

Exercise walk-through

10.1

Similarities and trends in the properties of the Group 2 metals, magnesium to barium, and their compounds

A-Level Chemistry

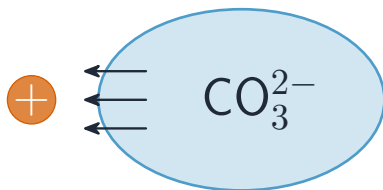
Thermal decomposition

Thermal decomposition : carbonates $\rightarrow$ oxide + CO_2 ; nitrates $\rightarrow$ oxide + NO_2 + O_2 .

Thermal stability rises down the group – a larger ion **polarises** the anion less, so it is harder to break.

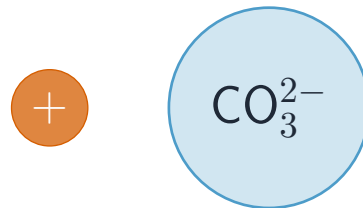
Thermal decomposition, in detail

small Mg^{2+} :
high polarising power



distorts the ion
 $\Rightarrow$ **decomposes easily**

large Ba^{2+} :
low polarising power



barely distorted
 $\Rightarrow$ **thermally stable**

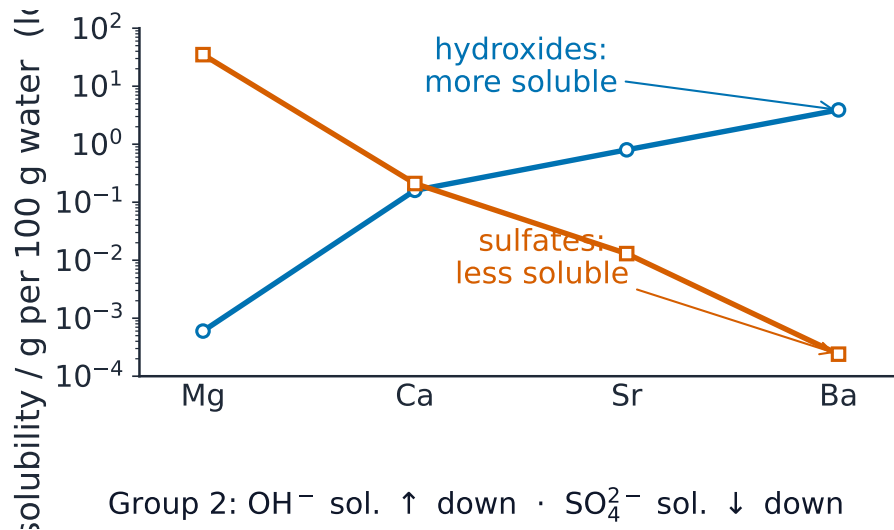
Thermal stability rises down the group: a small cation polarises (distorts) the carbonate ion more, weakening it so it decomposes more easily

Solubility trends

Down Group 2:

- **hydroxides** become **more** soluble ($\text{Ba}(\text{OH})_2$ soluble)
- **sulfates** become **less** soluble (BaSO_4 insoluble)

Solubility trends, in detail



Down Group 2 the two trends run opposite ways:

hydroxides become **more** soluble – Ba(OH)₂ is soluble.

sulfates become **less** soluble – BaSO₄ is insoluble.

Worked example – thermal stability down Group 2

MgCO₃ decomposes at about 540 °C and BaCO₃ at about 1360 °C. Explain, and predict radium's.

- the cation **polarises** the carbonate, weakening a C–O bond
- Mg²⁺ is small with a **high charge density**, so it polarises strongly
- Ba²⁺ is far larger, polarises weakly, and needs more heat
- radium is larger still, so RaCO₃ would be **more stable than BaCO₃**

Charge density – charge over size – is the whole explanation, and it lets you predict radium's properties without ever meeting it.

Exercises 2.1·2.2

2.1 Write the equation for the reaction of calcium with water.

[1]

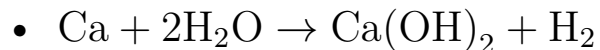
2.2 State the trend in reactivity down Group 2 and why.

[2]

Exercises 2.1·2.2

2.1 Write the equation for the reaction of calcium with water. [1]

2.1



2.2 State the trend in reactivity down Group 2 and why. [2]

2.2

- reactivity increases down the group; the atoms are larger, so the two outer electrons are lost more easily

Exercises 3.1-3.2

3.1 Which carbonate is the **most** thermally stable?

[1]

☐

A MgCO_3

B CaCO_3

C SrCO_3

D BaCO_3

3.2 Down Group 2, the solubility of the sulfates:

[1]

☐

A increases

B decreases

C stays the same

D first rises then falls

Exercises 3.1·3.2

3.1 Which carbonate is the **most** thermally stable?

[1]

☐

A MgCO_3

B CaCO_3

C SrCO_3

D BaCO_3

3.1 D

- Thermal stability increases down the group, so BaCO_3 is most stable

3.2 Down Group 2, the solubility of the sulfates:

[1]

☐

A increases

B decreases

C stays the same

D first rises then falls

3.2 B

- Sulfate solubility decreases down Group 2

Exercise 3.3

3.3 (a) Write the equation for the thermal decomposition of calcium nitrate. [2]

(b) Explain why barium carbonate is more thermally stable than magnesium carbonate.[3]

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(b) Explain why barium carbonate is more thermally stable than magnesium carbonate.[3]

3.3

(a)



(b)

- the Ba^{2+} ion is larger (lower charge density) than Mg^{2+} ; it polarises/distorts the carbonate ion less; so the C–O bonds are weakened less and a higher temperature is needed to decompose it

Exercise 3.4

3.4 Describe and explain the trend in reactivity of the Group 2 metals with water. [2]

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3.4

- reactivity increases down the group; larger atoms hold their outer electrons less tightly, so they react faster with water