

PERIODIC TABLE OF THE ELEMENTS

1 H												2 He 4.00	
3	4 Be												
Li	Be												
6.94	9.01												
11	12												
Na	Mg												
22.99	24.30												
19	20	21	22	23	24	25	26	27	28	29	30	31	32
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge
39.10	40.08	44.96	47.90	50.94	52.00	54.94	55.85	58.93	58.69	63.55	65.39	69.72	72.59
37	38	39	40	41	42	43	44	45	46	47	48	49	50
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn
85.47	87.62	88.91	91.22	92.91	95.94	(98)	101.1	102.91	106.42	107.87	112.41	114.82	118.71
55	56	57	72	73	74	75	76	77	78	79	80	81	82
Cs	Ba	* La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb
132.91	137.33	138.91	178.49	180.95	183.85	186.21	190.2	192.2	195.08	196.97	200.59	204.38	207.2
87	88	89	104	105	106	107	108	109	110	111	111	111	111
Fr	Ra	+ Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg			
(223)	226.02	227.03	(261)	(262)	(266)	(264)	(277)	(268)	(271)	(272)			

*Lanthanide Series		58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
140.12	140.91	144.24	(145)	150.4	151.97	157.25	158.93	162.50	164.93	167.26	168.93	173.04	174.97		
90	91	92	93	94	95	96	97	98	99	100	101	102	103		
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		
232.04	231.04	238.03	(237)	(244)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(259)	(262)	

*Lanthanide Series
 †Actinide Series

STANDARD REDUCTION POTENTIALS IN AQUEOUS SOLUTION AT 25°C

Half-reaction		$E^\circ(V)$
$F_2(g) + 2e^-$	\rightarrow	2F ⁻ 2.87
$Co^{3+} + e^-$	\rightarrow	Co ²⁺ 1.82
$Au^{3+} + 3e^-$	\rightarrow	Au(s) 1.50
$Cl_2(g) + 2e^-$	\rightarrow	2Cl ⁻ 1.36
$O_2(g) + 4H^+ + 4e^-$	\rightarrow	2H ₂ O(l) 1.23
$Br_2(l) + 2e^-$	\rightarrow	2Br ⁻ 1.07
$2Hg^{2+} + 2e^-$	\rightarrow	Hg ₂ ²⁺ 0.92
$Hg^{2+} + 2e^-$	\rightarrow	Hg(l) 0.85
$Ag^+ + e^-$	\rightarrow	Ag(s) 0.80
$Hg_2^{2+} + 2e^-$	\rightarrow	2Hg(l) 0.79
$Fe^{3+} + e^-$	\rightarrow	Fe ²⁺ 0.77
$I_2(s) + 2e^-$	\rightarrow	2I ⁻ 0.53
$Cu^+ + e^-$	\rightarrow	Cu(s) 0.52
$Cu^{2+} + 2e^-$	\rightarrow	Cu(s) 0.34
$Cu^{2+} + e^-$	\rightarrow	Cu ⁺ 0.15
$Sn^{4+} + 2e^-$	\rightarrow	Sn ²⁺ 0.15
$S(s) + 2H^+ + 2e^-$	\rightarrow	H ₂ S(g) 0.14
$2H^+ + 2e^-$	\rightarrow	H ₂ (g) 0.00
$Pb^{2+} + 2e^-$	\rightarrow	Pb(s) -0.13
$Sn^{2+} + 2e^-$	\rightarrow	Sn(s) -0.14
$Ni^{2+} + 2e^-$	\rightarrow	Ni(s) -0.25
$Co^{2+} + 2e^-$	\rightarrow	Co(s) -0.28
$Cd^{2+} + 2e^-$	\rightarrow	Cd(s) -0.40
$Cr^{3+} + e^-$	\rightarrow	Cr ²⁺ -0.41
$Fe^{2+} + 2e^-$	\rightarrow	Fe(s) -0.44
$Cr^{3+} + 3e^-$	\rightarrow	Cr(s) -0.74
$Zn^{2+} + 2e^-$	\rightarrow	Zn(s) -0.76
$2H_2O(l) + 2e^-$	\rightarrow	H ₂ (g) + 2OH ⁻ -0.83
$Mn^{2+} + 2e^-$	\rightarrow	Mn(s) -1.18
$Al^{3+} + 3e^-$	\rightarrow	Al(s) -1.66
$Be^{2+} + 2e^-$	\rightarrow	Be(s) -1.70
$Mg^{2+} + 2e^-$	\rightarrow	Mg(s) -2.37
$Na^+ + e^-$	\rightarrow	Na(s) -2.71
$Ca^{2+} + 2e^-$	\rightarrow	Ca(s) -2.87
$Sr^{2+} + 2e^-$	\rightarrow	Sr(s) -2.89
$Ba^{2+} + 2e^-$	\rightarrow	Ba(s) -2.90
$Rb^+ + e^-$	\rightarrow	Rb(s) -2.92
$K^+ + e^-$	\rightarrow	K(s) -2.92
$Cs^+ + e^-$	\rightarrow	Cs(s) -2.92
$Li^+ + e^-$	\rightarrow	Li(s) -3.05

ADVANCED PLACEMENT CHEMISTRY EQUATIONS AND CONSTANTS

ATOMIC STRUCTURE

$$\begin{aligned}E &= h\nu & c &= \lambda\nu \\ \lambda &= \frac{h}{mv} & p &= mv \\ E_n &= \frac{-2.178 \times 10^{-18}}{n^2} \text{ joule}\end{aligned}$$

EQUILIBRIUM

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

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

$$\begin{aligned}K_w &= [\text{OH}^-][\text{H}^+] = 1.0 \times 10^{-14} @ 25^\circ\text{C} \\ &= K_a \times K_b\end{aligned}$$

$$\begin{aligned}\text{pH} &= -\log[\text{H}^+], \text{pOH} = -\log[\text{OH}^-] \\ 14 &= \text{pH} + \text{pOH}\end{aligned}$$

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

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

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

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

where Δn = moles product gas – moles reactant gas

THERMOCHEMISTRY/KINETICS

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

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

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

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

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

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

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

$$q = mc\Delta T$$

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

$$\ln[\text{A}]_t - \ln[\text{A}]_0 = -kt$$

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

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

E = energy	v = velocity
ν = frequency	n = principal quantum number
λ = wavelength	m = mass
p = momentum	

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

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

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

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

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

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

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, $\mathcal{F} = 96,500$ 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

$$PV = nRT$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$= 760 \text{ torr}$$

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

Faraday's constant, $F = 96,500$ coulombs per mole of electrons