

Exercise walk-through

2.1

Relative masses of atoms and molecules

A-Level Chemistry

Formulas and equations

empirical formula

simplest ratio – CH_3

molecular formula

actual atoms – C_2H_6

Equations are **balanced** with **state symbols** (s, l, g, aq). An **ionic equation** drops **spectator ions** : $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$.

Formulas and equations, in detail

element	% by mass	$\div A_r \rightarrow$ moles	smallest (3.33)	ratio
C	40.0	$40.0/12 = 3.33$	1.0	1
H	6.7	$6.7/1 = 6.7$	2.0	2
O	53.3	$53.3/16 = 3.33$	1.0	1

empirical formula CH_2O - if $M_r = 180$, it fits $180/30 = 6$ times: molecular formula $\text{C}_6\text{H}_{12}\text{O}_6$

The empirical-formula recipe: divide by A_r , divide by the smallest, read off the ratio

Hydrated and anhydrous solids

Some solids hold water inside their crystals.

This water is the **water of crystallisation** .

Reacting masses and yield

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

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

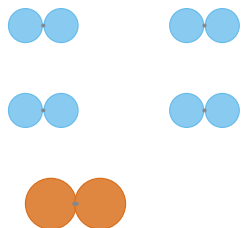
$$\text{percentage yield} = \frac{\text{actual product}}{\text{maximum possible}} \times 100\%$$

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

Limiting reagent



start with



O₂ runs out first:
limiting reagent

you get



2 H₂O made

2 H₂ left over (excess)

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

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

Exercises 2.1·2.2

2.1 Define **relative atomic mass**.

[2]

2.2 Calculate the relative molecular mass of calcium carbonate, CaCO_3 (A_r : Ca 40, C 12, O 16).

[1]

Exercises 2.1·2.2

2.1 Define **relative atomic mass**.

[2]

2.1

- the average mass of an element's atoms (over its isotopes) compared with $\frac{1}{12}$ of a carbon-12 atom

2.2 Calculate the relative molecular mass of calcium carbonate, CaCO_3 (A_r : Ca 40, C 12, O 16).

[1]

2.2

- $40 + 12 + 3(16) = 100$

Exercises 3.1·3.2

3.1 Why is the relative atomic mass of chlorine 35.5 and not a whole number? [1]

☐

- A chlorine atoms are damaged
- B it is a weighted average of two isotopes
- C chlorine has half a neutron
- D the value is rounded

3.2 What is the relative formula mass of magnesium hydroxide, $\text{Mg}(\text{OH})_2$ (A_r : Mg 24, O 16, H 1)? [1]

☐

- A 41
- B 49
- C 58
- D 74

Exercises 3.1·3.2

3.1 Why is the relative atomic mass of chlorine 35.5 and not a whole number? [1]

☐

- A chlorine atoms are damaged
- B it is a weighted average of two isotopes
- C chlorine has half a neutron
- D the value is rounded

3.1 B

- It is a weighted average of ^{35}Cl and ^{37}Cl

3.2 What is the relative formula mass of magnesium hydroxide, $\text{Mg}(\text{OH})_2$ (A_r : Mg 24, O 16, H 1)? [1]

☐

- A 41
- B 49
- C 58
- D 74

3.2 C

- $24 + 2(16 + 1) = 24 + 34 = 58$

Exercise 3.3 (a)

3.3 Magnesium has three isotopes: ^{24}Mg (79%), ^{25}Mg (10%) and ^{26}Mg (11%).

(a) Calculate the relative atomic mass of magnesium to 1 decimal place. [3]

Exercise 3.3 (a)

3.3 Magnesium has three isotopes: ^{24}Mg (79%), ^{25}Mg (10%) and ^{26}Mg (11%).

(a) Calculate the relative atomic mass of magnesium to 1 decimal place. [3]

(a)

$$\bullet \quad A_r = \frac{(24 \times 79) + (25 \times 10) + (26 \times 11)}{100} = \frac{2432}{100} = 24.3$$

Exercise 3.3 (b)

3.3 Magnesium has three isotopes: ^{24}Mg (79%), ^{25}Mg (10%) and ^{26}Mg (11%).

(b) Explain why this value is not a whole number.

[1]

Exercise 3.3 (b)

3.3 Magnesium has three isotopes: ^{24}Mg (79%), ^{25}Mg (10%) and ^{26}Mg (11%).

(b) Explain why this value is not a whole number.

[1]

(b)

- it is a weighted average of isotopes of different mass

Exercise 3.4

3.4 Calculate the relative molecular mass of ethanol, $\text{C}_2\text{H}_5\text{OH}$ (A_r : C 12, H 1, O 16). [2]

Exercise 3.4

3.4 Calculate the relative molecular mass of ethanol, $\text{C}_2\text{H}_5\text{OH}$ (A_r : C 12, H 1, O 16). [2]

3.4

- $2(12) + 6(1) + 16 = 24 + 6 + 16 = 46$