

Find the chloride

Introduction

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

Prior knowledge

Properties of carbonates, flame tests, electrolysis, test for chloride ions and properties of concentrated sulphuric acid. 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.

Numbered, solid samples of barium carbonate, calcium chloride, copper(II) carbonate, potassium carbonate and anhydrous sodium carbonate should be provided at the start of the exercise.

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

Risk assessment

A risk assessment must be carried out for this problem.

Special safety requirements

The use of concentrated sulphuric acid and electrolysis to produce chlorine gas requires teacher supervision.

Group size

4.

Possible methods

1. Add dilute acid – the one that does not effervesce is the chloride.
2. Flame tests.
3. Make solutions of the three soluble salts.
 - a) Test them with pH paper: two are strongly alkaline: the third salt – calcium chloride – is neutral.
 - b) Mix the salts together in pairs. The one that gives a white precipitate twice (calcium carbonate) is the calcium chloride.
 - c) Silver nitrate test.

If the students know the test in the form 'make the solution acidic by adding dilute nitric acid and then add silver nitrate solution', then it can be applied directly.

However, if they have not met this test for halide ions before they are likely to need help because of the precipitation of silver carbonate. They should add silver nitrate solution to the three solutions; all give a precipitate; reference to solubility tables show that silver carbonate and silver chloride are both insoluble. Addition of dilute nitric acid dissolves silver carbonate but not silver chloride and thus identifies the calcium chloride.

4. Add to water and electrolyse – chloride gives chlorine at the anode.

5. Add a drop of concentrated sulphuric acid to the solid – the chloride gives acidic steamy fumes of hydrogen chloride.

Suggested approach

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

1. Working as a group, see how many different methods you can devise. Ask for help if you can't think up at least four methods. Some methods will seem to be better than others – discuss the advantages and disadvantages of each of the methods. 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 ten minutes should be spent initially with further discussion as required.
2. Select a method each, and write up your method in note form.
3. Get your method checked for safety and then carry out the practical work.
4. Write a brief account of what you did. You should include notes on the advantages and disadvantages of your method.
5. If there are still methods to test when you have finished, try another method. If all the methods have been started, join in and help another member of the group to finish that method.
6. Once all the methods have been tested, have a group discussion of each method and try to decide on the best one. This could be one person's method or one using the 'best bits' from several methods.
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 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.

Find the chloride

By using chemicals and apparatus in the laboratory, devise experiments to determine which of the solids is the chloride.

Five solids are provided. They are unnamed but are known to be barium carbonate, copper(II) carbonate, potassium carbonate, sodium carbonate and calcium chloride.

At least four different methods should be devised and tested, and then a decision made as to which method is the 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.

Health safety and technical notes

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.