

Sulfates

4.8.3.5 · Chemical analysis · revision notes

Sulfate ions give a white precipitate of barium sulfate with barium chloride solution in the presence of dilute hydrochloric acid. This is in GCSE Chemistry only (not Combined Science). The sulfate test is often combined with other ion tests to identify a compound in the required practical.

Key facts

- Test: dilute hydrochloric acid, then barium chloride solution
- Hydrochloric acid removes carbonate ions, which would also give a white precipitate
- $\text{BaCl}_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{NaCl}$
- Result: white precipitate of barium sulfate → sulfate ions present
- Never use sulfuric acid: it adds sulfate ions
- Halides: nitric acid + silver nitrate. Sulfates: hydrochloric acid + barium chloride.

Notes

The test

- Make a solution of the sample. Add a few drops of **dilute hydrochloric acid**, then a few drops of **barium chloride solution**.
- If sulfate ions (SO_4^{2-}) are present, a **white precipitate** of barium sulfate forms.
- If no precipitate forms, there are no sulfate ions.
- Barium chloride solution is toxic: wear eye protection and avoid skin contact.

Why dilute hydrochloric acid?

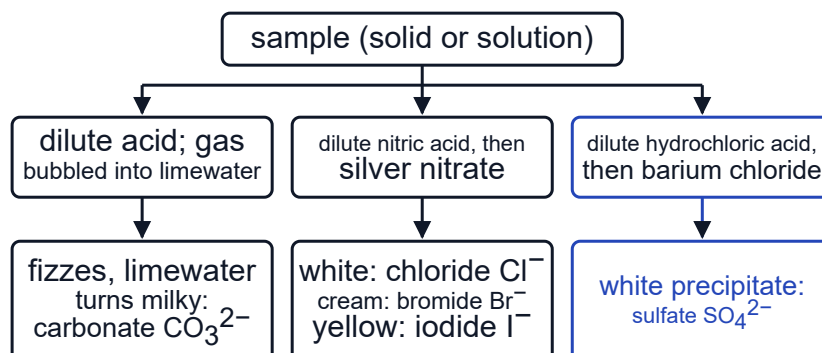
- The acid removes carbonate ions, which would otherwise form a white precipitate (barium carbonate) with barium chloride.
- Do **not** use sulfuric acid: it contains sulfate ions, so it would give a white precipitate every time.
- Compare the halide test, which uses nitric acid because hydrochloric acid would add chloride ions. In the sulfate test, extra chloride ions do not matter.

Equations

- Example: $\text{BaCl}_2(\text{aq}) + \text{Na}_2\text{SO}_4(\text{aq}) \rightarrow \text{BaSO}_4(\text{s}) + 2\text{NaCl}(\text{aq})$

Required practical: identifying an unknown compound

- An ionic compound contains a positive ion and a negative ion, so you need a test for each.
- Positive ion: flame test, or sodium hydroxide solution.
- Negative ion: dilute acid and limewater (carbonate), nitric acid and silver nitrate (halide), or hydrochloric acid and barium chloride (sulfate).



One test for each negative ion; test the positive ion with a flame test or NaOH.

How to answer each type of question

Describe the test for sulfate ions and give the result

2 to 3 marks

Grade 3

1. Add dilute hydrochloric acid to a solution of the sample.
2. Add barium chloride solution.
3. Result: a white precipitate.

Example. Describe a test to show that a solution contains sulfate ions. Give the result.

Model answer. Add dilute hydrochloric acid (1), then barium chloride solution (1). A white precipitate forms (1).

Describe tests to confirm both ions in a compound

4 marks

Grade 5

1. Dissolve the solid in water.
2. Test one portion for the positive ion (flame test or sodium hydroxide solution) and give the result.
3. Test another portion for the negative ion and give the result.

Example. A solid is thought to be iron(III) sulfate.

Describe tests to show that it contains iron(III) ions and sulfate ions. Give the results.

Model answer. Dissolve the solid in water and add sodium hydroxide solution to one portion (1). A brown precipitate shows iron(III) ions (1). To another portion, add dilute hydrochloric acid and then barium chloride solution (1). A white precipitate shows sulfate ions (1).

Don't lose marks

- ✗ Using sulfuric acid, which adds sulfate ions, instead of hydrochloric acid.
- ✗ Mixing up the reagents: silver nitrate is for halides; barium chloride is for sulfates.
- ✗ Writing 'goes cloudy' without saying that a white precipitate forms.
- ✗ Writing the sulfate ion wrongly. It is SO_4^{2-} .

More tips

Memory tricks

- Barium for sulfate, silver for halides.
- The acid matches the reagent's negative ion: barium chloride with hydrochloric acid; silver nitrate with nitric acid.
- Both tests: acid first (to remove carbonate ions), then the reagent.

Exam technique

- Name both reagents (dilute hydrochloric acid and barium chloride solution) and the result (white precipitate).
- In 6-mark 'identify' questions, go test by test and give the result for every substance.
- Say 'dissolve the solid in water' first: the halide and sulfate tests are done on solutions.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Describe the test for sulfate ions

Add dilute hydrochloric acid, then barium chloride solution, to a solution of the sample.

Grade 3

State the positive result for sulfates

A white precipitate of barium sulfate forms.

Grade 5

Identify a compound using two ion tests

e.g. a blue precipitate with sodium hydroxide and a white precipitate with barium chloride → copper(II) sulfate.

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