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Stoichiometry

Stoichiometry is the relationship between the quantities of substances in a reaction.

We look at:

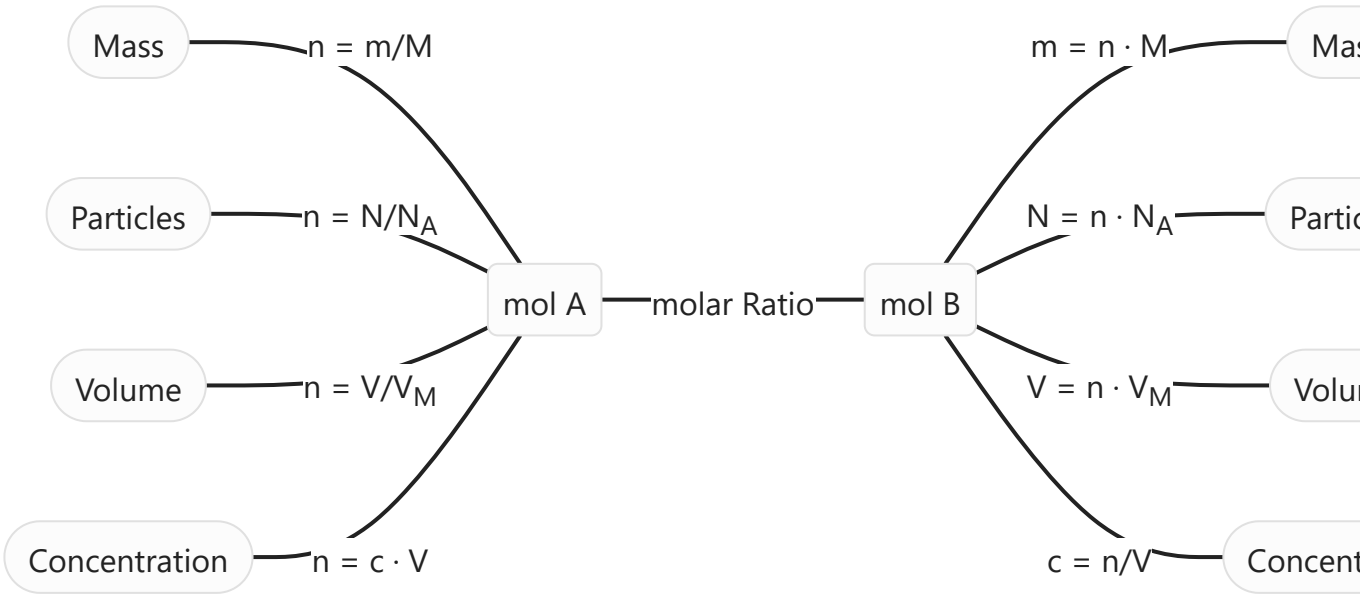
- Mass, Molar mass, and the Mole
- Concentration, Volume, and the Mole
- Number of Particles, Avogadro's Number, and the Mole
- Volume, Molar volume, and the Mole.

We can use *balances chemical formulas* to work out these substances, as the chemical formula shows us the *mole ratio* of substances.

> 💡 **Eg.**
>
> The formula: $4H_2 + O_2 \rightarrow 2H_2O$ means that:
>
> For every mole of $2H_2O$ there is $4\ H_2$ mole and $1\ O_2$ mole
>
> We can also state this as: $4 : 1 : 2 = H_2 : O_2 : H_2O$

This becomes very useful when we try to convert between different amounts of substances. We can use formulas that dictate the relationship between the number of moles and other quantities to convert from one quantity to another, even across chemical reactions.

This means we can take the mass of our reactants, convert it into moles, and then use the molar ratios to find the amount of moles in our product. From there we can find the mass, number of particles, volume, or concentration of our product. These relationships are shown in this diagram:



Conversion Formulas

Mass

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

Where:

$n =$ moles (mol)

$m =$ mass $(grams)$

$M =$ Molar Mass $(g.mol^{-}1)$

Particles

$$n = \frac{N}{N_A}$$

Where:

$n =$ Moles (mol)

$N =$ Particles $(particles)$

$N_A =$ Avogadro's Constant (6.02×10^{23})

Volume

$$n = \frac{V}{V_m}$$

Where:

$n =$ Moles (mol)

$m =$ Volume (dm^3)

$V_m =$ Molar Volume $(22.4dm^3)$

Concentration

$$n = c \times V$$
Where:
$n = \text{Moles } (mol)$
$c = \text{Concentration } (mol.\, dm^{-3})$
$V = \text{Volume } (dm^3)$

Steps to Stoichiometry

1. Balance your Equation – always check it is balanced
2. Convert given information into moles
3. Find the Molar Ratio between the given substance and the substance you are trying to calculate
4. Convert moles of the substance you are trying to calculate into the wanted unit

☰ 💡 Example

$2H_20 \rightarrow 2H_2 + 0_2$

14g of O_2 reacts with hydrogen. Find out the mass of H_2 will react to form $2H_2O$

Given: Mass of O_2 (14g)

Needed: Mass of H_2

$$\text{Finding Moles of } O_2\text{: } n = \frac{m}{M} \rightarrow n = \frac{14}{2(16)} = 0.4375mol$$

$$\begin{aligned} \text{Finding Molar Ratio: } 2H_2 : O_2 &= 2:1 \\ 2:1 &= n_{H_2} : n_{O_2} \\ 2:1 &= n_{H_2} : 0.4375mol \\ n_{H_2} &= 0.875mol \\ \text{converting to mass: } m = n(M) &\rightarrow m = 0.875(2) = 1.75g \end{aligned}$$