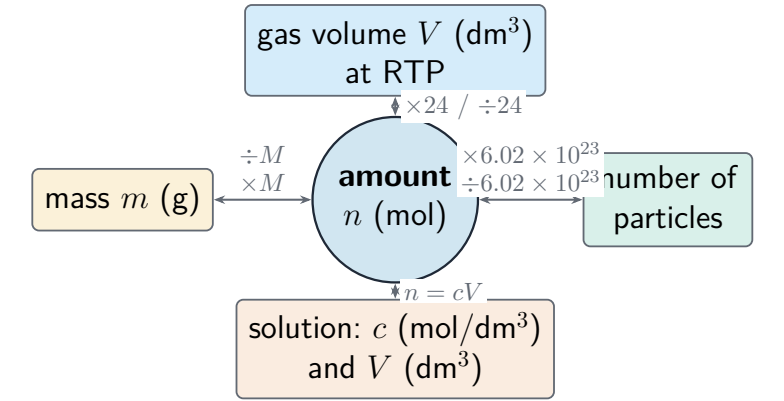
Exercise walk-through

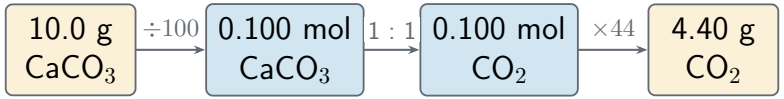
3.1 Measurements, conservation of mass and equations (4.3.1.1–4.3.1.3)

AQA · GCSE · Chemistry

Figure: Moles and reacting masses (higher tier)



worked chain: $CaCO_3 \rightarrow CaO + CO_2$



the equation ratio links amounts in moles, never masses

- Mass $\div$ M gives moles; moles $\times$ M gives mass.
- Use the equation's ratio in moles.

Concentrations in mol/dm^3 (chemistry only, higher tier)

- **Molar concentration** is the number of moles of **solute** in each dm^3 of solution:
- To change it into **mass concentration** , multiply by the Mr: 0.20 mol/dm^3 NaOH is $0.20 \times 40 = 8.0$ g/dm^3.
- In a **titration** , you measure the exact volumes of an acid and an alkali that react.
- If you know one **concentration**, you can calculate the other, using the mole ratio in the equation.

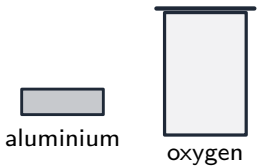
$$\text{moles} = \text{concentration (mol/dm}^3\text{)} \times \text{volume (dm}^3\text{)}$$

Sources for this lesson

- AQA, *GCSE Chemistry (8462) specification*, section 4.3.
- G. H. Lockwood, *Final Report of the Board of Inquiry Investigating the Circumstances of an Accident Involving the Air Canada Boeing 767 Aircraft C-GAUN that Effected an Emergency Landing at Gimli, Manitoba* (Government of Canada, April 1985).
- A. Lavoisier, *Traité élémentaire de chimie* (1789), where the law of **conservation of mass** was first stated clearly.
- International Bureau of Weights and Measures, *The International System of Units* (9th edition, 2019), on the mole and the **Avogadro constant**.

Exercises 2.1·2.2

2.1 Balance: ___ Al + ___ O_2 → ___ Al_2O_3. [1]

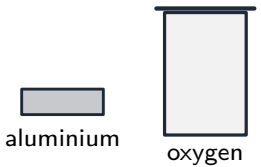


2.2 Calculate the Mr of ammonium sulfate, $(NH_4)_2SO_4$ (N = 14, H = 1, S = 32, O = 16). [2]

$(NH_4)_2SO_4$

Exercises 2.1·2.2

2.1 Balance: ___ Al + ___ O_2 → ___ Al_2O_3. [1]



2.1 4 Al + 3 O_2 → 2 Al_2O_3.

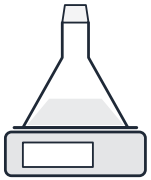
2.2 Calculate the Mr of ammonium sulfate, $(NH_4)_2SO_4$ (N = 14, H = 1, S = 32, O = 16). [2]

$(NH_4)_2SO_4$

2.2 $2 \times (14 + 4) + 32 + 64 = 36 + 32 + 64 = 132$.

Exercises 2.3·3.1

2.3 A marble chip reaction loses 2.2 g. Suggest what left the flask. [1]



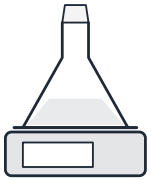
3.1 A student heats 5.00 g of copper in air and obtains 5.63 g of black copper oxide. Explain the mass change and show it obeys conservation of mass. [4]



copper

Exercises 2.3·3.1

2.3 A marble chip reaction loses 2.2 g. Suggest what left the flask. [1]



2.3 Carbon dioxide gas.

3.1 A student heats 5.00 g of copper in air and obtains 5.63 g of black copper oxide. Explain the mass change and show it obeys conservation of mass. [4]



3.1 Copper combines with oxygen from the air; the oxygen's mass adds to the solid; mass gain = 5.63 − 5.00 = 0.63 g of oxygen; total reactant mass (copper + oxygen) equals product mass – conservation of mass holds once the gas is counted.

Setup for exercise 3.2 (1/2)

3.2 Calculate the percentage by mass of sulfur in sulfuric acid, H_2SO_4 (H = 1, S = 32, O = 16). [3]

H_2SO_4

3.3 Four repeated volume readings are 24.10, 24.30, 24.20 and 24.80 cm^3. The final trial has a recorded reading error and must be excluded. Give the mean of the remaining readings and estimate uncertainty using the stated half-range convention. [3]

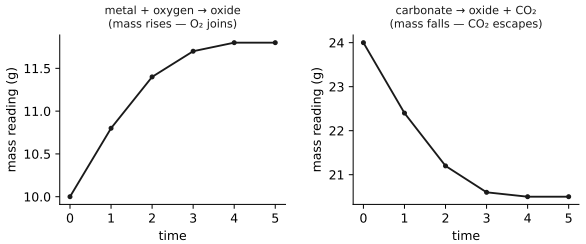


Setup for exercise 3.2 (2/2)

3.4 Three repeated masses are 2.40, 2.42 and 2.44 g. Describe their positions on a number line, calculate the mean and range, then explain why a narrow range does not prove accuracy. [4]



3.5 A student heated a metal in an open crucible and, separately, heated a metal carbonate in an open tube. The graphs show the mass readings.



(a) Use the left graph to find the mass of oxygen that combined with the metal. [1]

(b) Use the right graph to find the mass of carbon dioxide given off. [1]

(c) Explain why both mass readings become constant after time 4. [1]

Exercise 3.2

(d) Suggest how the carbonate experiment could be changed so that the mass reading stays the same throughout. Explain your answer. [2]

Exercise 3.2

(d) Suggest how the carbonate experiment could be changed so that the mass reading stays the same throughout. Explain your answer. [2]

3.2 $\mathrm{Mr}(H_2SO_4) = 2 + 32 + 64 = 98$; sulfur contributes 32; $\%S = 32/98 \times 100 = 32.65\ \% \approx 32.7\ \%$.

3.3 The recorded-error reading 24.80 is excluded for the stated reason, not merely because it is furthest from the others; mean $= (24.10 + 24.20 + 24.30) \div 3 = 24.20\ \mathrm{cm}^3$; uncertainty $\pm$ range$/2 = \pm 0.10\ \mathrm{cm}^3$.

3.4 Marks at 2.40, 2.42 and 2.44 g on an equally spaced labelled mass axis. Mean $= (2.40 + 2.42 + 2.44)/3 = 2.42$ g; range $= 2.44 - 2.40 = 0.04$ g. A systematic calibration error can shift all readings together while leaving a narrow range.

3.5 (a) $11.8 - 10.0 = 1.8$ g of oxygen. (b) $24.0 - 20.5 = 3.5$ g of carbon dioxide. (c) The reaction has finished: all the metal (or carbonate) has reacted. (d) Heat the carbonate in a sealed (closed) container; the carbon dioxide cannot escape, so the total mass of the system stays the same – mass is conserved.