

Family/ Group
↓
Period →

Periodic Table of the Elements

1 H Hydrogen 1.01	2 He Helium 4.00																		
3 Li Lithium 6.94	4 Be Beryllium 9.01																	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31																	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 51.99	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.63	33 As Arsenic 74.92	34 Se Selenium 78.97	35 Br Bromine 79.90	36 Kr Krypton 84.80		
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.95	43 Tc Technetium 98.91	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.6	53 I Iodine 126.90	54 Xe Xenon 131.29		
55 Cs Cesium 132.91	56 Ba Barium 137.33	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.85	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.20	83 Bi Bismuth 208.98	84 Po Polonium [208.98]	85 At Astatine 209.98	86 Rn Radon 222.02		
87 Fr Francium 223.02	88 Ra Radium 226.03	89-103 Actinides	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [280]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]		

57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium 144.91	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.06	71 Lu Lutetium 174.97
89 Ac Actinium 227.03	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium 237.05	94 Pu Plutonium 244.06	95 Am Americium 243.06	96 Cm Curium 247.07	97 Bk Berkelium 247.07	98 Cf Californium 251.08	99 Es Einsteinium [254]	100 Fm Fermium 257.10	101 Md Mendelevium 258.10	102 No Nobelium 259.10	103 Lr Lawrencium [262]

Alkali Metal	Alkaline Earth	Transition Metal	Basic Metal	Metalloid	Nonmetal	Halogen	Noble Gas	Lanthanide	Actinide
Group 1 metals	Group 2 metals			(steps)					

Constants and Formulas

$$c_{\text{water}} = 4182 \frac{\text{J}}{\text{kg} \cdot ^\circ\text{C}}$$

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

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

$$1 \text{ L} \cdot \text{atm} = 101.325 \text{ J} = 101.325 \text{ Pa} = 760 \text{ mmHg}$$

$$T(^{\circ}\text{F}) = 1.8 T(^{\circ}\text{C}) + 32$$

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

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

$$R = 0.08206 \text{ L atm mol}^{-1} \text{ K}^{-1} = 8.3145 \text{ J mol}^{-1} \text{ K}^{-1}$$

$$N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$$

$$h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s}$$

$$c = 2.998 \times 10^8 \text{ m/s}$$

$$g = 9.80665 \text{ m/s}^2$$

units in Δ
 $\uparrow 10 = 323.56^\circ\text{C} - 30^\circ\text{C}$

size Partial charge (C)
 distance between charges (m)

dipole moment (μ) = $q \cdot r$
 \rightarrow % ionic character = $\left(\frac{\mu}{(0.622 \text{ e} - 1.90) (100)} \right) = \frac{\mu_{\text{observed}}}{\mu_{\text{calculated}}}$

λ meters (per photon)
 $\lambda = \frac{h}{mv}$

Heisenberg uncertainty
 $\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$

$$E \propto \frac{Q_1 Q_2}{r}$$

$$F \propto \frac{Q_1 Q_2}{r^2}$$

$$E = h\nu$$

$$c = \lambda \nu$$

$$E_{\text{photon}} = h\nu$$

$$KE = h\nu - h\nu_0 = h\nu - W$$

where W = binding energy

$$\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$$

$$KE = \frac{1}{2} mv^2$$

$$E_n = -B \left(\frac{1}{n^2} \right)$$

$$\Delta E = -B \left(\frac{1}{n_f^2} - \frac{1}{n_i^2} \right)$$

$$|\Delta E| = h\nu$$

$$B = 2.179 \times 10^{-18} \text{ J}$$

$$\Delta E = q + w$$

$$w = -P\Delta V$$

$$H = E + PV$$

$$q = m \cdot C \cdot \Delta T$$

n_1 final n_2 initial
 Rydberg
 $\frac{1}{\lambda} = (1.0974 \times 10^7 \text{ m}^{-1}) \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$

$$\Delta H^\circ_{\text{rxn}} = \sum n_p \Delta H^\circ_f (\text{products}) - \sum n_R \Delta H^\circ_f (\text{reactants})$$

$$\Delta H^\circ = \sum BE(\text{broken}) - \sum BE(\text{formed})$$

$$h\nu = w + KE$$

$$\text{bond order} = \frac{1}{2} [\# \text{bonding } e^- - \# \text{antibonding } e^-]$$

$$KE = \frac{1}{2} mu^2 = \frac{3}{2} RT$$

$$P_i = X_i P_{\text{total}}$$

$$\text{Molarity} = \frac{\text{mol}}{\text{L}} \quad \& \quad M_c V_c = M_d V_d$$

$$\text{Formal charge} = (\# \text{valence } e^-) - [\# \text{nonbonding } e^-] + \frac{1}{2} [\# \text{bonding } e^-]$$

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

$$\frac{r_1}{r_2} = \frac{t_2}{t_1} = \sqrt{\frac{M_2}{M_1}}$$

$$PV = nRT$$

$$P = dgh$$

$$\% \text{ yield} = \frac{\text{Actual yield}}{\text{Theoretical yield}} \times 100$$

$$PV = nRT$$

Soluble	Exceptions	Insoluble
$\text{Li}^+, \text{Na}^+, \text{K}^+, \text{Rb}^+, \text{Cs}^+, \text{NH}_4^+$	none	
$\text{NO}_3^-, \text{CH}_3\text{COO}^-, \text{ClO}_3^-$	none	
$\text{Cl}^-, \text{Br}^-, \text{I}^-$	$\text{Ag}^+, \text{Hg}_2^{2+}, \text{Pb}^{2+}$	
SO_4^{2-}	$\text{Ca}^{2+}, \text{Sr}^{2+}, \text{Ba}^{2+}, \text{Ag}^+, \text{Hg}_2^{2+}, \text{Pb}^{2+}$	
	$\text{Li}^+, \text{Na}^+, \text{K}^+, \text{Rb}^+, \text{Cs}^+, \text{Ba}^{2+}$	OH^-
	$\text{Li}^+, \text{Na}^+, \text{K}^+, \text{Rb}^+, \text{Cs}^+, \text{NH}_4^+$	$\text{CO}_3^{2-}, \text{PO}_4^{3-}, \text{S}^{2-}, \text{CrO}_4^{2-}$

$$- \text{Mg}(\text{ClO}_4)_2$$

$$- \text{K}_2\text{H}_2\text{O}_2$$

$$\Delta H_{\text{condensation}} = -\Delta H_{\text{vaporization}}$$

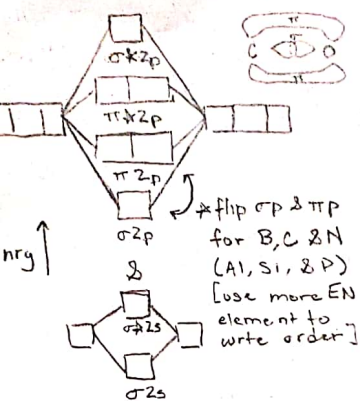
$$\Delta H_{\text{crystallization}} = -\Delta H_{\text{fusion}}$$

$$\Delta H_{\text{sublimation}} = \Delta H_{\text{fusion}} + \Delta H_{\text{vaporization}}$$

$$\text{Clausius - Clapeyron}$$

$$\ln \left(\frac{P_2}{P_1} \right) = \frac{-\Delta H_{\text{vap}}}{8.314 \text{ J/mol K}} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)$$

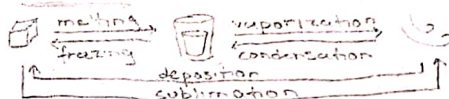
Molecular Orbital



Hybridization

sp^3, sp^2, sp
 - # combined atomic orbitals
 = # hybrid orbitals

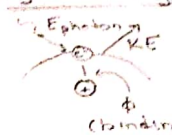
Form



% Ionic Character

↑ difference EN values = ↑ % ionic

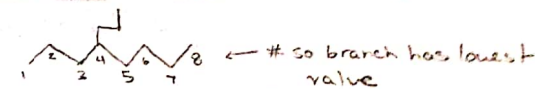
Light 2 ring



$$E_{ph} = \Phi + KE$$

$$h\nu = \frac{hc}{\lambda_0}$$

Naming IUPAC (M/C things)



[4 propyl] 3 octane

- 1C → methane
 - 2C → ethane
 - 3C → propane
 - 4C → butane
 - 5C → pentane
 - 6C → hexane
 - 7C → heptane
 - 8C → octane
 - 9C → nonane
 - 10C → decane
- = (2x bond)
 ↳ end in -ly
 • # substituent connect to parent @
 substituent name
 -
 locations of 2x or 3x bonds
 -
 parent name

- if multiple substituents, list in alphabetical order
- same sub type in multiple places → #, #
- 2x & 3x bonds on main body
 (single → -ane, 2x → -ene, 3x → -yne)

Strong Acids

- hydrochloric acid $HCl(aq) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$
- hydrobromic acid $HBr(aq) + H_2O(l) \rightarrow H_3O^+(aq) + Br^-(aq)$
- hydroiodic acid $HI(aq) + H_2O(l) \rightarrow H_3O^+(aq) + I^-(aq)$
- nitric acid $HNO_3(aq) + H_2O(l) \rightarrow H_3O^+(aq) + NO_3^-(aq)$
- perchloric acid $HClO_4(aq) + H_2O(l) \rightarrow H_3O^+(aq) + ClO_4^-(aq)$
- sulfuric acid $H_2SO_4(aq) + H_2O(l) \rightarrow H_3O^+(aq) + HSO_4^-(aq)$

Strong Bases

- $LiOH(aq) \rightarrow Li^+(aq) + OH^-(aq)$
 - $NaOH(aq) \rightarrow Na^+ + OH^-$
 - $KOH(aq) \rightarrow K^+ + OH^-$
 - $RbOH(aq) \rightarrow Rb^+ + OH^-$
 - $CsOH(aq) \rightarrow Cs^+ + OH^-$
- group 1A hydroxides
- $Ca(OH)_2(aq) \rightarrow Ca^{2+} + 2OH^-$
 - $Sr(OH)_2(aq) \rightarrow Sr^{2+} + 2OH^-$
 - $Ba(OH)_2(aq) \rightarrow Ba^{2+} + 2OH^-$
- group 2A hydroxides

Electrolytes

- strong - strong acid/base, soluble ionic compound
- weak - weak acid/base, insoluble ionic compound
- non - covalent compounds

Electronegativity (EN diff)

$\Delta EN \rightarrow 0.1 - 0.4 \rightarrow$ nonpolar covalent
 $0.5 - 1.9 \rightarrow$ polar covalent
 $\geq 2.0 \rightarrow$ ionic

-1 ions	-2 ions	-3 ions
CH_3COO^- or $C_2H_3O_2^-$ acetate CHO_2^- formate ClO^- hypochlorite ClO_2^- chlorite ClO_3^- chlorate ClO_4^- perchlorate CN^- cyanide HCO_3^- hydrogen carbonate or bicarbonate HSO_3^- hydrogen sulfite or bisulfite HSO_4^- hydrogen sulfate or bisulfate $H_2PO_4^-$ dihydrogen phosphate MnO_4^- permanganate NO_2^- nitrite NO_3^- nitrate OH^- hydroxide	CO_3^{2-} carbonate $C_2O_4^{2-}$ oxalate CrO_4^{2-} chromate $Cr_2O_7^{2-}$ dichromate HPO_4^{2-} hydrogen phosphate O_2^{2-} peroxide SiO_3^{2-} silicate SO_3^{2-} sulfite SO_4^{2-} sulfate $S_2O_3^{2-}$ thiosulfate	AsO_4^{3-} arsenate BO_3^{3-} borate PO_3^{3-} phosphite PO_4^{3-} phosphate NH_4^+ ammonium

Name _____

Section Number _____

Avogadro

molecules → to find atoms need # of atoms molecule

POSSIBLY USEFUL INFORMATION

$$N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$$

$$2.54 \text{ cm} = 1 \text{ in}$$

$$1 \text{ L} = 1000 \text{ cm}^3$$

$$A = \pi r^2$$

$$C = 2\pi r$$

$$F = ma$$

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

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

$$R = 8.3145 \text{ J/mol K}$$

$$[760 \text{ mmHg} = 1 \text{ atm} = 760 \text{ Torr} = 101.325 \text{ kPa} = 1.01325 \text{ bar}]$$

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

$$(E_k)_{average} = (3/2)(R/N_A)T$$

$$\text{rate} \propto u_{rms}$$

$$E = (3/2)nRT$$

$$\Delta E = q + w$$

$$\Delta H = \Delta E + \Delta(PV)$$

$$\Delta X = X_{final} - X_{initial}$$

$$R = 1.097 \times 10^7 \text{ m}^{-1}$$

$$E = h\nu$$

$$(\Delta x)(\Delta p) \geq (h/4\pi)$$

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

$$1.057 \text{ qt} = 1 \text{ L}$$

$$\nu = \text{frequency}$$

$$m_p = 1.6726 \times 10^{-27} \text{ kg}$$

$$m_n = 1.675 \times 10^{-27} \text{ kg}$$

$$m_e = 9.109 \times 10^{-31} \text{ kg}$$

Periodic Table Group Numbers are 1 through 18 on the periodic table.

In an alternative system numbering system, each group has a number from 1 through 8 and either the letter A or B. The correspondence between the two numbering systems follows:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	8A

SOLUBLE IONIC COMPOUNDS

Compounds containing: Group 1(1A) ions, NH_4^+ , NO_3^- , CH_3COO^- , ClO_4^-

Cl^- , Br^- , I^- except compounds of Ag^+ , Pb^{2+} , Cu^+ , Hg_2^{2+}

F^- except compounds of Group 2(2A) ions and of Pb^{2+}

SO_4^{2-} except compounds of Ca^{2+} , Sr^{2+} , Ba^{2+} , Ag^+ , Pb^{2+}

INSOLUBLE IONIC COMPOUNDS Compounds containing:

OH^- except compounds of Group 1(1A) ions and of Ca^{2+} , Sr^{2+} , Ba^{2+}

CO_3^{2-} , PO_4^{3-} except compounds of Group 1(1A) ions and of NH_4^+

S^{2-} except compounds of Group 1(1A) ions, of Group 2(2A) ions, and of NH_4^+

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C159F15E1 Form 1 Scientific Calculators Only. Cell Phones Off Away from Body. No Talking



lattice nrg = $\frac{1 \text{ cation} \cdot \text{anion}}{\text{period cat} + \text{period an}}$

$$1 \text{ Pa} = 1 \text{ N/m}^2 = \frac{1 \text{ kg}}{\text{m} \cdot \text{s}^2}$$

STP is 0°C , 1 atm, 22.41 L

$$n = N/N_A$$

$$n = m/M$$

$$6.022 \times 10^{23} \text{ amu} = 1 \text{ g}$$

$$\frac{r_1}{r_2} = \frac{t_2}{t_1} = \sqrt{\frac{M_2}{M_1}}$$

$$q = mc\Delta T$$

$$H = E + PV$$

$$\Delta H = \Delta E + V\Delta P$$

$$\lambda = h/mc$$

$$c = 3.00 \times 10^8 \text{ m/s}$$

$$\lambda = h/mu \rightarrow \text{de Broglie}$$

$$c = \lambda \nu$$

$$u = \text{speed}$$