

Metals by reactivity and how we extract them

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab

Name: _____ Date: _____ Class: _____

A more reactive metal pushes a less reactive one out of solution, and the reaction releases energy as heat. This lab measures the temperature rise when four metals are added to copper(II) sulfate solution, so reactivity can be ranked with numbers instead of guesses.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE C4

Aim

To compare the reactivity of magnesium, zinc, iron and copper by measuring the temperature rise when each is added to copper(II) sulfate solution.

Equipment

- Polystyrene cup with lid, and a 250 cm³ beaker to support it
- 25.0 cm³ measuring cylinder, thermometer (0.5 °C divisions)
- 0.500 mol/dm³ copper(II) sulfate solution
- 1.0 g portions of magnesium, zinc and iron powder and copper powder
- Spatula, stopwatch

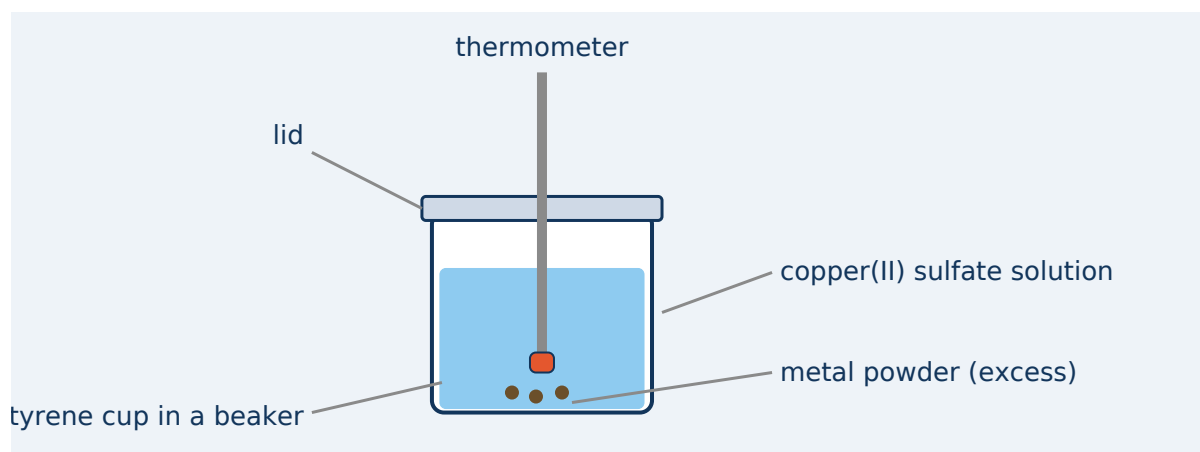
Safety

Safety

Wear goggles. Copper sulfate is harmful if swallowed and toxic to aquatic life: put waste into the labelled container. Metal powders can be a fire risk, so keep them away from flames.

Method

1. Measure 25.0 cm³ of copper(II) sulfate solution into the cup and record the starting temperature.
2. Add one 1.0 g portion of the metal powder, replace the lid and stir gently with the thermometer.
3. Record the highest temperature reached.
4. Rinse the cup and repeat with each of the other metals.



A lidded polystyrene cup keeps heat loss small.

Results

Metal	Start (°C)	Highest (°C)	Rise (°C)	Observation
Magnesium	21.0	66.5	?	Blue colour fades, brown solid
Zinc	21.0	42.5	?	Blue colour fades, brown solid
Iron	21.0	36.0	?	Blue fades to pale green, brown solid
Copper	21.0	21.0	?	No change

Analysis questions

Question 1 Temperature rises

Complete the temperature rise for each metal.

Question 2 Order of reactivity

Use the rises to place the metals in order of reactivity and compare with the reactivity series.

Question 3 Explain the copper result

Explain why copper powder causes no temperature rise.

Question 4 Energy released

Calculate the energy released by magnesium using $Q = m \times c \times \Delta T$, with $m = 25.0$ g of solution and $c = 4.18$ J/g/°C.

Question 5 Energy per mole

The cup holds 0.0125 mol of Cu^{2+} . Calculate the energy released per mole of copper ions displaced by magnesium and by zinc.

Question 6 Why excess metal

Explain why 1.0 g of each metal is used, and show it is in excess for zinc (Ar: Zn = 65).

Question 7 Errors

State one source of error that makes the energy values too low and how to reduce it.

Question 8 Extending the lab

Predict the temperature rise order if aluminium powder were added, and explain what might make the result unexpected.