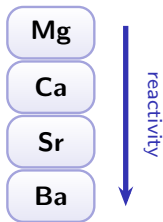


Group 2

A-Level Chemistry ■ Topic 10

A-Level Chemistry



What we will cover

- 1 Reactivity down the group
- 2 Reactions of the elements
- 3 Thermal decomposition
- 4 Solubility trends

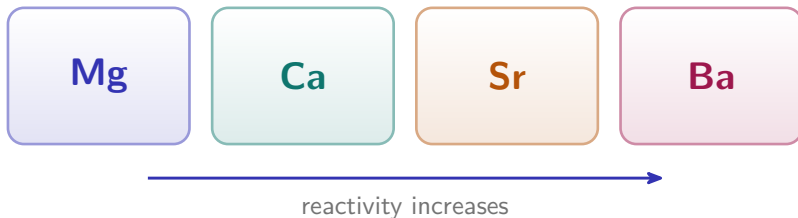


magnesium burns brilliantly



Reactivity down the group

Group 2 metals get **more reactive** down the group: the outer pair is further from the nucleus and more shielded, so it is lost more easily.



Reactions of the elements

with oxygen: $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$

with water: $\text{Ca} + 2\text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{H}_2$

with acid: $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$

Reactions get faster down the group – but with **sulfuric acid** they slow, because the insoluble **sulfate** coats the metal.



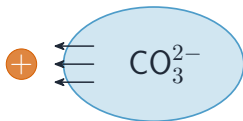
Thermal decomposition

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.

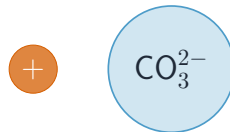
Thermal decomposition, in detail

small Mg^{2+} :
high polarising power



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

large Ba^{2+} :
low polarising power



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

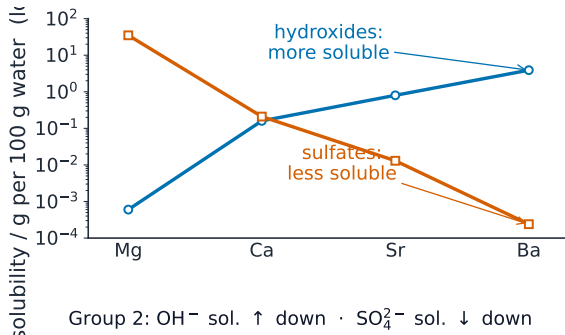
Thermal stability rises down the group: a small cation polarises (distorts) the carbonate ion more, weakening it so it decomposes more easily

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 – $\text{Ba}(\text{OH})_2$ is soluble.

sulfates become **less** soluble – BaSO_4 is insoluble.

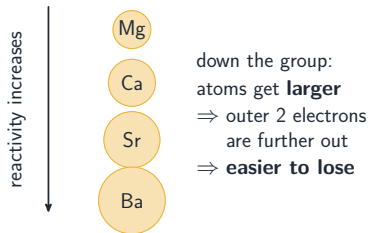
Worked example – thermal stability down Group 2

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.

The Group 2 metals



Reactivity increases down Group 2: larger atoms hold their two outer electrons less tightly. The **oxides** and **hydroxides** are **basic** – they react with water and with dilute acids – and the **carbonates** give a salt, water and carbon dioxide with a dilute acid.

Thermal decomposition means breaking a compound apart by heating it.

The Group 2 metals, continued



Limestone is calcium carbonate – a compound of the Group 2 metal calcium.

Exam tips

- Reactivity **increases down** Group 2: ionisation energy falls as atoms get larger, so electrons are lost more easily.
- Reactions with water become **more vigorous** down the group; Mg reacts slowly with cold water but fast with steam ($\rightarrow$ MgO).
- Hydroxides get **more soluble** down the group; sulfates get **less soluble** (BaSO_4 insoluble – the basis of the sulfate test).
- Write equations with the correct +2 ion and state the observations (fizzing, dissolving).



Worked example – Group 2 with water

Write the equation for calcium with water, and explain the reactivity trend down Group 2.

- $\text{Ca} + 2\text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{H}_2$
- Down the group the outer shell is **further out** and more **shielded**.
- So the two outer electrons are lost more easily – **ionisation energy falls**.
- **Reactivity increases down**: Mg slow in cold water, Ca steady fizzing, Ba vigorous.

Group 2 gets more reactive down because it is easier to **lose** electrons. Group 17 gets *less* reactive down because it is harder to **gain** them.

Topic 10 – key takeaways

1

Reactivity

increases down the group

2

Reactions

form oxides, hydroxides & salts + H_2

3

Thermal stability

rises down; small ions polarise more

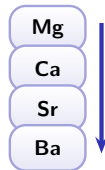
4

Solubility

hydroxides up, sulfates down

Check yourself

- 1 Which way does reactivity change down Group 2?
- 2 What does a carbonate decompose into?
- 3 Which is more soluble, $\text{Mg}(\text{OH})_2$ or $\text{Ba}(\text{OH})_2$?
- 4 Why is BaSO_4 hard to dissolve?



Answers 1. increases 2. the oxide + CO_2 3. $\text{Ba}(\text{OH})_2$ 4. sulfate solubility falls down the group