

GROUP II ELEMENTS

Beryllium to Barium

Introduction

Elements in Group I (*alkali metals*) and Group II (*alkaline earths*) are known as **s-block elements** because their valence (bonding) electrons are in s orbitals.

	Be	Mg	Ca	Sr	Ba
Atomic Number	4	12	20	38	56
Electronic configuration	1s ² 2s ²	[Ne] 3s ²	[Ar] 4s ²	[Kr] 5s ²	[Xe] 6s ²

TRENDS

Atomic Radius

Increases down each group electrons are in shells further from the nucleus

	Be	Mg	Ca	Sr	Ba
Atomic radius / nm	0.106	0.140	0.174	0.191	0.198

Ionic Size

Increases down the group

The size of positive ions is less than the original atom because the nuclear charge exceeds the electronic charge.

	Be ²⁺	Mg ²⁺	Ca ²⁺	Sr ²⁺	Ba ²⁺
Ionic radius / nm	0.030	0.064	0.094	0.110	0.134

Melting Points

Decrease down each group metallic bonding gets weaker due to increased size. Each atom contributes two electrons to the delocalised cloud. Melting points tend not to give a decent trend as different crystalline structures affect the melting point.

	Be	Mg	Ca	Sr	Ba
Melting point / °C	1283	650	850	770	710

Ionisation Energy

Decreases down the group atomic size increases

Values for Group I are low because the electron has just gone into a new level and is shielded by filled inner levels. This makes them reactive. Group II elements have higher values than their Group I equivalents due to the increased nuclear charge.

	Be	Mg	Ca	Sr	Ba
1st I.E. / kJ mol ⁻¹	899	738	590	550	500
2nd I.E. / kJ mol ⁻¹	1800	1500	1100	1100	1000
3rd I.E. / kJ mol ⁻¹	14849	7733	4912	4120	3390

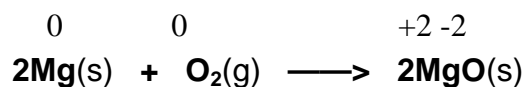
There is a **large increase for the 3rd I.E.** as the electron is now being removed from a **shell nearer the nucleus** and there is **less shielding**.

CHEMICAL PROPERTIES OF THE ELEMENTS

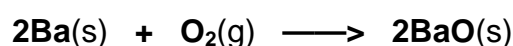
Overall Reactivity increases down the Group due to the ease of cation formation

Oxygen • **react with increasing vigour down the group**

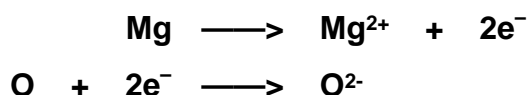
Mg burns readily with a bright white flame



Ba burns readily with an apple-green flame

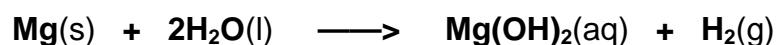


In both cases **metal is oxidised** Oxidation No. increases from 0 to +2
 oxygen is reduced Oxidation No. decreases from 0 to -2

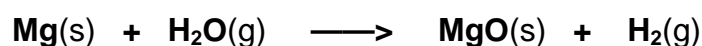


Water • **react with increasing vigour down the group**

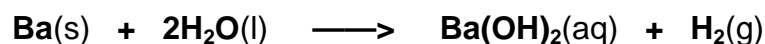
Mg reacts very slowly with cold water



but reacts quickly with steam



Ba react with vigourously with cold water



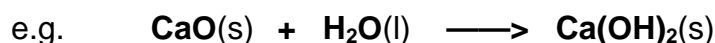
OXIDES OF GROUP II ELEMENTS

Properties • ionic solids; EXC. beryllium oxide which has covalent character

- **BeO** *beryllium oxide*
- **MgO** *magnesium oxide*
- **CaO** *calcium oxide*
- **SrO** *strontium oxide*
- **BaO** *barium oxide*

Reaction with water

Most Group II oxides react with water to produce the hydroxide



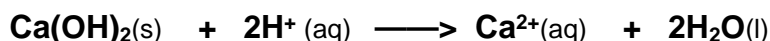
	BeO	MgO	CaO	SrO	BaO
<i>Reactivity with water</i>	NONE	reacts	reacts	reacts	reacts
<i>Solubility of hydroxide g/100cm³ of water</i>	insoluble	sparingly	slightly	quite	very
<i>pH of solution</i>	-		9-10		

Hydroxides

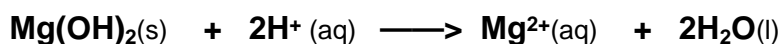
- **basic strength also increases down group**
- this is **because the solubility increases**
- the **metal ions get larger** so charge density decreases
- there is a lower attraction between the OH⁻ ions and larger dipositive ions
- the ions will split away from each other more easily
- there will be a greater concentration of OH⁻ ions in water

Uses of hydroxides

- Ca(OH)₂** • used in agriculture to neutralise acid soils



- Mg(OH)₂** • used in toothpaste and indigestion tablets as an antacid



- *both the above are weak alkalis and not as caustic as sodium hydroxide*

CARBONATES

Properties

- insoluble in water
- undergo thermal decomposition to oxide and carbon dioxide



- ease of decomposition decreases down the group

	MgCO ₃	CaCO ₃	SrCO ₃	BaCO ₃
<i>Solubility (g/100cm³ of water)</i>	1.5 x 10 ⁻⁴	1.3 x 10 ⁻⁵	7.4 x 10 ⁻⁶	9.1 x 10 ⁻⁶
<i>Decomposition temperature / °C</i>	400	980	1280	1360