Carbon and copper oxide

Introduction
There are two parts to the problem; the first part asks students to distinguish between carbon and copper(II) oxide; and the second asks them to decide which of the three given samples is a mixture. Each part can be tackled separately or consecutively.
Teachers who have not used the problems before should read the section Using the problems before starting.

Prior knowledge
Properties of dilute acids, reduction of metal oxides and reactivity series. A detailed knowledge is unnecessary as students are encouraged to consult textbooks and data books during the exercise.

Equipment
Data books and inorganic textbooks should be available for reference.

- For part 1 unlabelled, but numbered, samples of powdered carbon and copper(II) oxide should be provided.
- For part 2 unlabelled, but numbered, samples of powdered carbon and copper(II) oxide are needed and a mixture of roughly equal amounts of the two mixed together are needed.

Students can request apparatus and chemicals during the practical session, and these should be issued if they are safe to use eg flame test equipment will probably be required but it should not be on view.

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

Group size
3–6.

Possible methods
Part 1
1. On heating in air, copper(II) oxide is unchanged, carbon burns away.
2. On warming with dilute acid the copper(II) oxide sample gives a blue solution (filtration is probably needed).
3. On reduction, the copper(II) oxide sample releases copper. Ethanol vapour passed over the heated solids would cause similar reactions to occur.
4. Flame tests.
5. Solid phase displacement with a more reactive metal such as magnesium, iron or zinc also produces copper. These reactions are quite unpredictable and are not recommended.

Part 2
The easiest method of discriminating between the three solids is to heat them; the one that gives copper metal is the mixture. For this to work, students will have to take care not to oxidise away all the carbon. It is sometimes necessary to cool the hot mixture quickly under a slowly running water tap to prevent reoxidation of the copper.

Suggested approaches

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

Part 1

1. Working as a group, see how many different methods you can devise. Ask for help if you can't think up at least three different methods.
   Some methods will seem to be better than others – write down and discuss the particular advantages and disadvantages of each of the methods that you have devised.
   This discussion plays an important part in devising suitable methods, and can save much time and effort. Several minds focusing on a problem together can achieve much more than the same minds working independently. About 10 minutes should be spent on this initially, with further discussion as required.
2. Divide into subgroups, one method per subgroup, and write up your subgroup's chosen method in note form.
3. Get your subgroup's method checked for safety and then carry out the practical work. The subgroups should work independently in different parts of the laboratory.
4. Write a brief account of what your subgroup did. Your report should include the advantages and disadvantages of your method or methods.
5. Coming together as one group, discuss all the methods you tested and decide on the best one. This could be one of the methods or one using the 'best bits' from more than one method.
6. 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 choice of best method. After the presentation, be prepared to accept and answer questions and to discuss what you did with the rest of the class.

Part 2

1. Working as a group, discuss the methods you used in part 1 and decide on the best method or methods for this part. If you choose more than one method, decide who is going to test each of them and form two (or more) subgroups. As before, you should spend sufficient time discussing the different methods and their advantages and disadvantages.
2. Write up your subgroup's chosen method in note form.
3. Get your subgroup's method checked for safety and then carry out the practical work. If it doesn't work think again, discuss again, and if necessary try a revised method.
4. Write a brief account of what your subgroup did.
5. Once all the methods have been tested, come together as one group, discuss all your results and decide which solid is the mixture.
6. 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 choice of best method. Your presentation should include the first part you did as well as this part. After the presentation, be prepared to accept and answer questions and to discuss what you did with the rest of the class.

Note

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

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Part 1

The two unnamed black solids are known to be either copper(II) oxide or carbon. Devise three or more different methods of labelling them correctly using chemicals and apparatus in the laboratory, test each method and compare them to decide which is best.

Part 2

Three unlabelled black solids are known to be either carbon, copper(II) oxide or a mixture of the two. Use the knowledge that you acquired in part 1 to determine which one is the mixture.

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

There are no special safety requirements. Normal safety procedures when handling chemicals should be adhered to and eye protection worn.

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