

UNIT-10**The s-Block Elements****SECTION-A: NCERT-Intext Questions with Answers****10.1. What are the common physical and chemical features of alkali metals?**

Ans. Physical features of alkali metals

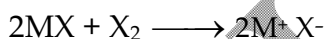
- (i) All alkali metals are silvery white, soft and light metals.
- (ii) The melting and boiling points of alkali metals are low.
- (iii) The alkali metals and their salts impart colour when subjected to flame.

Chemical features of alkali metals.

- (i) The alkali metals tarnish in dry air due to the formation of their oxides M_2O
- (ii) The alkali metals react with water to form hydroxide and dihydrogen.



- (iii) The alkali metals react vigorously with halogen to form ionic halides MX

**10.2. Discuss the general characteristics and gradation in properties of alkaline earth metals.**

Ans. (i) Atomic and ionic radii

The atomic and ionic radii of the alkaline earth metals are small than those of the corresponding alkali metals in the same period. Within the group, the atomic and ionic radii increase with increase in atomic number.

(ii) Ionization enthalpy

The first ionization enthalpy of the alkaline earth metals are higher than those of the alkali metals. But within the group, ionization enthalpy decreases due to increased atomic size.

- (iii) Electronegativity of alkaline earth metals also decreases down the groups

10.3. Why are alkali metals not found in nature?

Ans. Due to the presence of just one electron in their valence shell, alkali metals are highly reactive. Hence, alkali metals do not found in nature in their native state.

10.4. Find out the oxidation state of sodium in Na_2O_2 .

Ans. In Na_2O_2 , the oxidation state of sodium is +1.

10.5. Explain why is sodium less reactive than potassium.

Ans. Due to small size and high ionization enthalpy, sodium is less reactive than potassium.

10.6. Compare the alkali metals and alkaline earth metals with respect to (i) ionisation enthalpy (ii) basicity of oxides and (iii) solubility of hydroxides.

Ans.

		Alkali metals	Alkaline earth metals
(i)	Ionization enthalpy	Alkali metals have a low ionization enthalpy in a given period. The ionization enthalpy decreases down the group.	Alkaline earth metals have a higher ionization enthalpy than the alkali metals. Also, ionization enthalpy decreases down the group.
(ii)	Basicity of oxides	Basicity of oxides increases down the group as metallic character increases.	Basicity of oxides also increases down the group but group 2 oxides are less basic than alkali metal oxides.
(iii)	Solubility of hydroxides	The solubility of alkali metals hydroxides $\text{M} - \text{OH}$ increases down the group.	The solubility of alkaline earth metal hydroxides also increases down the group.

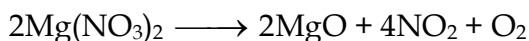
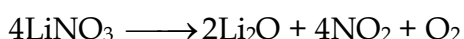
10.7. In what ways lithium shows similarities to magnesium in the chemical behavior?

Ans. Similarities between Lithium and Magnesium

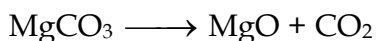
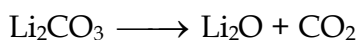
(i) Li and Mg both reacts with N_2 to form their respective nitrides



(ii) Lithium nitrate and magnesium nitrate both decompose on heating to give brown fumes of NO_2 gas



- (iii) Lithium carbonate and magnesium carbonate both decompose on heating to give CO₂ gas



- (iv) Lithium fluoride and magnesium fluoride both are insoluble in water.

10.8. Explain why can alkali and alkaline earth metals not be obtained by chemical reduction methods?

Ans. Alkali metals and alkaline earth metals are highly reactive and they themselves are strong reducing agents. There is no chemical reducing agents better than these metals available. Hence alkali metals and alkaline earth metals are obtained only by electrolytic reduction and not by chemical reduction method.

10.9. Why are potassium and caesium, rather than lithium used in photoelectric cells?

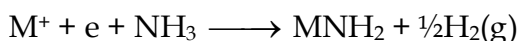
Ans. Due to low ionization enthalpy, potassium and cesium atoms lose an electron easily when irradiated with light. This property make these metals useful in electrodes in photoelectric cells.

10.10. When an alkali metals dissolves in liquid ammonia the solution can acquire different colours. Explain the reasons for this type of colour change.

Ans. The alkali metals dissolve in liquid ammonia and give deep blue solution which conducts electricity



The blue colour is due to the presence of solvated or ammoniated electron which absorbs energy in the visible region of light and thus imparts blue colour to the solution. The solution is also paramagnetic. The electrical conduction is due to the both ammoniated metal ion and ammoniated electron. On standing, solution slowly liberate H₂ gas and form metal amide.



amide

In concentrated solution, the blue colour changes to bronze colour due to the formation of metal clusters. The solution is diamagnetic in nature due to absence of unpaired electron.

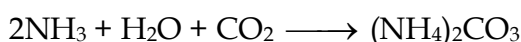
10.11. Beryllium and magnesium do not give colour to flame whereas other alkaline earth metals do so. Why?

Ans. Due to small size, the electrons in beryllium and magnesium are too strongly bound to the nucleus and do not get excited by flame to higher energy level. Hence, these elements do not impart any colour to the flame.

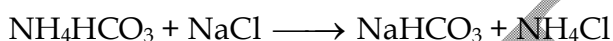
10.12. Discuss the various reactions that occur in the Solvay process.

Ans. Various reactions occur in the **Solvay process**:

(i) Carbonation of ammonia solution:



(ii) Formation of NaHCO_3 crystals using brine solution



(iii) Heating NaHCO_3 gives Na_2CO_3



In this process, NH_3 is recovered when the solution containing NH_4Cl is treated with $\text{Ca}(\text{OH})_2$. Calcium chloride is the by-product of Solvay process.



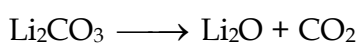
10.13. Potassium carbonate cannot be prepared by Solvay process. Why?

Ans. Potassium carbonate cannot be obtained by Solvay process because potassium hydrogen carbonate is too soluble to be precipitated by the addition of ammonium hydrogen carbonate to a saturated solution of potassium chloride.



10.14. Why is Li_2CO_3 decomposed at a lower temperature whereas Na_2CO_3 at higher temperature?

Ans. Li_2CO_3 decomposes on heating. This is because lithium being very small in size polarizes a large CO_3^{2-} ion leading to the formation of more stable lithium oxide Li_2O and CO_2 .



Na_2CO_3 is stable towards heat and decomposes only at a higher temperature.

10.15. Compare the solubility and thermal stability of the following compounds of the alkali metals with those of the alkaline earth metals. (a) Nitrates (b) Carbonates (c) Sulphates.

Ans.

		Alkali Metals		Alkaline Earth Metals	
		Solubility	Thermal stability	Solubility	Thermal stability
(i)	Nitrates	Increases down the group because lattice enthalpy decreases more rapidly than hydration enthalpy.	Increases down the group	Decreases down the group because hydration enthalpy decreases more rapidly than lattice enthalpy.	Increases down the group $MCO_3 \rightarrow MO + CO_2$ $MSO_4 \rightarrow MO + SO_3$
(ii)	Carbonates		$4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$		
(iii)	Sulphates		$MNO_3 \rightarrow MNO_2 + \frac{1}{2}O_2$ $M_2CO_3 \rightarrow M_2O + CO_2$		

10.16. Starting with sodium chloride how would you proceed to prepare (i) sodium metal (ii) sodium hydroxide (iii) sodium peroxide (iv) sodium carbonate?

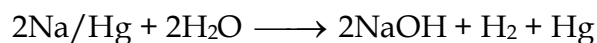
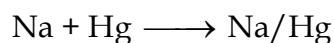
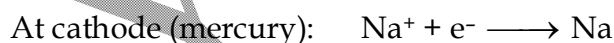
Ans. (i) Preparation of Sodium metal (Down cell process)

Electrolytic reduction of molten NaCl mixed with CaCl₂

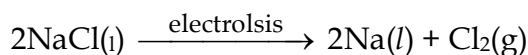


(ii) Preparation of sodium hydroxide

Electrolysis of aqueous NaCl solution

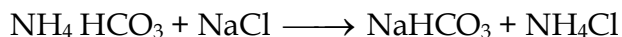


(iii) Preparation of sodium peroxide

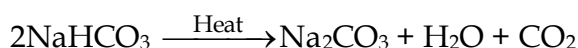


(iv) Preparation of sodium carbonate

- (a) Preparation of sodium hydrogen carbonate

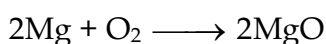


- (b) Heating sodium hydrogen carbonate

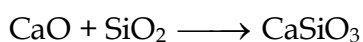


10.17. What happens when (i) magnesium is burnt in air (ii) quick lime is heated with silica (iii) chlorine reacts with slaked lime (iv) calcium nitrate is heated?

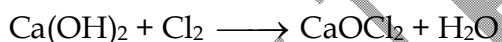
Ans. (i) Magnesium oxide is formed. Also formed magnesium nitride



- (ii) Calcium silicate is formed



- (iii) Bleaching powder is formed



- (iv) It forms calcium oxide, brown fumes of
- NO_2
- gas and oxygen gas



10.18. Describe two important uses of each of the following (i) caustic soda (ii) sodium carbonate (iii) quicklime.

Ans. (i) Caustic soda

- (a) used in the manufacture of soap, paper

- (b) used in the textile industry for mercerising cotton fabrics.

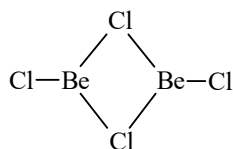
- (ii) Sodium carbonate

- (a) it is used in water softening, laundering, cleaning

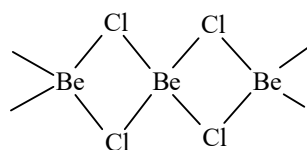
- (b) used in the manufacturing of glass, soaps

10.19. Draw the structure of (i) BeCl_2 (vapour) (ii) BeCl_2 (solid).

Ans. (i) BeCl_2 (vapour) It exist as a dimer with bridged chlorine atom.



(ii) BeCl_2 (solid) It has a chain structure with bridged chlorine atom



10.20. The hydroxides and carbonates of sodium and potassium are easily soluble in water while the corresponding salts of magnesium and calcium are sparingly soluble in water. Explain.

Ans. Due to larger size of Na and K as compared to Mg and Ca, the hydroxides and carbonates of Na and K have a lower lattice enthalpies than hydration enthalpies. Hydroxides and carbonates of Na and K are easily soluble in water than the corresponding Mg and Ca.

10.21. Describe the importance of the following (i) limestone (ii) cement (iii) plaster of Paris.

Ans. Importance of

(i) **Lime stone, CaCO_3**

- (a) It is used in the manufacture of high quality paper.
- (b) It is used as an antacid
- (c) It is used as mild abrasive in tooth paste.

(ii) **Cement**

- (a) It is used in concrete and reinforce concrete.
- (b) It is used in plastering and in the construction of bridges, dams and buildings.

(iii) **Plaster of Paris**

- (a) It is used in the building industry as well as plasters.
- (b) It is used in bone fracture or sprain.

(c) It is used for making caste of statues and busts.

10.22. Why are lithium salts commonly hydrated and those of the other alkali ions usually anhydrous?

Ans. Due to small size, high charge to radius ratio, high polarizing power, lithium salts are more heavily hydrated than those of other alkali metal ions.

10.23. Why is LiF almost insoluble in water whereas LiCl soluble not only in water but also in acetone?

Ans. LiF is almost insoluble in water due to its high lattice enthalpy.

10.24. Explain the significance of sodium, potassium, magnesium and calcium in biological fluids.

Ans. Importance of sodium, potassium, magnesium and calcium in biological fluids.

(i) Sodium

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.

(ii) Potassium

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.

(iii) Magnesium

All enzymes that utilize ATP in phosphate transfer require magnesium as the cofactor.

(iv) Calcium

Calcium plays an important role in neuromuscular function, interneuronal transmission, cell membrane integrity and blood coagulation.

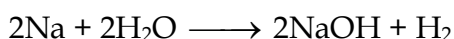
10.25. What happens when

(i) sodium metal is dropped in water?

(ii) sodium metal is heated in free supply of air?

(iii) sodium peroxide dissolves in water?

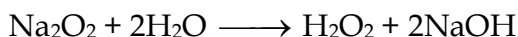
Ans. (i) H₂ gas is evolved



(ii) It forms sodium peroxide



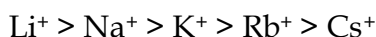
(iii) Hydrogen peroxide is formed



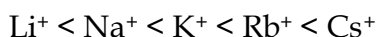
10.26. Comment on each of the following observations:

- (i) The mobilities of the alkali metal ions in aqueous solution are $\text{Li}^+ < \text{Na}^+ < \text{K}^+ < \text{Rb}^+ < \text{Cs}^+$
- (b) Lithium is the only alkali metal to form a nitride directly
- (c) E° for $\text{M}^{2+}(\text{aq}) + 2\text{e}^- \longrightarrow \text{M}(\text{s})$ (where $\text{M} = \text{Ca}, \text{Sr}$ or Ba) is nearly constant.

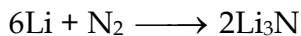
Ans. (i) As the size of the ion increases down the group, the hydration enthalpies of alkali metal ions decreases.



Li^+ has maximum degree of hydration and hence the least ionic mobility. The ionic mobility increases down the group



(ii) Lithium is the only alkali metal which reacts directly with nitrogen of air to form the nitride Li_3N



This is due to small size of Li^+ and high lattice enthalpy of Li_3N .

(iii) The value of E° depends on

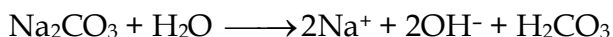
- (a) enthalpy of sublimation ($\text{M}(\text{s}) \longrightarrow \text{M}(\text{g})$)
- (b) enthalpy of ionization ($\text{M}(\text{g}) \longrightarrow \text{M}^{2+}(\text{g}) + 2\text{e}^-$)
- (c) enthalpy of hydration ($\text{M}^{2+}(\text{g}) \longrightarrow \text{M}^{2+}(\text{aq})$)

The combined effect of these three is almost same for these three metals. Hence, E° value for Ca, Sr and Ba is nearly constant.

10.27. State as to why?

- (a) a solution of Na_2CO_3 is alkaline?
- (b) alkali metals are prepared by electrolysis of their fused chlorides?
- (c) sodium is found to be more useful than potassium?

Ans. (a) Na_2CO_3 is a salt of strong base NaOH and weak acid H_2CO_3 . So, it gets hydrolysed to give more OH^- ions in solution. Hence the solution of Na_2CO_3 is alkaline.



(b) Since E° value of hydrogen is greater than E° value of alkali metals. So, electrolysis of an aqueous solution of alkali metal chloride liberates H_2 gas at cathode and not alkali metals.

Therefore, the alkali metals are obtained by the electrolysis of fused alkali metal chlorides.

(c) 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.

10.28. Write balanced equations for reactions between

(a) Na_2O_2 and water

(b) KO_2 and water

(c) Na_2O and CO_2

Ans. (a) $\text{Na}_2\text{O}_2 + 2\text{H}_2\text{O} \longrightarrow 2\text{NaOH} + \text{H}_2\text{O}_2$

(b) $2\text{KO}_2 + 2\text{H}_2\text{O} \longrightarrow 2\text{KOH} + \text{H}_2\text{O}_2 + \text{O}_2$

(c) $\text{Na}_2\text{O} + \text{CO}_2 \longrightarrow \text{Na}_2\text{CO}_3$

10.29. How would you explain the following observations?

(i) BeO is almost insoluble but BeSO_4 is soluble in water.

(ii) BaO is soluble but BaSO_4 is insoluble in water.

(iii) LiI is more soluble than KI in ethanol.

Ans. (i) Due to small size, high ionization enthalpy and high electronegativity, BeO is covalent and is insoluble in water. Also, in BeO , lattice enthalpy is much higher than the hydration enthalpy. So, BeO is insoluble in water. But in BeSO_4 , due to difference in size, BeSO_4 is less stable and its lattice enthalpy is less than hydration enthalpy. Hence BeSO_4 is soluble in water.

(ii) BaO is soluble in water because its lattice enthalpy is less than hydration enthalpy. BaSO_4 is insoluble in water because its lattice enthalpy is much higher than its hydration enthalpy.

(iii) Due to small size of Li^+ and high polarizing power of Li^+ , is more covalent than KI. Hence, LiI is more soluble in ethanol than KI.

10.30. Which of the alkali metal is having least melting point?

- (a) Na (b) K (c) Rb (d) Cs

Ans. (d)

As we move down the group, the atomic size increases the strength of metallic bond decreases, softness increases and melting point decreases.

10.31. Which one of the following alkali metals gives hydrated salts?

- (a) Li (b) Na (c) K (d) Cs

Ans. (a)

Due to small size and high charge density, Li^+ salts are more heavily hydrated than other alkali metals.

10.32. Which one of the alkaline earth metal carbonates is thermally the most stable?

- (a) MgCO_3 (b) CaCO_3 (c) SrCO_3 (d) BaCO_3

Ans. (d)

Due to stabilization of large cation by large anion, BaCO_3 is thermally the most stable alkaline earth metal carbonates. The correct order of increasing thermal stability is

