Carbonates

4.8.3.3 · Chemical analysis · revision notes

Carbonate ions are identified by adding dilute acid: the mixture fizzes and the gas turns limewater milky. This ion test is in GCSE Chemistry only (not Combined Science). Questions ask for the method, the result and equations.

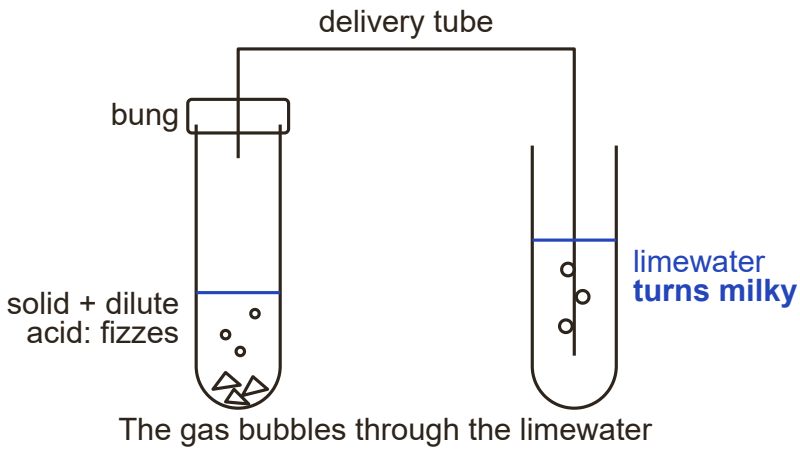
Key facts

- Test: add dilute acid; bubble the gas through limewater
- Result: fizzing, and limewater turns milky → carbonate ions (CO_3^{2-}) present
- acid + metal carbonate → salt + water + carbon dioxide
- $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$
- Grade 7+ only $CO_3^{2-} + 2H^+ \rightarrow H_2O + CO_2$
- Acid is added before the halide and sulfate tests to remove carbonate ions

Notes

The test

- Add **dilute acid**, e.g. dilute hydrochloric acid, to the solid or solution.
- If carbonate ions (CO_3^{2-}) are present, the mixture **fizzes** as carbon dioxide is given off.
- Bubble the gas through **limewater** using a delivery tube. The limewater turns **milky** (cloudy), so the gas is carbon dioxide and a carbonate is present.



Fizzing plus milky limewater shows a carbonate.

- Fizzing alone is not enough: a metal reacting with acid also fizzes (giving hydrogen). The limewater result proves the gas is carbon dioxide.

Equations

- acid + metal carbonate → salt + water + carbon dioxide
- $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$
- $CuCO_3 + H_2SO_4 \rightarrow CuSO_4 + H_2O + CO_2$
- Ionic equation for carbonate ions in solution: $CO_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2O(l) + CO_2(g)$ Grade 7+ only

Why this matters for the halide and sulfate tests

- Carbonate ions also form precipitates with silver nitrate solution and with barium chloride solution, so they could give a false positive in the halide and sulfate tests.
- That is why dilute acid is added first in those tests: it reacts with any carbonate ions and removes them as carbon dioxide.

How to answer each type of question

Describe the test for carbonate ions and give the result — 2 to 3 marks — Grade 3

1. Add dilute acid to the sample.
2. Bubble the gas through limewater.
3. Result: fizzing, and the limewater turns milky.

Example. Describe a test to show that a white powder contains carbonate ions. Give the result.

Model answer. Add dilute hydrochloric acid to the powder (1). Bubble the gas given off through limewater (1). The mixture fizzes and the limewater turns milky / cloudy (1).

Name the salt and write a balanced equation — 2 to 3 marks — Grade 6

1. Products: salt + water + carbon dioxide.
2. Name the salt: metal from the carbonate, ending from the acid (chloride, sulfate, nitrate).
3. Write the formulae, then balance and check each element.

Example. Potassium carbonate, K_2CO_3, reacts with dilute nitric acid, HNO_3.
(a) Name the salt formed.
(b) Write a balanced symbol equation for the reaction.

Model answer.

(a) potassium nitrate (1)
(b) $K_2CO_3 + 2HNO_3 \rightarrow 2KNO_3 + H_2O + CO_2$: correct formulae (1); correctly balanced (1)

Explain why acid is added first in the sulfate or halide test 2 marks **Grade 7**

1. Say that carbonate ions would also form a precipitate with the test reagent.
2. Say that the acid reacts with the carbonate ions and removes them, so any precipitate must come from the ion being tested.

Example. In the test for sulfate ions, dilute hydrochloric acid is added before barium chloride solution. Explain why.

Model answer. Carbonate ions would also form a white precipitate with barium chloride, giving a false result (1). The acid reacts with and removes any carbonate ions (1).

Don’t lose marks

- Stopping at 'it fizzes'. You need the limewater test to prove the gas is carbon dioxide.
- Writing 'the limewater turns white'. Write milky or cloudy.
- Leaving water out of the products of acid + carbonate.
- Writing the carbonate ion without its charge. It is CO_3^{2-}.

More tips

Memory tricks

- Carbonate test = 'fizz, then milk': bubbles, then milky limewater.
- Salt names: hydrochloric → chloride, sulfuric → sulfate, nitric → nitrate.
- Every acid + carbonate equation ends ‘+ H_2O + CO_2’.

Exam technique

- For full marks, give the observation (fizzing) AND the limewater result.
- Say 'dilute' acid, e.g. dilute hydrochloric acid.
- To identify a whole compound, add a flame test or sodium hydroxide test for the metal ion.

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 carbonate ions**
Add dilute acid and bubble any gas given off through limewater.

Grade 3 **State the positive result for carbonates**
Fizzing, and the gas turns limewater milky (cloudy).

Grade 5 **Name the products of acid and carbonate**
A salt, water and carbon dioxide.

Grade 6 **Balance equations for acids with carbonates**
e.g. $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$.

Grade 7 **Write the ionic equation for carbonate and acid**
$CO_3^{2-} + 2H^+ \rightarrow H_2O + CO_2$.

Grade 7

Explain why acid is added in other tests

In the halide and sulfate tests, the acid removes carbonate ions, which would also form a precipitate.

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