Reacting copper(II) oxide with sulfuric acid

Class practical

In this experiment an insoluble **metal oxide** is reacted with a **dilute acid** to form a **soluble salt**. **Copper(II) oxide**, a black solid, and colourless dilute **sulfuric acid** react to produce **copper(II) sulfate**, giving a characteristic blue colour to the solution. From this solution, blue copper(II) sulfate pentahydrate crystals may be obtained if desired.

Lesson organisation

This is a well-tried standard class experiment. It should take no more than 30 minutes to produce the filtered salt solution.

Experimental work can begin without delay if the dilute sulfuric acid and copper(II) oxide powder are provided in ready–measured quantities. See Technical notes.

The procedure below could be used by students. A demonstration aided by students may be more sensible if there are real doubts about safe behaviour or adequate manipulative skills.

Apparatus	Chemicals
Eye protection **Each working group will require:** **Glass beaker (100 cm^3)** **Conical flask (100 cm^3)** **Spatula** **Glass stirring rod** **Filter funnel (Note 1)** **Filter paper (Note 2)** **Bunsen burner, tripod and gauze** **Heat resistant mat** **pH or litmus paper**	Dilute sulfuric acid, 0.5 M (IRRITANT), 20 cm^3 Copper(II) oxide (HARMFUL, DANGEROUS FOR THE ENVIRONMENT), about 1 g **Refer to Health & Safety and Technical notes section below for additional information.**

Health & Safety and Technical notes

Read our standard health & safety guidance

Wear eye protection throughout. Consider clamping the beaker.

Provide the reagents in ready-measured quantities to reduce waste and assist lesson organisation. All containers must be

clearly spanled.

Copper(II) oxide, CuO(s), (HARMFUL, DANGEROUS TO THE ENVIRONMENT) - see CLEAPSS Hazcard. The copper(II) oxide powder can be provided in approximately 1 g quantities in spanled specimen tubes or plastic weighing boats.

Dilute sulfuric acid, H_2SO_4(aq), (IRRITANT at concentration used) - see CLEAPSS Hazcard. 20 cm^3 of the dilute sulfuric acid should be provided in small spanled bottles.

Copper(II) sulfate, $CuSO_4$(s), (HARMFUL, DANGEROUS TO THE ENVIRONMENT) - see CLEAPSS Hazcard.

1 Polythene filter funnels are safer and cheaper than glass funnels. Filter funnel diameter is important - too large a funnel makes the filtration set-up unstable.

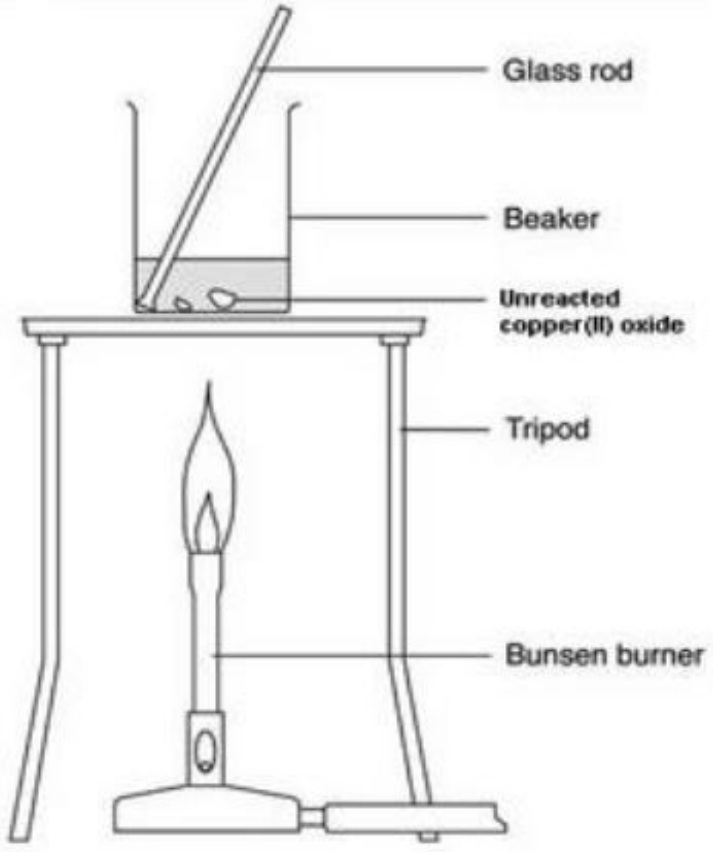
2 Filter paper size when folded should match funnel size. Student-grade filter paper is adequate.

Procedure

Stage 1

a Add 20 cm^3 of the 0.5 M sulfuric acid to the 100 cm^3 beaker. Heat carefully on the tripod with a gentle blue flame until nearly boiling.

SAFETY: Be very careful not to knock the tripod while the beaker is on it.

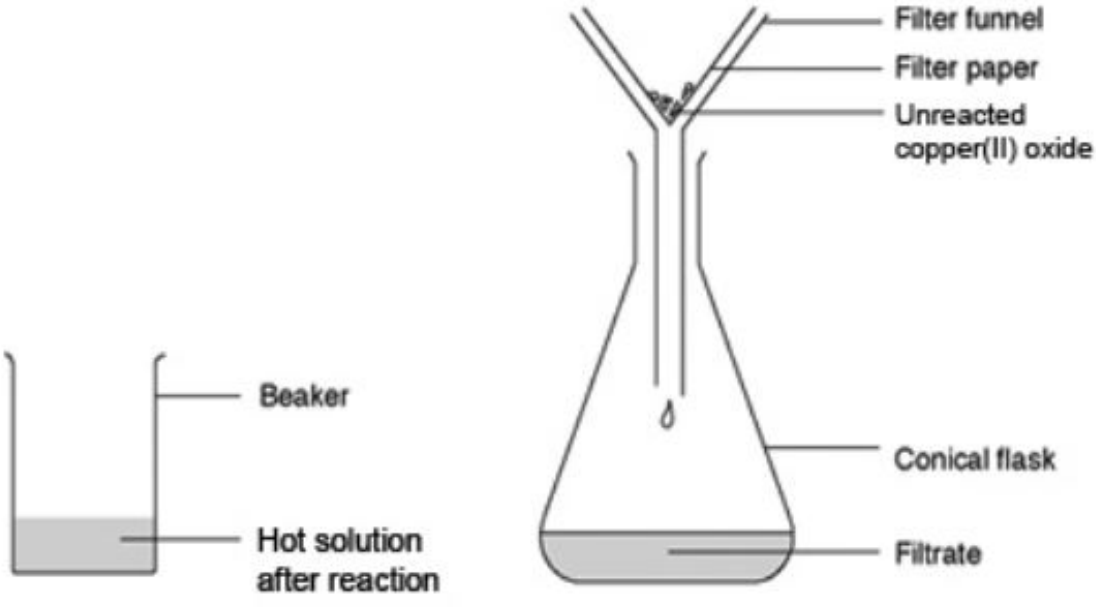


b When the acid is hot enough (just before it starts to boil), use a spatula to add small portions of copper(II) oxide to the beaker. Stir the mixture gently for up to half a minute after each addition.

SAFETY: When adding the solid to the beaker, take care to avoid knocking the beaker.

c When all the copper(II) oxide has been added, continue to heat gently for 1 to 2 minutes to ensure reaction is complete. Then turn out the Bunsen burner. It may be wise to check (using pH or litmus paper) that no acid remains. If the acid has not been hot enough, excess acid can co-exist with copper oxide. If someone should decide to attempt to evaporate the acid after filtering, the lab would fill with fumes.

d Allow the beaker to cool slightly while you set up Stage 2.



Stage 2

e Place the filter funnel in the neck of the conical flask.

f Fold the filter paper to fit the filter funnel, and put it in the funnel.

g Make sure the beaker is cool enough to hold at the top. The contents should still be hot.

h Gently swirl the contents to mix, and then pour into the filter paper in the funnel. Allow to filter through.

i A clear blue solution should collect in the flask. If the solution is not clear, and black powder remains in it, you will need to repeat the filtration.

Stage 3 (optional)

j Rinse the beaker, and pour the clear blue solution back into it. Label the beaker with your name(s). Leave the beaker in a warm place, where it won't be disturbed, for a week or so. This will enable most of the water to evaporate.

k Before all the water has evaporated, you should find some crystals forming on the bottom of the beaker. Filter the solution. Collect the crystals from the filter paper onto a paper towel.

Teaching notes

Practical points

The safety warnings in Stage 1 of the procedure are particularly relevant to younger or more inexperienced students.

Be aware of the problems associated with younger or inexperienced students heating beakers perched on tripods, and with lifting hot glassware off a hot tripod after heating.

For lifting the hot beaker, the provision of beaker tongs of suitable size is a good solution. But many schools will not have these. Do not be tempted to use ordinary tongs. If there is any doubt about the safety of this step, the teacher should lift each beaker down onto the heat-resistant mat.

Chemistry notes

Most **metal oxides** react with dilute acids. Soluble metal oxides and hydroxides are called **alkalis**, and react with acids in solution. Most metal oxides are insoluble solids. The reaction between an insoluble metal oxide and a dilute acid is often quite slow so it is possible to observe the progress of the reaction as the solid reactant disappears as a soluble product is formed.

In Stage 1, students should be able to observe the colour change from colourless to blue, at the same time as the black powder disappears. The blue colour intensifies as more black powder is used.

In Stages 2 and 3, younger students should be able to use their previous experience of blue solutions/crystals to recognise the familiar colour of copper sulfate. This can then be used as the starting point for teaching about acid + metal oxide salt + water reactions.

Older students, already familiar with acid/base reactions, should be able to predict the identity of the compound formed, using the colour change as confirmation of that prediction.

The symbol equation for the reaction is:

$CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$

Otherwise, a simple word equation will be sufficient.

Note that there is no easy way of demonstrating that water is the other product.

Health & Safety checked, September 2014

Credits
This Practical Chemistry resource was developed by the Nuffield Foundation and the Royal Society of Chemistry.

Weblinks

The Copper Development Association - provides a wealth of information about copper and its compounds.

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