

13.2 ALKALINE EARTH METALS

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🔗 Learning outcomes

By the end of this chapter, Students should be able to:

- Give general characteristics of alkaline earth metals.
- Write the molecular formula and uses of (quick lime, bleaching powder, magnesia, Plaster of Paris, and Epsom salt).
- Explain the solubility of hydroxides, carbonates, and sulphates of alkaline earth metals (General trend)
- Describe the stability of carbonates and nitrates of alkaline earth metals (general trend)

10.3.1 Periodic discussion and general characteristics

- Elements like Beryllium, Magnesium, Calcium, Strontium, etc. are kept in the IIA or Group 2 of the periodic table.
- The compounds of these elements are mainly found in the earth with high melting points.
- They dissolve in water, forming an alkaline solution; hence, called Alkaline earth metals.
- The valence shell electronic configuration = ns^2

Be (4)	[He] $2s^2$
Mg (12)	[Ne] $3s^2 = 1s^2 2s^2 2p^6 3s^2$
Ca (20)	[Ar] $4s^2$
Sr (38)	[Kr] $5s^2$
Ba (56)	[Xe] $6s^2$
Ra (88)	[Rn] $7s^2$
- Due to the presence of 2 electrons in the last cell, their valency is 2, and the oxidation number is +2.
- Highly electropositive, but less electropositive than alkali metals; being reactive metals, never found in the free state in nature.
- Atomic sizes are relatively large but lower than those of the corresponding alkali metals
- Possess metallic properties like malleability, ductility, sonorous, good conductivity of heat and electricity, and metallic lustre (silvery white).
- Relatively soft metals with low densities. But slightly harder than alkali metals.
- Like alkali metals, alkaline earth metals, except Be and Mg, impart a characteristic colour to the Bunsen flame. This is used for the identification of alkaline earth metals by the flame test.
- Get tarnished when exposed to air due to the formation of a layer of oxides.
- Be does not react with water; Mg reacts with hot water, and the rest of the metals react with cold water, forming hydroxides (alkaline) and liberating hydrogen gas.
- React with dilute acids, giving hydrogen gas.

Students' activity: Write the reaction of any two alkaline earth metals with water. Hint: similar to that of alkali metals.

Magnesia

Magnesium oxide (MgO) is called Magnesia.

Uses

- Due to its high Melting point, used as a refractory material in the lining of furnaces, bricks etc.
- To make crucibles, especially in metallurgical processes.

- Its aqueous suspension, called milk of magnesia, is used to neutralise the acidity of the stomach (as an antacid).
- To produce magnesia-based cement in place of CaO-based cement.

Epsom salt (Magnesium sulphate heptahydrate)

Heptahydrate magnesium sulphate is commonly known as Epsom salt because of its previous source, i.e., the water of Epsom Springs in England.

Molecular formula - $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$

Uses

- In medicine as a purgative
- Source of Mg in fertilisers
- Dyeing and sizing of textiles
- Manufacture of paints, soaps, etc.
- Cosmetic lotions
- In tanning

Quick lime

Calcium oxide (CaO) is also called quicklime, burnt lime, common lime, or caustic lime.

Uses

- Quick lime is used in the manufacture of slaked lime, bleaching powder, cement, mortar, etc.
- In the preparation of soda lime ($\text{CaO} + \text{NaOH}$)
- For whitewashing
- In agriculture, to decrease the acidity of the soil
- In softening water
- As a germicide and fungicide
- As a basic flux in metallurgy to remove acidic impurities
- As a cheap drying agent in desiccators in laboratories

Plaster of Paris

Plaster of Paris is calcium sulphate hemihydrate.

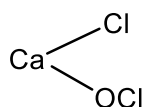
$(\text{CaSO}_4)_2 \cdot \text{H}_2\text{O}$ or $\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$ or $2 \text{CaSO}_4 \cdot \text{H}_2\text{O}$

Uses

- Making casts, moulds, statues, etc.
- In surgical bandages for plastering fractured parts of the bones
- To make blackboard chalk, etc.

Bleaching powder

It is also called chloride of lime or chlorinated lime. It has the following formula. CaOCl_2



Uses

- For bleaching clothes and textiles
- As a disinfectant and germicide, especially in the sterilisation of water
- In the manufacture of chloroform
- As an oxidising agent

10.3.3 Solubility of hydroxides, carbonates, and sulphates of alkaline earth metals

- Solubility of a substance is defined as the amount of substance (mass in grams) that is dissolved in 100 g of water (solvent) to make a saturated solution at a given temperature.
- Solubility of a solid depends on the **lattice energy** of the solid and the **hydration energy** of the ions.
- *Lattice energy* is a measure of the energy contained in the crystal lattice of a compound, equal to the energy that would be released if the component ions were brought together from infinity.
- *Hydration energy* can be defined as the amount of energy released when one mole of ions is hydrated.
- For a substance to dissolve, the hydration energy must exceed the lattice energy.
- An increase in lattice energy decreases solubility, and an increase in hydration energy increases solubility. The extent of dissolution of a solute in water is decided by the competition between these two energies.

Hydroxides of alkaline earth metals: The hydroxides of group II metals have relatively low solubility in water, and the solubility increases down the group. This is because the lattice energy decreases down the group in the solid because of the increasing size of the positively charged ions.

Sulphates of II group metals: the solubility of sulphates of alkaline earth metals decreases down the group. The increase in the size of the metal ions decreases both the lattice energy and hydration energy, but the decrease in hydration energy is higher

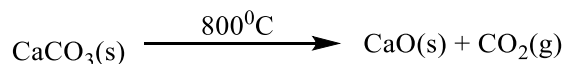
Carbonates of group second metals: The alkaline metal carbonates are not very soluble in water. Their solubility decreases down the group. This is mainly due to a decrease in the hydration energy.

This is due to their insolubility in water; these metal carbonates occur as solid rock minerals in nature. For example, CaCO_3 is an abundant mineral of Calcium.

10.3.4 Stability of carbonates and nitrates of alkaline earth metals (general trend with explanation)

When alkaline earth metal carbonates and nitrates are heated, they decompose to give metal oxides.

Stability of carbonates: The Group 2 metal carbonates are fairly stable to heat. *The thermal stability increases from top to bottom in the group.*



Stability of nitrates: The nitrates also thermally decompose on heating to give metal oxides. Similar to carbonates, the stability increases from top to bottom in the group.



Some Questions - Answers

1. Write two important characteristics of alkaline earth metals.

Answer – The two important characteristics of alkaline earth metals are

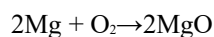
- a. formation of hydroxide with water
- b. electropositive nature

2. Account for the fact that alkaline earth metals exhibit only +2 oxidation state.

Answer – Alkaline earth metals exhibit only a +2 oxidation state. As there are two valence electrons in the valence shell, which are lost and +2 oxidation state is achieved.

3. Write two uses of Magnesium oxide.

Answer – Magnesium oxide is prepared by burning magnesium in air or oxygen as



Its two functions are as follows

- used as refractory lining for metal, glass and cement furnaces
- used as an antacid for the treatment of acidity in the stomach

4. Mention two uses of Epsom salt.

Answer - i. Used in cleaning substances or as a purgative in medicine
ii. Used for fireproofing fabrics

5. Mention two uses of plaster of Paris

Answer – i. used in dentistry ii. Making casts for statues

6. Write uses of lime.

Answer - Uses of lime are

- as fertiliser in crops
- purification of sugar
- drying of gas
- softening of hard water
- used as a disinfectant

7. Write the uses of Epsom salt.

Answer – Magnesium sulphate is an inorganic salt (chemical compound) containing magnesium, sulphur, and oxygen, with the formula MgSO_4 . It is often encountered as the heptahydrate sulfate mineral epsomite ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$), commonly called Epsom salt, taking its name from a bitter saline spring in Epsom in Surrey, England, where the salt was produced from the springs.

The monohydrate, $\text{MgSO}_4 \cdot \text{H}_2\text{O}$, is found as the mineral kieserite.

- Anhydrous magnesium sulphate is used as a drying agent.
- Epsom salt has been traditionally used as a component of bath salts.
- Epsom salt can also be used as a beauty product.

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