Week 40

A-Level Chemistry

Homework bundle for this week

本周作业合集

exercises.lol

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27. Group 2

Starter Quiz · 课前小测

A-Level Chemistry Name: _____ Score: _____

1. Going down Group 2, the thermal stability of the nitrates and carbonates:

   ☐ increases

   ☐ decreases

   ☐ stays the same

   ☐ becomes zero

2. The enthalpy of solution is given by:

   ☐ $\Delta H\_sol = -\Delta H\_latt + \Delta H\_hyd$

   ☐ $\Delta H\_sol = \Delta H\_latt + \Delta H\_hyd$

   ☐ $\Delta H\_sol = \Delta H\_latt - \Delta H\_hyd$

   ☐ $\Delta H\_sol = \Delta H\_hyd \times \Delta H\_latt$

3. A small cation makes a carbonate decompose more easily because it:

   ☐ polarises (distorts) the carbonate ion, weakening a bond inside it

   ☐ makes the carbonate ion bigger

   ☐ adds electrons to the anion

   ☐ lowers the temperature

4. Group 2 hydroxides become MORE soluble down the group because:

   ☐ the small OH^- means the lattice energy falls a lot down the group

   ☐ the lattice energy stays constant

   ☐ the hydration energy increases

   ☐ they stop dissolving

5. A larger cation lower in the group:

   ☐ polarises the anion less, so the compound is more stable

   ☐ polarises the anion more

   ☐ has a higher charge density

   ☐ cannot form compounds

6. A more thermally stable carbonate needs a higher temperature to decompose.

   ☐ True ☐ False

7. Group 2 carbonates become more stable to heat going down the group.

   ☐ True ☐ False

8. Group 2 hydroxides become more soluble down the group.

   ☐ True ☐ False

9. Group 2 sulfates become LESS soluble down the group because:

   ☐ the large SO_4^{2-} keeps the lattice energy almost constant, so the fall in hydration energy dominates

   ☐ the lattice energy falls a lot

   ☐ the hydration energy rises

   ☐ they become more polar

10. A solid dissolves easily when the hydration energy:

    ☐ roughly matches or beats the lattice energy

    ☐ is much smaller than the lattice energy

    ☐ is zero

    ☐ is positive

27. Group 2

Answers · 答案

A-Level Chemistry

1. **increases**

   A larger cation polarises the anion less, so the compound is harder to decompose — more stable down the group.

2. **$\Delta H\_sol = -\Delta H\_latt + \Delta H\_hyd$**

   You reverse the lattice energy (to break the lattice) and add the hydration enthalpy.

3. **polarises (distorts) the carbonate ion, weakening a bond inside it**

   High charge density distorts the anion, weakening it so it breaks down at a lower temperature.

4. **the small OH^- means the lattice energy falls a lot down the group**

   With the small OH^- ion, the lattice energy drops sharply down the group, outweighing the hydration fall.

5. **polarises the anion less, so the compound is more stable**

   Bigger cation = lower charge density = less polarisation = more thermally stable.

6. **True**

   Greater stability means more energy is needed to break it down.

7. **True**

   Larger cations distort the carbonate ion less.

8. **True**

   While the sulfates become less soluble.

9. **the large SO_4^{2-} keeps the lattice energy almost constant, so the fall in hydration energy dominates**

   The big sulfate ion makes the lattice energy nearly constant, so the decreasing hydration energy controls the trend.

10. **roughly matches or beats the lattice energy**

    If hydration releases about as much (or more) energy than is needed to break the lattice, dissolving is favourable.

A-LEVEL CHEMISTRY • EXERCISE SHEET

27.1 Group 2 trends in thermal stability and solubility

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

KEY WORDS lattice energy 晶格能 • thermal stability 热稳定性 • cation 阳离子 • carbonate 碳酸盐 • nitrate 硝酸盐

Objective

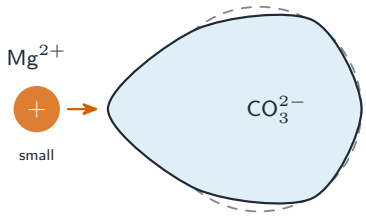
Build the skills to answer exam questions on the **Group 2 trends** — the **thermal stability** 热稳定性 of the nitrates and carbonates, and the **solubility** 溶解度 of the hydroxides and sulfates.

You must be able to:

- explain the thermal-stability trend using ionic radius and **polarisation** 极化
- explain the solubility/ΔH_{sol} trends using lattice energy and hydration enthalpy

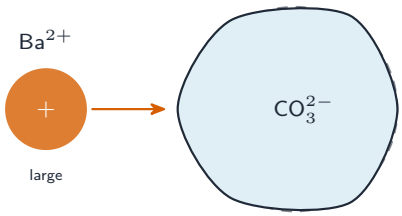
1 Worked examples

■ Thermal stability and polarisation



high charge density — **distorts the anion a lot**

less stable: decomposes easily



low charge density — **distorts the anion little**

more stable: needs high heat

A small cation (high charge density) polarises the large anion more, weakening it — so stability rises down the group

Down the group the cation gets larger → lower charge density → polarises the anion **less** → the carbonate/nitrate is harder to decompose (more stable).

■ Solubility energetics

$$\Delta H_{sol} = -\Delta H_{latt} + \Delta H_{hyd}$$

hydroxides (small OH^-):
lattice energy falls *a lot* down the group
⇒ outweighs the smaller hydration fall → **more** soluble

sulfates (large SO_4^{2-}):
lattice energy stays almost constant
⇒ the hydration fall then dominates → **less** soluble

ΔH_{sol} depends on the balance of lattice energy and hydration enthalpy as both change down the group

Hydroxides become **more soluble**, sulfates **less soluble** down the group — because the lattice energy and hydration enthalpies change at different rates as the cation grows.

2 Practice

2.1 State the trend in thermal stability of the Group 2 carbonates down the group. [1]

2.2 State the trend in solubility of the Group 2 sulfates down the group. [1]

3 Exam-style questions

3.1 Magnesium carbonate decomposes at a lower temperature than barium carbonate because the Mg^{2+} ion: [1]

- **A** is larger
- **B** has a higher charge density and polarises the carbonate more
- **C** has a lower charge
- **D** is more soluble

3.2 The increasing thermal stability of the nitrates down Group 2 is explained by: [1]

- **A** increasing cation charge
- **B** decreasing polarisation of the anion by the larger cation

- **C** increasing anion size
- **D** decreasing temperature

3.3 Explain, in terms of polarisation, why the thermal stability of the Group 2 nitrates increases down the group. [3]

3.4 ΔH_{sol} depends on the lattice energy and the hydration enthalpies. Explain why both quantities become **less** exothermic down Group 2. [2]

Solutions

2.1 it increases down the group.

2.2 it decreases down the group.

3.1 B. The small Mg^{2+} has a high charge density and polarises the carbonate more.

3.2 B. The larger cation polarises the anion less, so the nitrate is more stable.

3.3 down the group the cation gets larger, so its charge density falls; it polarises/distorts the large nitrate ion less; so the N–O bonds are weakened less and a higher temperature is needed to decompose it.

3.4 down the group the cation is larger; so both the lattice energy (ions further apart) and the hydration enthalpy (lower charge density, weaker attraction to water) become less exothermic.