

CHEMISTRY 3 | Quantitative chemistry

AQA Combined Science Trilogy • Core knowledge first • Purple panels are Higher Tier

1 Conservation and balancing

No atoms are created or destroyed.

Total reactant mass = total product mass.

Include **all gases**. In a closed system, matter cannot enter or leave.

Missing mass: 12 g carbon + 32 g oxygen = **44 g carbon dioxide**. Add or subtract.



H: 4 each side. O: 2 each side.

Change **front coefficients**, never subscripts.
A coefficient multiplies the **whole formula**.

3H₂O: 6 H and 3 O atoms.

Check every element; use the simplest ratio.

2 Formula mass and percentages

M_r = sum of A_r values for every atom.

Relative formula mass has **no unit**.

Use the A_r values given in the question.

H₂O: (2 × 1) + 16 = **18**.

Ca(OH)₂: 40 + 2 × (16 + 1) = **74**.

The bracket 2 multiplies both O and H.

% = element contribution / M_r × 100

Count **all atoms** of the chosen element.

Use masses, not the fraction of atoms.

Ca: 40

Total M_r = 100

Calcium in CaCO₃: 40/100 × 100 = **40%**.

Oxygen in H₂O: 16/18 × 100 = **88.9%**.

Keep extra digits; round the final answer.

3 Gases and measurement uncertainty

Solid gains mass: gas enters and reacts.



2.4 g Mg → 4.0 g MgO: **1.6 g O₂ gained**.

Solid loses mass: a product gas escapes.



10.0 g → 5.6 g solid: **4.4 g CO₂ released**.

Mass is conserved when the gas is included.

Readings: 4.8, 5.0, 5.2 g

Mean = (4.8 + 5.0 + 5.2)/3 = **5.0 g**.

Range = 5.2 – 4.8 = **0.4 g**.

If using **half the range**, uncertainty = ±0.2 g.

Report **5.0 ± 0.2 g**. Follow the stated method.

Precise: readings close together.

Accurate: close to the true value.

Repeats do not remove a systematic error.

4 Concentration in g/dm³

Concentration = mass / volume

c = m/V · solute mass in g; volume in dm³.

Use the **final solution volume**.

$$1000 \text{ cm}^3 = 1 \text{ dm}^3$$

cm³ → dm³: divide by 1000.

250 cm³ = 0.250 dm³; 500 cm³ = 0.500 dm³.

Example: 10 g in 500 cm³ of solution.

c = 10/0.500 = **20 g/dm³**.

Mass = concentration × volume

For 250 cm³ at 20 g/dm³:

m = 20 × 0.250 = **5.0 g**.

Volume = mass / concentration.

HT: fixed volume, double mass → double c.

Fixed mass, double volume → half c.

5 Higher Tier: moles and masses

1 mol = 6.02 × 10²³ stated particles.

Molar mass (g/mol) is numerically equal to M_r.

n = mass / molar mass

Mass = n × molar mass.

9 g H₂O: 9/18 = **0.50 mol**.

Molecules = 0.50 × 6.02 × 10²³

= **3.01 × 10²³ water molecules**.

Mass → moles → ratio → mass



From 12 g Mg with excess oxygen:

1. Mg = 12/24 = **0.50 mol**.

2. Mg:MgO = 1:1 → **0.50 mol MgO**.

3. MgO mass = 0.50 × 40 = **20 g**.

Coefficients give **mole ratios, not gram ratios**.

Convert mg or kg to **g** before using molar mass.

6 Higher Tier: ratios and limits

Find coefficients from masses:

Convert every mass to moles; divide by the smallest amount; scale to whole numbers.

1:0.5:1 → 2:1:2. Check the atom counts.

1:1.5:1 → 2:3:2; do not round 1.5 to 2.

Limiting reactant: used up first, limiting product.

Compare **available moles / coefficient**.

The smaller result limits the reaction.



12 g Mg: 12/24 = 0.50 mol; ÷2 = **0.25**.

4 g O₂: 4/32 = 0.125 mol; ÷1 = **0.125**.

Oxygen limits. MgO = 2 × 0.125 = 0.25 mol.

Maximum MgO mass = 0.25 × 40 = **10 g**.

Mg used = 0.25 × 24 = 6 g; **6 g Mg remains**.

Adding more of the excess reactant alone cannot make more product.