CAIE Chemistry A-level

27: Group 2

(A-level only)

Notes

Similarities and Trends in the Properties of the Group 2 Metals, Magnesium to Barium, and their Compounds

Thermal Stability of the Nitrates and Carbonates

Both **carbonates** and **nitrates** become **more thermally stable** as you go down Group 2. The stability of the compounds is influenced by **charge density of the cation** and how **polarised** the **anion** becomes.
Ions formed from elements at the top of group 2 are **smaller** than those at the bottom. A **smaller +2 ion** has a **greater charge density** because the same charge is packed into a small volume. This means smaller group 2 ions have a **greater polarising effect** on neighbouring negative ions.

When a carbonate or nitrate ion is placed near the metal cation, the **anion becomes polarised** because the **cation draws the electrons** towards itself. Smaller Group 2 ions are more polarising due to their greater charge density. The **more polarised the anion** is, the **less heat is required** for thermal decomposition to occur. This means that **thermal stability increases down the group** because ions further down the group are worse at polarising the anion so more heat energy is required to break bonds for thermal decomposition.

Predicting Trends

The reactions of Group 2 metals, metal oxides, metal hydroxides and metal carbonates generally indicate that **reactivity increases as you go down Group 2.**
Reactivity increases down the group because **ionisation energy decreases** due to the **increasing atomic radius** and the **shielding effect** of electrons. This means further down the group, the electrons become easier to remove so reactivity increases.

Some **exceptions** to this trend can be seen when **sulfates and hydroxides are produced**, however this is due to the **insolubility** of some sulfates and hydroxides inhibiting reactions.

Solubility of Hydroxides and Sulfates

The **solubilities** of the Group 2 metal **hydroxides** and **sulfates** show trends in the group. The trend in the solubility of sulfates is **opposite** to the trend in the hydroxides:

Group 2 element - X	Hydroxide - $X(OH)_2$	Sulfate - XSO_4
Magnesium	Least soluble	Most soluble
Calcium		
Beryllium		
Barium	Most soluble	Least soluble

Compounds with very **low solubilities**, like magnesium hydroxide, are often said to be **sparingly soluble**. Most sulfates are soluble in warm water except barium sulfate which is insoluble.

Solubility in Terms of Enthalpy Change of Hydration and Lattice Energy

The trends in the solubilities of the Group 2 hydroxides and sulfates can be seen above.
As you go **down Group 2**, the **lattice enthalpy** required to break up the compound **decreases** because the **size of the positive ions increases**. Larger cations means there is **more space between ions** in the compound so there are **weaker forces of attraction** between the ions.
As the **cations increase in size** down the group, **the enthalpy change of hydration** (the amount of energy released as the ions bond to water molecules) also **decreases**.

Hydroxides
For hydroxide ions (relatively **small** ions), the **lattice enthalpy falls faster than the enthalpy change of hydration** of the cations. This means the **enthalpy change of solution** will become **more negative** down the group (more exothermic).

Sulfates
For sulfate ions (relatively **large** ions), the **lattice enthalpy falls slower than the hydration enthalpy** of the cations. This means the **enthalpy of solution** will become **more positive** down the group (more endothermic).

The **more exothermic** the **enthalpy of solution** is, the **more soluble** a compound is. Therefore sulfates become less soluble down the group and hydroxides become more soluble down the group.