# Reversible reactions: dehydration and return

Student activity • practical and reasoning

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## The question

**Can changing conditions restore the original substance?**

Observe copper sulfate losing and regaining water, then interpret an ammonium chloride reversible equation as a written example. Distinguish reversibility from dynamic equilibrium.

## Equipment

- Eye protection, dry heat-resistant test tube with holder/clamp, burner, mat and small spatula
- Watch glass or evaporating basin, dropping pipette and water
- Staff-issued 0.50 g hydrated copper(II) sulfate; no ammonium chloride apparatus

Wear eye protection; avoid copper-salt dust/contact. Heat gently in an open tube, point away from people, and cool fully before dropwise water addition.

Course coverage: Shared core: 3.17–3.18. Copper sulfate practical; ammonium chloride is discussed as a reference example only.

## Plan, model or apparatus sketch

**Draw the open heated tube and the separate cooled rehydration stage, with forward and reverse labels.**

# Method and reasoning

Read the whole sequence before starting

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**1.** Wear eye protection. Record the appearance of the hydrated copper sulfate and place the issued small sample in a dry heat-resistant tube.

**2.** Point the open tube away from people and heat gently as demonstrated, moving the flame to avoid local overheating. Do not stopper the tube.

**3.** Record colour changes and any condensation; stop heating once the change is clear, without strongly heating the white residue.

**4.** Leave the tube on a heatproof surface until fully cool. Transfer a small portion of the cooled solid to the watch glass as directed.

**5.** Add water one drop at a time and observe the return of colour. Do not add water to a hot tube or touch the mixture to test its temperature.

**6.** Write $CuSO_4 \cdot 5H_2O \rightleftharpoons CuSO_4 + 5H_2O$. Interpret $NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$ as a separate heating/cooling example, not a procedure to perform.

## Cleanup

- Collect all copper-containing residues as labelled metal waste; leave hot glass to cool and wash hands.

# Record your evidence

Blank spaces are for your own work

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## Reference and task data

Reference equations: $CuSO_4 \cdot 5H_2O(s) \rightleftharpoons CuSO_4(s) + 5H_2O(g)$ on heating; hydration can reverse the change when water is added to cooled material. $NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$: gases can recombine in a cooler region. An open heating experiment is not evidence of dynamic equilibrium.

| Stage | Actual observation | Explanation |
| --- | --- | --- |
| Before / gentle heating | | |
| After cooling / water | | |
| $NH_4Cl$ written example | | |

**Show your calculations, labelled model or correction here.**

# Explain and evaluate

Use evidence and show calculation steps where relevant

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**1.** Describe the actual colour changes in your experiment.

**2.** What does ⇌ indicate?

**3.** Why must the tube cool before adding water?

**4.** Explain the role of water of crystallisation.

**5.** Name the two gaseous products in the ammonium chloride example.

**6.** Why does reversibility alone not prove equilibrium in the open tube?