Metals with dilute acids

Teacher / technician edition • both school-concentration acids

YEAR 10 / LESSON 28 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

Staff use only; keep separate from student copies. This document is not a local risk assessment or classroom authorisation. No local physical validation is claimed. Complete normal teacher/technician checks and follow the employer's risk assessment before use.

Scope and honest specification mapping

Year 10 IGCSE Chemistry and Science (Double Award). Core Practical 2.21: Mg, Zn, Fe and Cu with dilute HCl AND H_2SO_4. 2.15 covers the acid reactions of this subset only, not water; 2.17 remains a full recall list, not an experimentally established order here. No Ca/Al, alkali-metal water demonstration, salt crystallisation or required gas-volume/temperature-rise protocol is included.

Requisition • per group of up to three

Eye protection; eight 100 × 16 mm or similar test tubes with actual size disclosed; rack; 10 cm^3 cylinder; forceps; emery paper; two LOOSE bungs for hydrogen testing only; splints and teacher-controlled lighting flame (never a Bunsen under tubes); labelled residue bowl. Issue about 25 cm^3 of each acid for four × 4.0 cm^3 plus spare; scale to the actual class and stock.

Metal	Issue and record the actual form
Magnesium	Ribbon, about 1.0 cm; one piece per acid, under supervision.
Zinc	One small granule (up to about 5 mm) OR a piece of foil; record which.
Iron	Clean, uncoated filings, short nail or wire; not painted or galvanised.
Copper	Foil or turnings; record actual form and approximate size.

Observed bubbling rate also depends on exposed surface area, surface condition and temperature. With unlike metal forms, report the apparent order under these conditions; it does not alone establish an intrinsic reactivity ranking. Do not promise a complete order.

Acids • staff issue, no invented concentrated-stock recipe

Issue labelled 0.4 mol dm^{-3} HCl and 0.2 mol dm^{-3} H_2SO_4, the school local pair. Prepare from standard school stock under the school recipe book; no dilution from an unstated concentrated stock is specified. Read actual hazard labels; the issued dilute acids can irritate eyes/skin.

Delivery and the hydrogen test

Teacher demonstration first • no tight seals, no flame below tubes

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Preparation and comparison

Supervise distribution of about 1.0 cm Mg ribbon pieces (HC059a); account for spares. Do not issue painted/galvanised nails as iron. Clean metal surfaces with emery and handle with forceps. Label eight tubes for four metals × two acids. Use 4.0 cm^3 MEASURED acid per tube as an explicit local choice, not a conversion from “about 2 cm depth”. If using a depth alternative, measure/record the consistent volume in the named tube.

Add one matching small metal piece, one acid set at a time. Observe for a few minutes: onset/vigour of bubbling, metal consumption, colour and qualitative warmth only. No numerical temperature rise is required. Observed bubbling rate also depends on exposed surface area, surface condition and temperature. With unlike metal forms, report the apparent order under these conditions; it does not alone establish an intrinsic reactivity ranking.

Hydrogen-test demonstration • RSC 446 Lesson 1, step 6

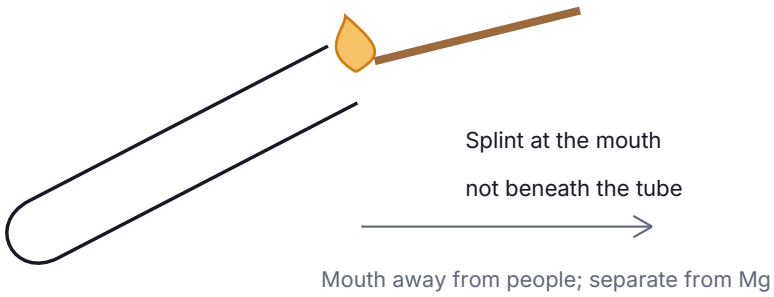
If a loosely fitting bung is used, remove it before bringing the lighted splint to the tube mouth. Never seal the reacting tube tightly.

Demonstrate on a tube clearly producing gas. A loose bung may allow gas to escape slowly; remove it before the splint approaches. Bring a lighted wood splint to the open mouth, directed away from people and kept well apart from magnesium. Test only gas-producing tubes, never the copper tubes. No other naked flames. If Mg is vigorous, wait until fizzing is not violent or keep that test teacher-operated. Local risk assessment decides whether students subsequently test or only watch; no authorisation is supplied here.

Teacher-demonstrated test

Open mouth: bung removed

Never tightly sealed



Only when gas is clearly produced; no test on copper. Schematic, not a result.

Pre-lesson checks and residues

Staff-only handling • do not seal hydrogen-evolving waste

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Normal practical setup checks

Check one iron piece in the issued HCl for visible bubbling over a few minutes under classroom conditions; this is ordinary professional practice, not a publication gate and not a claim of a completed physical trial. If unclear, check/clean the actual iron form and labelled acid. Do not invent student results.

RSC 446 uses 1 mol dm^{-3} HCl and 0.5 mol dm^{-3} H_2SO_4 (the latter irritant), unlike the school 0.4 / 0.2 pair. Do not silently upgrade concentrations or promise equal visibility. Any later concentration change requires local risk assessment and accurate new labels; these student booklets specify the school pair.

Residues • unsealed and away from flames

Collect metal residues and used mixtures in an UNSEALED residue container, away from flames, until hydrogen evolution has stopped. Never seal hydrogen-evolving waste. Then follow the school's solid-waste and residual-acid procedure. Account for magnesium pieces. Do not put metal solids down the sink.

Troubleshooting • retain actual observations

• Zinc barely reacts: surface film or small exposed area may matter; cleaning or a recorded foil form may help. A slow start is still an observation.

• Iron shows no visible bubbling: check it is clean, uncoated iron and the acid is at its labelled concentration. Slower observations at the school concentrations may leave an incomplete order.

• Copper seems to fizz: consider dissolved air, contamination or plated alloy. Describe what was seen; do not force a claim that genuine copper reacted with these dilute acids.

Complete locally before use: actual tube size / acid-label check / iron-form check / hydrogen-test participation decision / employer assessment reference / responsible teacher:

Interpretation and sources

Teaching guidance • keep out of student copies

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Qualified interpretation

For these four metals, a more vigorous, sustained production of gas in the same acid, at the same measured volume, supports a higher apparent reactivity under the conditions used. Observed bubbling rate also depends on exposed surface area, surface condition and temperature. With unlike metal forms, report the apparent order under these conditions; it does not alone establish an intrinsic reactivity ranking. An incomplete or inconclusive order is an acceptable result. Copper often shows no bubbling; bubbles that appear only on wetting a dirty surface, or a few bubbles of dissolved air, should be described as seen and not forced into 'a slow reaction.' Iron may be slow in 0.4 mol dm^{-3} / 0.2 mol dm^{-3} acid, especially if the surface is greasy or coated; record what is seen. The observations apply only to Mg, Zn, Fe and Cu with these dilute acids. They do not, by themselves, place K, Na, Li, Ca, Al, Ag or Au, and they do not investigate water. School slide illustrative sample results and worksheet matching exercises are not class data.

Keep comparisons within the same acid at the recorded volume before comparing acid sets. Do not infer intrinsic metal ranking from unmatched surface areas or forms. Do not infer the positions of untested metals or their water reactions. Gas-volume-in-fixed-time is an evaluation suggestion only, not an extra operational method in this booklet.

Sources and pre-use responsibilities

• Pearson Edexcel IGCSE Chemistry, Issue 3 (2024): 2.21, acid part of 2.15, subset of 2.17. The scheme cites lab-book pages 18–19, but those pages were unavailable in the QA sample; no Pearson lab-book quantities or results are claimed.

• School Lesson 28 confirms 0.4 mol dm^{-3} HCl and 0.2 mol dm^{-3} H_2SO_4. Its "about 2 cm" wording is not converted to 4.0 cm^3. The measured 4.0 cm^3 is the disclosed local volume choice.

• RSC / Nuffield, Reactions of metals with acids producing salts: edu.rsc.org/experiments/reactions-of-metals-with-acids-producing-salts/446.article — Lesson 1 only, including bung removal in step 6. Lesson 2 crystallisation is not included.

• CLEAPSS identifiers cited by RSC: Cu HC026, Fe HC055a, Mg HC059a, Zn HC107, HCl HC047a / RB043, H_2SO_4 HC098a / RB098, hydrogen HC048. Consult current school cards/recipes; full cards are not reproduced.

No local physical validation or completed employer risk assessment is claimed. Before classroom use, complete normal checks of products, labels, metal condition, vessel size, teacher demonstration and residue arrangements; obtain local teacher approval. Source notes accompany the editable master.

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