

CAIE IGCSE Chemistry

12.5 Identification of ions and gases

Notes

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Describe tests to identify the anions:

Carbonates: CO_3^{2-}

- Carbonates react with dilute acids, i.e. nitric acid, to create carbon dioxide.
- This gas can be bubbled through limewater
- If the limewater goes cloudy, the gas is CO_2 so a carbonate is present

Halides: Chlorides (Cl^-) Bromides (Br^-) Iodides (I^-)

- First add dilute nitric acid to the sample, followed by silver nitrate solution
- Chlorides produce a white precipitate
- Bromides produce a cream precipitate
- Iodides produce a yellow precipitate

Nitrates: NO_3^-

- Firstly, add aqueous sodium hydroxide to your unknown sample
- Then add aluminium powder or foil, and proceed to heat the mixture strongly.
- If nitrate ions are present, they will be reduced to ammonia, giving off ammonia gas.
- This can be identified by testing it with damp red litmus paper, which will turn blue in its presence.

Sulfates: SO_4^{2-}

- First add dilute hydrochloric acid, followed by barium chloride solution
- A white precipitate will form if sulfate ions are present in this solution

Sulfite: SO_3^{2-}

- Add a dilute acid and heat gently
- Sulfur dioxide gas is given off
- Bubble this gas through aqueous potassium manganate(VII)
- There will be a colour change from purple to colourless if the sulfite ion is present.



Describe tests using aqueous sodium hydroxide and aqueous ammonia to identify the aqueous cations:

Using aqueous dilute sodium hydroxide

Ions	Observation after a few drops of NaOH is added	Observation after excess NaOH is added
Aluminium, Al ³⁺	White precipitate forms	Precipitate redissolves
Ammonium, NH ₄ ⁺	Ammonia gas given off (how to test is further below)	No change
Calcium, Ca ²⁺	White precipitate forms	No change
Chromium(III), Cr ³⁺	Grey-green precipitate forms	Dark green solution forms
Copper(II), Cu ²⁺	Blue precipitate forms	No change
Iron(II), Fe ²⁺	Green precipitate forms	No change
Iron(III), Fe ³⁺	Orange-brown precipitate forms	No change
Zinc, Zn ²⁺	White precipitate forms	Precipitate redissolves

Using aqueous ammonia

Ions	Observation after a few drops of ammonia is added	Observation after excess ammonia is added
Aluminium, Al ³⁺	White precipitate forms	No change
Calcium, Ca ²⁺	Very faint precipitate forms	No change
Chromium(III), Cr ³⁺	Grey-green precipitate forms	No change
Copper(II), Cu ²⁺	Light blue precipitate forms	Precipitate dissolves to form a dark blue solution
Iron(II), Fe ²⁺	Green precipitate forms	No change
Iron(III), Fe ³⁺	Orange-brown precipitate forms	No change
Zinc, Zn ²⁺	White precipitate forms	Precipitate dissolves to form a colourless solution



- Testing with both solutions can differentiate between the different cations, i.e. there are 3 cations which all produce white precipitates:
 1. Aluminium ions, Al^{3+}
 2. Calcium ions, Ca^{2+}
 3. Zinc ions, Zn^{2+}
- To distinguish Calcium ions (Ca^{2+})

The white precipitate formed when NaOH is added does not dissolve in excess NaOH, whereas the hydroxide precipitates of aluminium and zinc do
- To distinguish Zinc ions (Zn^{2+})

The white precipitate formed when a few drops of ammonia is added to zinc dissolves into a colourless solution when excess ammonia is added, but the white precipitate of aluminium doesn't dissolve

Describe tests to identify the gases:

Ammonia: NH_3

- Turns damp red litmus paper blue

Carbon dioxide: CO_2

- Bubble the gas through the limewater (calcium hydroxide)
- If carbon dioxide is present, the limewater will turn cloudy

Chlorine: Cl_2

- When damp litmus paper is put into chlorine gas the litmus paper is bleached and turns white

Hydrogen: H_2

- Hold a burning splint at the open end of a test tube of the gas sample
- Creates a 'squeaky pop' sound if hydrogen gas is present

Oxygen: O_2

- Insert a glowing splint into a test tube of the gas sample
- Splint relights if oxygen gas is present

Sulfur dioxide: SO_2

- Bubble the gas through aqueous potassium manganate(VII)
- If sulfur dioxide gas is present, there will be a colour change from purple to colourless



Describe the use of a flame test to identify the cations:

A flame test could be used to identify the cations by distinguishing the colour of the flame they produce

Cation	Flame colour
Lithium, Li^+	Crimson
Sodium, Na^+	Yellow
Potassium, K^+	Lilac
Calcium, Ca^{2+}	Red
Barium, Ba^{2+}	Yellow-green
Copper(II), Cu^{2+}	Blue-green

