Core practical: comparing reaction rates

Teacher / technician

YEAR 10 / LESSON 39 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

Staff preparation and answer guidance. Keep separate from student sheets. Core practical: each pair conducts both comparisons with repeats. No whoosh bottle or solvent ignition. Laboratory trial and local risk assessment remain required.

Coverage and delivery

3.15 practical, supported by 3.9–3.11: effects of marble-chip surface area and hydrochloric-acid concentration on reaction rate.

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 / graph paper / ruler	1 set per learner	30 sets
Gas syringe/flask/stand/timer	1 checked set per pair	15 sets
Eye protection / cylinder / balance access	1 protector each; equipment per pair	30 protectors; 15 cylinders
Sorted marble chips	0.20 g × 6 per pair	22 g incl. spare
HCl working solutions	10.0 cm^3 per run	1.0 M: 750 cm^3; 0.5 M: 375 cm^3

Immediate safety

Wear eye protection; avoid acid splashes and report them immediately. Keep the syringe plunger free and tubing unobstructed. Stop if apparatus sticks or pressurises; call the teacher. Handle glassware carefully. No flames or heating.

Preparation and delivery

Read alongside the student method

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1. Each of 15 pairs performs six runs: A1/A2, B1/B2 and C1/C2. Ninety runs need 18 g marble; supply 22 g sorted into comparable large and smaller chip fractions. No powder. Each pair must make both comparisons, not rely only on pooled results.

2. Ninety runs require 600 cm^3 of 1.0 mol dm^{-3} HCl and 300 cm^3 of 0.5 mol dm^{-3} HCl; provide 750 and 375 cm^3 respectively including spare. Every run uses 10.0 cm^3 acid and 0.20 g marble with a 100 cm^3 gas syringe.

3. Use 0.20 g marble to keep expected gas below 50 cm^3, leaving margin in a 100 cm^3 syringe. Both acid amounts exceed the 4 mmol HCl needed for 0.20 g pure $CaCO_3$. Do not substitute larger masses, powder, smaller syringes or stronger acid.

4. Trial chip size and timing before class. Staff check free syringe travel, secure supports, gas path and leaks. If equipment sticks, pupils stop and call staff; do not operate a blocked pressure system. No flame or whoosh bottle belongs to this investigation.

5. Allow 10 minutes planning, 25 minutes collection, 15 analysis and 10 cleanup. Trial chip fractions first; if slow reactions need longer, continue the data work next lesson rather than ending while still reacting or inventing final readings.

Close of lesson

• After reaction stops, staff direct collection/disposal of dilute mixtures and leftover chips. Rinse equipment as instructed; return dry apparatus 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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• A/B: chip size changes; acid concentration/volume, marble mass and temperature are controlled. A/C: concentration changes with chip size fixed. Gas volume over time is measured in both.

• Use the plotted early gradient Δvolume/Δtime; report units $cm^3\ s^{-1}$. No numerical rate is specified because the class supplies the measurements.

• Smaller pieces of the same mass expose more surface for collisions with acid particles, usually increasing the rate.

• Higher concentration means more reacting particles per unit volume and more frequent successful collisions at the same temperature; their average kinetic energy is not increased by concentration alone.

• The same limiting marble mass can produce a similar final amount of CO_2 if acid is in excess and reaction completes. A three-minute reading need not be the final volume.

• Gas loss before bunging and leaks reduce readings; syringe friction and chip variability affect curves. Use prompt consistent bunging, checked apparatus, repeats and matched chip fractions; do not hide anomalous raw data.

References and provenance

Pearson Chemistry specification

RSC teaching marble/acid rate investigations

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.