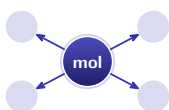


Stoichiometry

IGCSE Chemistry • Topic 3

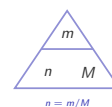
IGCSE Chemistry



Stoichiometry

What we will cover

- 1 Formulae & equations
- 2 The mole & molar mass
- 3 Gas volumes & concentration
- 4 Reaction calculations
- 5 Limiting reactant & titration
- 6 Empirical formulae & percentages



the mole and molar mass

1

Formulae and equations

Stoichiometry

Formulae and equations

Chemical formulae



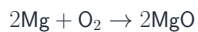
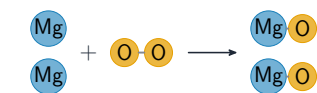
the charge numbers cross over to become the subscripts (then simplify if they share a factor)

- The **molecular formula** 分子式 is the actual number of each atom in one **molecule** 分子. For glucose it is $\text{C}_6\text{H}_{12}\text{O}_6$.
- The **empirical formula** 实验式 is the simplest whole-number **ratio** 比例 of the atoms or **ions** 离子 in a **compound** 化合物. For glucose it is CH_2O .

Stoichiometry

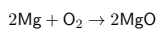
Formulae and equations

Writing and balancing equations



2 Mg and 2 O on each side: balanced

A **balanced** 配平 symbol equation has the **same** number of each atom on both sides.

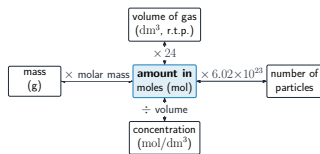


State symbols 状态符号:
(s) (l) (g) (aq).

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The mole

The mole and molar mass



One **mole** 摩尔 = 6.02×10^{23} particles (the **Avogadro constant** 阿伏伽德罗常数).

$$n = \frac{\text{mass}}{\text{molar mass}}$$

Example

36 g of water: $n = \frac{36}{18} = 2$ mol.

Gas volumes and concentration

At r.t.p. one mole of **any** gas fills 24 dm³.
 $V = n \times 24$

Example

0.25 mol CO₂: $V = 0.25 \times 24 = 6$ dm³.

$$\text{conc (mol/dm}^3\text{)} = \frac{n}{V(\text{dm}^3)}$$

Convert volume first: 1 dm³ = 1000 cm³.

Reaction calculations

Three steps:

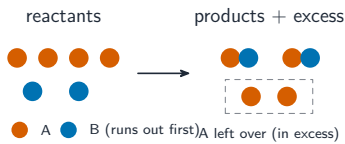
- 1 known mass → moles
- 2 use the equation **ratio**
- 3 moles → mass / volume

12 g Mg burns: mass of MgO?

$2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$
moles Mg = $12/24 = 0.5$
ratio 1:1 ⇒ 0.5 mol MgO
mass = $0.5 \times 40 = 20$ g

3 Applications

Limiting reactant



The **limiting reactant** 限量反应物 runs out first and **decides** how much product forms. The other reactant is left over in **excess** 过量.

Titration



25.0 cm³ NaOH neutralised by 20.0 cm³ of 0.10 HCl

moles HCl = $0.10 \times \frac{20.0}{1000} = 0.0020$
ratio 1:1 ⇒ 0.0020 mol NaOH
conc = $\frac{0.0020}{25.0/1000} = 0.08$ mol/dm³

Empirical formula and percentages

40% Ca, 12% C, 48% O

$\div A_r$: 1, 1, 3

ratio 1:1:3 $\Rightarrow$ **CaCO₃**

$$\% \text{ by mass} = \frac{\text{mass of element}}{M_r} \times 100$$

% N in NH₄NO₃

$$\frac{28}{80} \times 100 = \mathbf{35\%}$$

4

Recap

Topic 3 – key takeaways

1 Mole

$$n = \text{mass} / \text{molar mass}; 6.02 \times 10^{23}$$

2 Gas & conc

$$24 \text{ dm}^3 \text{ per mole; conc} = n/V$$

3 Calculations

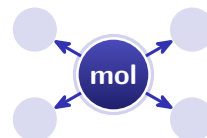
to moles, use the ratio, back again

4 Limiting

the reactant that runs out sets the yield

Check yourself

- 1 How many moles are in 18 g of water?
- 2 What volume does 1 mol of gas fill at r.t.p.?
- 3 What is a spectator ion?
- 4 How do you find an empirical formula from masses?



Answers 1. 1 mol 2. 24 dm³ 3. an ion unchanged on both sides 4. divide each mass by A_r , then by the smallest