Volumetric analysis: evidence and precision

Student activity • shared task / Chemistry practical

YEAR 10 / LESSON 60 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

The question

How reliable is a concentration calculated from your titres?

Review shared-core stoichiometry, then Chemistry learners measure reacting volumes and evaluate a coded acid solution. The concentration is unknown to learners but checked and known to staff.

Equipment

- Shared task: booklet, calculator and periodic table
- Chemistry practical: eye protection, 50 cm^3 burette with stand/clamp and funnel; 25.0 cm^3 volumetric pipette and filler
- Conical flask, white tile, reagent beakers, deionised-water wash bottle and methyl orange
- Staff-checked 0.100 mol dm^{-3} NaOH and coded HCl near 0.100 mol dm^{-3}; no heating or metals

For the Chemistry practical, wear eye protection, use a pipette filler and fill burettes below eye level. Avoid splashes and report spills; do not heat or mix with other reagents.

Course coverage: Shared core: 1.29, step 1 and question 1. Chemistry-only practical and calculations: 1.34C/2.33C, steps 2–7 and questions 2–6.

Plan, model or apparatus sketch

Shared: draw a mass-to-moles route. Chemistry: sketch the titration setup.

Method and reasoning

Read the whole sequence before starting

YEAR 10 / LESSON 60 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

1. Shared core: use HCl + NaOH → NaCl + H_2O to calculate NaCl mass from 0.200 g NaOH in excess acid (M values 40 and 58.5). Double Award learners explain the ratio and evaluate mass-transfer losses; the remaining practical is Chemistry only.

2. Chemistry only: wear eye protection. Rinse burette with coded HCl, pipette with NaOH and conical flask with deionised water. Use a filler, never mouth pipetting.

3. Clamp the burette, lower it below eye level to fill and fill the jet without bubbles. Remove the funnel. Record the initial meniscus reading at eye level.

4. Deliver 25.0 cm^3 NaOH into the flask with the pipette and add two drops of methyl orange. Swirl while adding acid, then add dropwise near the first persistent orange endpoint. Do not overshoot to deep red.

5. Record the final reading and calculate the titre. Obtain a rough run and up to three accurate runs; seek two within 0.10 cm^3. Record outliers honestly and ask for more solution if further runs are needed.

6. Use the mean concordant titre and the known NaOH amount to calculate the coded HCl concentration. Keep unrounded intermediate values and include units.

7. Compare with the staff reference value after calculating. Explain repeatability versus accuracy and a possible systematic error. Keep actual measurements separate from practice data.

Cleanup

• Staff direct collection of dilute reaction mixtures and rinsings under the local waste plan. Rinse apparatus, return pipettes safely and wash hands.

Record your evidence

Blank spaces are for your own work

YEAR 10 / LESSON 60 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

Reference and task data

Chemistry-only: n(NaOH)=cV, n(HCl)=n(NaOH), c(HCl)=n(HCl)/mean acid volume in dm^3. Invented example for question 4 only: accurate titres 24.90, 24.95, 25.60 cm^3, with 25.0 cm^3 0.100 mol dm^{-3} NaOH. Do not enter these values as class readings. Two close titres show repeatability; they do not rule out a biased concentration or instrument.

Run	Initial / cm^3	Final / cm^3	Titre / cm^3
Rough			
Accurate 1			
Accurate 2			
Accurate 3			

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

YEAR 10 / LESSON 60 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

1. Shared core: calculate NaCl mass from 0.200 g NaOH in excess HCl and explain the 1:1 ratio.

2. Chemistry only: record actual readings and select concordant titres, or state that no suitable pair was obtained.

3. Chemistry only: calculate your coded HCl concentration from your actual results.

4. Chemistry only: calculate HCl concentration from the invented example and explain which value is excluded.

5. Chemistry only: explain how an air bubble initially in the burette jet can affect the calculated acid concentration.

6. Chemistry only: distinguish repeatability from accuracy and suggest a check for a systematic error.