Chemical Equations

solid(s)  liquid(l)  gas(g)

aqueous(aq): dissolved in water

Balancing Chemical Equations by Inspection

\[ \text{Mg(s)} \rightarrow \text{N}_2(g) \longrightarrow \text{Mg}_2\text{N}_2(s) \]

\[ \text{C}_3\text{H}_8(l) + \text{O}_2(g) \rightarrow \text{CO}_2(g) + \text{H}_2\text{O}(g) \]

Combustion

Relative Atomic Masses

- **Relative Mass**: Not integer because:
  1. Naturally occurring isotopes
  2. \( p^+; n^0 \) mass not identical: 1.0073, 1.0087 (wrt to \( ^{12}\text{C} \))
  3. \( E = mc^2 \); some mass converted to \( E \)

\[ ^{35}\text{Cl} = 75.555\% \text{ relative mass} = 34.96885 \]
\[ ^{37}\text{Cl} = 24.445\% \text{ relative mass} = 36.94739 \]

**Weighted average**: 
\[
\frac{0.75555(34.96885) + 0.24445(36.94739)}{1} = 35.453
\]

Formula Weight (FW) = 35.453

Relative Atomic Masses

- **Relative masses; no units**

\[ \text{H} \quad 1.008 \]
\[ \text{C} \quad 12.011 \]

"Average" C atom = 12.011 x 1.008 x 10^-24 g
\( (\frac{1}{12} \text{ mass } ^{12}\text{C} \text{ atom}) \)

Why The Mole?

\[ \text{Br} \quad 35 \quad 80 \]
\[ \text{Ca} \quad 20 \quad 40 \]

1 atom \( \text{Br} \) = \( \_ \) x mass of 1 atom \( \text{Ca} \)
1 atom \( \text{Br} \) = same mass as 1 atom \( \text{Ca} \)
1 g \( \text{Br} \) = \( \_ \) # of atoms as 1 g \( \text{Ca} \)
2 g \( \text{Br} \) = same # of atoms as 1 g \( \text{Ca} \)
80 g \( \text{Br} \) = same # of atoms as

Wilhelm Ostwald
German
1893

Amedeo Avogadro
Italian
1776 - 1856

Avogadro's Number: \( N_A \)

6.022 x 10^{23}

80 g Br = same # of atoms as
Unit for Formula Weight

(molar mass) \( \text{FW} = \frac{29}{63.546} \) g/mole

mass, in grams, that contains 1 mole

\( \text{FW Cu} = 63.546 \text{ g Cu per 1 mole Cu} = 63.546 \text{ g Cu}/1 \text{ mole Cu} = 63.546 \text{ g/mole} \)
do not use amu!

Formula Weight of Compounds

atom’s FW \( \Rightarrow \) compound’s FW (molecular/ionic)

\( \text{C}_4\text{H}_12\text{O}_6 \) \( \text{FW} = \)

\( \text{NaClO}_3 \) \( \text{FW} = \)

Percent Composition (by Weight) from Formula

copper(II) oxide \( \text{CuO} \)

\(-80\% \text{ Cu}, -20\% \text{ O} \)

\( \%X = \frac{\#X \times \text{FW}_X}{\text{FW}} \times 100 \)

\( \%\text{Cu} = \frac{1 \times 63.546 \text{ g/mole}}{79.545 \text{ g/mole}} \times 100 = 79.887\% \)

\( \%\text{O} = \frac{1 \times 15.999 \text{ g/mole}}{79.545 \text{ g/mole}} \times 100 = 20.113\% \)

Combustion Analysis

chemical composition of organic compounds \( (\text{C}_x\text{H}_y\text{O}_z) \)

\( x \text{ CO}_2 + \frac{y}{2} \text{H}_2\text{O} \)

\( \frac{\%\text{H}}{2} + \frac{\%\text{C}}{4} + \%\text{O} \)

Stoichiometry

1. find a balanced equation
2. convert what you have (mass, concentration) to moles
3. use balanced equation to convert moles of what you have to moles of what you want: stoichiometry
4. answer question: mass, concentration, gas volume…

\( \text{C}_{15}\text{H}_{11}\text{I}_4\text{NO}_4 \)

mass from 100 mg NaI?