Reacting amounts and titration calculations

Student activity • calculation and evidence workshop

YEAR 10 / LESSON 59 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

The question

How does the balanced equation control a concentration calculation?

Start with shared-core reacting masses, then use a clearly labelled Chemistry-only titration dataset. Keep unit conversion, mole ratio and concentration as separate steps.

Equipment

- Booklet, calculator and periodic table
- No laboratory reagents or equipment

Desk activity only; equations do not authorise mixing chemicals.

Course coverage: Shared core: 1.29, steps 1–2 and questions 1–2. Chemistry-only: 1.34C, steps 3–6 and questions 3–6. All values are original invented practice data.

Plan, model or apparatus sketch

Draw a calculation flowchart; label shared and Chemistry-only stages.

Method and reasoning

Read the whole sequence before starting

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1. Shared core: balance Mg + HCl → $MgCl_2$ + H_2 and calculate the mass of HCl required for 1.20 g Mg. Use Ar(Mg)=24, Ar(H)=1 and Ar(Cl)=35.5.

2. Shared core: for $CaCO_3$ + 2HCl → $CaCl_2$ + H_2O + CO_2, calculate the CO_2 mass from 5.00 g $CaCO_3$ in excess acid. Use M($CaCO_3$)=100 and M(CO_2)=44 g mol^{-1}. Double Award learners explain both routes and check units.

3. Chemistry only: use invented accurate HCl titres 20.00, 20.05 and 20.70 cm^3. Select the pair agreeing within 0.10 cm^3 and calculate its mean; retain extra digits during the calculation.

4. The HCl concentration is 0.150 mol dm^{-3} and the pipetted NaOH volume is 25.0 cm^3. Convert both volumes to dm^3, calculate acid moles and apply HCl:NaOH = 1:1.

5. Divide the NaOH amount by its own solution volume to calculate concentration. Label the denominator clearly; it is not the titre or total mixed volume.

6. Apply the method to 20.0 cm^3 of 0.100 mol dm^{-3} H_2SO_4 reacting with 25.0 cm^3 NaOH. Explain the 1:2 ratio and compare the two calculations.

Cleanup

- Keep corrections and return shared materials.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Shared formulas: n=m/M; use coefficients for mole ratios. Chemistry-only formulas: n=cV and c=n/V with V in dm^3 when c is mol dm^{-3}; 1000 cm^3 = 1 dm^3. The two titration examples are separate invented scenarios, not experimental observations. Keep unrounded intermediate values; give final concentrations to three significant figures.

Task	Amount / ratio / units	Answer and check
Shared: Mg + acid		
Shared: $CaCO_3 \rightarrow CO_2$		
Chemistry: HCl / NaOH		
Chemistry: H_2SO_4 / NaOH		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Shared core: calculate HCl mass required for 1.20 g Mg and show the mole ratio.

2. Shared core: calculate CO_2 mass from 5.00 g $CaCO_3$ in excess acid.

3. Chemistry only: choose the concordant HCl titres and calculate the mean.

4. Chemistry only: calculate NaOH concentration in the HCl titration, showing the converted volumes.

5. Chemistry only: calculate NaOH concentration for the sulfuric-acid example and explain the coefficient 2.

6. Chemistry only: explain the errors in using cm^3 directly in $n=cV$ or dividing by the total mixed volume.