27 Group 2

Thermal decomposition of Group 2 nitrates and carbonates

The changes in thermal stability stem from of the ability of a cation to polarise the anion. This is more pronounced at the top of the group, where the cations are smaller and have a high charge density. This applies to both the nitrate and carbonate, where polarisation results in the formation of the oxide:

$$2X(NO_3)_2(s) \rightarrow 2XO(s) + 4NO_2(g) + O_2(g)$$

$$XCO_3(s) \rightarrow XO(s) + CO_2(g)$$

You can examine this trend by comparing the decomposition temperatures of the carbonates (Table 27.1).

Table 27.1

Element	Decomposition temperature of the carbonate/K
Beryllium	Unstable at 298
Magnesium	700
Calcium	1200
Strontium	1580
Barium	1660

NOW TEST YOURSELF

1 Why are the nitrates of Group 2 elements less stable at the top of the group than at the bottom?

Solubility of Group 2 sulfates and hydroxides

The solubility and the enthalpy change of solution of the sulfates of Group 2 elements decrease down the group. This is due to a combination of the relative sizes of the enthalpy change of hydration of the cations and the lattice energy of the sulfate concerned:

STUDY TIP

The **solubility** of the sulfates of Group 2 decreases down the group. This is due to the relative magnitudes of the enthalpy change of hydration and the lattice energy for compounds.

- As the cations get bigger, the energy released when the ions bond to water molecules (the enthalpy change of hydration) falls.
- Larger ions are not as strongly attracted to the water molecules.
- As you go down a group, the energy needed to break up the lattice decreases as the positive ions get bigger. The bigger the ions, the more distance there is between them and the weaker are the forces holding them together.
- Because both energy changes decrease, it is a question of which is the more significant. For large ions, such as SO_4^{2-}, it is the enthalpy change of hydration factor that dominates.
- Conversely the hydroxides of Group 2 elements become *more* soluble descending the group, but there is not a simple explanation for this.

NOW TEST YOURSELF

2 Put the following sulfates in order of increasing solubility, explaining your answer:

$BaSO_4$ $CaSO_4$ $SrSO_4$

REVISION ACTIVITY

Predict the relative thermal stabilities of $MgCO_3$ and $BaCO_3$, giving a reason for your answer.

END OF CHAPTER CHECK

By now you should be able to:

- describe and explain qualitatively the trend in thermal stability of Group 2 nitrates and carbonates using the effect of ionic radius on the polarisation of a large anion
- describe and explain qualitatively the variation in solubility and of enthalpy change of solution, ΔH_{sol}, of Group 2 hydroxides and sulfates in terms of the magnitudes of the enthalpy change of hydration and the lattice energy