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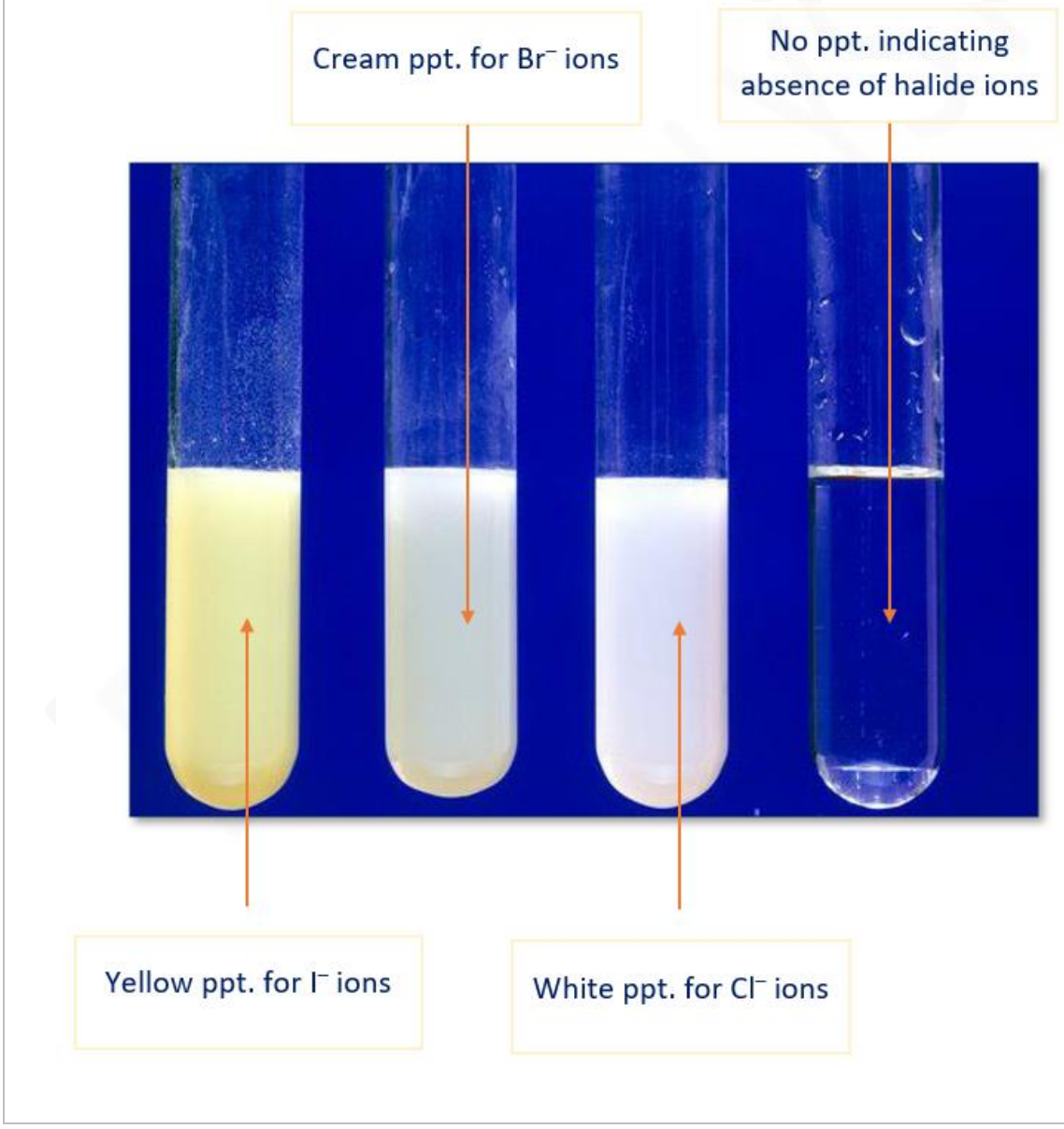
Notes for use in qualitative analysis

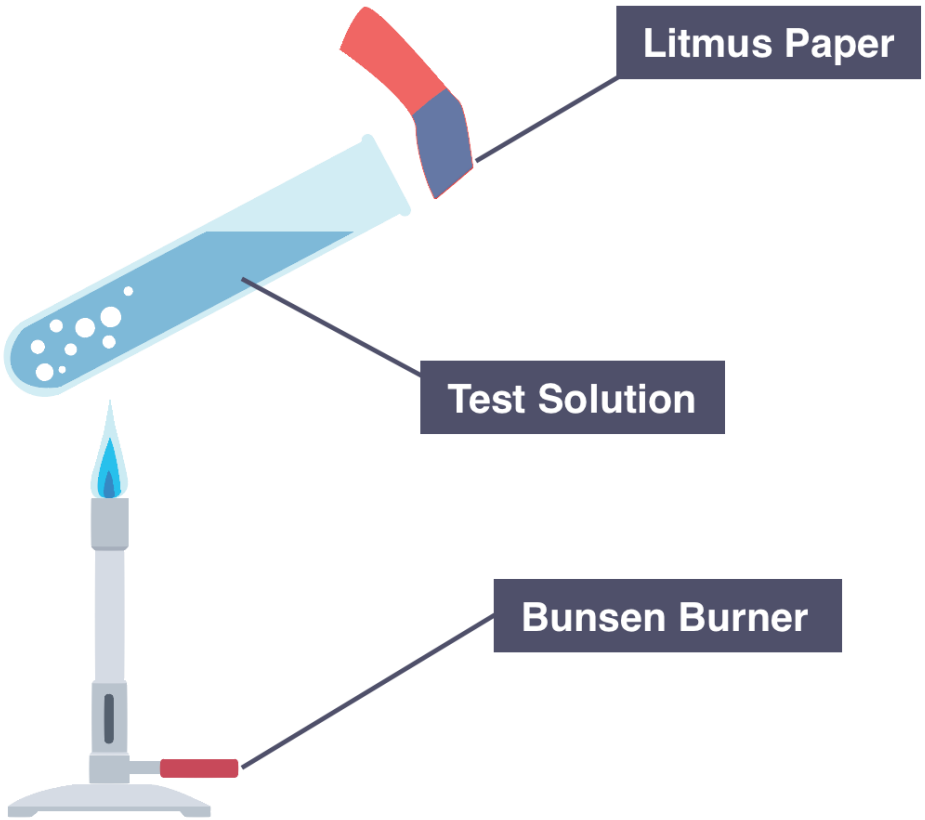
Tests for anions

***precipitate = ppt.**

Test for halide ions in solution: Chloride (Cl^-), Bromide (Br^-), Iodide (I^-)
Test: Acidify with dilute Nitric acid, then add aqueous Silver nitrate.
Positive Result: (Coloured/White) ppt. formed.
Negative Result: No ppt. formed.



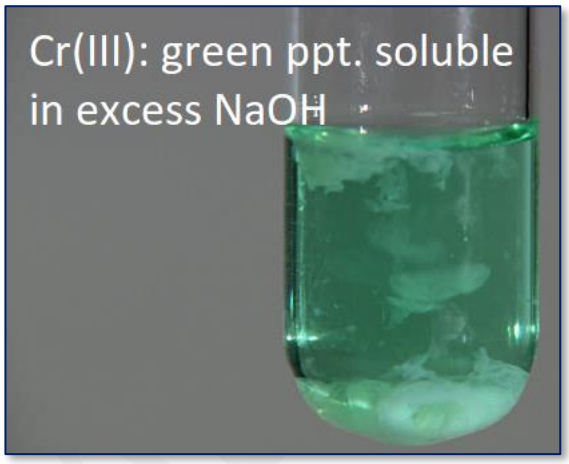
Test for Carbonate ions
Test: Add dilute acid
Positive Result: Effervescence (fizz seen), Carbon dioxide produced 
Negative Result: No effervescence
To confirm the identity of the gas, bubble the gas through limewater.
If limewater turns milky, the gas is Carbon dioxide.
Limewater turns milky 

Test for Nitrate ions
Test: Add aqueous Sodium hydroxide, then add Aluminium foil, warm carefully
Positive Result: Ammonia gas (with pungent, irritating odour) produced
Negative Result: No gas produced
To confirm the identity of the gas, test it with damp red litmus paper.
If the litmus paper turns blue, the gas is Ammonia.
Damp red litmus paper turns blue. 

Test for Sulfate ions
Test: Acidify with dilute Hydrochloric or dilute Nitric acid, then add aqueous Barium nitrate.
Positive Result: White ppt. forms 
Negative Result: No white ppt.

Test for Sulfite ions
Test: Add dilute Hydrochloric acid, warm gently and test for the presence of Sulfur dioxide gas by bubbling the gas produced through acidified aqueous Potassium manganate (VII).
Positive Result: Gas produced turns acidified aqueous Potassium manganate (VII) from purple to colourless. 
Negative Result: No gas produced or no colour change.

Tests for aqueous cations

<table>
<tr><td colspan="2">Test 1: Add aqueous Sodium hydroxide (dropwise)</td></tr>
<tr><td colspan="2">Result</td></tr>
<tr><td>White ppt.</td><td>Coloured ppt.</td></tr>
<tr><td>  </td><td>Chromium (III), Cr^{3+}: grey-green ppt.
  </td></tr>
<tr><td>Aluminium (Al^{3+})
Calcium (Ca^{2+})
Zinc (Zn^{2+})</td><td>Copper (II), Cu^{2+}: Light blue ppt.
Watch precipitation of Copper(II) hydroxide
  </td></tr>
</table>

Test 1: Add aqueous Sodium hydroxide (dropwise)	
Result	
	Iron (II), Fe^{2+}: Green ppt.
	Iron (III), Fe^{3+}: Red-brown ppt. 

Test 1: Add aqueous Sodium hydroxide **in excess**	
Result	
Aluminium (Al^{3+}) & Zinc (Zn^{2+}): white ppt. dissolves forming a colourless solution	Chromium (III), Cr^{3+}: green ppt. soluble in excess (forms a green solution)
Calcium (Ca^{2+}): white ppt. **insoluble** in excess	Copper (II), Cu^{2+} Iron (II), Fe^{2+} Iron (III), Fe^{3+} } Coloured ppt. insoluble in excess

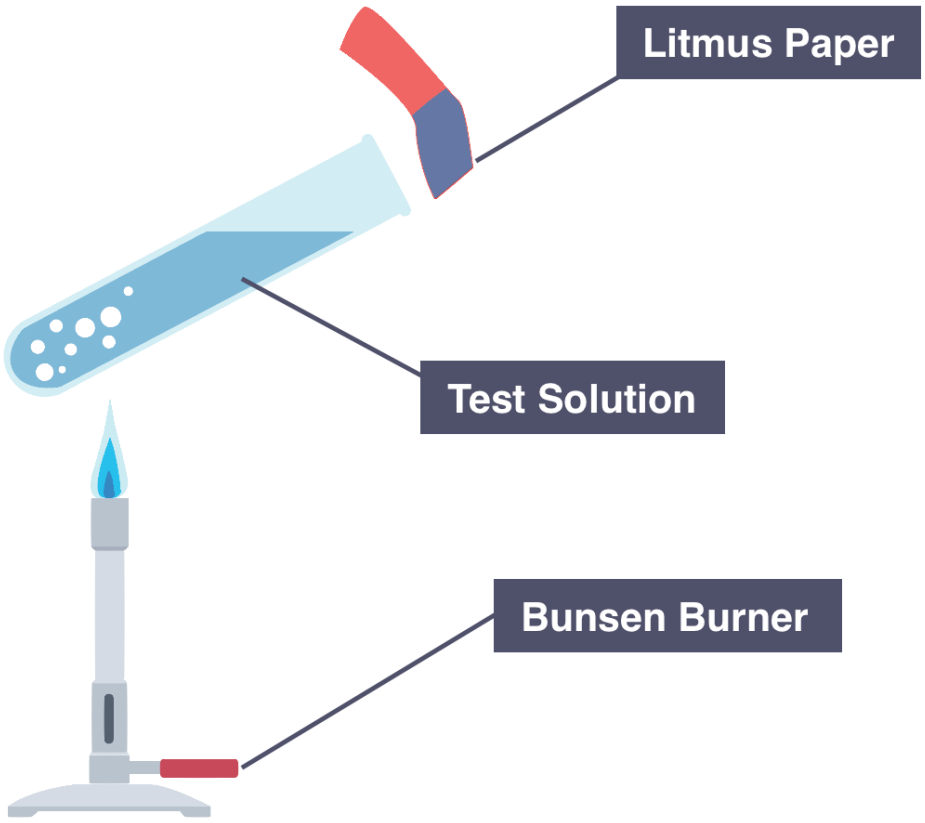
NOTE

Although not specified in the syllabus, questions may be asked about the reactions of alkali metals ions such as Li^+, Na^+ and K^+ with aq. NaOH.
Alkali metal hydroxides are water-soluble, hence no ppt. would be formed.

<table>
<tr><th colspan="2">Test 2: Add aqueous Ammonia (dropwise) and then in excess</th></tr>
<tr><th colspan="2">Result</th></tr>
<tr><th>White ppt.</th><th>Coloured ppt.</th></tr>
<tr><td>Aluminium (Al^{3+}): white ppt. insoluble in excess</td><td>Chromium (III), Cr^{3+}: grey-green ppt. insoluble in excess</td></tr>
<tr><td>Zinc (Zn^{2+}): White ppt. soluble in excess</td><td>Copper (II), Cu^{2+}: Light blue ppt. dissolves in excess to form a dark blue solution.
FAQ!
  </td></tr>
<tr><td>Calcium (Ca^{2+}): slight white or no ppt.
Note: If left open to air for some time, the green ppt. for Fe(II) changes to red-brown as it undergoes oxidation to Fe(III).</td><td>Iron (II), Fe^{2+}: Green ppt. insoluble in excess
Iron (III), Fe^{3+}: Red-brown ppt. insoluble in excess
*same as that with aq. NaOH</td></tr>
</table>

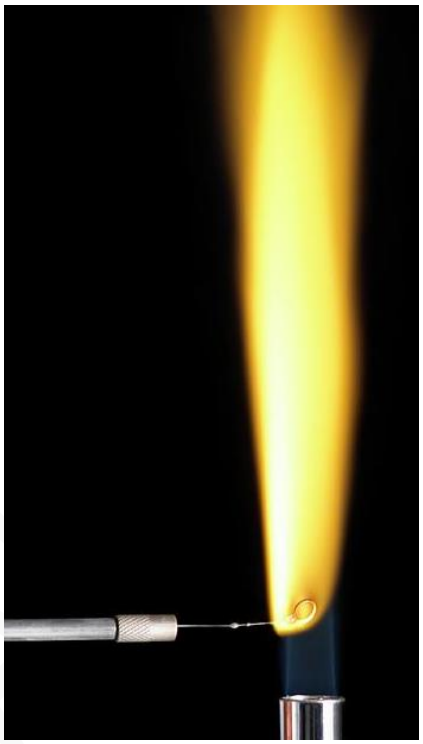
Test for NH_4^+ ions (Ammonium ions)
Test: Add aqueous Sodium hydroxide and warm gently
Positive Result: Ammonia gas (with pungent, irritating odour) produced on warming
Negative Result: No gas produced
To confirm the identity of the gas, test it with damp red litmus paper.
If the litmus paper turns blue, the gas is Ammonia.

Damp red litmus paper turns blue.



NOTE **This test can also be used to detect the presence of hydroxide ions.**
Test: Add some solid Ammonium chloride solid (using a spatula) and warm gently.
Result: same as that for Ammonium; positive result indicates presence of hydroxide ions.

Flame tests for metal ions

Metal ion: Flame colour	
Lithium (Li^+): Red 	Sodium (Na^+): Yellow 
Potassium (K^+): Lilac 	Copper(II) (Cu^{2+}): Blue-green 

FLAME TESTS

Tests for gases

Ammonia (NH_3)

Test: Test the gas with damp red litmus paper.

Result: The litmus paper turns blue.

Other observations: Pungent, irritating odour

Carbon dioxide (CO_2)

Test: Bubble the gas through limewater.

Result: Limewater turns milky.

Chlorine (Cl_2)

Test: Test the gas with damp litmus paper.

Result: Litmus paper gets bleached.

Note: If a damp blue litmus paper is used, it turns red first (since Chlorine is weakly acidic) and then white.
If a damp red litmus paper is used, it turns white.

Hydrogen (H_2)

Test: Test the gas with a lighted splint.

Result: The lighted splint goes off with a pop sound.

Other observations: A tiny flame can be seen for an instant as the gas catches fire.
*Hydrogen is highly inflammable.

Oxygen (O_2)

Test: Test the gas with a glowing splint.

Result: The glowing splint relights.

Sulfur dioxide (SO_2)
Test: Bubble the gas through acidified aqueous Potassium manganate (VII). **Result**: Change in colour from purple to colourless **Note:** Acidified aqueous Potassium manganate (VII) can be written in a simpler format as aq. $KMnO_4/H^+$

SOME MORE TESTS…

Chemical Tests for Water / Water vapour

Test 1: Test with (DRY) Cobalt(II) chloride paper.

Result: Change in colour from blue to pink

Test 2: Test with anhydrous Copper(II) sulfate powder

Result: Change in colour from white to blue

Physical Tests for Pure Water

Test 1: Determine its boiling point

Result: Pure water boils at 100℃. In the presence of an impurity, the boiling point will be greater than 100℃.

FAQ!

Test 2: Determine the melting point of ice made by freezing the water sample.

Result: Pure ice melts at 0℃. In the presence of an impurity, the melting point will be lower than 0℃.

FAQ!

Test to distinguish between Alkanes (saturated) and Alkenes (unsaturated)

Test: Add bromine water.

Result: Change in colour from orange or brown to colourless for alkenes; no change in colour for alkanes

Test for Alcohol (Ethanol)

Test: Touch a lighted splint to some alcohol taken in a watch glass.

Result: It catches fire, burns with a clean blue flame.

Deductions that can be made from a substance's appearance or smell

Observation on substance	Indication
Black powder	Carbon, or contains O^{2-} ions (as in CuO), or S^{2-} ions (as in CuS)
Pale green crystals	Contains Fe^{2+} ions (as in iron (II) salts)
Dark green crystals	Contains Ni^{2+} ions (as in nickel (II) salts)
Blue or blue-green crystals	Contains Cu^{2+} ions (as in copper (II) salts)
Yellow-brown crystals	Contains Fe^{3+} ions (as in iron (III) salts)
Smell of ammonia **(Pungent, irritating smell)**	Contains NH_4^+ ions (as in ammonium salts)

QUESTION-BANK