Metals and non-metals

Teacher / technician preparation • separate staff-only edition

YEAR 10 / LESSON 12 / 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 pre-lesson checks and follow the employer's risk assessment before use.

Scope and honest course coverage

Year 10 Chemistry and Science (Double Award). 1.20 uses two representative, distinct evidence sets: Cu, Mg, Zn, Fe, sulfur and graphite conductivity; and six oxide-character stand-ins. Sulfur is the only overlap, and its H_2SO_4 stand-in is not an observed SO_2-and-water product. 1.21 is related Periodic Table work, not an experimental measurement. Insoluble and amphoteric oxides are not tested.

Requisition • planning estimate for 30 students

Ten groups of up to three; review quantities against stock. Issue eye protection to every student. Per group: one maximum 6.0 V DC tester, leads, clips/probes and series 6 V lamp (or LED with suitable series resistor); six labelled solid samples with separate spatulas/tweezers; clean tile; emery/spatula, wash bottle and paper towels; six 150 × 16 mm tubes/rack; 10 cm^3 cylinder or 5/10 cm^3 graduated pipette and filler; full-range indicator and matching chart; waste and recovery containers.

Reusable Cu, Mg, Zn, Fe and graphite. Sulfur as lumps. Do not issue iodine, sodium metal or potassium metal for this class practical.

Electrical setup and ordinary pre-lesson checks

Maximum 6.0 V DC only; no mains. Use a 6 V lamp in series with the sample, or an LED with a suitable series resistor, so the circuit is current-limited. Keep the supply dry. Switch OFF before handling, moving or rinsing contacts. Use clean, dry contacts. Probes must not touch except for a brief lamp-tester function check.

Lamp-in-series tester: briefly touch probes together and check lamp on, then separate and check lamp off. This tests function, not weak-sample sensitivity. If a meter is issued, use its own instructions: no universal probe-short or zero-in-air check. An ammeter must never be shorted across a supply. Keep spare batteries and lamps available.

Student workflow

Part A: same-piece contacts about 1.0 cm apart; OFF before handling or changing samples; clean/dry contacts; scratch a dirty metal surface and preserve any differing retest. Part B: actual-reagent labels visible; 2.0 cm^3 and 3 indicator drops per separate tube; gentle swirling only. No shared rod. Keep class results blank until observed.

Iodine conductivity, reactive sodium/potassium metal, real-oxide reactions, gas generation, air-gap oxygen tests and lead work are not class activities. Do not invent an iodine apparatus or observation.

Stand-in preparation and labels

Recipes are staff-only; actual identities and hazards are visible to every handler

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Class stock • follow current CLEAPSS recipes

Prepare 100 cm^3 of each 0.2 mol dm^{-3} acid/alkali: 10 × 2.0 cm^3 = 20 cm^3, plus rinsing, dead volume and spare. Use RB085 (NaOH), RB071 (KOH), RB098 (sulfuric acid), RB061 (nitric acid), RB065 (phosphoric acid). Keep solutions below 0.5 mol dm^{-3}. No concentrated-stock dilution volumes are prescribed here.

Limewater: use CLEAPSS RB020 saturated $Ca(OH)_2$, typically below 0.02 mol dm^{-3}; never force it to 0.2 mol dm^{-3}. More dilute does not mean a weaker base. Issue about 20 cm^3 full-range indicator for the class (3 drops × 6 tubes × 10 groups), in dropper bottles with its matching chart. Indicator references: HC032 / RB000 / SSS070.

Actual working label	Concentration	Hazard / teaching-purpose qualification
Sodium hydroxide, NaOH(aq)	0.2 mol dm^{-3}	Irritant. Stand-in illustrating a soluble metal oxide in water; not sodium oxide.
Potassium hydroxide, KOH(aq)	0.2 mol dm^{-3}	Irritant. Stand-in illustrating a soluble metal oxide in water; not potassium oxide.
Limewater, saturated $Ca(OH)_2$(aq)	Saturated; much more dilute than 0.2 mol dm^{-3}	Treat as irritant. Stand-in illustrating a soluble metal oxide in water; not calcium oxide.
Sulfuric(VI) acid, H_2SO_4(aq)	0.2 mol dm^{-3}	Treat as potentially irritating, as labelled. Acidic stand-in; NOT the product of SO_2 and water.
Nitric(V) acid, HNO_3(aq)	0.2 mol dm^{-3}	Irritant. Acidic stand-in; NOT a verified generic nitrogen-oxide-and-water product.
Phosphoric(V) acid, H_3PO_4(aq)	0.2 mol dm^{-3}	Treat as potentially irritating, as labelled. Acidic stand-in; not made in class from phosphorus(V) oxide.

Use small labelled dropping bottles or small flasks with a dropping pipette. Never use an oxide teaching name as the sole label. HNO_3 is not a verified generic nitrogen-oxide product; H_2SO_4 is not SO_2 + water. Staff preparation recipes must not be issued as student pages.

Delivery, safety and waste

Normal pre-lesson checks remain the teacher's responsibility

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Teacher demonstration • copper / aluminium only

1. Use copper and/or aluminium to show whether a piece can bend or flatten. Students watch and record only: no student hammering, no lead, no anvil and no heavy hammer.

2. Staff prepare and place hot water in a beaker on a heatproof mat; students do not carry kettles. Show heat travelling along a metal rod or strip with one end in the hot water. Handle the hot end with tongs; students stand back and do not touch.

3. Keep observations separate from Tables A and B. Heat conduction and malleability are demonstrations of properties, not the 1.20 classification tests.

Hazard controls and waste

Wear splash-proof eye protection throughout. Read actual reagent labels; alkalis can seriously damage eyes. Wash skin splashes with plenty of water and tell the teacher at once. For an eye splash, rinse under running water as directed and tell the teacher immediately. Universal indicator may be alcohol-based and flammable: no flames. Avoid sulfur dust and sharp metal edges; use spatulas or tweezers. Do not taste. Follow the school's risk assessment.

Collect indicator mixtures and dilute acid/alkali residues; neutralise and dispose under school procedure. Recover metal, sulfur and graphite. Use the employer's current Hazcards, spill procedures and local risk assessment. Recover the separate solids; keep them out of the sink. Switch OFF before cleaning/drying contacts.

Troubleshooting • guidance, not guaranteed outcomes

• Lamp never lights even with probes touching: flat battery, loose lead, blown lamp, or the indicator not in series.

• Metal does not conduct: oxide film or dirty or wet contact; scratch, dry, and retest with firm contact.

• Graphite does not conduct: painted pencil; use a graphite rod or a freshly broken 2B lead.

• Similar indicator colours: confirm the matching chart, an uncontaminated dropper, and clean tubes. Limewater is more dilute than 0.2 mol dm^{-3} NaOH; do not promise a colour from that fact; record the colour actually seen.

• Students treat Table A and Table B as the same elements' results, or add sodium or potassium metal, or invent an iodine observation: return them to the two distinct evidence sets and the actual tested list.

Pre-lesson record (complete locally, not an approval supplied by this booklet): apparatus / labels / matching chart / employer assessment reference / responsible teacher:

Interpretation and sources

Teaching guidance • keep this page out of student copies

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Reasoning to support, without invented observations

A lamp that lights means the sample conducted in this circuit. Colour and pH describe the stand-in mixture tested. Table A and Table B are two representative evidence sets, not paired results for the same elements; they overlap at sulfur only, and the sulfur-related liquid is an H_2SO_4 acidic stand-in, not an observed SO_2-and-water product. Both kinds of evidence, and the Periodic Table, may support a discussion of classification, but a single test is not proof, and graphite is a known exception to 'conductors are metals'. Limewater is more dilute than the 0.2 mol dm^{-3} hydroxide stand-ins; that does not make calcium hydroxide a weaker base in the teaching sense used here, and it does not guarantee a paler or any other particular colour. If groups disagree, record both observations rather than forcing a match.

Structure explanation: metals conduct through mobile delocalised electrons; graphite is the non-metal exception discussed in this lesson. Do not replace student observations with an expected-brightness table. Use Periodic Table position as a separate reference task. A near-neutral water test on an insoluble oxide would not establish that it is chemically neutral; insoluble oxides are not tested here.

Sources and pre-use checks

• Pearson Edexcel International GCSE Chemistry (2017 linear, 4CH1): 1.20–1.21, as recorded in the scheme extracts; existing school worksheet and knowledge organiser inform the lesson context.

• RSC / Nuffield, Testing the pH of oxides: edu.rsc.org/experiments/testing-the-ph-of-oxides/405.article — 2.0 cm^3, 3 drops and stand-in approach, with actual-label/product-claim corrections.

• RSC / Nuffield, Which substances conduct electricity?: edu.rsc.org/experiments/which-substances-conduct-electricity/1789.article — low-voltage technique only; molten procedures excluded.

• CLEAPSS SSS031, SSS032 and SSS070; RSC-cited HC067/RB061, HC072/RB065, HC098a/RB098, HC091b/RB071, HC091a/RB085, HC018/RB020 and HC032/RB000. Consult the current employer resources. SSS056 informs iodine deferral, not a class method.

Source details and adaptations are recorded in the accompanying source notes. No fresh independent source verification or local physical validation is claimed. Before classroom use: check actual products, labels, contacts, indicator chart and teacher demonstration apparatus; complete the employer/local risk assessment and obtain teacher approval.

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