Chapter 10
S -BLOCK ELEMENTS

Question and answers carrying 1 mark

1. What are s- block elements?

***s*-block elements are those in which the last electron enters the outermost *s*-orbital**.

As the *s*-orbital can accommodate only two electrons, two groups (1 & 2) belong to the s-block of the Periodic Table.

2. Name the elements present in the 1st Group of the Periodic Table

lithium, sodium, potassium, rubidium, caesium and francium. They are collectively known as the ***alkali metals***.

3. Why I group elements are called alkali metals ?

These are called so because they form hydroxides on reaction with water which are strongly alkaline in nature.

4. Name the elements present in the 2nd Group of the Periodic Table:

beryllium, magnesium, calcium, strontium, barium and radium. These elements with the **exception of beryllium** are commonly known as the ***alkaline earth metals***.

5. Why II group elements are called alkaline earth metals ?

These are called so because their oxides and hydroxides are alkaline in nature and these metal oxides are found in the earth's crust.

6. What is the reason for the diagonal relationship ?

Diagonal relationship is due to the similarity in ionic sizes and /or charge/radius ratio of the elements.

7. Which is smaller in size between a metal ion and its parent atom?

The monovalent ions (M^+) are smaller than the parent atom.

8. Which group elements show very low ionization enthalpy in the periodic table?

First group elements (alkali metals)

9. How the ionization enthalpy varies in alkali metals

Ionization enthalpy decrease down the group from Li to Cs.

10. Arrange the first group elements in the decreasing order of Hydration Enthalpy

The hydration enthalpies of alkali metal ions decrease with increase in ionic sizes.

$$Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$$

11. why Li salts are hydrated?

Li^+ has maximum degree of hydration and for this reason lithium salts are mostly hydrated, e.g., $LiCl \cdot 2H_2O$

12. Write the chemical composition of washing soda.

$Na_2CO_3 \cdot 10H_2O$.

13. Give reason for the higher melting point and boiling point of alkali earth metals than alkali metals.

The melting and boiling points of these metals are higher than the corresponding alkali metals due to smaller sizes.

14. Why Be and Mg do not impart colour to the flame ?

The electrons in beryllium and magnesium are too strongly bound to get excited by flame. Hence, these elements do not impart any colour to the flame.

15. Name the gas liberated when alkali metals react with dil acid?

The alkaline earth metals readily react with acids liberating dihydrogen gas .
$M + 2HCl \rightarrow$□$MCl_2 + H_2$

16. Name the alkaline earth metal used in radio therapy.

Radium salts are used in radiotherapy, for example, in the treatment of cancer.

17. Give reason .the compounds of alkaline earth metals are less ionic than alkali metals

This is due to increased nuclear charge and smaller size.

18. How is Calcium Hydroxide (Slaked lime), $Ca(OH)_2$ Prepared?

Calcium hydroxide is prepared by adding water to quick lime, CaO.

19. How milk of lime reacts with chlorine?

Milk of lime reacts with chlorine to form hypochlorite, a constituent of **bleaching powder.**

$$2Ca(OH)_2 + 2Cl_2 \rightarrow CaCl_2 + \underbrace{Ca(OCl)_2}_{\text{Bleaching powder}} + 2H_2O$$

□□□□□□□□□

20. What happens when Calcium carbonate is heated to 1200 K?

When heated to 1200 K, it decomposes to evolve carbon dioxide.

$$CaCO_3 \xrightarrow{1200\,K} CaO + CO_2$$

Question and answers carrying 2 mark

1. Write the general electronic configuration of *s*-block elements.

[noble gas]ns^1 for alkali metals and
[noble gas] ns^2 for alkaline earth metals.

2. Lithium and beryllium, shows similarity with which elements .

Lithium shows similarities to magnesium and beryllium to aluminium in many of their properties. This type of diagonal similarity is commonly referred to as ***diagonal relationship*** in the periodic table.

3. Which elements of s- block are largely found in biological fluids & what is its importance?

Mono valent sodium and potassium ions and divalent magnesium and calcium ions are found in large proportions in biological fluids. These ions perform important biological functions such as maintenance of ion balance and nerve impulse conduction.

4. Why alkali metals are highly electro positive & they are not found in free state ?

The loosely held *s*-electron in the outermost valence shell of these elements makes them the most electropositive metals. They readily lose electron to give monovalent M^+ ions. Hence they are never found in free state in nature.

5. How the atomic and ionic radii varies in alkali metals

The atomic and ionic radii of alkali metals increase on moving down the group i.e., they increase in size while going from Li to Cs.

6. Why the ionization enthalpy decreases down the group ?

This is because, the Increase in atomic size is more predominant over increasing nuclear charge and the outer most electrons are very well screened from the nuclear charge by the inner shell electrons

7. Give reason .the melting point and boiling point of alkali metals are low

The melting and boiling points of the alkali metals are low indicating weak metallic bonding due to the presence of only a single valence electron in them.

8. Give reason for the colour imparted to the flame by alkali metals

The alkali metals and their salts impart characteristic colour to an oxidizing flame. This is because the heat from the flame excites the outermost orbital electron to a higher energy level. When the excited electron comes back to the ground state, there is emission of radiation in the visible region.

9. Why are Cs and K used as electrodes in photoelectric cells?

The alkali metal atoms have the largest sizes in a particular period of the periodic table. With **This property makes caesium and potassium useful as electrodes in photoelectric cells.**

10. What happens when alkali metals react with dihydrogen?

The alkali metals react with dihydrogen at about 673K (lithium at 1073K) to form hydrides. **All the alkali metal hydrides are ionic solids with high melting points**.

$$2M + H_2 \rightarrow 2M^+H^-$$

11. Name the most power full reducing agent & give reason for it .

The alkali metals are strong reducing agents, lithium being the most and sodium the least powerful reducing agent.

Note--- With the small size of its ion, lithium has the highest hydration enthalpy which accounts for its high
negative E^0 value and its high reducing power.

12.Give reason for the low solubility of LiF & CsI in water.

The low solubility of LiF in water is due to its high lattice enthalpy whereas the low solubility of CsI is due to smaller hydration enthalpy of its two ions. Other halides of lithium are soluble in ethanol, acetone and ethylacetate; LiCl is_soluble in pyridine also.

13. What are Oxo-Acids?give ex .

Oxo-acids are those in which the acidic proton is on a hydroxyl group with an oxo group attached to the same atom e.g., carbonic acid, H_2CO_3 ($OC(OH)_2$; sulphuric acid, H_2SO_4 ($O_2S(OH)_2$).

14. Why does Li show anomalous behaviour

This is due to the :
(i) Exceptionally small size of its atom and ion, and
(ii) High polarising power (i.e., charge/ radius ratio).
As a result, there is increased covalent character of lithium compounds which is responsible for their solubility in organic solvents. And lithium shows diagonal relationship to magnesium .

15. Why Solvay process cannot be extended for the manufacture of potassium carbonate?

Solvay process cannot be extended to the manufacture of potassium carbonate because potassium hydrogencarbonate is too soluble to be precipitated by the addition of ammonium hydrogencarbonate to a saturated solution of potassium chloride.

16.Write any four Uses of washing soda.

i) It is used in water softening, laundering and cleaning.
(ii) It is used in the manufacture of glass, soap, borax and caustic soda.
(iii) It is used in paper, paints and textile industries.
(iv) It is an important laboratory reagent both in qualitative and quantitative analysis.

17.How is pure NaCl obtained from crude Nacl?

To obtain pure sodium chloride, the crude salt is dissolved in minimum amount of water and filtered to remove insoluble impurities. The solution is then saturated with hydrogen chloride gas. Crystals of pure sodium chloride separate out.
Calcium and magnesium chloride, being more soluble than sodium chloride, remain in solution.

18.Mention any two Uses of NaCl :

(i) It is used as a common salt or table salt for domestic purpose.
(ii) It is used for the preparation of Na_2O_2, NaOH and Na_2CO_3.

19.Write anote on the Physical Properties of Sodium hydroxide

Sodium hydroxide is a white, translucent solid. It melts at 591 K. It is readily soluble in water to give a strong alkaline solution. Crystals of sodium hydroxide are deliquescent. The sodium hydroxide solution at the surface reacts with the CO_2 in the atmosphere to form Na_2CO_3.

20. Mention the uses of NaOH.

It is used in
(i) The manufacture of soap, paper, artificial silk and a number of chemicals,
(ii) In petroleum refining,
(iii) In the purification of bauxite,
(iv) In the textile industries for mercerising cotton fabrics,
(v) For the preparation of pure fats and oils, and
(vi) As a laboratory reagent.

21.Mention the uses of Sodium hydrogencarbonate

i) Sodium hydrogencarbonate is a mild antiseptic for skin infections.
ii) It is used in fire extinguishers.

22. How does the atomic and Ionic Radii of alkaline earth metals vary in comparison to alkali metals

The atomic and ionic radii of the alkaline earth metals are smaller than those of the corresponding alkali metals in the same periods. This is due to the increased nuclear charge in these elements. Within the group, the atomic and ionic radii increase with increase in atomic number.

23. How does the of Ionization Enthalpy of alkaline earth metals vary in comparison to alkali metals

The alkaline earth metals have low ionization enthalpies due to fairly large size of the atoms. Since the atomic size increases down the group, their ionization enthalpy decreases The first ionisation enthalpies of the alkaline earth metals are higher than those of the corresponding Group 1 metals. This is due to their small size as compared to the corresponding alkali metals. It is interesting to note that the second ionisation enthalpies of the alkaline earth metals are smaller than those of the corresponding alkali metals.

24. How does the of Hydration Enthalpy of alkaline earth metals vary & compare it with alkali metals

The hydration enthalpies of alkaline earth metal ions decrease with increase in ionic size down the group. $Be^{2+} > Mg^{2+} > Ca^{2+} > Sr^{2+} > Ba^{2+}$ The hydration enthalpies of alkaline earth metal ions are larger than those of alkali metal ions. Thus, compounds of alkaline earth metals are more extensively hydrated than those of alkali metals, e.g., $MgCl_2$ and $CaCl_2$ exist as $MgCl_2.6H_2O$ and $CaCl_2\cdot 6H_2O$ while NaCl and KCl do not form such hydrates.

25.What is the colour imparted to the flame by Ca,Sr and Ba?
Calcium, strontium and barium impart characteristic brick red, crimson and apple green colours respectively to the flame. In flame the electrons are excited to higher energy levels and when they drop back to the ground state, energy is emitted in the form of visible light.

26. Why are Be & Mg inert to O_2& H_2O?

Beryllium and magnesium are kinetically inert to oxygen and water because of the formation of an oxide film on their surface. However, powdered beryllium burns brilliantly on ignition in air to give BeO and Be_3N_2.
Magnesium is more electropositive and burns with dazzling brilliance in air to give MgO and Mg_3N_2. Calcium, strontium and barium are readily attacked by air to form the oxide and nitride. They also react with water with increasing vigour even in cold to form hydroxides.

27. How can BeF_2, and $BeCl_2$ be prepared conveniently ?

Thermal decomposition of $(NH_4)_2BeF_4$ is the best route for the preparation of BeF_2, and $BeCl_2$ is conveniently made from the oxide.

$$BeO + C + Cl_2 \xrightleftharpoons{600-800K} BeCl_2 + CO$$

28. Account for the reducing nature of Be even though it has less negative value of reduction potential .

Like alkali metals, the alkaline earth metals are strong reducing agents. This is indicated by large negative values of their reduction potentials However their reducing power is less than those of their corresponding alkali metals. Beryllium has less negative value compared to other alkaline earth metals. However, its reducing nature is due to large hydration energy associated with the small size of Be^{2+} ion and relatively large value of the atomization enthalpy of the metal.

29. write the general equation for the reaction of alkali earth metals with NH_3.

Alkaline earth metals dissolve in liquid ammonia to give deep blue black solutions forming ammoniated ions.

$$M + (x+y)NH_3 \rightarrow [M(NH_3)_x]^{2+} + 2[e(NH_3)_y]^-$$

From these solutions, the ammoniates, $[M(NH_3)_6]^{2+}$ can be recovered.

30.Give reason . the sulphate of Be & Mg are soluble in water .

The sulphates of the alkaline earth metals are all white solids and **stable to heat.** $BeSO_4$, and $MgSO_4$ are readily soluble in water; the solubility decreases from $CaSO_4$ to $BaSO_4$. The greater hydration enthalpies of Be^{2+} and Mg^{2+} ions overcome the lattice enthalpy factor and therefore their sulphates are soluble in water.

31.What happens when nitrates of alkalin earth metal is heated?

The nitrates are made by dissolution of the carbonates in dilute nitric acid. Magnesium nitrate crystallises with six molecules of water, whereas barium nitrate crystallises as the anhydrous salt. This again shows a decreasing tendency to form hydrates with increasing size and decreasing hydration enthalpy. **All of them decompose on heating to give the oxide like lithium nitrate**.

$$2M(NO_3)_2 \rightarrow 2MO + 4NO_2 + O_2$$ (M = Be, Mg, Ca, Sr, Ba)

32.How is Calcium oxide (quick lime), CaO Prepared?

It is prepared on a commercial scale by heating limestone($CaCO_3$) in a rotary kiln at 1070-1270K.

$$CaCO_3 \xrightleftharpoons{heat} CaO + CO_2$$

The carbon dioxide is removed as soon as it is produced to enable the reaction to proceed to completion.

33.What happens when CaO is exposed to atmospheric air?

On exposure to atmosphere, it absorbs moisture and carbon dioxideto form Calcium hydroxide and Calcium carbonate.

$CaO + H_2O \rightarrow Ca(OH)_2$ $CaO + CO_2 \rightarrow CaCO_3$

Note; The addition of limited amount of water breaks the lump of lime. This process is called **slaking of lime**.

34.Write few uses of quick lime.

(i) It is an important primary material for manufacturing cement and is the cheapest form of alkali.
(ii) It is used in the manufacture of sodium carbonate from caustic soda.
(iii) It is employed in the purification of sugar and in the manufacture of dye stuffs.

35.Write a note on the Physical Properties of Calcium Hydroxide (Slaked lime), $Ca(OH)_2$

It is a white amorphous powder. It is sparingly soluble in water. The aqueous solution is known as **lime water** and a suspension of slaked lime in water is known as **milk of lime**.

36.How lime water reacts with limited CO_2 and excess CO_2 ?

When carbon dioxide is passed through lime water it turns milky due to the formation of calcium carbonate.

□□□□ $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

On passing excess of carbon dioxide, the precipitate dissolves to form calcium hydrogen carbonate.

□□□□ $CaCO_3 + CO_2 + H_2O \rightarrow Ca(HCO_3)_2$

37. write any three uses of **Calcium Hydroxide (Slaked lime)**

i) It is used in the preparation of mortar, a building material.

(ii) It is used in white wash due to its disinfectant nature.
(iii) It is used in glass making, in tanning industry, for the preparation of bleaching powder and for purification of sugar.

38.How do you prepare Calcium carbonate?

It can be prepared by passing carbon dioxide through slaked lime

□□□□ $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

or by the addition of sodium carbonate to calcium chloride.

$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$

Note--Excess of carbon dioxide should be avoided since this leads to the formation of water soluble calcium hydrogencarbonate.

39.Which gas is liberated when Calcium carbonate is reacted with dil acid ?

It reacts with dilute acid to liberate carbon dioxide.

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$

***40. Mention the Uses* of Calcium carbonate?**

It is used as a building material in the form of marble and in the manufacture of quick lime. Calcium carbonate along with magnesium carbonate is used as a flux in the extraction of metals such as iron. Specially precipitated $CaCO_3$ is extensively used in the manufacture of high quality paper. **It is also used as an antacid, mild abrasive in tooth paste**, a constituent of chewing gum, and a filler in cosmetics.

41.How is Calcium Sulphate (Plaster of Paris), $CaSO_4 \cdot \frac{1}{2} H_2O$ (hemihydrate of calcium sulphate)
prepared from gypsum?

It is obtained when gypsum, $CaSO_4 \cdot 2H_2O$, is heated to 393 K.

□□□□□□□□□ $2(CaSO_4.2H_2O) \rightarrow 2(CaSO_4).H_2O + 3H_2O$

Above 393 K, no water of crystallisation is left and anhydrous calcium sulphate, $CaSO_4$ is formed. This is known as **'dead burnt plaster'**. It has a remarkable property of setting with water. On mixing with an adequate quantity of water it forms a plastic mass that gets into a hard solid in 5 to 15 minutes.

***42. What are the uses of* Plaster of Paris?**

The largest use of Plaster of Paris is in the building industry as well as plasters. It is used for immoblising the affected part of organ where there is a bone fracture or sprain. It is also employed in dentistry, in ornamental work and for making casts of statues and busts.

43.What are the Uses of cement? Cement has become a commodity of national necessity for any country next to iron and steel. It is used in concrete and reinforced concrete, in plastering and in the construction of bridges, dams and buildings.

Question and answers carrying 3&4 mark

1. write a note on the abundance of first and second group elements.

Among the alkali metals sodium and potassium are abundant and lithium, rubidium and
caesium have much lower abundances. **Francium is highly radioactive;** its longest-lived isotope 223-Fr has a half-life of only 21 minutes.

Among the alkaline earth metals calcium and magnesium rank fifth and sixth in abundance respectively in the earth's crust. Strontium and barium have much lower abundances. Beryllium is rare and radium is the rarest of all comprising only 10^{-10} per cent of igneous rocks.

2.Why do the alkali metals tarnish in dry air ?

The alkali metals tarnish in dry air due to the formation of their oxides which in turn react with moisture to form hydroxides. **They burn vigorously in oxygen forming oxides.**

Lithium forms **monoxide,**
sodium forms **peroxide,**
the other metals form **superoxides.**
The superoxide O^{2-} ion is stable only in the presence of large cations such as K, Rb, Cs.

$4\,Li + O_2 \rightarrow 2\,Li_2O$ (oxide)

$$2Na + O_2 \rightarrow Na_2O_2 \text{ (peroxide)}$$
$$M + O_2 \rightarrow MO_2 \text{ (superoxide)}$$

(M = K, Rb, Cs)

In all these oxides the oxidation state of the alkali metal is +1. Lithium shows exceptional behaviour in reacting directly with nitrogen of air to form the nitride, Li_3N as well. **Because of their high reactivity towards air and water, they are normally kept in kerosene oil.**

3. Explain the reactivity of alkali metals towards water.

The alkali metals react with water to form hydroxide and dihydrogen.

$$2M + 2H_2O \rightarrow 2M^+ + 2OH^- + H_2 \quad \text{(M = an alkali metal)}$$

It may be noted that although lithium has most negative E^0 value, its reaction with water is less vigorous than that of sodium which has the least negative E^0 value among the alkali metals. This behaviour of lithium is attributed to its small size and very high hydration energy. Other metals of the group react explosively with water.

They also react with proton donors such as alcohol, gaseous ammonia and alkynes.

4. How does alkali metals react with halogens?

The alkali metals readily react vigorously with halogens to form ionic halides, M+X–. However, lithium halides are somewhat covalent. It is because of the high polarisation capability of lithium ion (The distortion of electron cloud of the anion by the cation is called polarisation). The Li+ ion is very small in size and has high tendency to distort electron cloud around the negative halide ion. Since anion with large size can be easily distorted, among halides, lithium iodide is the most covalent in nature.

5.Why do the the alkali metals give blue solution ,when treated with liq NH_3?

The alkali metals dissolve in liquid ammonia giving deep blue solutions which are conducting in nature.

$$M + (x+y)NH_3 \rightarrow [M(NH_3)_x]^+ + [e(NH_3)_y]^-$$

The blue colour of the solution is due to the ammoniated electron which absorbs energy in the visible region of light and thus imparts blue colour to the solution. The solutions are paramagnetic and on standing slowly liberate hydrogen resulting in the formation of amide.

$$M^+_{(am)} + e^- + NH_3(l) \rightarrow MNH_{2(am)} + \tfrac{1}{2}H_2(g)$$

(where 'am' denotes solution in ammonia.) In concentrated solution, the blue colour changes to bronze colour and becomes diamagnetic.

6.What are the uses of alkali metals ?

Lithium metal is used to make useful alloys, for example with lead to make 'white metal' bearings for motor engines, with aluminium to make aircraft parts, and with magnesium to make armour plates. It is used in thermonuclear reactions. Lithium is also used to make electrochemical cells. Sodium is used to make a Na/Pb alloy needed to make $PbEt_4$ and $PbMe_4$. These **organolead compounds were earlier used as anti-knock additives to petrol**, but nowadays vehicles use lead-free petrol. Liquid sodium metal is used as a coolant in fast breeder nuclear reactors. Potassium has a vital role in biological systems. Potassium chloride is used as a fertilizer. Potassium hydroxide is used in the manufacture of soft soap. It is also used as an excellent absorbent of carbon dioxide. Caesium is used in devising photoelectric cells.

7.What is the reason for the increasing stability of peroxide & superoxide of alkali metals down the group?

On combustion in excess of air, lithium forms mainly the oxide, Li_2O (plus some peroxide Li_2O_2), sodium forms the peroxide, Na_2O_2 (and some superoxide NaO_2) whilst potassium, rubidium and caesium form the superoxides, MO_2. Under appropriate conditions pure compounds M_2O, M_2O_2 and MO_2 may be prepared. The increasing stability of the peroxide or superoxide, as the size of the metal ion increases, is due to the stabilisation of large anions by larger cations through lattice energy effects. These oxides are easily hydrolysed by water to form the hydroxides according to the following reactions :

$$M_2O + H_2O \rightarrow 2M^+ + 2OH^-$$

$$M_2O_2 + 2H_2O \rightarrow 2M^+ + 2OH^- + H_2O_2$$

$$2MO_2 + 2H_2O \rightarrow 2M^+ + 2OH^- + H_2O_2 + O_2$$

The oxides and the peroxides are colourless when pure, but the superoxides are yellow or orange in colour. The superoxides are also paramagnetic. Sodium peroxide is widely used as an oxidising agent in inorganic chemistry.

8. Explain the stability of carbonates & bicarbonates of alkali metals .

The alkali metals form salts with all the oxo-acids. They are generally soluble in water and thermally stable. Their carbonates (M_2CO_3) and in most cases the hydrogencarbonates ($MHCO_3$) also are highly stable to heat. As the electropositive character increases down the group, the stability of the carbonates and hydorgencarbonates increases. Lithium carbonate is not so stable to heat; lithium being very small in size polarises a large CO_3^{2-} ion leading to the formation of more stable Li_2O and CO_2. Its hydrogencarbonate does not exist as a solid.

9. Mention the Points of Difference between 'Lithium and other Alkali Metals'

(i) Lithium is much harder. Its m.p. and b.p. are higher than the other alkali metals.
(ii) Lithium is least reactive but the strongest reducing agent among all the alkali metals. On combustion in
air it forms mainly monoxide, Li_2O and the nitride, Li_3N unlike other alkali metals.
(iii) LiCl is deliquescent and crystallises as a hydrate, $LiCl.2H_2O$ whereas other alkali metal chlorides do not
form hydrates.
(iv) Lithium hydrogencarbonate is not obtained in the solid form while all other elements form solid
hydrogen carbonates.
(v) Lithium unlike other alkali metals forms no ethynide on reaction with ethyne.
(vi) Lithium nitrate when heated gives lithium oxide, Li_2O, whereas other alkali metal nitrates decompose to
give the corresponding nitrite.

$$4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$$

$$2NaNO_3 \rightarrow 2NaNO_2 + O_2$$

(vii) LiF and Li_2O are comparatively much less soluble in water than the corresponding compounds of other
alkali metals.

10. Mention the Points of Similarities between 'Lithium and Magnesium'

The similarity between lithium and magnesium is particularly striking and arises because of their similar sizes : (atomic radii, Li = 152 pm, Mg = 160 pm; ionic radii : Li^+ = 76 pm, Mg^{2+}= 72 pm.)

The main points of similarity are:

(i) Both lithium and magnesium are harder and lighter than other elements in the respective groups.

(ii) Lithium and magnesium react slowly with water. Their oxides and hydroxides are much less soluble and their hydroxides decompose on heating. Both form a nitride, Li_3N and Mg_3N_2, by direct combination with nitrogen.

(iii) The oxides, Li_2O and MgO do not combine with excess oxygen to give any superoxide.

(iv) The carbonates of lithium and magnesium decompose easily on heating to form the oxides and CO_2.

Solid hydrogencarbonates are not formed by lithium and magnesium.

(v) Both LiCl and $MgCl_2$ are soluble in ethanol.

(vi) Both LiCl and $MgCl_2$ are deliquescent and crystallise from aqueous solution as hydrates, $LiCl\cdot 2H_2O$ and $MgCl_2\cdot 8H_2O$.

11. How is Sodium Carbonate (Washing Soda), $Na_2CO_3\cdot 10H_2O$ manufactured by "<u>Solvay Process</u>"

Principle-- In this process, advantage is taken of the low solubility of sodium hydrogencarbonate whereby it gets precipitated in the reaction of sodium chloride with ammonium hydrogencarbonate. The latter is prepared by passing CO_2 to a concentrated solution of sodium chloride saturated with ammonia, where ammonium carbonate followed by ammonium hydrogencarbonate are formed. The equations for the complete process may be written as :

$$2NH_3 + H_2O + CO_2 \rightarrow (NH_4)_2CO_3$$

$$(NH_4)_2CO_3 + H_2O + CO_2 \rightarrow 2NH_4HCO_3$$

$$NH_4HCO_3 + NaCl \rightarrow NH_4Cl + NaHCO_3$$

Sodium hydrogencarbonate crystal separates. These are heated to give sodium carbonate.

$$2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$$

Recovery of some raw material--In this process NH_3 is recovered when the solution containing NH_4Cl is treated with $Ca(OH)_2$. Calcium chloride is obtained as a by-product.

□□□□ $2NH_4Cl + Ca(OH)_2 \rightarrow 2NH_3 + CaCl_2 + H_2O$

12.What happens ,when washing soda is heated ?

On heating, the decahydrate loses its water of crystallization to form monohydrate. Above 373K, the monohydrate becomes completely anhydrous and changes to a white powder called **soda ash**.

$$Na_2CO_3 \cdot 10H_2O \xrightarrow{375K} Na_2CO_3 \cdot H_2O + 9H_2O$$

$$Na_2CO_3 \cdot H_2O \xrightarrow{>373K} Na_2CO_3 + H_2O$$

Carbonate part of sodium carbonate gets hydrolysed by water to form an alkaline solution.

$$CO_3^{2-} + H_2O \rightarrow HCO_3^- + OH^-$$

13.Explain the extraction of Sodium Chloride, NaCl

The most abundant source of sodium chloride is sea water which contains 2.7 to 2.9% by mass of the salt. In tropical countries like India, common salt is generally obtained by evaporation of sea water. Approximately 50 lakh tons of salt are produced annually in India by solar evaporation. Crude sodium chloride, generally obtained by crystallization of brine solution, contains sodium sulphate, calcium sulphate, calcium chloride and magnesium chloride as impurities. **Calcium chloride, $CaCl_2$, and magnesium chloride, $MgCl_2$ are deliquescent impurities (because they absorb moisture easily from the atmosphere).**

14.Explain the manufacture of Sodium Hydroxide (Caustic Soda), NaOH by castner kellner cell

Preperation--Sodium hydroxide is generally prepared commercially by the electrolysis of sodium chloride in **Castner-Kellner cell**. A brine solution is electrolysed using a mercury cathode and a carbon anode. Sodium metal discharged at the cathode combines with mercury to form sodium amalgam. Chlorine gas is evolved at the anode.

$$\text{Cathode}: Na^+ + e^- \xrightarrow{Hg} Na - \text{amalgam}$$

$$\text{Anode}: Cl^- \rightarrow \frac{1}{2}Cl_2 + e^-$$

The amalgam is treated with water to give sodium hydroxide and hydrogen gas.
$2Na\text{-amalgam} + 2H_2O \rightarrow 2NaOH + 2Hg + H_2$

15.How is Sodium Hydrogencarbonate (Baking Soda), $NaHCO_3$ prepared ?

Sodium hydrogencarbonate is known as baking soda because it decomposes on heating to generate bubbles of carbon dioxide (leaving holes in cakes or pastries and making them light and fluffy).

Preparation--Sodium hydrogencarbonate is made by saturating a solution of sodium carbonate with carbon dioxide. The white crystalline powder of sodium hydrogencarbonate, being less soluble, gets separated out.
$Na_2CO_3 + H_2O + CO_2 \rightarrow 2\,NaHCO_3$

16.Write a note on biological importance of sodium and potassium

Sodium ions are found primarily on the outside of cells, being located in **blood plasma** and in the **interstitial fluid** which surrounds the cells. These ions participate in the **transmission of nerve signals**, in regulating the flow of water across cell membranes and in the **transport of sugars and amino acids into cells**. Sodium and potassium, although so similar chemically, **differ quantitatively in their ability to penetrate cell membranes**, in their transport mechanisms and in their **efficiency to activate enzymes**. Thus, **potassium ions are the most** abundant cations within cell fluids, where they activate many enzymes, participate in the oxidation of glucose to produce ATP and, with sodium, are responsible for the transmission of nerve signals.

17. What are the uses of alkaline earth metals ?

Beryllium is used in the manufacture of alloys. Copper-beryllium alloys are used in the preparation of high strength springs. Metallic beryllium is used for making windows of X-ray tubes. Magnesium forms alloys with aluminium, zinc, manganese and tin. Magnesium-aluminium alloys being light in mass are used in air-craft construction.

Magnesium (powder and ribbon) is used in flash powders and bulbs, incendiary bombs and signals. A suspension of magnesium hydroxide in water (called *milk of magnesia*) is used as antacid in medicine. Magnesium carbonate is an ingredient of toothpaste. Calcium is used in the extraction of metals from oxides which are difficult to reduce with carbon. Calcium and barium metals, owing to their reactivity with oxygen and nitrogen at elevated temperatures, have often been used to remove air from vacuum tubes. Radium salts are used in radiotherapy, for example, in the treatment of cancer.

18.Explain the structure of $BeCl_2$?

Except for beryllium halides, all other halides of alkaline earth metals are ionic in nature. Beryllium halides are essentially covalent and soluble in organic solvents. Beryllium chloride has a chain structure in the solid state as shown below:

In the vapour phase $BeCl_2$ tends to form a chloro-bridged dimer which dissociates into the linear monomer at high temperatures of the order of 1200 K.

19. Mention the anomalous behaviour of beryllium

Beryllium, the first member of the Group 2 metals, shows anomalous behaviour as compared to magnesium and rest of the members. Further, it shows diagonal relationship to aluminium

(i) Beryllium has exceptionally small atomic and ionic sizes and thus does not compare well with other members of the group. Because of high ionisation enthalpy and small size it forms compounds which are largely covalent and get easily hydrolysed.

(ii) Beryllium does not exhibit coordination number more than four as in its valence shell there are only four orbitals. The remaining members of the group can have a coordination number of six by making use of *d*-orbitals.

(iii) The oxide and hydroxide of beryllium, unlike the hydroxides of other elements in the group, are amphoteric in nature.

20. Mention the Diagonal Relationship between Beryllium and Aluminium

The ionic radius of Be^{2+} is estimated to be 31 pm; the charge/radius ratio is nearly the same as that of the Al^{3+} ion. Hence beryllium resembles aluminium in some ways. Some of the similarities are:

(i) Like aluminium, beryllium is not readily attacked by acids because of the presence of an oxide film on the surface of the metal.

(ii) Beryllium hydroxide dissolves in excess of alkali to give a beryllate ion, $[Be(OH)_4]^{2-}$ just as aluminium hydroxide gives aluminate ion, $[Al(OH)_4]^{-}$.

(iii) The chlorides of both beryllium and aluminium have Cl^{-} bridged chloride structure in vapour phase.

Both the chlorides are soluble in organic solvents and are strong Lewis acids. They are used as Friedel Craft catalysts.

(iv) Beryllium and aluminium ions have strong tendency to form complexes, BeF_4^{2-}, AlF_6^{3-}.

21. Write a note on the manufacture of Cement:

Cement is an important building material. It was first introduced in England in 1824 by Joseph Aspdin. It is also called Portland cement because it resembles with the natural limestone quarried in the Isle of Portland, England.

Cement is a product obtained by combining a material rich in lime, CaO with other material such as clay which contains silica, SiO_2 along with the oxides of aluminium, iron and magnesium. The average composition of Portland cement is : CaO, 50- 60%; SiO_2, 20-25%; Al_2O_3, 5-10%; MgO, 2- 3%; Fe_2O_3, 1-2% and SO_3, 1-2%. For a good quality cement, the ratio of silica (SiO_2) to alumina (Al_2O_3) should be between 2.5 and 4 and the ratio of lime (CaO) to the total of the oxides of silicon (SiO_2) aluminium (Al_2O_3) and iron (Fe_2O_3) should be as close as possible to 2.

The raw materials for the manufacture of cement are limestone and clay. When clay and lime are strongly heated together they fuse and react to form ‘cement clinker’. This clinker is mixed with 2-3% by weight of gypsum ($CaSO_4 \cdot 2H2O$) to form cement. Thus important ingredients present in Portland cement are dicalcium silicate (Ca_2SiO_4) 26%, tricalcium silicate (Ca_3SiO_5) 51% and tricalcium aluminate ($Ca_3Al_2O_6$) 11%.

22. How does the setting of cement takes place & what is the role of gypsum in setting of cement ?

When mixed with water, the setting of cement takes place to give a hard mass. This is due to the hydration of the molecules of the constituents and their rearrangement. The purpose of adding gypsum is only to slow down the process of setting of the cement so that it gets sufficiently hardened.

23.Write a note on biological importance of magnesium and calcium

An adult body contains about 25 g of Mg and 1200 g of Ca compared with only 5 g of iron and 0.06 g of copper. The daily requirement in the human body has been estimated to be 200 – 300 mg. All enzymes that utilise ATP in phosphate transfer require magnesium as the cofactor. The main pigment for the absorption of light in plants is chlorophyll which contains magnesium. About 99 % of body calcium is present in bones and teeth. It also plays important roles in neuromuscular function, interneuronal transmission, cell membrane integrity and blood coagulation. The calcium concentration in plasma is regulated at about 100 mgL^{-1}. It is maintained by two hormones: calcitonin and parathyroid hormone. Do you know that bone is not an inert and unchanging substance but is continuously being solubilised and redeposited to the extent of 400 mg per day in man? All this calcium passes through the plasma.