Reactions of acids: patterns and particles

Student activity • small-scale investigation

YEAR 10 / LESSON 53 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

The question

How does the reacting substance determine the products?

Compare small-scale reactions of hydrochloric acid with a metal, a metal oxide and a carbonate. Separate observations from inferred products and use reference gas-test evidence without adding flames to the pupil work.

Equipment

- Eye protection; three test tubes in a rack, tray and dedicated acid pipette
- 0.50 mol dm^{-3} HCl, 1.0 cm^3 per tube
- Teacher-preloaded solids: 0.5 cm Mg ribbon (at most 0.01 g), about 0.01 g CuO, and about 0.02 g $CaCO_3$ chips
- Reference cards for hydrogen and carbon-dioxide tests; no pupil splints or burners

Wear eye protection; avoid acid splashes and report them. Staff preload powders. Keep tubes open, in racks and away from faces; hydrogen is flammable, so no flames or heating. Copper residues must be collected separately.

Course coverage: Shared core: 2.35–2.37, proton transfer and acid reactions. Nitric-acid/metal reactions are excluded; chloride, sulfate and nitrate naming is practised on paper.

Plan, model or apparatus sketch

Sketch the three open test tubes and label the reactants.

Method and reasoning

Read the whole sequence before starting

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1. Wear eye protection. Identify the teacher-preloaded tubes M (magnesium), O (copper oxide) and C (calcium carbonate). Leave tubes open in the rack and pointed away from people.

2. Add 1.0 cm^3 0.50 mol dm^{-3} HCl to M, then O, then C using the labelled acid pipette. Do not add extra solids or mix tubes.

3. Observe each tube for several minutes. Record gas formation, changes to solids and solution colour. Do not heat, stopper, smell directly or introduce a flame.

4. The oxide reaction may be slow at room temperature; record what you actually see and label any unfinished change. Compare with the supplied reference description after observing.

5. Use the gas-test reference to explain how hydrogen and carbon dioxide could be distinguished. Fizzing alone does not identify a gas; gas tests are reference evidence in this lesson.

6. Write the three balanced equations and compare the product patterns. Explain proton acceptance by OH^- and by carbonate. Apply salt naming to hydrochloric, sulfuric and nitric acids on paper only.

Cleanup

- Leave any active tubes in their rack for staff supervision.
- Staff collect copper-containing waste separately; dispose of other residues under the local plan. Rinse equipment as instructed and wash hands.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Reference only: hydrogen gives a pop with a lighted splint in a properly assessed small gas test; CO_2 turns limewater cloudy. Neither test is performed here. Acid + reactive metal → salt + H_2; acid + metal oxide/hydroxide → salt + water; acid + carbonate → salt + water + CO_2. CuO can dissolve slowly to a blue/green copper(II) chloride solution. Do not copy a reference description as your own observation.

Tube / solid	Actual observations	Inferred products / evidence
M: magnesium		
O: copper oxide		
C: calcium carbonate		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Describe your three observations and distinguish each from an inference.

2. Write balanced equations for HCl with Mg, CuO and $CaCO_3$.

3. Explain why visible bubbles alone cannot prove which gas formed.

4. Name the salts formed from magnesium oxide with hydrochloric, sulfuric and nitric acids.

5. In $H^+ + OH^- \rightarrow H_2O$, identify the proton donor and acceptor; explain why carbonate also behaves as a base.

6. Explain two limits of “acid + metal gives hydrogen”, including the nitric-acid exclusion.