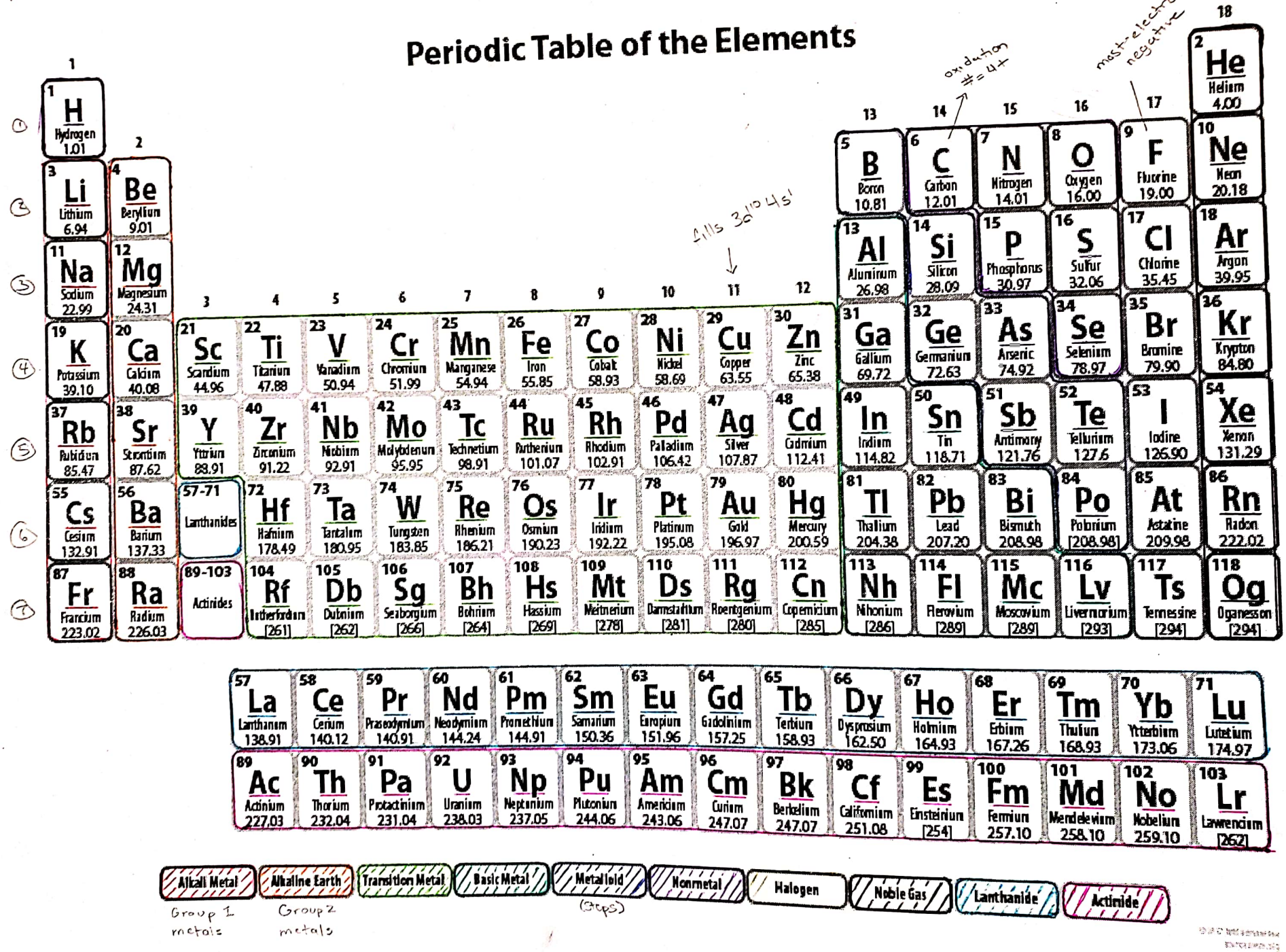
Family/ Group ↓ Period →

# Periodic Table of the Elements




oxidation # = 4+

most electro-negative

fills $3d^{10}4s^1$

Group 1 metals

Group 2 metals

(steps)

# Constants and Formulas

$c_s$ water = 4182 $\frac{J}{kg\,K}$

1 N = 1 kg m/s$^2$

1 J = 1 kg m$^2$/s$^2$

1 L·atm = 101.325 J = 101.325 Pa = 760 mmHg  ($p$ = 760 torr)

T(°F) = 1.8 T(°C) + 32

T(K) = T(°C) + 273.15

1 eV = 1.602 × 10$^{-19}$ J

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

$N_A$ = 6.022 × 10$^{23}$ mol$^{-1}$

h = 6.626 × 10$^{-34}$ J·s

c = 2.998 × 10$^8$ m/s

g = 9.80665 m/s$^2$

units in D: 1 D = 3.3356 E-30 Cm

dipole moment ($\mu$) = $\delta \cdot r$ (size partial charge (C) · distance btwn charges (m))

% ionic character = $\left(\frac{\delta}{1.0622E-19C}\right)(100) = \frac{\mu \text{ observed}}{\mu \text{ calculated}}$  (charge of e$^-$)

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

$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$  $c = \lambda\nu$  ($\lambda$ meters (per photon))  $\lambda = \frac{h}{mv}$

$h_1\delta_1 = h_2\delta_2$  $E = h\nu$  $KE = \frac{1}{2}mv^2$  $KE = h\nu - h\nu_0 = h\nu - W$ (where W = binding energy; $E_{photon}$, $\phi$, $\phi$)  $\Delta x \cdot m\Delta v \geq \frac{h}{4\pi}$ (Heisenberg uncertainty)

$PV = nRT$  $E_n = -B\left(\frac{1}{n^2}\right)$  $\Delta E = -B\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$ ($\Delta E$ btwn n lvls)  $|\Delta E| = h\nu$  $B = 2.179 \times 10^{-18}$ J

$P_t = \sum P_{(components)}$

$\frac{\text{mol}}{\Sigma \text{mol}} = \frac{P}{\Sigma P}$  $\Delta E = q + w$ (heat, work nrg)  $w = -P\Delta V$  $H = E + PV$

(mol fraction = ratio partial P)  $q = m \cdot C \cdot \Delta T$ (specific heat; or $q = C\,\Delta T$ if C is kJ)  $\frac{1}{\lambda} = (1.0974 \times 10^7\ m^{-1})\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$ ($n_f$ final, $n_i$ initial; Rydberg)

$\delta = \frac{PM}{RT}$

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

$h\nu = W + KE$ (work function)

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

bond order = $\frac{1}{2}$[#bonde$^-$ − # antibond e$^-$]

$KE = \frac{1}{2}mu^2 = \frac{3}{2}RT$  ($u_{rms}$ = root mean square; 8.314 J/K·mol; K; kg/mol)  $\frac{r_1}{r_2} = \frac{t_2}{t_1} = \sqrt{\frac{M_2}{M_1}}$ (ratio of rates of effusion)

↳ 0 DNE, >0 exists ✓

↳ ↑order = ↑nrg = ↓bond length

$u_{rms} = \sqrt{\frac{3RT}{M}}$  $PV = nRT$  $P = dgh$

mole fraction: $P_i = \chi_i P_{total}$

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

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

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

Real gasses → $[P + a(\frac{n}{V})^2][V - nb] = nRT$

| Soluble | Exceptions | Insoluble |
|---|---|---|
| $Li^+$, $Na^+$, $K^+$, $Rb^+$, $Cs^+$, $NH_4^+$ | none | |
| $NO_3^-$, $CH_3COO^-$, $ClO_3^-$ | none | |
| $Cl^-$, $Br^-$, $I^-$ | $Ag^+$, $Hg_2^{2+}$, $Pb^{2+}$ | |
| $SO_4^{2-}$ | $Ca^{2+}$, $Sr^{2+}$, $Ba^{2+}$, $Ag^+$, $Hg_2^{2+}$, $Pb^{2+}$ | |
| | $Li^+$, $Na^+$, $K^+$, $Rb^+$, $Cs^+$, $Ba^{2+}$ | $OH^-$ |
| | $Li^+$, $Na^+$, $K^+$, $Rb^+$, $Cs^+$, $NH_4^+$ | $CO_3^{2-}$, $PO_4^{3-}$, $S^{2-}$, $CrO_4^{2-}$ |

- $Mg(ClO_4)_2$
- $KC_2H_3O_2$

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

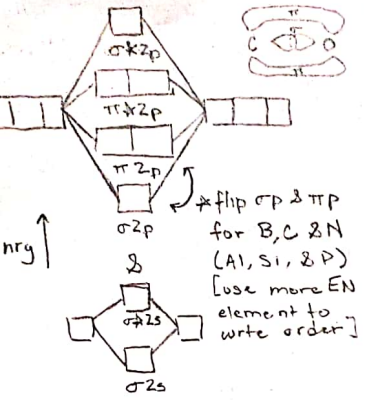
$\Delta H_{crystallization} = -\Delta H_{fusion}$

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

Clausius – Clapeyron

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

## Molecular Orbital

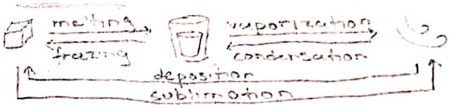



## Hybridization

$s^1 p^3 d^5$

- # combined atomic orbitals = # hybrid orbitals

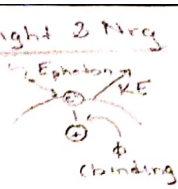
## Forms




## % Ionic Character

↑ difference EN values = ↑ % ionic

## Light & Mrg

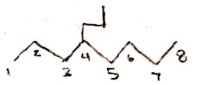



$h\nu = \frac{hc}{\lambda}$

$E_{ph} = \phi + KE$ ($KE = \frac{1}{2}mv^2$)

$h\nu_0 = \frac{hc}{\lambda_0}$

## Naming IUPAC (~~ & things)




← # so branch has lowest value

[4 propyl 3 octene]

1C → methane
2C → ethane
3C → propane
4C → butane
5C → pentane
6C → hexane
7C → heptane
8C → octane
9C → nonane
10C → decane

- = (2x bond) ↳ end in -lyl
- # substituents connected to parent ②

substituent name – locations of 2x or 3x bonds – parent name

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

## Strong Acids

① hydrochloric acid — $HCl_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$
② hydrobromic acid — $HBr_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + Br^-_{(aq)}$
③ hydroiodic acid. — $HI_{(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + I^-_{(aq)}$
④ nitric acid — $HNO_{3(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + NO_3^-_{(aq)}$
⑤ perchloric acid — $HClO_{4(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + ClO_4^-_{(aq)}$
⑥ sulfuric acid — $H_2SO_{4(aq)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + HSO_4^-_{(aq)}$

## Strong Bases

① $LiOH_{(aq)} \rightarrow Li^+_{(aq)} + OH^-_{(aq)}$
② $NaOH_{(aq)} \rightarrow Na^+ + OH^-$
③ $KOH_{(aq)} \rightarrow K^+ + OH^-$
④ $RbOH_{(aq)} \rightarrow Rb^+ + OH^-$
⑤ $CsOH_{(aq)} \rightarrow Cs^+ + OH^-$

} group 1A hydroxides

⑥ $Ca(OH)_{2(aq)} \rightarrow Ca^{2+} + 2OH^-$
⑦ $Sr(OH)_{2(aq)} \rightarrow Sr^{2+} + 2OH^-$
⑧ $Ba(OH)_{2(aq)} \rightarrow Ba^{2+} + 2OH^-$

} group 2A hydroxides

## Electrolytes

- strong — strong acid/base, soluable ionic compound
- weak — weak acid/base, insoluable ionic compound
- non — covalent compounds

## Electronegativity (EN diff)

ΔEN → 0.1–0.4 → nonpolar covalent; 0.5–1.9 → polar covalent; ≥ 2.0 → ionic

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

$NH_4^+$ ammonium

Conversion Formula Value

Name _____ Section Number _____

molecules / mol → to find atoms need # atom / molecule

## POSSIBLY USEFUL INFORMATION

Avogadro

$N_A = 6.022 \times 10^{23}\ mol^{-1}$ | $T(°F) = (1.8T(°C)) + 32$ | $T(K) = T(°C) + 273.15$

$2.54\ cm = 1\ in$ | $V = (4/3)\pi r^3$ | $V = \pi r^2 h$

$1\ L = 1000\ cm^3$ | $V = \ell w h$ | $V = Ah$

$A = \pi r^2$ | $A = \ell w$ | $A = 4\pi r^2$

$C = 2\pi r$ | $PV = nRT$ | $P = F/A$ lattice nrg = (1 cation · 1 anion) / (1 cation radius + 1 anion radius)

$F = ma$ | $P = gdh$ | $1\ Pa = 1\ N/m^2 = \frac{1\ kg}{m \cdot s^2}$

$1\ N = 1\ kg\ m/s^2$ | $g = 9.80665\ m/s^2$ | STP is 0°C, 1 atm, 22.41L,

$1\ J = 1\ kg\ m^2/s^2$ | $1\ L\ atm = 101.325\ J$ | $n = N / N_A$

$R = 8.3145\ J/mol\ K$ | $R = 0.08206\ L\ atm/mol\ K$ | $n = m / M$

[760 mmHg = 1 atm = 760 Torr = 101.325 kPa = 1.01325 bar] | | $6.022 \times 10^{23}\ amu = 1\ g$

$u_{rms} = \sqrt{\frac{3RT}{M}}$ | $(E_k)_{average} = (3/2)(R / N_A)T$ | rate $\alpha$ $u_{rms}$ | $\frac{r_1}{r_2} = \frac{t_2}{t_1} = \sqrt{\frac{M_2}{M_1}}$

$E = (3/2)nRT$ | $q = C\Delta T$ | $q = mc\Delta T$

$\Delta E = q + w$ | $w = -P_{external}\Delta V$ | $H = E + PV$

$\Delta H = \Delta E + \Delta(PV)$ | $\Delta H = \Delta E + P\Delta V$ | $\Delta H = \Delta E + V\Delta P$

$\Delta X = X_{final} - X_{initial}$ | $h\nu = \phi + (1/2)mu^2$ ($\phi$ = bonding nrg $= h\nu_0 = \frac{hc}{\lambda_0}$) | $\lambda = h / mc$

$R = 1.097 \times 10^7\ m^{-1}$ | $h = 6.626 \times 10^{-34}\ J\ s$ | $c = 3.00 \times 10^8\ m/s$

Heisenberg uncertainty principle: $E = h\nu$ | $E_n = -R\,h\,c\,Z^2 / n^2$ | $\lambda = h / mu$ → de Broglie (u - m/s, m - kg)

$(\Delta x)(m\Delta u) \geq (h/4\pi)$ | $R\,h\,c = 2.18 \times 10^{-18}\ J$ | $c = \lambda\nu$

$1\ gallon = 4\ qt$ | $1.057\ qt = 1\ L$ | $\nu$ = frequency | $u$ = speed

$m_p = 1.6726 \times 10^{-27} kg$ | $m_n = 1.675 \times 10^{-27} kg$ | $m_e = 9.109 \times 10^{-31} kg$

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 $NH_4^+$