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12. Five white solids

Introduction

This is an ill-defined problem, in that the 'best method' is not clear cut. Students carrying out the problem will have to find the best balance between their method that uses fewest additional chemicals or test papers, and the one that takes the shortest time. There is no one correct answer.

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

Prior knowledge

pH of solutions of ionic compounds, tests for ions and solubility rules. 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, but numbered, solid samples of barium chloride, magnesium nitrate, silver nitrate, sodium carbonate and sodium hydrogensulphate should be provided at the start of the exercise. Some of these, for example the silver nitrate, may be issued as solutions if this is more convenient.

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

4–6.

Risk assessment

A risk assessment must be carried out for this problem.

Special safety precautions

The hazards of handling acidic sodium hydrogensulphate and the staining effect of silver nitrate should be noted.

Possible methods

1. Dissolve all five solids in a little water and add dilute hydrochloric acid:

— silver nitrate gives a white precipitate; and

— sodium carbonate effervesces.

Add the silver nitrate solution to the other three solutions:

— barium chloride gives a white precipitate.

Add the sodium carbonate solution to the remaining two solutions:

— sodium hydrogensulphate effervesces; and

— magnesium nitrate gives a white precipitate of magnesium carbonate.

2. **a.** Mix the solids in pairs in the presence of a little water.

The pair that effervesces is sodium carbonate and sodium hydrogensulphate.

b. Take one of these two solids, dissolve it in water and add it to the other substances dissolved in water. Repeat with the other solid.

The one that gives a precipitate each time is the sodium carbonate; the other should give a precipitate once – this identifies it as barium chloride.

c. Working with solutions, add the barium chloride to the other two.

The one that gives a precipitate is silver nitrate, the other magnesium nitrate.

In practice, depending on the actual concentrations, methods such as **2b** do not always work as predicted. In any case, most students use some standard ion tests to get started.

3. Other possibilities include:

a. flame tests;

b. using pH or litmus paper – this identifies the sodium hydrogensulphate (very strongly acidic) and the sodium carbonate (strongly basic);

c. adding a metal such as copper to the solutions: this will turn black (finely divided silver) in the silver nitrate solution; and

d. standard tests for ions.

4. Heating the solids identifies the two nitrates, because they give a brown gas. The brown ring test also identifies the two nitrates.

Suggested approach

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

1. Divide your group into two subgroups and move to different parts of the laboratory so that the two can work independently.

2. Working in your subgroup of two or three, plan an experiment to label the solids correctly. Write this up in note form.

This discussion plays an important part in devising a suitable method, and can save much effort. Several minds focusing on a problem together can achieve more than the same minds working independently.

3. Get your subgroup's method checked for safety and then carry out the practical work. If it doesn't work try changing it, get it checked and test it again.

4. Write a brief account of what your subgroup did. You should record any changes to your initial scheme and any problems you encountered.

5. The two subgroups should join together, discuss the advantages and disadvantages of each method and select the best procedure for the identification – this could be one of the group's methods in its entirety or a procedure using the 'best bits' from each.

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Remember that the 'best method' is the one that involved fewest additional chemicals or test papers and does not take too long to complete.

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.

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Label the five white solids correctly by using chemical tests and any suitable apparatus. Any chemicals and any test papers can be used but the best method is the one that is fairly quick and uses fewest chemicals.

Five solids are provided. They are unnamed but are known to be barium chloride, magnesium nitrate, silver nitrate, sodium carbonate and sodium hydrogensulphate.

You should refer to any sources of information that you think might help such as your notebooks, textbooks and data books. Solubility tables may be of use. Ask for assistance if you get stuck.

Safety

Note that sodium hydrogensulphate is strongly acidic and that silver nitrate can stain skin and clothing. 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.