AQA Chemistry A-level

3.2.2: Group II - The Alkaline Earth Metals

Detailed Notes

3.2.2.1 - Group II

The Group II metals lose two electrons to **form 2+ ions** when they react in order to achieve a full outer shell.

Atomic Radius

The atomic radius of group II metals **increases** down the group due to additional electron shells.

Reactivity

Increased electron **shielding** down the group makes the outer electrons **easier to lose**. Therefore reactivity of the group II metals **increases** down the group.

Ionisation Energy

The first ionisation energy of group II metals **decreases** down the group due to a greater atomic radius and increased amounts of shielding.

Melting Point

The group II elements are **metallic** meaning the larger the ions within the metallic structure, the weaker the attractive forces as the attractive force has to **act over a much greater distance**. Therefore the melting points **decrease** down the group.

Reactions with Water

The group II metals react with water in a redox reaction to produce a **metal hydroxide and hydrogen**. The metal hydroxide form as an **alkaline solution**, hence why the group II metals are known as the alkali metals.
Example:

$$Mg + 2H_2O \longrightarrow Mg(OH)_2 + H_2$$

The magnesium is oxidised from OS (oxidation state) 0 to OS +2.
(Oxidation is loss of e^-)

Magnesium reacts very slowly in this way with liquid water, however the reaction can be much **faster with steam** as it provides the reaction with **extra energy**. When steam is used, the magnesium burns with a **bright white flame** to form hydrogen and magnesium oxide, a **white powder**.

Example:

$$Mg + H_2O \longrightarrow MgO + H_2$$

Solubility of Hydroxides

The solubility of group II hydroxides varies and means these compounds have different uses. Solubility **increases down the group** meaning magnesium hydroxide ($Mg(OH)_2$) is the least soluble and barium hydroxide ($Ba(OH)_2$) the most soluble.

As a result, magnesium hydroxide is used in medicine as an **antacid** as it is alkaline and can neutralise acids. It is used in a similar way in agriculture to neutralise acidic soils.

Solubility of Sulfates

Group II sulfates **decrease in solubility down the group** meaning magnesium sulfate ($MgSO_4$) is the most soluble and barium sulfate ($BaSO_4$) is the least soluble.

The insolubility of **barium sulfate** means it is very useful in medicine as **barium meals**. These are a form of medical tracer that allow internal tissues and organs to be imaged. Barium sulfate is toxic if it enters the bloodstream, however because it is insoluble, it **cannot be absorbed** into the blood. Therefore it is safe to use in this way.

Barium chloride is used as a **test for sulfate ions** as it reacts to form barium sulfate which forms as a **white precipitate** when sulfate ions are present.

Example:

$$Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_{4(s)}$$

Metal Extraction

Magnesium is used in the **extraction of titanium** from titanium chloride via a **displacement** reaction.

Example:

$$TiCl_4 + 2Mg \longrightarrow 2MgCl_2 + Ti$$

Flue Gas Removal

Calcium oxide reacts with sulfur dioxide to remove it from factory pollutants and prevent it from being released into the atmosphere. This forms **calcium sulfite and water**.

Example:

$$CaO + 2H_2O + SO_2 \longrightarrow CaSO_3 + 2H_2O$$