Core practical: copper sulfate crystals

Student activity • supervised practical

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The question

How can an insoluble base produce pure hydrated salt crystals?

React copper(II) oxide with warm dilute sulfuric acid, remove excess solid and crystallise the dissolved salt. Record actual changes and revisit the labelled dish after crystals have formed.

Equipment

- Eye protection; 50 cm^3 beaker, 10 cm^3 measuring cylinder, glass rod and spatula
- 10.0 cm^3 1.0 mol dm^{-3} sulfuric acid; up to 0.90 g teacher-portioned CuO
- Filter funnel/paper and support, receiving vessel, shallow crystallising dish and label
- Teacher-managed 50–60 °C water bath, heat mat, suitable holder, wash bottle and clean absorbent paper

Wear eye protection. Avoid acid contact and CuO dust; report spills. Hot vessels can burn even without a flame. Staff manage the water bath and collect all copper-containing residues; never taste or take crystals home.

Course coverage: Shared core: 2.39 and 2.42. Soluble salt from an insoluble reactant; pure, dry hydrated copper(II) sulfate crystals. Drying/crystal collection needs a later follow-up.

Plan, model or apparatus sketch

Draw the supported filtration setup and label residue and filtrate.

Method and reasoning

Read the whole sequence before starting

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1. Wear eye protection. Label your dish and measure 10.0 cm^3 of the supplied dilute sulfuric acid into a 50 cm^3 beaker. Staff manage the warm water bath; do not use a flame.

2. Warm the beaker in the bath. Add teacher-portioned CuO in small portions while stirring gently, up to 0.90 g total. Do not create dust. Continue gentle warming/stirring until some black solid remains despite further time.

3. Ask staff to check that the reaction has had enough time; persistent solid should be excess base, not merely slow reaction. Remove the beaker using the approved holder and allow safe handling.

4. Filter into a clean vessel. Collect the black residue for copper waste and keep the blue filtrate. Transfer the filtrate to your labelled shallow dish.

5. Under supervision, concentrate gently in the water bath. Stop when a small drop on a cool clean surface starts to form crystals; never heat to dryness. If time is short, leave the labelled solution for slow evaporation in the designated tray.

6. Leave to cool and crystallise, loosely covered against dust. At the follow-up, separate the crystals from the mother liquor, rinse with a very small amount of cold deionised water and blot gently between clean absorbent papers.

7. Record actual crystal appearance and mass only when suitably dry. Keep hydrated crystals away from strong heat; return all copper-containing material to staff.

Cleanup

- Return copper-containing liquids/solids and used filters to the labelled staff waste containers.
- Leave labelled dishes in the designated tray for the follow-up; wash hands after clearing the station.

Record your evidence

Blank spaces are for your own work

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Reference and task data

$CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$. The solution subsequently forms $CuSO_4 \cdot 5H_2O$ crystals. A pure, dry hydrated crystal contains water of crystallisation but has no adhering mother liquor. Reference calculation only: 10.0 cm^3 of 1.0 mol dm^{-3} acid contains 0.0100 mol; use M(CuO)=80 and M($CuSO_4 \cdot 5H_2O$)=250 g mol^{-1}. Do not copy expected colours as observations.

Stage	Actual observation	Purpose / interpretation
Warm reaction		
Excess CuO / filtration		
Concentration / cooling		
Crystals at follow-up		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Why is a small excess of insoluble copper(II) oxide used, and how is it removed?

2. Why would copper metal not be a suitable replacement in this dilute-acid method?

3. Explain why the filtrate, rather than the black residue, is kept after the first filtration.

4. Why are the solution and final hydrated crystals not heated to dryness?

5. Calculate the CuO mass required for the stated acid and the maximum theoretical hydrated-crystal mass.

6. Explain how mother liquor, washing and incomplete crystallisation affect purity or recovered mass.