

Chapter 10a (AS-Level)

Group II

General properties of group II elements:

- They are all metals
- They are good conductors of electricity
- Their compounds are all white or colourless
- They all have an oxidation number of +2 in their compounds
- They are called the alkaline earth metals because their oxides and hydroxides are basic
- They react with acids to give hydrogen gas

Compared with group I elements:

- They are harder and denser
- Have a higher melting point
- Exhibit stronger metallic bonding due to 2 outer shell electrons

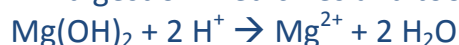
Uses

Magnesium

- It is used in flares, incendiary bombs and tracer bullets
- It has a strong reducing power, so is used to protect metals from corrosion. It is also used to extract less electropositive metals like titanium in the Kroll process at 1250K under an argon atmosphere.



- It is found in chlorophyll
- $\text{Mg}(\text{OH})_2$ is a weak alkali used in indigestion medicines and toothpastes.



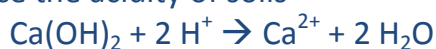
- MgO is a refractory material (resistant to heat, melting point over 3000K). It is used as a lining for furnaces
- MgF_2 is used to coat the surfaces of camera lenses, to reduce the amount of reflected light (responsible for the violet colour of lens surfaces)

Calcium

- CaCO_3 (limestone) is used to make cement
- CaO (quicklime) is used to purify iron



- CaO glows with a bright light when heated
- $\text{Ca}(\text{OH})_2$ (solid) is used to reduce the acidity of soils



- Plaster of Paris (calcium sulphate $2\text{CaSO}_4 \cdot \text{H}_2\text{O}$) when mixed with water hydrates to $\text{CaCO}_4 \cdot 2\text{H}_2\text{O}$ and sets hard. It is used to set broken bones and for modeling
- The hydrogen carbonate of Ca and Mg are responsible for the hardness of water

Barium

- Barium sulphate is used in the Barium metal, which is insoluble and coats the lining of the alimentary canal to make any imperfections visible for x-ray photographs. It is insoluble so is used as a test for the sulphate ions as it forms a precipitate.

Strontium

- Strontium has a few uses. ^{90}Sr is a product of many nuclear reactions.

Reactions of group II elements

With water

All group II elements produce H_2 with water reducing it to H_2 .

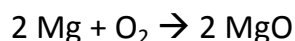
- Mg reacts slowly with water to produce an alkaline solution of $\text{Mg}(\text{OH})_2$ and H_2

$$\text{Mg} + 2 \text{H}_2\text{O} \rightarrow \text{Mg}(\text{OH})_2 + \text{H}_2$$
- Mg reacts with steam to produce MgO , which is a rapid reaction.

$$\text{Mg} + \text{H}_2\text{O} \rightarrow \text{MgO} + \text{H}_2$$
- The reactivity of the elements with water increase down the group. Ca to Ba reacts readily with water to form a cloudy white precipitate of the hydroxide.

With oxygen

The reactions are vigorous once started.



Formation of salts with HCl

- All salts of group II elements are crystalline and white. They are prepared by the reaction of the metal, oxide or carbonate with an acid.
- $\text{Mg}(\text{s}) + 2 \text{HCl}(\text{l}) \rightarrow \text{MgCl}_2 + \text{H}_2$ (rapid with cold HCl)
- $\text{MgO}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$ (rapid with heating)
- $\text{MgCO}_3 + 2 \text{HCl}(\text{aq}) \rightarrow \text{MgCl}_2 + \text{H}_2\text{O} + \text{CO}_2$ (rapid with cold HCl)

Reactions of oxides with water

- All are basic and form a solution of the hydroxide (alkaline)

$$\text{MgO} + \text{H}_2\text{O} \rightarrow \text{Mg}(\text{OH})_2 (\text{aq})$$

$$\text{BaO} + \text{H}_2\text{O} \rightarrow \text{Ba}(\text{OH})_2 (\text{aq})$$
- The reaction of MgO with water is slow, others react readily with water
- The solubility of the hydroxides increase down the group and become more alkaline

Thermal decomposition of Group II nitrates and carbonates

- All nitrates decompose to form metal oxides, nitrogen dioxide and oxygen:

$$2 \text{Mg}(\text{NO}_3)_2 \rightarrow 2 \text{MgO} + 4 \text{NO}_2 + \text{O}_2$$
- All carbonates decompose to form metal oxide and carbon dioxide:

$$\text{BaCO}_3 \rightarrow \text{BaO} + \text{CO}_2$$
- Decomposition temperature increase down the group

Chalk and lime industry

- Chalk and limestone are both Calcium Carbonate
- Heating CaCO_3 produces CaO (quicklime) and CO_2



- CaO reacts with H₂O to make Ca(OH)₂ (slaked lime)



- Adding more water to calcium hydroxide produces lime water (pH 9 -10)
- Adding more CO₂ to Ca(OH)₂ (aq) form a cloudy precipitate of CaCO₃



- Adding more CO₂ to the lime water after the precipitate, the mixture becomes clear again. The CaCO₃ reacts with the water and CO₂ (aq) to make Calcium hydrogen carbonate Ca(HCO₃)₂



- Hard water contains Mg²⁺ and Ca²⁺ ions which react with soap to produce scum. These ions are come from the action of H₂O and CO₂ with CaCO₃. The CO₂ (aq) is formed when rainwater dissolves CO₂ in the air.

- Flue gas desulphurization (FGD)

CaCO₃ is used to remove SO₂ from waste gases produced when coal is burned. These gases are passed through a suspension of CaCO₃ forming CaSO₄



The CaSO₄ is used to make plaster.