Rusting: conditions and protection

Teacher / technician

YEAR 10 / LESSON 31 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

Staff preparation and answer guidance. Keep separate from student sheets. Multi-day investigation with staff-prepared controls. Barrier and sacrificial protection are explanatory extensions, not measured outcomes of the three-tube test.

Coverage and delivery

2.18–2.19: conditions for rusting; barrier methods and sacrificial protection.

Allow about 50 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
Student booklet / eye protection	1 set per learner	30 plus staff
Tubes / nails / racks	3 tubes, 3 nails, 1 rack	48 tubes/nails; 16 racks incl. comparator
Stoppers / labels	2 stoppers; 3 labels per set	32 stoppers; 48 labels
Water / oil / desiccant / cotton	Staff trials tube fill volumes	16 matched prepared sets

Immediate safety

Wear eye protection; handle nails with care. Only cooled tubes reach pupils. Do not open desiccant tubes or touch drying agent. Keep tubes upright; report broken glass. Oil spills make surfaces slippery.

Preparation and delivery

Read alongside the student method

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1. Prepare 16 sets: 15 for pairs plus one dated comparator. Each needs three similar clean uncoated iron nails, three tubes, one rack, labels and two suitable stoppers. Keep nail type, exposed size and storage conditions comparable; avoid galvanised nails.

2. Staff prepare B with enough freshly boiled water to submerge the nail and about 5 mm oil over the water. Prepare behind the bench, allow to cool fully, then stopper. Pupils do not boil water or handle hot tubes.

3. Staff prepare C using a small quantity of anhydrous calcium chloride below a cotton-wool support, with the dry nail above and out of contact. Stopper promptly. Check supplier SDS; avoid skin/eye contact with desiccant. Do not use cobalt indicator salts.

4. Amounts depend on tube bore: trial one set, then prepare 15 identical sets. Start an additional comparison set three to five days ahead and label dates. Do not promise visible rust in a single lesson.

5. Paint and sacrificial protection are case reasoning in this version. No heated agar, indicator recipe, hydrochloric acid treatment or copper-cleaning activity is included. Retain the original mixed activity in backups.

Close of lesson

• Leave labelled tubes in the assigned rack for observations. Staff collect desiccant, oil and nails separately after the study; follow the local disposal plan. 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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• Actual observations must be dated. Typically A develops orange-brown corrosion while well-prepared B and C show much less; leaks or residual oxygen/moisture can affect comparisons.

• A supplies both requirements. B restricts oxygen while retaining water; C restricts water while retaining oxygen. Compare controls rather than claiming any single tube proves the whole explanation.

• Boiling removes much dissolved air; oil limits oxygen returning. Ordinary water contains dissolved oxygen. Neither treatment establishes perfect oxygen absence.

• Paint forms a barrier to water and oxygen; scratches expose iron and can permit local rusting.

• Zinc is more reactive and oxidises preferentially while electrically connected. Copper is less reactive and does not provide sacrificial protection; contact can accelerate iron corrosion.

• Keep nails, size and temperature comparable. Limitations include imperfect seals, residual oxygen/moisture, surface coatings and qualitative judgement. Repeat or photograph under fixed lighting.

References and provenance

Pearson Chemistry specification

RSC rusty nail experiment

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.