Making copper

Introduction
Teachers who have not used the problems before should read the section Using the problems before starting.

Prior knowledge
Reactivity series, interconversion of salts and the effect of heat on nitrates. A detailed knowledge is unnecessary as students are encouraged to consult textbooks and data books during the exercise.

Resources
Data books and inorganic textbooks should be available for reference.
Solid copper(II) nitrate should be provided at the start of the exercise.
The reactions should be carried out in test tubes or – in the case of the electrolysis – in small beakers.
Students can request apparatus and chemicals during the practical session: these should be issued if they are safe to use. In particular, electrolysis apparatus will probably be required but should not be on view.

Group size
2–3.

Risk assessment
A risk assessment must be carried out for this problem.

Special safety requirements
If the nitrate is heated you should note that poisonous nitrogen dioxide is produced; also water released from the hydrated salt could run down and crack the hot glass.
There is a hazard of explosion with any gas reduction apparatus.

Possible methods
1. Dissolve the salt in water and electrolyse the solution.

2. Dissolve the nitrate in water and add a more reactive metal (preferably powdered) such as zinc or magnesium. It is usually necessary to stir the mixture with dilute acid after the reaction to remove excess displacing metal.

3. Heat the nitrate to get the oxide and reduce it with carbon or natural gas.

4. Dissolve the nitrate in water; add aqueous sodium carbonate; filter off and dry the copper(II) carbonate; heat to produce copper(II) oxide; and finally reduce this with carbon or natural gas.

If students do not think of the short methods (**1** and **2**), see if they are suggested in the final discussion. If they aren't, join in the discussion yourself!

NB Thermite reaction is a possible method but the inherent hazards mean that students must not carry it out. Teachers may wish to do so at their own discretion.

Suggested approach

During trialling the following instructions were given to students and proved to be extremely effective:

1. Working as a group, discuss the problem and list as many different methods as you can. Ask for help if you can't think of at least three.

2. Discuss the advantages and disadvantages of each method. Discussion can play a vital part in working out solutions to open-ended problems. Several minds working together on a problem can stimulate ideas that one on its own could not manage. About 10 minutes should be spent on this spent initially, coming together for further discussion as required.

3. Each person in the group should select a method and write it up in note form.

4. Get your method checked for safety and then carry out the practical work to find out how well it works.

5. Write a brief account of what you did; include discussion of the advantages and disadvantages of your method.

6. Working as a group, try and decide on the best method from all those tried.

7. Working as a group, prepare a short (ca 5-minute maximum) presentation to give to the rest of the class. If possible all group members should take part: any method of presentation (such as a blackboard, overhead projector, etc) can be used.

Outline the problem, describe what you did and explain your conclusion.

After the presentation, be prepared to accept and answer questions and to discuss what you did with the rest of the class.

Notes

1. Zinc powder can be a particular problem – some samples react well, others explosively, perhaps because different samples are oxidised to different extents.

Making copper

Make some copper metal starting from copper(II) nitrate crystals. Normal laboratory apparatus and any other chemicals can be used provided that they do not contain any copper.

At least three different methods should be tested. Which method works best? You should refer to any sources of information that you think might help such as your notebooks, textbooks and data books. Ask for assistance if you get stuck.

Safety

Normal safety procedures when handling chemicals should be adhered to and eye protection worn. There are particular hazards that could arise depending upon how you tackle the problem.

You must get your method checked for safety before starting on the practical work.