

The extraction of copper: a microscale version

The reduction of copper with hydrogen is an interesting experiment and this microscale version is safe enough for students to perform themselves. Some exam specifications now require coursework which shows that the student has made a substance and calculated the percentage yield of the product. This reduction lends itself to that type of work. It could also be used to show the relative positions of copper and hydrogen in the reactivity series. It uses similar equipment to that needed for Cracking hydrocarbons: a microscale version (2.5).

Microscale equipment suppliers

Microscale equipment can be sourced on the Internet.

Phillip Harris has a range of suitable equipment.

<http://www.philipharris.co.uk> (accessed November 2005).

Equipment required

Per student or pair of students:

- 1 comboplate®
- 2 cm³ syringe
- 1 x lid number 1
- 1 x lid number 2
- 2 short lengths silicone tubing
- 1 x 10 cm piece of glass tubing of a width to match the silicone tubing
- 1 microburner filled with ethanol (**Highly flammable**)
- Copper(II) oxide (**Harmful**)
- 3 cm clean magnesium ribbon (**Highly flammable**)
- Approx 2 cm³ 2 mol dm⁻³ hydrochloric acid (**Irritant**)
- Eye protection.

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3 sheets

If you intend to ask students to calculate their yield, they will also need access to a balance reading to 2 decimal places.

Health and safety

- Eye protection should be worn at all times during this experiment.
- Read our standard health and safety guidance at <https://rsc.li/49lxgUC>
- There is a danger of the glass tube breaking when it is inserted into the silicone tubing.
- Warn students of this and show them how to hold the glass tube near the end that they are attaching the silicone tubing in order to minimise the risk. Technicians could perhaps do this for them.
- This practical may not be appropriate for all classes as it involves putting 2 mol dm⁻³ acid into a syringe.
- Teachers should do a risk assessment for their class.

Answers to questions

1. As it is heated, the black copper oxide begins to turn into a shiny, orange solid. A liquid can be seen to collect near the end of the tube.
2. The products are copper and water.
3. The reactants are copper oxide and hydrogen.

4. copper oxide + hydrogen → copper + water
 $\text{CuO(s)} + \text{H}_2\text{(g)} \rightarrow \text{Cu (s)} + \text{H}_2\text{O(l)}$
5. Oxygen is lost from the copper so this is a reduction reaction. (Note: The hydrogen is also oxidised – this is a redox reaction.)
6. Hydrogen is more reactive – it takes the oxygen from the copper.
7.
 - a. Sodium – no.
 - b. Magnesium – no.
 - c. Lead – yes.

References

For a large-scale demonstration version of this experiment, see:

T. Lister, *Classic Chemistry Demonstrations*, London: Royal Society of Chemistry, 1995.

The extraction of copper: a microscale version

Copper can be extracted from copper oxide using hydrogen. The risk of an explosion makes this experiment quite hazardous on a large scale, but when approached with care it can be done safely on a microscale level.

Equipment

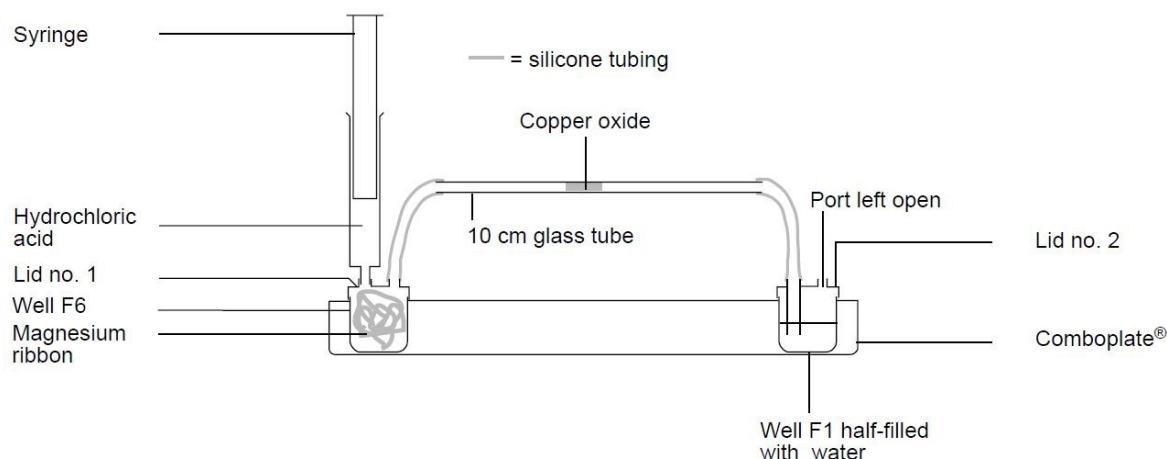
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- Approx 2 cm³ hydrochloric acid 2 mol/dm³ (**Irritant**)
- Eye protection

Health and safety

Wear eye protection.

Ethanol is highly flammable – keep the microburner upright and blow it out when you have finished.

Take care when fixing the silicone tubing to the glass tube – the glass could break and cut your hand. To minimise the risk, hold the glass tube near to the end where you are attaching the silicone tube. If in doubt, ask your teacher.



What to do

- Attach a piece of silicone tubing to each of the lids.
- Half fill well F1 with tap water and attach lid number 2 to it.
- Gently coil the magnesium ribbon to fit into well F6 and attach lid number 1.
- Fill well E6 with hydrochloric acid.
- Dip the end of the glass tubing into the pot of copper oxide and collect some of the powder in the end of the tube. Gently tap the tube to get the copper oxide more or less into the middle of the tube.

- Fix each end of the glass tube to the silicone tubing attached to the lids (see the diagram for what the set-up should look like). Hold the glass tube near the end you are attaching when you do this.
- Carefully fill the syringe with acid from well E6, attach the syringe to the lid on well F6 and add a drop or two of the acid to the magnesium so that it starts fizzing. You will be able to see if the hydrogen produced by this reaction is flowing through the system because it will produce bubbles in the water in well F1. You need to add the acid in drops throughout the experiment to keep a slow but steady stream of bubbles.
- Light the microburner and begin to heat the copper oxide in the tube. Keep heating for a minute or two and watch for changes occurring in the tube. When there are no more changes, stop heating, wait for a moment and then try and light the gas coming out of well F1.
- Blow out the microburner and detach the lids from the comboplate®.
- When the glass tube has cooled, remove it from the other apparatus and tap the end gently on a piece of rough paper to extract the product.

Questions

- 1) Record what you observed in the tube throughout the experiment.

- 2) Two products are made in this reaction – what are they?

- 3) What are the reactants?
(Hint: You tested for one of them with the microburner at the very end of the experiment.)

- 4) Write a word and a symbol equation for the reaction.

- 5) What type of reaction is this?

6) Which is more reactive – hydrogen or copper?

7) Could you use hydrogen to extract the metals below from their ores?
You may need a copy of the reactivity series to answer this question.

a. Sodium

b. Magnesium

c. Lead
