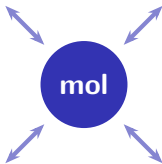


Atoms, Molecules & Stoichiometry

A-Level Chemistry ■ Topic 2

A-Level Chemistry



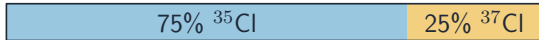
What we will cover

- 1 Relative masses
- 2 The mole
- 3 Formulas & equations
- 4 Reacting masses & yield
- 5 Gas volumes
- 6 Titration



mass is the basis

Relative masses



$$A_r = \frac{(75 \times 35) + (25 \times 37)}{100} = 35.5$$



titration photo

The mole

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

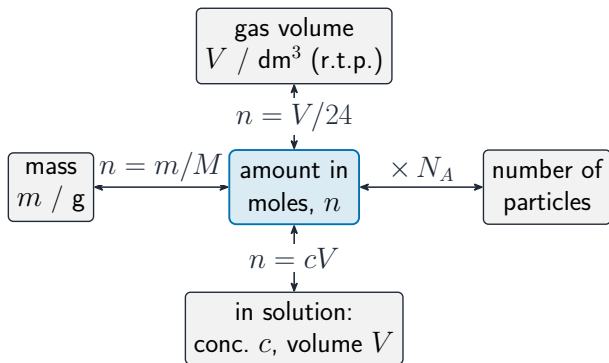
$$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$$

Worked example

moles in 8.0 g of CH_4 ($M = 16$): $n = \frac{8.0}{16} = 0.50 \text{ mol}$

One **mole** 摩尔 contains N_A particles (atoms, molecules or ions); the **molar mass** 摩尔质量 M in g mol^{-1} equals A_r or M_r .

The mole map



The mole is the hub of every amount calculation:

- mass: $n = m/M$
- particles: $\times N_A$
- gas: $n = V/24$
- solution: $n = cV$

Formulas and equations

empirical formula 实验式

simplest ratio – CH_3

molecular formula 分子式

actual atoms – C_2H_6

Equations are **balanced** 配平 with **state symbols** 状态符号 (s, l, g, aq). An **ionic equation** 离子方程式 drops **spectator ions** 旁观离子: $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$.

Reacting masses and yield

Worked example: $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$

4.8 g Mg = 0.20 mol; ratio 1:1 $\Rightarrow$ 0.20 mol MgO = $0.20 \times 40 = 8.0$ g

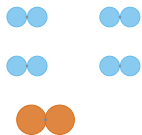
$$\text{percentage yield} = \frac{\text{actual product}}{\text{maximum possible}} \times 100\%$$

The numbers in a balanced equation give the mole ratio – the **stoichiometry** 化学计量.

Limiting reagent



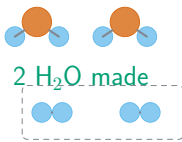
start with



4 H₂ 1 O₂

O₂ runs out first:
limiting reagent

you get



2 H₂O made

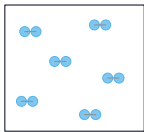
2 H₂ left over (excess)

The **limiting reagent** 限量试剂 runs out first and decides how much product forms.

The leftover reactant is in **excess** 过量试剂. Always base the calculation on the limiting reagent.

Gas volumes

same volume, same temperature and pressure



hydrogen, H_2



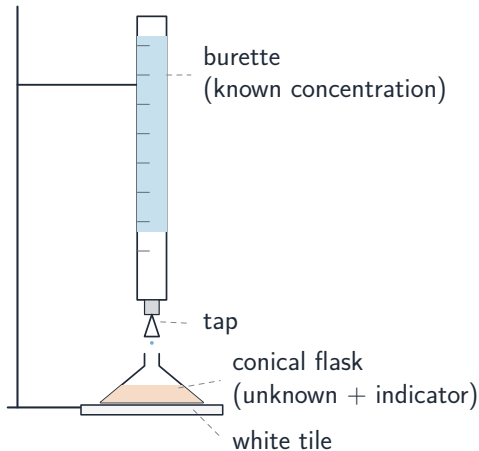
carbon dioxide, CO_2

the same **number** of molecules (6 each), even though CO_2 is bigger

Equal volumes of any gases (same temperature & pressure) hold equal numbers of molecules.

At r.t.p., one mole of any gas is 24.0 dm^3 , so $n = \frac{V}{24.0}$.

Titration



Concentration 浓度: $n = c \times V$ (in mol dm^{-3} , V in dm^3).

NaOH neutralised by HCl

20.0 cm^3 of $0.100 \text{ mol dm}^{-3}$ HCl $\Rightarrow$
NaOH = $0.0800 \text{ mol dm}^{-3}$

A **titration** 滴定 finds an unknown concentration.

Topic 2 – key takeaways

1 The mole

$$n = m/M; N_A = 6.02 \times 10^{23}$$

2 Formulas

empirical (ratio) vs molecular (actual)

3 Reacting masses

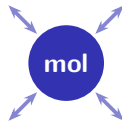
use the mole ratio; limiting reagent

4 Gases & solutions

$$n = V/24 \text{ at r.t.p.}; n = cV$$

Check yourself

- 1 How many moles in 16 g of CH_4 ?
- 2 Empirical formula of C_2H_6 ?
- 3 What volume does 1 mol of gas occupy at r.t.p.?
- 4 Which reagent decides how much product forms?



Answers 1. 1 mol 2. CH_3 3. 24.0 dm^3 4. the limiting reagent