Metal-salt displacement on a microscale

Student activity • microscale practical

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The question

Which metal can displace another from its salt solution?

Compare magnesium, zinc and copper in a nine-well grid. Record visible changes first, then use them to justify an order. The wider reactivity series is reference knowledge, not a conclusion from only these three metals.

Equipment

- Eye protection; nine-well spotting tile on a tray; forceps
- Three labelled dedicated droppers: 0.1 mol dm^{-3} copper(II) sulfate, zinc sulfate and magnesium sulfate
- Three small clean pieces each of magnesium ribbon, zinc foil and copper foil; teacher-issued only
- Waste collection vessel supplied by teacher; timer and paper grid

Wear eye protection. Avoid skin/eye contact with salts; report splashes and rinse affected skin promptly. Keep magnesium away from ignition sources. Use forceps and a tray; all metal-salt waste is collected. Wash hands after cleanup.

Course coverage: 2.16, 2.17 and 2.20: metal-salt displacement, evidence for reactivity and electron transfer.

Plan, model or apparatus sketch

Sketch and label your 3 × 3 tile: solutions in columns, metals in rows.

Method and reasoning

Read the whole sequence before starting

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1. Wear eye protection. Label three columns $CuSO_4$, $ZnSO_4$ and $MgSO_4$ and three rows Mg, Zn and Cu. Keep the tile on a tray away from flames.

2. Using the dedicated dropper for each solution, place three drops in each of its three column wells. Do not let dropper tips touch metal or liquid already in a well.

3. With forceps place one fresh small piece of the row metal in each well. Start timing and leave the tile still. Never use powders.

4. Observe at the start and after about five minutes. Record metal coatings, solution changes and any bubbles separately. Do not touch the solutions.

5. Use the same-metal wells as comparison controls. Mark unclear changes as inconclusive; absence of a rapid visible change does not prove no reaction is possible.

6. Infer an order for the three metals from evidence of displaced metal. Write a word equation and an ionic equation for one supported reaction.

7. Compare the evidence with the reference series. Collect every mixture and rinsing as instructed; do not pour metal salts into the sink.

Cleanup

• Transfer mixtures and first rinses to the teacher’s labelled metal-salt waste vessel. Return tools after instructed cleaning; wash hands.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Record initial appearance and five-minute changes in each cell below. Reference order: Mg > Zn > Cu. In a displacement, metal atoms lose electrons and dissolved metal ions gain them. Bubbles alone are not evidence of metal displacement; some solutions may be slightly acidic.

Metal added	$CuSO_4(aq)$	$ZnSO_4(aq)$	$MgSO_4(aq)$
Mg			
Zn			
Cu			

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Use your nine-cell table to distinguish deposited metal, solution changes and bubbles.

2. Use two observations to justify an order for Mg, Zn and Cu.

3. Write the word and balanced ionic equations for zinc with copper(II) sulfate.

4. Explain why sulfate ions are omitted from that ionic equation.

5. Explain why bubbles alone or a single negative result can mislead.

6. Suggest one repeat or control that would strengthen an inconclusive result.