

(m)L	(milli)Liter(s)	mmHg	mm of Mercury
g	Gram(s)	(k)J	(kilo)Joule(s)
nm	Nanometer(s)	V	Volt(s)
atm	Atmosphere(s)	mol	Mole(s)

Avogadro's Number  $N_A = 6.02214 \times 10^{23} \text{ mol}^{-1}$   
Faraday Constant  $F = 96485.33 \text{ C mol}^{-1}$   
Atomic Mass Constant  $1 \text{ amu} = 1.660538 \times 10^{-27} \text{ kg}$   
Molar Gas Constant  $R = 8.3144 \text{ J mol}^{-1} \text{ K}^{-1}$   
 $R = 62.36 \text{ L atm (mol K)}^{-1} = 0.08205746 \text{ L atm K}^{-1} \text{ mol}^{-1}$   
Coulomb's Constant  $k_e = 8.987551 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$   
Speed of Light (Vacuum)  $c = 2.998 \times 10^8 \text{ m s}^{-1}$   
Boltzmann Consant  $k_b = 1.3807 \times 10^{-23} \text{ J K}^{-1}$   
Charge on a Proton/Electron  $e = 1.602 \times 10^{-19} \text{ C}$   
Planck's Constant  $h = 6.626 \times 10^{-34} \text{ Js}$   
Specific heat cap. of H<sub>2</sub>O(l)  $c = 4.18 \text{ kJ kg}^{-1} \text{ }^\circ\text{C}^{-1}$

Kinetics

$[A]_t - [A]_0 = -kt$  (first order)  
 $\ln[A]_t - \ln[A]_0 = -k$  (second order)  
 $\frac{1}{[A]_t} - \frac{1}{[A]_0} = kt$  (third order)  
 $t_{1/2} = \frac{0.963}{t}$  (first order)

Conversions

1 L · atm = 101.3 J  
K = °C + 273.15  
1 cal = 4.184 J

Quantum

$E_{\text{photon}} = hf = \frac{hc}{\lambda}$   
 $\lambda = \frac{h}{mv}$   
 $R_{H\text{Rydberg}} = 1.097 \times 10^7 \text{ m}^{-1}$   
 $\frac{1}{\lambda} = R_H \left( \frac{1}{n_i^2} - \frac{1}{n_f^2} \right)$   
 $\Delta E = (-2.18 \times 10^{-18} \text{ J}) \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$

Thermo/Electrochem

$q = mc\Delta T$   
 $\Delta S^\circ = \sum_{\text{products}} S^\circ - \sum_{\text{reactants}} S^\circ$   
Same for  $\Delta H^\circ$  and  $\Delta G^\circ$   
 $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$   
 $= -RT \ln K = -nFE^\circ$   
 $I = \frac{q}{t}$   
 $E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{RT}{nF} \ln Q$   
 $PV = nRT$   
 $P_A = P_{\text{total}}X_A$ , where  $X_A = \frac{\text{moles } A}{\text{total moles}}$   
 $P_{\text{total}} = P_A + P_B + P_C + \dots$   
K = °C + 273.15  
 $M = \frac{\text{moles solute}}{\text{Liters solution}}$ ,  $m = \frac{\text{moles solute}}{\text{kg solvent}}$   
1 atm = 760 mmHg = 760 torr  
STP = 273.15 K and 1.0 atm  
At STP, ideal gas 22.4L mol<sup>-1</sup>.  
Standard conditions are 25° C and 1 atm.

Equilibrium

$K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$ , where  $aA + bB \rightleftharpoons cC + dD$ .  
 $K_p = \frac{(P_C)^c(P_D)^d}{(P_A)^a(P_B)^b}$   
 $K_a = \frac{[H^+][A^-]}{[HA]}$   
 $K_b = \frac{[OH^-][HB^+]}{[B]}$   
 $K_w = K_aK_b = [H^+][OH^-] = 1.0 \times 10^{-14} \text{ (25}^\circ\text{ C)}$   
pH = -log[H<sup>+</sup>], pOH = -log[OH<sup>-</sup>]  
pH + pOH = 14.  
pH = pK<sub>a</sub> + log  $\frac{[A^-]}{[HA]}$   
pK<sub>a</sub> = -log K<sub>a</sub>, pK<sub>b</sub> = -log K<sub>b</sub>.

Gasses/Solutions

$PV = nRT$   
 $P_A = P_{\text{total}}X_A$ , where  $X_A = \frac{\text{moles } A}{\text{total moles}}$   
 $P_{\text{total}} = P_A + P_B + P_C + \dots$   
K = °C + 273.15  
 $M = \frac{\text{moles solute}}{\text{Liters solution}}$ ,  $m = \frac{\text{moles solute}}{\text{kg solvent}}$   
1 atm = 760 mmHg = 760 torr  
STP = 273.15 K and 1.0 atm  
At STP, ideal gas 22.4L mol<sup>-1</sup>.  
Standard conditions are 25° C and 1 atm.

Gas	Super <sup>7</sup>	
NO	HI	
NO <sub>2</sub>	HBr	
CO	HCl	
CO <sub>2</sub>	HNO <sub>3</sub>	
CH <sub>4</sub>	H <sub>2</sub> SO <sub>4</sub>	
C <sub>2</sub> H <sub>6</sub>	HClO <sub>3</sub>	
C <sub>3</sub> H <sub>8</sub>	HClO <sub>4</sub>	
C <sub>4</sub> H <sub>10</sub>		
N <sub>2</sub> O	NH <sub>3</sub>	
SO <sub>3</sub>	SO <sub>2</sub>	
H <sub>2</sub> S	HCl	

Alkali Metal  
Alkaline-Earth Metal  
Metalloid  
Non-metal  
Halogen  
Noble Gas  
Lanthanide/Actinide  
Synthetic  
★Aufbau Exception  
EN, IE, EA, &  $\mathbb{Z}_{eff}$  increase →↑  
Radius & Metallic decrease →↑

# Periodic Table of Elements v3.1

1 IA												18 VIIIA						
1	2.20 <b>H<sub>2</sub></b> Hydrogen 1.01											2 <b>He</b> Helium 4.00						
2	3 0.98 <b>Li</b> Lithium 6.94	4 1.57 <b>Be</b> Beryllium 9.01																
3	11 0.93 <b>Na</b> Sodium 22.99	12 1.31 <b>Mg</b> Magnesium 24.31																
		3 IIIA	4 IVB	5 VB	6 VIB	7 VIIB	8 VIIIB	9 VIIIB	10 VIIIB	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA		
4	19 0.82 <b>K</b> Potassium 39.10	20 1.00 <b>Ca</b> Calcium 40.08	21 1.36 <b>Sc</b> Scandium 44.96	22 1.54 <b>Ti</b> Titanium 47.87	23 1.63 <b>V</b> Vanadium 50.94	24 1.66 <b>Cr★</b> Chromium 52.00	25 1.55 <b>Mn</b> Manganese 54.94	26 1.83 <b>Fe</b> Iron 55.85	27 1.88 <b>Co</b> Cobalt 58.93	28 1.91 <b>Ni</b> Nickel 58.69	29 1.90 <b>Cu★</b> Copper 63.55	30 1.65 <b>Zn</b> Zinc(2+) 65.38	31 1.81 <b>Ga</b> Gallium 69.72	32 2.01 <b>Ge</b> Germanium 72.63	33 2.18 <b>As</b> Arsenic 74.92	34 2.55 <b>Se</b> Selenium 78.97	35 2.96 <b>Br<sub>2</sub></b> Bromine 79.90	36 3.00 <b>Kr</b> Krypton 83.80
5	37 0.82 <b>Rb</b> Rubidium 85.47	38 0.95 <b>Sr</b> Strontium 87.62	39 1.22 <b>Y</b> Yttrium 88.91	40 1.33 <b>Zr</b> Zirconium 91.22	41 1.6 <b>Nb★</b> Niobium 92.91	42 2.16 <b>Mo★</b> Molybdenum 95.95	43 1.9 <b>Tc</b> Technetium (98)	44 2.2 <b>Ru★</b> Ruthenium 101.07	45 2.28 <b>Rh★</b> Rhodium 102.91	46 2.20 <b>Pd★★</b> Palladium 106.42	47 1.93 <b>Ag★</b> Silver(1+) 107.87	48 1.69 <b>Cd</b> Cadmium 112.41	49 1.78 <b>In</b> Indium 114.82	50 1.96 <b>Sn</b> Tin 118.71	51 2.05 <b>Sb</b> Antimony 121.76	52 2.1 <b>Te</b> Tellurium 127.60	53 2.86 <b>I<sub>2</sub></b> Iodine 126.90	54 2.60 <b>Xe</b> Xenon 131.29
6	55 0.79 <b>Cs</b> Caesium 132.91	56 0.89 <b>Ba</b> Barium 137.33	57-71 <b>La-Lu</b> Lanthanide	72 1.3 <b>Hf</b> Hafnium 178.49	73 1.5 <b>Ta</b> Tantalum 180.95	74 2.36 <b>W</b> Tungsten 183.84	75 1.9 <b>Re</b> Rhenium 186.21	76 2.2 <b>Os</b> Osmium 190.23	77 2.20 <b>Ir</b> Iridium 192.22	78 2.28 <b>Pt★</b> Platinum 195.08	79 2.54 <b>Au★</b> Gold 196.97	80 2.00 <b>Hg</b> Mercury 200.59	81 1.62 <b>Tl</b> Thallium 204.38	82 1.87 <b>Pb</b> Lead 207.2	83 2.02 <b>Bi</b> Bismuth 208.98	84 2.0 <b>Po</b> Polonium (209)	85 2.2 <b>At</b> Astatine (210)	86 2.2 <b>Rn</b> Radon (222)
7	87 0.7 <b>Fr</b> Francium (223)	88 0.9 <b>Ra</b> Radium (226)	89-103 <b>Ac-Lr</b> Actinide	104 <b>Rf</b> Rutherfordium (267)	105 <b>Db</b> Dubnium (268)	106 <b>Sg</b> Seaborgium (269)	107 <b>Bh</b> Bohrium (270)	108 <b>Hs</b> Hassium (277)	109 <b>Mt</b> Meitnerium (278)	110 <b>Ds</b> Darmstadtium (281)	111 <b>Rg</b> Roentgenium (282)	112 <b>Cn</b> Copernicium (285)	113 <b>Nh</b> Nihonium (286)	114 <b>Fl</b> Flerovium (289)	115 <b>Mc</b> Moscovium (290)	116 <b>Lv</b> Livermorium (293)	117 <b>Ts</b> Tennessine (294)	118 <b>Og</b> Ogannesson (294)
Gas Super <sup>7</sup> NO HI NO <sub>2</sub> HBr CO HCl CO <sub>2</sub> HNO <sub>3</sub> CH <sub>4</sub> H <sub>2</sub> SO <sub>4</sub> C <sub>2</sub> H <sub>6</sub> HClO <sub>3</sub> C <sub>3</sub> H <sub>8</sub> HClO <sub>4</sub> C <sub>4</sub> H <sub>10</sub> N <sub>2</sub> O NH <sub>3</sub> SO <sub>3</sub> SO <sub>2</sub> H <sub>2</sub> S HCl			Z E.N. <b>Sym</b> Name mass	57 1.1 <b>La</b> Lanthanum 138.91	58 1.12 <b>Ce</b> Cerium 140.12	59 1.13 <b>Pr</b> Praseodymium 140.91	60 1.14 <b>Nd</b> Neodymium 144.24	61 1.13 <b>Pm</b> Promethium (145)	62 1.17 <b>Sm</b> Samarium 150.36	63 1.2 <b>Eu</b> Europium 151.96	64 1.2 <b>Gd</b> Gadolinium 157.25	65 1.1 <b>Tb</b> Terbium 158.93	66 1.22 <b>Dy</b> Dysprosium 162.50	67 1.23 <b>Ho</b> Holmium 164.93	68 1.24 <b>Er</b> Erbium 167.26	69 1.25 <b>Tm</b> Thulium 168.93	70 1.1 <b>Yb</b> Ytterbium 173.05	71 1.27 <b>Lu</b> Lutetium 174.97
★Aufbau Exception EN, IE, EA, & Z <sub>eff</sub> increase →↑				89 1.1 <b>Ac</b> Actinium (227)	90 1.3 <b>Th</b> Thorium 232.04	91 1.5 <b>Pa</b> Protactinium 231.04	92 1.38 <b>U</b> Uranium 238.03	93 1.36 <b>Np</b> Neptunium (237)	94 1.28 <b>Pu</b> Plutonium (244)	95 1.13 <b>Am</b> Americium (243)	96 1.28 <b>Cm</b> Curium (247)	97 1.3 <b>Bk</b> Berkelium (247)	98 1.3 <b>Cf</b> Californium (251)	99 1.3 <b>Es</b> Einsteinium (252)	100 1.3 <b>Fm</b> Fermium (257)	101 1.3 <b>Md</b> Mendelevium (258)	102 1.3 <b>No</b> Nobelium (259)	103 1.3 <b>Lr</b> Lawrencium (266)