

## 13.2 ALKALINE EARTH METALS

### Periodic discussion and general characteristics

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The compounds of the elements like Beryllium, Magnesium, Calcium, Strontium etc which are kept in the IIA or 2 group of the periodic table were mainly found in earth with high melting point. These were found to dissolve in water forming alkaline solution. Hence these are called Alkaline earth metals.

These have  $ns^2$  as the valance cell electronic configuration.

Be (4)                      [He]  $2s^2$

Mg (12)                    [Ne]  $3s^2$

Ca (20)                    [Ar]  $4s^2$

Sr (38)                    [Kr]  $5s^2$

Ba (56)                    [Xe]  $6s^2$

Ra (88)                    [Rn]  $7s^2$

Due to presence of 2 electrons in the last cell, their valency is 2 and oxidation number is +2.

Highly electropositive and reactive metals.

Possess metallic properties like malleability, ductility, sonorous, good conductivity of heat and electricity, metallic lustre

Relatively soft metals with low densities.

Like alkali metals, alkaline earth metals except Be and Mg impart characteristic colour to the Bunsen flame. This is used for identification of alkaline earth metals by flame test.

Get tarnished when exposed to air due to formation of a layer of oxides.

Be does not react with water, Mg reacts with hot water and rest of the metals react with cold water forming hydroxides(alkali) and liberating hydrogen gas.

- 51) Name the alkaline earth metals. Give their symbol also. 2
- 52) Give the characteristics of alkaline earth metals. 5
- 69) Give any two characteristics of alkaline earth metals. 2
- 70) Give any three points do distinguish alkali metals form alkaline earth metals. 3

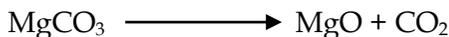
## **Magnesia**

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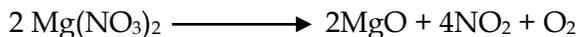
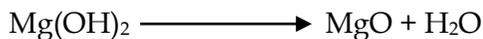
Magnesium oxide (MgO) is called Magnesia.

### Preparation

Commercially it is prepared by heating Magnesite (MgCO<sub>3</sub>).



It can be prepared in laboratory by heating magnesium hydroxide, or magnesium nitrate.



Magnesium can also be obtained by burning of magnesium in air.



### Properties

White powder with very high melting point (2500°C)

Insoluble in water

Basic oxide hence reacts with acids to form salt and water.



### Uses

Due to high Melting point, it is used as refractory material in lining of furnaces, bricks etc.

To make crucibles.

Its aqueous solution is called milk of magnesia.

## Epsom salt

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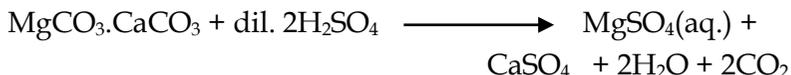
Heptahydrate magnesium sulphate is commonly known as epsom salt because of its previous source i.e., water of Epsom springs in England.

### Preparation

It is generally prepared by the action of dilute sulphuric acid on magnesium, its oxide, hydroxide or carbonate, followed by crystallization from aqueous solution.

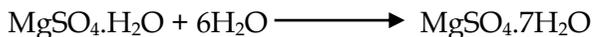


It is manufactured in large scale by dissolving magnesite or dolomite in dilute sulphuric acid.



In case of dolomite, insoluble calcium sulphate is removed by filtration and aqueous solution of  $\text{MgSO}_4$  is crystallized by heating.

It is also prepared by hydration of Kieserite.



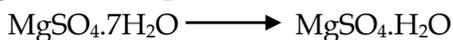
68) Give a suitable chemical reaction for the preparation of Epsom salt. 1

### Properties

Epsom salt is a colourless, crystalline, efflorescent substance having bitter taste.

It is fairly soluble in water. 100g of water at 20°C dissolves 35.5 g of the salt.

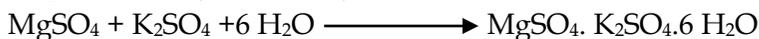
It loses water of crystallization on heating. At 150°C, it is converted into monohydrate and at 200°C, anhydrous salt is formed. On strong heating, it is decomposed into its oxide.



73) What is the action of heat on Epsom salt?

1

When equimolar solution of magnesium sulphate and potassium sulphate is subjected to crystallization, double salt is formed.



### Uses

- In medicine
- Source of mg in fertilizers
- Dyeing and sizing of textiles
- Manufacture of paints soaps etc
- Cosmetic lotions.

76/71) write down the chemistry of Epsom salt.

5

53) Write the chemical formula and one use of Epsom salt.

1

## **Quick lime**

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

### Preparation

Commercially quick lime is prepared by decomposition of limestone (Calcium carbonate) in a specially designed furnace called lime kiln.

At 800°C- 1000°C, limestone or chalk decomposes into calcium oxide and CO<sub>2</sub> gas which escapes.



This is a reversible reaction. Hence the CO<sub>2</sub> formed must be swept away by a current of air.

It can also be prepared by heating calcium hydroxide or calcium bicarbonates.



Or heating calcium nitrate.



55) How is quick lime prepared from marble? Give pertinent equation. 2

71) Write down the balanced chemical reaction for the preparation of Quick lime. 1

68) Give a suitable chemical reaction for the preparation of Quick lime. 1

### Properties

- White amorphous solid
- When heated to high temperature by oxyacetylene flame, emits bright white light called lime light.
- M. pt. = 2570°C

### **Action of water:**

- When quick lime is added to water, the mass swells up giving a hissing noise with liberation of heat and finally crumbles giving powder. The process is called slaking of lime and the product, Ca(OH)<sub>2</sub>, is called **slaked lime**.



- Slaked lime is slightly soluble in water. If small quantity of slaked lime is added to water, it forms saturated solution called **lime water**.
- If large quantity of quick lime is mixed with water a slurry is formed which looks like milk so is called **milk of lime**.

73) Give the balanced chemical reaction for the preparation of slaked lime.

64) What is meant by slaking of lime? 1

73) How would you obtain lime water from slaked lime? 1

71/68) What happens when water is added to quick lime? 1

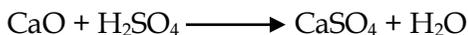
71) Starting from quick lime how would you prepare lime water? 1

68) How would you obtain lime water from quick lime? 1

71) What is meant by milk of lime? 1

### Basic nature:

It is a basic oxide, so reacts with acid and acidic oxide.

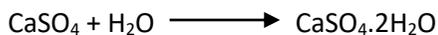


72/70) Starting from quick lime, how would you prepare bleaching powder? 2

### Uses

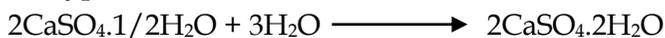
- Quick lime is used in manufacture of slaked lime, bleaching powder, cement, mortar etc.
- For white washing
- In agriculture to decrease the acidity of soil
- In softening water
- As germicide and fungicide
- As a basic flux in metallurgy





### Properties

It is a white powder which has the property of setting in the presence of water forming hard mass. This process is called **setting of plaster of paris**. The setting is due to rehydration of the Plaster of Paris into Gypsum.



During setting, it expands a little (about 1%) which gives very good impression on statue or moulds.

- 72) Define the term: Setting of plaster of paris. 1  
68) What is meant by setting of plaster? 1  
65) Why is plaster of Paris suitable for immobilizing of broken limbs? 1

### Uses

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

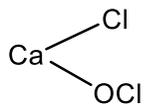
53) Write the chemical formula and one use of Plaster of Paris. 1

76/71) Give the chemistry of plaster of paris. 5

## **Bleaching powder**

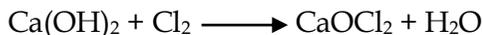
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It is also called chloride of lime or chlorinated lime it has following formula.



### Preparation

It is generally prepared by the action of chlorine on dry slaked lime.



The chlorine used should be dilute and temperature below 40°C.

53) How is bleaching powder manufactured? Give a neat labeled diagram and reactions involved. 5

68) Give a suitable chemical reaction for the preparation of Bleaching powder. 1

75/74/67) What happens when chlorine gas is passed through slaked lime? 1

### Properties

Bleaching powder is pale yellow which emits the intense smell of chlorine.

It loses chlorine when it comes in contact with carbon dioxide or excess of any dilute acid.



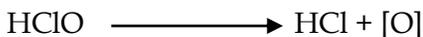
Bleaching powder is only sparingly soluble in the water. In water it gives Cl<sup>-</sup> and ClO<sup>-</sup> ions in cold.



In hot condition, it gives chloride and chlorate ions.



Bleaching powder bleached vegetable in presence of moisture. The bleaching action is due to the oxidizing action of nascent oxygen given out by bleaching powder in presence of little dilute acid.



Bleaching powder gradually loses chlorine. The amount of chlorine liberated when one mole of bleaching powder is treated with excess of acid is called available chlorine. The good quality bleaching powder contains about 35-40% available chlorine.

74) *What happens when Bleaching powder is treated with dil.  $\text{H}_2\text{SO}_4$ ?* 1

Uses

- For bleaching clothes and textiles
- As a disinfectant and germicide especially in sterilization of water
- In manufacture of chloroform

69) *Mention any use of bleaching powder.* 1

75) *Mention the bleaching action of bleaching powder.* 2

71) *Describe the preparations properties and uses of Bleaching powder.* 5

64) *Write down the preparations properties and uses of Bleaching powder.* 5

72) *Write down the chemistry of bleaching powder.* 5

Give the chemical formula of Dolomite and Carnalite.

Answer – The chemical formula of dolomite and Carnalite are given below

Dolomite =  $\text{CaCO}_3 \cdot \text{MgCO}_3$

Carnalite =  $\text{MgCl}_2 \cdot \text{KCl} \cdot 6\text{H}_2\text{O}$

3.

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. electro positive nature

4.

How is quick lime prepared from marble? Give pertinent reaction.

Answer – Marble on heating gives quick lime as

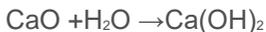


5.

6.

Starting from quick lime, how would you prepare lime water? What is meant by milk of lime?

Answer – When quick lime is dissolved in water, hissing sound is produced and clouds of steam are given up and later forms a fine powder called slaked lime



Further, if large amount of CaO is mixed with water to make slurry, it looks like milk of lime.

7.

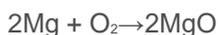
Account for the fact alkaline earth metals exhibit only +2 oxidation state.

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

8.

How is magnesium oxide prepared? Write its two uses.

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



Its two functions are as follows

- a. used as refractory lining for metals, glass and cement furnaces
- b. used as antacid for the treatment acidity in stomach

9. Mention two uses of

- a. Epsom salts
- b. plaster of paris

Answer – The two uses of the following are given below

- a. Epsom salts
  - i. used in cleaning substance or purgative in medicine
  - ii. used as fire proofing fabrics
- b. plaster of paris
  - i. used in dentistry
  - ii. Making caste for statue

10.

What do you mean by the setting of plaster of Paris?

Answer – When plaster of Paris is mixed with water it forms a plastic mass and evolves heat and quickly sets to a hard porous mass within 5 to 15 minutes during the setting a slight expansion in volume occurs so that it takes a sharp impression. This is setting of plaster of Paris.



11.

Account for the bleaching nature of bleaching powder.

Answer – Bleaching powder bleaches by oxidation as

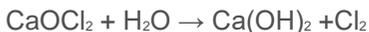


Colored matter + [O] → colourless matter

13.

What is the action of water on bleaching powder?

Answer – bleaching powder dissolves in the water to give calcium hydroxide and chlorine



14.

Mention biological importance of calcium and magnesium.

Answer – Calcium is required for the proper growth of bones and magnesium is required for the formation of chlorophyll

1.

What happens when gypsum is heated?

Answer – When Gypsum is heated then dead burnt plaster is formed. The di hydrated calcium sulphate changes into hemi hydrated form when heated to 120°C and on further heating above 140°C further dehydration takes place and dead burnt plaster is formed.



2.

Write the chemistry of Epsom salt.

Answer – Magnesium sulphate) is an inorganic salt (chemical compound) containing magnesium, sulphur and oxygen, with the formula  $\text{MgSO}_4$ . 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. The anhydrous form is hygroscopic (readily absorbs water from the air) and is therefore difficult to weigh accurately; the hydrate is often preferred when preparing solutions (for example, in medical preparations). Epsom salt has been traditionally used as a component of bath salts. Epsom salt can also be used as a beauty product.

3.

Write down the preparation properties and uses of bleaching powder.

Answer – The chemical name of bleaching powder is Calcium Chloro Hypochlorite ( $\text{CaOCl}_2$ ). It is prepared by the action of chloride on the dry slaked lime



Limited amount of chlorine and the temperature below  $40^\circ\text{C}$  is provided otherwise chlorate and calcium chloride is formed. It is manufactured by Bachmann's process. Now-a-days, bleaching powder is prepared by Bachmann's plant. It consists of a vertical cast iron tower fitted with eight shelves at different heights each equipped with rotating rakes. Slaked lime is fed into the tower through a hopper at the top. A current of chlorine is introduced in the seventh shelf. The slaked lime thus added moves downwards with the help of rotating rakes and meets upcoming current of  $\text{Cl}_2$ . Slaked lime and chlorine react together and form bleaching powder which is collected in a receiver placed at the base. A current of hot air is blown into the eighth shelf to remove the uncombined free chlorine. This uncombined free chlorine goes out from the exit at the top.

4.

Describe a method for the preparation of quick lime. What happens when rain falls on the quick lime?

Answer – The method for the preparation of Quick Lime (CaO) is given below

Preparation

1. It is produced by burning calcium in air.



2. It is produced by heating calcium nitrate.



3. In large scale calcium oxide is prepared by heating limestone in a vertical kiln to a temperature of about 800-1000°C. This process is called calcination.



This is reversible reaction. Therefore CO<sub>2</sub> must be removed from Kiln otherwise it reacts with lime to give back calcium carbonate. Carbon dioxide is obtained as an important by-product. The temperature should not exceed 1000°C since at high temperature, clay (present as impurity) combines with lime to give fusible silicate. Heating of limestone is carried out in modern vertical lime kiln as shown in the figure. The lumps of limestone are fed into the lime kiln through hopper. Fire boxes or furnaces are built around the lower part. The hot gaseous products find their way up through the kiln and the limestone is gradually decomposed by heat. A current of air is blown from the bottom of the kiln to cool the hot lime and to remove CO<sub>2</sub> from the kiln. The resulting lime is finally dropped into cars run under kiln. When rain falls on the quick lime then hissing noise is produced and the cloud of steam are produced with evolution of heat. Actually lime swells up and crakes forming fine powder like structure called slaking lime.



5.

What is bleaching powder? How is it manufacture by Bachmann's plant? Explain with diagram.

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Bachmann's Plant

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6.

Write the method of preparation of quick lime . Write their uses.

Answer –The preparation of Quick Lime (CaO) is given below

Preparation

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Uses of lime are

1. as fertilizer in crops
2. purification of sugar
3. drying of gas
4. softening of hard water
5. used as disinfectant
- 7.

Give the chemistry of quick lime.

Answer – The chemistry of Quick Lime (CaO) is given below quick lime can be prepared by burning calcium in air ( $2\text{Ca} + \text{O}_2 \rightarrow 2\text{CaO}$ ) by heating calcium nitrate. ( $2\text{Ca}(\text{NO}_3)_2 \rightarrow 2\text{CaO} + 4\text{NO}_2 + \text{O}_2$ ) In large scale calcium oxide is prepared by heating limestone in a vertical kiln to a temperature of about 800-1000°C. This process is called calcinations. ( $\text{CaCO}_3 \leftrightarrow \text{CaO} + \text{CO}_2$ ) This is reversible reaction. Therefore CO<sub>2</sub> must be removed from Kiln otherwise it reacts with lime to give back calcium carbonate. Carbon dioxide is obtained as an important by-product. The temperature should not exceed 1000°C since at high temperature, clay (present as impurity) combines with lime to give fusible silicate. Heating of limestone is carried out in modern vertical lime kiln as shown in the figure. The lumps of limestone are fed into the lime kiln through hopper. Fire boxes or furnaces are built around the lower part. The hot gaseous products find their way up through the kiln and the limestone is gradually decomposed by heat. A current of air is blown from the bottom of the kiln to cool the hot lime and to remove CO<sub>2</sub> from the kiln. The resulting lime is finally dropped into cars run under kiln.

Uses of lime are

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## Long answer questions

1.

Write short note on

A. magnesia

Magnesium oxide (MgO), or magnesia, is a white hygroscopic solid mineral that occurs naturally as periclase and is a source of magnesium. It has an empirical formula of MgO and consists of a lattice of Mg<sup>2+</sup> ions and O<sup>2-</sup> ions held together by ionic bonding. Magnesium hydroxide forms in the presence of water ( $\text{MgO} + \text{H}_2\text{O} \rightarrow \text{Mg}(\text{OH})_2$ ), but it can be reversed by heating it to separate moisture. Magnesium oxide is produced by the calcination of magnesium carbonate or magnesium hydroxide or by the treatment of magnesium chloride with lime followed by heat. Calcining at different temperatures produces magnesium oxide of with different reactivity. High temperatures 1500 - 2000 °C diminish the available surface area and produces dead-burned (often called dead burnt) magnesia, an unreactive form used as a refractory. Calcining temperatures 1000 - 1500 °C produce hard-burned magnesia which has limited reactivity, lower temperature, (700-1000°C) calcining produces light-burned magnesia, a reactive form, also known as caustic calcined magnesia. Although some decomposition to oxide occurs at temperatures below 700°C, this appears rapidly reversible due to adsorption of carbon dioxide from the air. It is used as refractory material.

B. plaster of paris

Answer - Plaster is a building material used for coating walls and ceilings. Plaster is manufactured as a dry powder and is mixed with water to form a

paste when used. The reaction with water liberates heat through crystallization and the hydrated plaster then hardens. Plaster can be relatively easily worked with metal tools or even sandpaper these characteristics make plaster suitable for a finishing, rather than a load-bearing material.

The term plaster can refer to gypsum plaster (also known as plaster of Paris)

Gypsum plaster, or plaster of Paris, is produced by heating gypsum to about 300 °F (150 °C)

$\text{CaSO}_4 \cdot 2\text{H}_2\text{O} + \text{heat} \rightarrow \text{CaSO}_4 \cdot 0.5\text{H}_2\text{O} + 1.5\text{H}_2\text{O}$  (released as steam)

When the dry plaster powder is mixed with water, it re-forms into gypsum. The setting of unmodified plaster starts about 10 minutes after mixing and is complete in about 45 minutes; but not fully set for 72 hours. If plaster or gypsum is heated above 392°F (200°C), anhydride is formed, which will also re-form as gypsum if mixed with water. It is used to make classic plaster orthopedics, casts to protect limbs with broken bones, the medical use having been partly inspired by the artistic.

### C. Epsom salt

Magnesium sulphate) is an inorganic salt (chemical compound) containing magnesium, sulphur and oxygen, with the formula  $\text{MgSO}_4$ . 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. The anhydrous form is hygroscopic (readily absorbs water from the air) and is therefore difficult to weigh accurately; the hydrate is often preferred when preparing solutions (for example, in medical preparations). Epsom salt has been traditionally used as a component of bath salts. Epsom salt can also be used as a beauty product. Athletes use it to soothe sore muscles, while gardeners use it to improve crops. It has a variety of other uses. Epsom salt is also effective in the removal of splinters. Magnesium sulphate is a common pharmaceutical preparation of magnesium, commonly known as Epsom salt, used both externally and internally. Epsom salt is used as bath salts and for isolation tanks. Oral

magnesium sulphate is commonly used as a saline laxative or osmotic purgative.

#### D. bleaching powder

Answer –Bleach refers to a number of chemicals which remove colour, whiten or disinfect, often by oxidation. In Calcium hypochlorite, "bleaching powder" chlorine is the agent that helps in bleaching and its effect is permanent. Most bleaches are oxidizing agents, some are reducing agents. Bleaches are used as household chemicals to whiten clothes and remove stains and as disinfectants, primarily in the bathroom and kitchen. Many types of bleach have strong bactericidal properties, and are used for disinfecting and sterilizing and thus are used in swimming pool sanitation to control bacteria, viruses and algae and in any institution where sterile conditions are needed. They are also used in many industrial processes, notably in the bleaching of wood pulp. Bleach is also used for removing mildew, killing weeds and increasing the longevity of flowers.