Core practical: comparing reaction rates

Student activity • rate investigation

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

The question

Can your own repeated measurements support two fair rate comparisons?

Build on Lesson 38 by completing and evaluating both required comparisons yourself. Each pair measures all three conditions twice. Keep raw measurements and explain the limitations of gas collection.

Equipment

- Eye protection; 100 cm^3 gas syringe with freely moving plunger, clamp and stand
- 100 cm^3 conical flask, fitted bung/tube to syringe, tray and timer
- 10 cm^3 measuring cylinder; balance reading to 0.01 g; weighing boats
- 0.20 g marble per run, in large or smaller chips; 10.0 cm^3 HCl per run, 0.5 or 1.0 mol dm^{-3}
- Graph paper and ruler; results table for six runs

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.

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

Plan, model or apparatus sketch

Draw the gas collection apparatus and label the controlled quantities.

Method and reasoning

Read the whole sequence before starting

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1. Wear eye protection and inspect the teacher-checked apparatus. The syringe must be free to move, connected without kinks, and set near zero. Do not cap its outlet or clamp the plunger.

2. Plan three conditions: A, large chips with 1.0 mol dm^{-3} HCl; B, smaller chips with 1.0 mol dm^{-3} HCl; C, large chips with 0.5 mol dm^{-3} HCl. Use 0.20 g marble and 10.0 cm^3 acid each time. Each pair completes two runs of each condition.

3. Measure the acid into the flask. Add the weighed chips, start the timer immediately and fit the bung promptly. Record any delay; do not shake the flask or point apparatus at anyone.

4. Read gas volume every 15 seconds for three minutes or until the volume has stopped changing. Stop and tell the teacher if the plunger sticks, pressure builds or a leak occurs; do not force it.

5. After gas production stops, disconnect under teacher direction, clean/rinse the apparatus and repeat with fresh materials. Complete A1/A2, B1/B2 and C1/C2; keep all six raw runs, including anomalies.

6. Plot the six volume–time curves with units, using graph paper. Compare early gradients for A/B and A/C, keeping the two repeats visible. Explain any gas lost during bunging; do not silently force data through zero.

7. Compare final volumes only when reactions have completed. Explain why the same marble mass should give a similar final amount when acid is in excess; faster is not the same as more product.

Cleanup

• After reaction stops, staff direct collection/disposal of dilute mixtures and leftover chips. Rinse equipment as instructed; return dry apparatus and wash hands.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Record assigned condition, chip description and starting temperature. Reaction: $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$. For 0.20 g pure $CaCO_3$, the theoretical CO_2 volume is about 48 cm^3 at room conditions; this is a capacity estimate, not a measured result. Use a 100 cm^3 syringe.

Time / s	A1 / cm^3	A2 / cm^3	B1 / cm^3	B2 / cm^3	C1 / cm^3	C2 / cm^3
0						
15						
30						
45						
60						
75						
90						
105						
120						
135						
150						
165						
180						

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Identify independent, dependent and controlled variables for each comparison.

2. Plot both repeat curves and estimate an early rate in $cm^3\ s^{-1}$.

3. Explain the chip-size effect in terms of exposed surface and collisions.

4. Explain the concentration effect without claiming particles gain extra energy.

5. Explain why completed final gas volumes may be similar despite different rates.

6. Evaluate gas loss, leaks, chip variability and syringe friction; suggest a practical improvement.