Ca}(\text{s})$	-2.87
$\text{Sr}^{2+} + 2\text{e}^-$	$\rightarrow \text{Sr}(\text{s})$	-2.89
$\text{Ba}^{2+} + 2\text{e}^-$	$\rightarrow \text{Ba}(\text{s})$	-2.90
$\text{Rb}^+ + \text{e}^-$	$\rightarrow \text{Rb}(\text{s})$	-2.92
$\text{K}^+ + \text{e}^-$	$\rightarrow \text{K}(\text{s})$	-2.92
$\text{Cs}^+ + \text{e}^-$	$\rightarrow \text{Cs}(\text{s})$	-2.92
$\text{Li}^+ + \text{e}^-$	$\rightarrow \text{Li}(\text{s})$	-3.05

ADVANCED PLACEMENT CHEMISTRY EQUATIONS AND CONSTANTS

ATOMIC STRUCTURE

$$E = h\nu \quad c = \lambda\nu$$

$$\lambda = \frac{h}{mv} \quad p = mv$$

$$E_n = \frac{-2.178 \times 10^{-18}}{n^2} \text{ joule}$$

EQUILIBRIUM

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

$$K_b = \frac{[OH^-][HB^+]}{[B]}$$

$$K_w = [OH^-][H^+] = 1.0 \times 10^{-14} \text{ @ } 25^\circ\text{C}$$

$$= K_a \times K_b$$

$$\text{pH} = -\log[H^+], \text{pOH} = -\log[OH^-]$$

$$14 = \text{pH} + \text{pOH}$$

$$\text{pH} = \text{p}K_a + \log \frac{[A^-]}{[HA]}$$

$$\text{pOH} = \text{p}K_b + \log \frac{[HB^+]}{[B]}$$

$$\text{p}K_a = -\log K_a, \text{p}K_b = -\log K_b$$

$$K_p = K_c(RT)^{\Delta n},$$

where Δn = moles product gas – moles reactant gas

THERMOCHEMISTRY/KINETICS

$$\Delta S^\circ = \sum S^\circ \text{ products} - \sum S^\circ \text{ reactants}$$

$$\Delta H^\circ = \sum \Delta H_f^\circ \text{ products} - \sum \Delta H_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \sum \Delta G_f^\circ \text{ products} - \sum \Delta G_f^\circ \text{ reactants}$$

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

$$= -RT \ln K = -2.303 RT \log K$$

$$= -n\mathcal{F}E^\circ$$

$$\Delta G = \Delta G^\circ + RT \ln Q = \Delta G^\circ + 2.303 RT \log Q$$

$$q = mc\Delta T$$

$$C_p = \frac{\Delta H}{\Delta T}$$

$$\ln[A]_t - \ln[A]_0 = -kt$$

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

$$\ln k = \frac{-E_a}{R} \left(\frac{1}{T} \right) + \ln A$$

E = energy

v = velocity

ν = frequency

n = principal quantum number

λ = wavelength

m = mass

p = momentum

Speed of light, $c = 3.0 \times 10^8 \text{ m s}^{-1}$

Planck's constant, $h = 6.63 \times 10^{-34} \text{ J s}$

Boltzmann's constant, $k = 1.38 \times 10^{-23} \text{ J K}^{-1}$

Avogadro's number = $6.022 \times 10^{23} \text{ mol}^{-1}$

Electron charge, $e = -1.602 \times 10^{-19} \text{ coulomb}$

1 electron volt per atom = 96.5 kJ mol^{-1}

Equilibrium Constants

K_a (weak acid)

K_b (weak base)

K_w (water)

K_p (gas pressure)

K_c (molar concentrations)

S° = standard entropy

H° = standard enthalpy

G° = standard free energy

E° = standard reduction potential

T = temperature

n = moles

m = mass

q = heat

c = specific heat capacity

C_p = molar heat capacity at constant pressure

E_a = activation energy

k = rate constant

A = frequency factor

Faraday's constant, $\mathcal{F} = 96,500 \text{ coulombs per mole of electrons}$

Gas constant, $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$
 $= 0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1}$
 $= 62.4 \text{ L torr mol}^{-1} \text{ K}^{-1}$
 $= 8.31 \text{ volt coulomb mol}^{-1} \text{ K}^{-1}$

GASES, LIQUIDS, AND SOLUTIONS

$$PV = nRT$$

$$\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$

$$P_A = P_{total} \times X_A, \text{ where } X_A = \frac{\text{moles A}}{\text{total moles}}$$

$$P_{total} = P_A + P_B + P_C + \dots$$

$$n = \frac{m}{M}$$

$$K = ^\circ\text{C} + 273$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$D = \frac{m}{V}$$

$$u_{rms} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M}}$$

$$KE \text{ per molecule} = \frac{1}{2}mv^2$$

$$KE \text{ per mole} = \frac{3}{2}RT$$

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

molarity, M = moles solute per liter solution

molality = moles solute per kilogram solvent

$$\Delta T_f = iK_f \times \text{molality}$$

$$\Delta T_b = iK_b \times \text{molality}$$

$$\pi = iMRT$$

$$A = abc$$

P = pressure

V = volume

T = temperature

n = number of moles

D = density

m = mass

v = velocity

u_{rms} = root-mean-square speed

KE = kinetic energy

r = rate of effusion

M = molar mass

π = osmotic pressure

i = van't Hoff factor

K_f = molal freezing-point depression constant

K_b = molal boiling-point elevation constant

A = absorbance

a = molar absorptivity

b = path length

c = concentration

Q = reaction quotient

I = current (amperes)

q = charge (coulombs)

t = time (seconds)

E° = standard reduction potential

K = equilibrium constant

OXIDATION-REDUCTION; ELECTROCHEMISTRY

$$Q = \frac{[C]^c [D]^d}{[A]^a [B]^b}, \text{ where } aA + bB \rightarrow cC + dD$$

$$I = \frac{q}{t}$$

$$E_{cell} = E_{cell}^\circ - \frac{RT}{n\mathcal{F}} \ln Q = E_{cell}^\circ - \frac{0.0592}{n} \log Q @ 25^\circ\text{C}$$

$$\log K = \frac{nE^\circ}{0.0592}$$

$$\text{Gas constant, } R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$$

$$= 0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1}$$

$$= 62.4 \text{ L torr mol}^{-1} \text{ K}^{-1}$$

$$= 8.31 \text{ volt coulomb mol}^{-1} \text{ K}^{-1}$$

$$\text{Boltzmann's constant, } k = 1.38 \times 10^{-23} \text{ J K}^{-1}$$

$$K_f \text{ for H}_2\text{O} = 1.86 \text{ K kg mol}^{-1}$$

$$K_b \text{ for H}_2\text{O} = 0.512 \text{ K kg mol}^{-1}$$

$$1 \text{ atm} = 760 \text{ mm Hg}$$

$$= 760 \text{ torr}$$

$$\text{STP} = 0.00^\circ\text{C and } 1.0 \text{ atm}$$

$$\text{Faraday's constant, } \mathcal{F} = 96,500 \text{ coulombs per mole of electrons}$$