UNIT 10 - GROUP 2

Physical Properties

The elements of Group 2 are referred to as Alkaline Earth Metals and are generally shiny, silver-white metals.

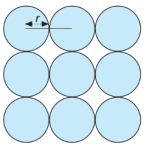
As they are in Group 2, the elements have atoms whose electronic configurations end with two electrons in their outermost principal quantum shell.

Beryllium (Be) $1s^2 2s^2$
Magnesium (Mg) $1s^2 2s^2 2p^6 3s^2$
Calcium (Ca) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
Strontium (Sr) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^2$
Barium (Ba) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 5s^2 5p^6 6s^2$

Metallic Radii

The metallic radius is half the distance between the nuclei in a giant metallic lattice.

The atoms of Group 2 elements get larger going down the group as the outer two electrons occupy a new principal quantum shell further from the nucleus.



Group 2 element	Metallic radius / nm
beryllium (Be)	0.122
magnesium (Mg)	0.160
calcium (Ca)	0.197
strontium (Sr)	0.215
barium (Ba)	0.217

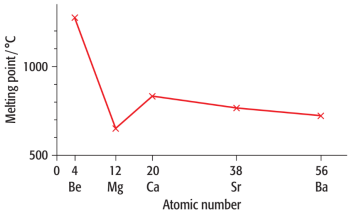
General Trends

Group 2 metals are reducing agents. They readily give up their two outermost electrons to form M^{2+} ions.

The elements get more reactive as we go down the group as it takes less energy to remove the pair of electrons.

	Mg	Ca	Sr	Ba
Melting point/°C	649	839	769	729
Boiling point/°C	1090	1484	1384	1637
First ionisation energy/kJ mol^{-1}	736	590	548	502
Second ionisation energy/kJ mol^{-1}	1450	1150	1060	966
Ionic radius of M^{2+} ion/nm	0.065	0.099	0.113	0.135

Melting Points



Chemical Properties

Reducing power and reactivity of elements increases down the group.

Ionisation energy decreases, due to increasing atomic size, nuclear charge decreases, therefore valence electrons are easily lost.

Greater tendency to be oxidised due to the ease of losing electrons making them better reducing agents.

Reactions with Oxygen

Group 2 metals burn with a bright flame to form basic oxides, (except for BeO). Reactivity with oxygen increases down the group.

$2M(s) + O_2(g) \longrightarrow 2MO(s)$	
Magnesium $2Mg_{(s)} + O_{2(g)} \longrightarrow 2MgO_{(s)}$	White
Calcium $2Ca_{(s)} + O_{2(g)} \longrightarrow 2CaO_{(s)}$	Red
Strontium $2Sr_{(s)} + O_{2(g)} \longrightarrow 2SrO_{(s)}$	Crimson
Barium $2Ba_{(s)} + O_{2(g)} \longrightarrow 2BaO_{(s)}$	Green

Reactions with water - 25°C

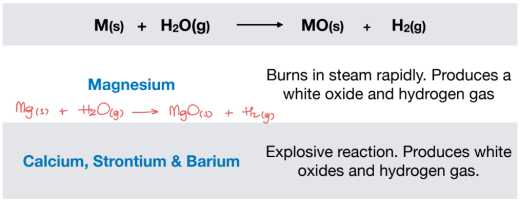
Group 2 metals react readily with water to produce metal hydroxides and hydrogen gas.

$M(s) + 2H_2O(l) \longrightarrow M(OH)_2(s) + H_2(g)$	
Magnesium $Mg_{(s)} + 2H_2O_{(l)} \longrightarrow Mg(OH)_{2(s)} + H_{2(g)}$	Slow reaction. Bubbles of hydrogen form. Produces an insoluble hydroxide and hydrogen gas
Calcium, Strontium & Barium	Rapid reactions. Vigour increases down the group, alkaline solution obtained. Produces hydroxide and hydrogen gas

© Copyright. StudyGuide

Reactions with steam

Group 2 metals react readily with steam to produce metal oxides and hydrogen gas.



Metal Oxides

All Group 2 oxides are basic in nature except for BeO, which is amphoteric due to its high charge density and partial covalent character.

Metal Oxide	With HCl(aq)	With $H_2O(l)$	pH
MgO	$MgO_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H_2O_{(l)}$	Slightly soluble	9
CaO	$CaO_{(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + H_2O_{(l)}$	Sparingly soluble	10
SrO	$SrO_{(s)} + 2HCl_{(aq)} \longrightarrow SrCl_{2(aq)} + H_2O_{(l)}$	Dissolves	11
BaO	$BaO_{(s)} + 2HCl_{(aq)} \longrightarrow BaCl_{2(aq)} + H_2O_{(l)}$ (neutral salts)	Dissolves	13

Group 2 carbonates with water and dilute acids

Carbonates of magnesium, calcium, strontium and barium are all insoluble in water.

However, they all react in dilute acid, forming salt and water and giving off carbon dioxide gas.

It also depends on what acid is being used.

1) $HCl_{(aq)}$
2) $H2SO4_{(aq)}$
3) $HNO3_{(aq)}$

$MgCO_3$:

① $MgCO_{3(s)} + 2HCl_{(aq)} \longrightarrow MgCl_2 + CO_2 + H_2O$

② $MgCO_{3(s)} + H_2SO_{4(aq)} \longrightarrow MgSO_4 + CO_2 + H_2O$

③ $MgCO_{3(s)} + 2HNO_{3(aq)} \longrightarrow Mg(NO_3)_2 + CO_2 + H_2O$

$BaCO_3$:

① $BaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow BaCl_2 + CO_2 + H_2O$

② $BaCO_{3(s)} + H_2SO_{4(aq)} \longrightarrow BaSO_{4(s)} + CO_2 + H_2O$

③ $BaCO_{3(s)} + 2HNO_{3(aq)} \longrightarrow Ba(NO_3)_2 + CO_2 + H_2O$

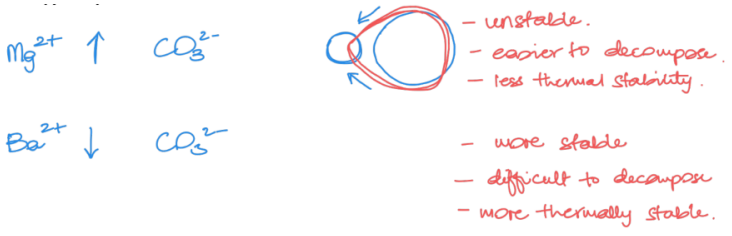
Thermal Decomposition of Carbonates

The thermal stability of carbonates <u>increases</u> down the group.

Group 2 metal carbonates break down to form metal oxide and carbon dioxide gas.

$$MCO_3(s) \rightarrow MO(s) + CO_2(g)$$

The temperature at which thermal decomposition takes place increases going down the group.



Thermal Decomposition of Nitrates

Group 2 Nitrates break down to form metal oxide, toxic nitrogen dioxide and oxygen.

$$M(NO_3)_2(s) \rightarrow MO(s) + 2NO_2(g) + ½O_2(g)$$

As with carbonates, a higher temperature is needed to thermally decompose the nitrates as you go down the group.

© Copyright. StudyGuide