BioMedical Admissions Test (BMAT)

Section 2: Chemistry

Topic C16: Chemical Tests

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There are a number of common tests for gases, ions and metals which you need to know for BMAT Section 2.

Testing for common gases

Testing for **Hydrogen Gas**	Known as the "squeaky pop test" Place a lighted splint in the sample. If hydrogen gas is present, a "squeaky pop" will be heard.
Testing for **Oxygen Gas**	Placing a glowing splint in the sample. If the splint relights, oxygen is present.
Testing for **Chlorine Gas**	Placing a piece of litmus paper into a sample containing chlorine gas will cause the litmus paper to turn first red and then white.

Tests for common anions (negative ions)

Testing for Carbonate ions (CO_3^{2-})

1. Add dilute acid to a sample.
2. Bubble the gas produced through limewater
3. If the limewater turns cloudy, $CO_{2:}$ is present. This means that there was carbonate in the sample.

- This is based on the principles:
    - Carbonate ions + acid → salt + carbon dioxide + water
    - CO_2 turns limewater cloudy.

Testing for halide ions

1. Acidify the sample solution by adding dilute nitric acid. (This is to remove any carbonate impurities in the sample).
2. Add a few drops of silver nitrate solution.
3. Observe the colour of the precipitate (solid) formed
    a. Chloride ions → white precipitate
    b. Bromide ions → cream precipitate
    c. Iodide ions → yellow precipitate

- This is based on the principle:
  - $X^-_{(aq)} + Ag^+_{(aq)} \rightarrow AgX_{(s)}$
  - The solid formed is a silver halide.
  - The sample is acidified because carbonate ions in the solution would form a white precipitate (silver carbonate) when the silver nitrate is added.

Testing for sulphate ions (SO_4^{2-})

1. Acidify the solution by adding dilute HCl solution
2. Then add barium chloride
3. Observe to see if a white precipitate (barium sulfate) forms.

- This is based on the principle:
  - $Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)}$
  - Barium sulfate is a white solid

Testing For	Acidified?	Adding	Positive test?	Formula of product
Halide ions	Yes - Nitric acid	Silver nitrate	Chloride - white	$AgCl_{(s)}$
			Bromide - cream	$AgBr_{(s)}$
			Iodide - yellow	$AgI_{(s)}$
CO_3^{2-}	Not as a separate step	DIlute acid	Gas turns limewater cloudy.	$CO_{2\,(g)}$
SO_4^{2-}	Yes - HCl	Barium Chloride	White precipitate	$BaSO_{4\,(s)}$

Testing for positive metal ions: Reacting with Sodium Hydroxide Solution

As well as by their **coloured flame**, metal ions can also be identified by the **coloured precipitate** they form when reacted with a **solution of sodium hydroxide**.

This is also the case with **transition metals**; adding sodium hydroxide solution to transition metal compounds causes the formation of an insoluble transition metal hydroxide precipitate.

The **general ionic equation** for the formation of the insolution metal hydroxide precipitate:

$$X^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow X(OH)_{2(s)} \quad \text{Or} \quad X^{3+}_{(aq)} + 3OH^-_{(aq)} \rightarrow X(OH)_{3(s)}$$

Where X is the metal:

Metal ion	Colour of metal hydroxide precipitate
Cu^{2+}	Blue
Fe^{2+}	Green
Fe^{3+}	Brown
Ca^{2+}	White
Al^{3+}	White → colourless
Mg^{2+}	White

The aluminium ion first reactions with the hydroxide ion to form a white precipitate. However in excess NaOH solution, the white precipitate formed then reacts with the excess hydroxide ions and a colourless solution is formed.

This process can be shown using **ionic equations**:

Formation of white precipitate: $Al^{3+}_{(aq)} + 3OH^{-}_{(aq)} \rightarrow Al(OH)_{3(s)}$

Formation of colourless precipitate: $Al(OH)_{3(s)} + OH^{-}_{(aq)} \rightarrow Al(OH)_{4}^{-}{}_{(aq)}$

More on ionic equations can be found in Topic C3 - Chemical Reactions, Formulae and Equations.

Testing for positive metal ions: Flame tests

Alkali metals (group 1 metals) and group 2 metals will lose electrons to form positive ions.

Due to the different configuration of the electron shells of each metal ion, when placed in a flame each metal ion will give a distinct colour that is specific to that metal ion only.

This property can be used to identify the alkali metal by doing a flame test using a solid sample of the compound:

1) Clean a wire loop by dipping it into a solution of hydrochloric acid and then rinsing it off using distilled water. It is important to clear wire loop like this to prevent contamination between samples which will distort the results.
2) Dip the cleaned wire loop into a solid sample of the compound. e.g . a sample of sodium chloride.
3) Place the wire loop into the hottest part of the bunsen burner - this is the edge of the blue flame. Placing the wire loop into this part of the flame will give the best results as the coloured flame can be seen strongly here.
4) The colour of the flame will indicate which alkali metal ion (in this case Na^+) is present in the sample compound.

You must learn the flame colours of the following metal ions:

Metal Ion	Flame Colour
Li^+	Crimson red
Na^+	Yellow-orange
K^+	Lilac
Ca^{2+}	Red-orange
Cu^{2+}	Green