# Volumetric analysis: evidence and precision

Teacher / technician

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

Staff preparation and answer guidance. Keep separate from student sheets. Shared stoichiometry task plus Chemistry-only titration. No calorimetry, heating or salt crystallisation in this lesson.

## Coverage and delivery

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.

Allow about 60 minutes. Follow the student sequence and use the answers to check reasoning.

## Requisition • class of 30, working in 15 pairs

| Item | Per pair / setup | Class total |
|---|---|---|
| Booklet / writing tools | 1 per learner | 30 sets |
| Calculator / periodic table | Shared task: each / per pair | 30 calculators; 15 tables |
| Titration set / eye protection | Chemistry: set per pair; protector each | 15 sets; 30 protectors |
| 0.100 M NaOH / coded HCl | Chemistry: about 100 $cm^3$ each + rinse | 2.0 L each incl. spare |
| Methyl orange / wash water | Chemistry: two drops per run | 10 $cm^3$; deionised-water bottles |

## Immediate safety

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.

# Preparation and delivery

Read alongside the student method

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**1.** Shared learners need only the stoichiometry task. For a full Chemistry class of 15 pairs, budget four 25 $cm^3$ titrations per pair: 1.50 L NaOH and approximately 1.50 L HCl; supply 2.0 L of each including rinsing/spare.

**2.** Staff prepare/verify 0.100 M NaOH and HCl close to 0.100 M using the school procedure; code the acid without concealing its hazard label. Keep the actual checked reference concentration. Do not issue an unidentified acid or assume an old NaOH bottle has its nominal value.

**3.** Provide 15 complete titration sets and 30 eye protectors. Supply 10 $cm^3$ approved methyl orange for at most 120 drops. No polystyrene cup, calorimetry thermometer, reactive metals or heating is part of this lesson.

**4.** Demonstrate burette reading (normally nearest 0.05 $cm^3$ for 0.1 divisions), bubble-free jet and correct volumetric pipette drainage. Let pupils retain nonconcordant results rather than replacing them.

**5.** Do not reveal the reference concentration until pupil calculations are complete. Discuss how $CO_2$ absorption affects NaOH and why concordance does not establish accuracy.

**6.** Allow 10 minutes shared review/briefing, 30 titration, 15 calculation/evaluation and 5 cleanup. If no concordant pair is obtained, diagnose the method rather than fabricate a value.

## Close of lesson

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

## Check before teaching

Check the cards, reference data and quantities against this requisition. Keep the staff answer guide separate until the checking stage. Supplied numerical practice datasets are labelled examples; they are not class measurements.

# Answers and teaching notes

Expected explanations • do not give as experimental observations

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• NaOH=0.200/40=0.00500 mol; NaCl=0.00500×58.5=0.2925 g, or 0.293 g to 3 s.f.

• Use actual final-minus-initial readings and the stated tolerance. Exclude the rough run; accept a report that further work is needed if results do not agree.

• n(NaOH)=0.100×0.0250=0.00250 mol; c(HCl)=0.00250 divided by actual mean titre in $dm^3$. Compare with the staff reference only afterwards.

• Use 24.90 and 24.95; mean=24.925 $cm^3$. c=0.00250/0.024925=0.1003009... mol $dm^{-3}$, or 0.100 to 3 s.f.; exclude 25.60.

• If liquid fills an initially empty jet, the recorded delivered volume is too large. With known alkali amount, dividing by that inflated acid volume gives an acid concentration that is too low.

• Repeatability concerns agreement under the same conditions; accuracy concerns closeness to the true/reference value. Check working-solution concentration and apparatus with an appropriate independent standard/check.

## References and provenance

Pearson Chemistry specification

RSC acid–alkali titration

Prepared 22 November 2026. Original wording, tables and questions. Sources inform the concepts and technique; the lesson scope and classroom quantities are explicitly described here. No laboratory trial or final school risk approval is claimed.