CAIE Chemistry A-Level

Practicals for Papers 3 and 5

Ion Identification

Group 2 Ions Identification

Example Method	Accuracy	Explanation
1. Place 10 drops of 0.1 mol dm^{-3} barium chloride in a clean test tube.		Must be clean to ensure a clear test result.
2. Add 10 drops of 0.6 mol dm^{-3} sodium hydroxide solution, mixing well and recording any observations.		
3. Continue to add this sodium hydroxide solution, **dropwise** with gentle **shaking**, until in **excess**. Record any observations.	• The test tube should not be more than half full.	
4. Once completed, dispose of the contents by placing the test tube in a bowl of water. Repeat this test with the calcium bromide, magnesium chloride and strontium chloride.		

Example Results Table:

	Barium chloride	**Calcium bromide**	**Magnesium chloride**	**Strontium chloride**
10 drops of 1.0 mol dm^{-3} H_2SO_4	white precipitate	slight white precipitate	slight white precipitate	white precipitate
Excess H_2SO_4	white precipitate	slight white precipitate	colourless solution	white precipitate

Safety precautions:

- Some barium salts are toxic so wear gloves.

Results to Learn:

	Mg^{2+}	Ca^{2+}	Sr^{2+}	Ba^{2+}
Ammonium solution	White precipitate of $Mg(OH)_2$	No change	No change	No change
Excess NaOH	White precipitate of $Mg(OH)_2$	White precipitate of $Ca(OH)_2$	Slight white precipitate	No change
Excess H2SO4	Colourless solution	Slight white precipitate	White precipitate	White precipitate

Identification of NH_4^+

Method	Accuracy	Explanation
1. Place 10 drops of ammonium chloride into a clean test tube. Add about 10 drops of sodium hydroxide solution. Shake the mixture.	• Shaking ensure the reactant combine properly.	
2. Warm the mixture in the test tube gently using a water bath. (necessary because ammonia gas is very soluble)		A water bath is **gentler** than using a flame.
3. Test the fumes released from the mixture by using forceps to hold a piece of damp red litmus paper in the mouth of the test tube.		
4. Dispose of the contents by placing in a test tube full of boiling water		
5. Record the observation of the damp red litmus paper (should turn blue).		Ammonium ions are basic.

Identification of: Halide ions, OH^-, CO_3^{2-}, SO_4^{2-}

Test for hydroxide ions: aqueous solution

1. Test a 1 cm depth of solution in a test tube with red litmus paper or universal indicator paper.
2. Record your observations. Dispose of the test tube contents.
3. Sodium hydroxide will turn damp red litmus paper blue.

Test for hydroxide ions: ammonia (hydroxide ions form when it comes into contact with water)

1. Take 5 drops of 1.0 mol dm^{-3} ammonia solution and place on a filter paper and place inside a petri dish with lid.
2. Dampen a piece of red litmus paper with deionised (distilled) water and place on the other side of the petri dish.
3. Replace the lid and observe over a few minutes.
4. Ammonia solution vapours will **turn damp red litmus paper blue**.

Identification of OH^-

Method	Accuracy	Explanation
1. Add an equal, small volume of dilute hydrochloric acid to sodium carbonate solution in a test tube.		

2. Use a delivery tube to transfer the gas produced into a second test tube containing a small volume of calcium hydroxide solution (limewater).	• Using a tube with a bung **prevents product loss**.	
3. Put a stopper into the test tube containing the calcium hydroxide solution (limewater).	• Shake the tube from side to side.	
4. The limewater will go cloudy if carbonate ions present.		**CO_2** is produced which turns the limewater cloudy.

Equations:

$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

Identification of SO_4^{2-}:

Method	Accuracy	Explanation
1. Add an equal volume of dilute hydrochloric acid then an equal volume of barium chloride solution to the solution.	• The HCl ensures any other compounds which may react are **removed**.	
2. Barium sulphate formed (white precipitate).		Barium sulfate is an **insoluble** salt.
3. Add a small volume of dilute HCl.		
4. As precipitate does not dissolve, sulphate or hydrogen sulfate ions are present.		

Equations:

$MgSO_4 + BaCl_2 \rightarrow BaSO_4(s) + MgCl_2(aq)$

Safety precautions:

- Barium Chloride is HARMFUL so wear gloves and a lab coat.

Identification of Group 7 ions:

Method	Accuracy	Explanation
1. Add a small volume of dilute nitric acid to the solution of potassium chloride.	• This **removes** any ions which may form a different precipitate.	
2. Add 2 cm of silver nitrate to the solution. Record any observations.		
3. Swirl the tubes to ensure that the precipitates formed in each case are evenly distributed and then divide the contents of each tube in half.		Allows further identification tests as initial precipitates can be hard to distinguish.
4. To one half of the contents, add an excess of dilute aqueous ammonia solution and observe what happens. Record your observations.		
5. To the other half, working in a fume cupboard, add an excess of concentrated ammonia solution and observe what happens. Record your observations.		
6. Repeat with solutions of potassium bromide and potassium iodide in new, separate test tubes.		

Safety:

- Concentrated ammonia is corrosive so chemical splash-proof eye protection and nitrile gloves should be worn.
- Use a fume cupboard.
- Dilute nitric acid is an irritant.

Overall results for Group 7:

	Silver nitrate	**Dilute ammonia**	**Conc. ammonia**
KCl	White precipitate	Colourless solution	Colourless solution
KBr	Cream precipitate	Cream precipitate	Colourless solution
KI	Yellow precipitate	Yellow precipitate	Yellow precipitate

Identification of Group 7 ions:

1. Place a small spatula measure of solid potassium chloride in a **dry** test tube in a test tube rack.
2. Working in a fume cupboard, add a few drops of **concentrated** sulfuric acid. Record any observations.
3. Test any gas evolved with moist blue litmus or universal indicator paper.
4. Repeat the experiment with solid potassium bromide and solid potassium iodide, recording any observations.

Overall results for Group 7:

	Conc. sulfuric acid	**Blue litmus paper**
KCl	White, steamy fumes	Turns red
KBr	Orange fumes	Turns red
KI	Purple fumes and purple/black solid	Turns red

Safety precautions:

- Concentrated sulfuric acid is corrosive.
- Gases produced are toxic and corrosive, therefore carry out in a **fume cupboard** using small quantities of chemicals.
- Wear chemical splash-proof **eye protection** and nitrile gloves.

Identifying metal ion solutions:

Ion Solutions	Test	Result
Cu^{2+} (blue)	1. Add NaOH 2. Add NH_3	1. A pale blue precipitate of $Cu(H_2O)_4(OH)_2$ forms that is insoluble in excess NaOH. 2. Initially, a pale blue precipitate of $Cu(H_2O)_4(OH)_2$ forms. When NH_3 is added in excess, the precipitate dissolves to form a deep blue solution of $[Cu(H_2O)_2(NH_3)_4]^{2+}$.
Al^{3+} (colourless)	Add NaOH	A white precipitate of $Al(H_2O)_3(OH)_3$ forms.
Mn^{2+} (pale pink)	Add NaOH	A pale brown precipitate forms which goes dark brown when exposed to the oxygen in the air.

Tips:

- Write observations based on the salt analysis **data sheet** where possible.
- Reagents should be written **in full** and not the ions e.g. write HCl in place of H^+.
- Write results and observations in a **table** format.