Three white solids

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

Prior knowledge
Properties of carbonates and flame tests. 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.
Unnamed powdered samples of calcium carbonate, anhydrous sodium carbonate and sodium hydrogencarbonate are needed at the start of the exercise. These could be in small bottles or on sheets of paper.

Students can request apparatus and chemicals during the practical session, and these should be issued provided that they are safe to use. In particular, litmus or pH paper and flame test equipment will probably be required but they should not be on view.

Group size
4 in two pairs.

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

Possible methods
1. a. Add small amounts to water – the insoluble solid is calcium carbonate.
b. Test the remaining two with moist pH paper – the most alkaline is sodium carbonate.

2. Other possibilities include:
a. Flame tests.
b. Heating – the sodium hydrogencarbonate gives carbon dioxide with little heating, calcium carbonate with a lot of heating, anhydrous sodium carbonate not at all.
c. On adding acid the volumes of gas evolved can be measured. Note that the volume of carbon dioxide collected is less than that produced because some of it remains dissolved in the solution.

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

1. Working as a group, devise as many different analysis schemes as you can. Ask for help if you can't think up at least two different schemes. Some methods will seem better than others – write down and discuss the advantages and disadvantages of each of the methods you have devised.

Discussion can play a vital part in working out solutions to problems like this and you should spend some time discussing the different methods and their advantages and disadvantages; about 10 minutes is suggested initially with further discussion as required.

2. Divide into subgroups, select a scheme each and write it up in note form.

3. Get your subgroup's scheme checked for safety and then carry out the practical work.

4. Write a brief account of what your subgroup did. You should include a note on the advantages and disadvantages of the scheme you tried.

5. Working as one group, discuss all the analysis schemes tested and decide on the best procedure. This could be one subgroup's scheme or one using the 'best bits' from several schemes.

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.

Three white solids

Devise experiments to label the white solids correctly by using chemicals and apparatus in the laboratory.

Three white solids are provided. They are unnamed but are calcium carbonate, sodium hydrogencarbonate and sodium carbonate.

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.