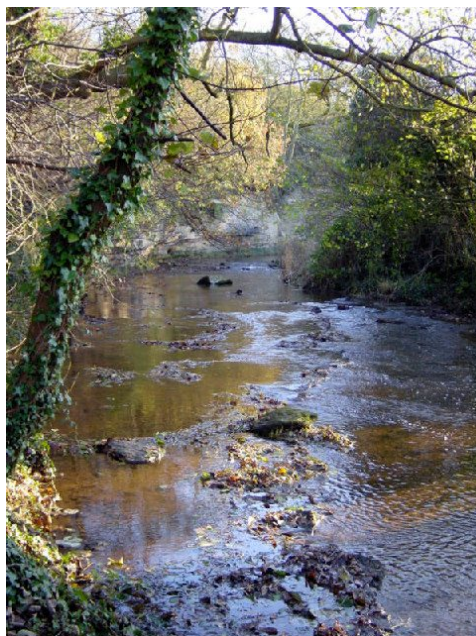


Group 2

A-Level Chemistry

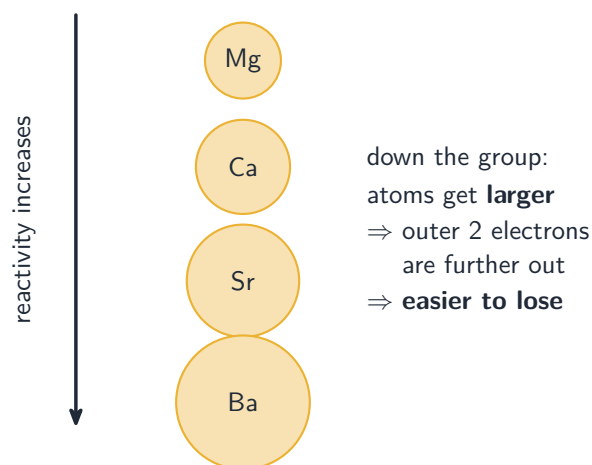
The Group 2 metals



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

Image: Heather Holdridge, CC BY-SA 2.0 (commons.wikimedia.org)

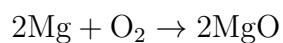
Group 族 2 holds the metals magnesium, calcium, strontium and barium. They all have two outer electrons, which they lose to form 2+ ions. Going **down** the group, the atoms get larger and the outer electrons are easier to lose, so the metals get **more reactive** — their **reactivity** 反应活性 increases down the group.



Reactivity increases down Group 2: larger atoms hold their two outer electrons less tightly, so they are lost more easily

Reactions of the elements

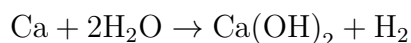
With **oxygen**, they burn to form an oxide:



Magnesium burns in air with a brilliant white flame, forming white magnesium oxide

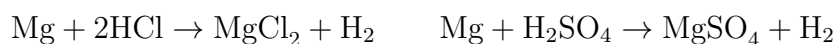
Image: Capt. John Yossarian, CC BY-SA 3.0 (commons.wikimedia.org)

With **water**, they form a hydroxide and hydrogen. The reaction gets faster down the group:



Magnesium is slow with cold water but reacts fast with steam, giving MgO and H₂.

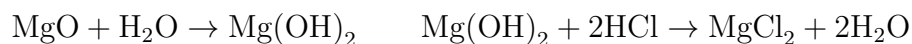
With **dilute hydrochloric or sulfuric acid**, they form a salt and hydrogen:



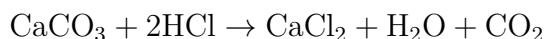
With sulfuric acid the reaction slows down the group, because the **sulfates** 硫酸盐 formed (such as BaSO₄) are insoluble and coat the metal.

Reactions of the compounds

The **oxides** 氧化物 and **hydroxides** 氢氧化物 are basic. They react with water and with dilute acids:



The **carbonates** 碳酸盐 react with dilute acids to give a salt, water and carbon dioxide:



Thermal decomposition

Thermal decomposition 热分解 means breaking a compound apart by heating it.

- the carbonates break into the oxide and carbon dioxide:

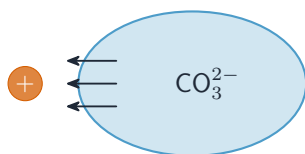


- the **nitrates** 硝酸盐 break into the oxide, brown nitrogen dioxide gas and oxygen:



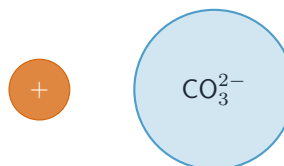
The **thermal stability** 热稳定性 of both the carbonates and the nitrates **increases** down the group. A larger metal ion pulls less on the carbonate or nitrate ion, so the compound is harder to break apart—it needs a higher temperature. So magnesium carbonate decomposes most easily, and barium carbonate is the hardest.

small Mg^{2+} : high polarising power



distorts the ion
⇒ **decomposes easily**

large Ba^{2+} : low polarising power

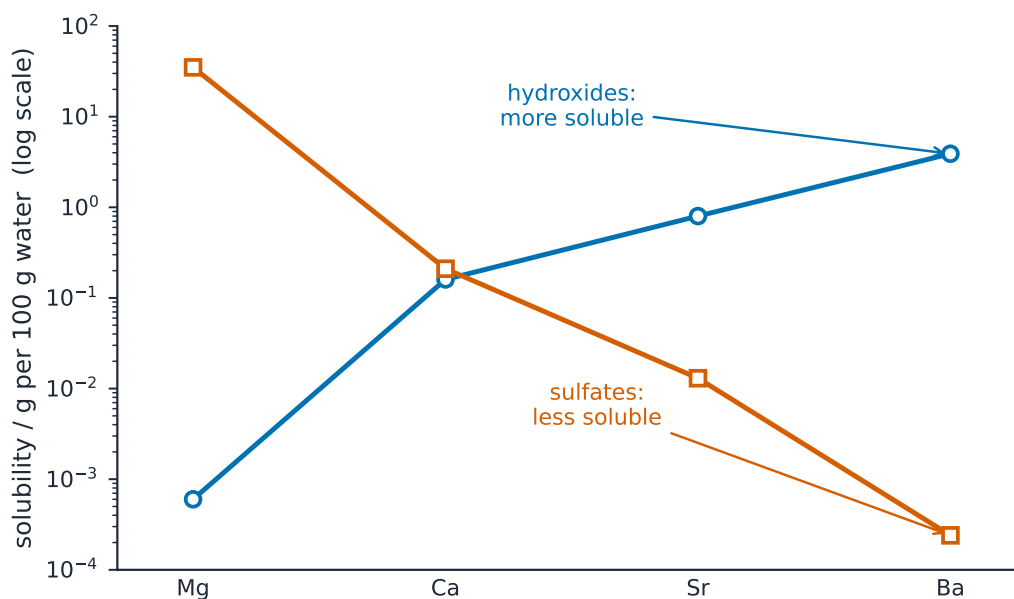


barely distorted
⇒ **thermally stable**

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

Trends in solubility

Compound	Trend in solubility 溶解度 down the group
hydroxides	increase ($\text{Mg}(\text{OH})_2$ almost insoluble; $\text{Ba}(\text{OH})_2$ soluble)
sulfates	decrease (MgSO_4 soluble; BaSO_4 insoluble)



Down Group 2 the hydroxides become more soluble while the sulfates become less soluble (note the log scale)

From these trends you can predict the properties of the next element down, radium, and of its compounds.

Worked example. MgCO_3 decomposes at about 540°C and BaCO_3 at about 1360°C . Explain the trend and predict where CaCO_3 sits. Going **down** Group 2 the cation gets **larger**, so its charge is spread over a bigger surface and its **polarising power** falls. A less polarising cation distorts the carbonate ion less, so the C-O bond is weakened less and more heat is needed to break it. Thermal stability therefore **increases down the group**, and CaCO_3 , lying between Mg and Ba, decomposes at an intermediate temperature of about 900°C . Argue the whole chain - **cation size, then polarising power, then distortion of the anion**; "it is more reactive" explains nothing here.

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 ($\rightarrow \text{MgO}$).
- 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).