



28. What compound?

Introduction

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

Prior knowledge

Familiarity with redox reactions, pH of solutions of ionic compounds (eg the knowledge that solutions of ammonium chloride and iron(III) sulphate are acidic) and tests for ions. 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 – solubility tables may be required.

The solid to be identified should not be issued until students have completed part (ii) of the problem. The solid could be any one of the following:

- ▼ aluminium sulphate;
- ▼ iron(III) sulphate;
- ▼ ammonium sulphate;
- ▼ aluminium nitrate;
- ▼ iron(III) nitrate; or
- ▼ ammonium nitrate.

Group size

3.

Risk assessment

A risk assessment must be carried out for this problem.

Possible solutions

Part (i)

The initial discussion can reduce the number of possible compounds:

- ▼ the acidic nature of the solution¹ eliminates sodium and barium ions because their soluble salts with the anions listed are neutral; and
- ▼ the unreactivity (redox) with manganate(VII) excludes the three halide ions.

This leaves the following possibilities:

- ▼ aluminium sulphate;
- ▼ iron(III) sulphate;
- ▼ ammonium sulphate;
- ▼ aluminium nitrate;
- ▼ iron(III) nitrate; or
- ▼ ammonium nitrate.

**Part (ii)**

Possible tests include:

- ▼ the barium chloride test;
- ▼ the brown ring test;
- ▼ the test for iron(III) with thiocyanate or hexacyanoferrate(II) ions; and
- ▼ the addition of a strong alkali to give ammonia from ammonium salts.

Colour is also relevant, but this is unlikely to be useful until part (iii).

Part (iii)

If it is colourless, it is aluminium nitrate or sulphate, or ammonium nitrate or sulphate. Two tests are required:

- ▼ to determine the cation, test with strong alkali; and
- ▼ to determine the anion, test with barium chloride solution or use the brown ring test.

If it is coloured, the cation is iron(III), and the barium chloride test or the brown ring test is required to determine the anion. It would, however, be more satisfactory if iron(III) was confirmed with thiocyanate or hexacyanoferrate(II) as suggested above.

Suggested approach

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

You can divide the work amongst you but keep one another informed of your progress.

1. Working as a group, list all the compounds that the solid could be.
2. Again working as a group, devise as many different ways of identifying the solid as you can. Some methods will seem better than others. Write down and discuss the advantages and disadvantages of each of the methods that you have devised.

Discussion can play a vital part in working out solutions to problems like this and sufficient time should be spent discussing the different methods and their advantages and disadvantages. About 10 minutes should be spent on this initially with further discussion as required.

3. Devise a systematic procedure to identify the solid. Get this checked for safety.
Note – You should ask for the solid at this point.
4. Use your procedure to identify the solid.
5. 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, explain how you selected possible compounds; the systematic procedure you devised to identify the solid; and describe how well it worked. 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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Possible extension

Use the systematic procedure that the students have devised to test other solids.

Notes

1. If students are unfamiliar with the acidity of aluminium or iron(III) salts, it may be worth issuing these or similar salts for them to test. They can refer to textbooks for explanations.



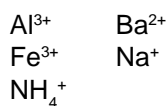
28. What compound?

Identify the solid you have been given by:

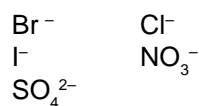
- (i) from the ions below, make a list of all of the compounds the solid could be;
- (ii) suggest as many ways as possible of identifying the solid and use this information to devise an analytical procedure; and
- (iii) use this procedure to identify the solid.

The solid that you have been given is made up of one cation and one anion from the following lists:

Cations



Anions



The following observations were made about the solid:

- ▼ the solid dissolved in water to give an acidic solution; and
- ▼ there was no observable change when this solution was added to acidified potassium manganate(VII) solution.

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.