

## Chapter 9. S Block Elements

### Question-1

Which alkali metals form superoxides? Give reason.

#### Solution:

Potassium, Rubium and caesium form superoxides. Li and Na do not form superoxide. In  $KO_2$  (potassium superoxide) larger anions are stabilized by bigger cation through lattice energy.  $Li^+$  and  $Na^+$  are small cations. They cannot stabilize too many oxide ions.

### Question-2

Why  $LiOH$  is a weak base while  $CsOH$  is a strong base?

#### Solution:

$Li^+$  ion due to its small size, is able to attract valence electrons from  $OH^-$  ion to form an ionic bond containing covalency (Fajan's rule)

Being covalent, it is sparingly soluble and less basic.

For  $CsOH$ , size of  $Cs^+$  ion is bigger. Hence, ionic bond strength is maximum and more soluble in water. Hence is a strong base.

### Question-3

Why is lithium the strongest reducing agent in solution?

#### Solution:

$Li^+$  ion being smallest in size has large hydration energy. This energy stabilizes the formation of  $Li^+$  ion in solution



$Li^+ + (H_2O)_x \rightarrow Li^+ (H_2O)_x + \text{Hydration energy}$ . Hence Li is the strongest reducing agent.

#### Question-4

Why is LiF sparingly soluble in water while other halides of Li are soluble in organic solvents?

#### Solution:

This can be explained through covalency in ionic compounds. As per Fajan's rule (i) small size of cation (2) larger charge of cation (3) large size of anion causes more polarization in ionic bond of ionic crystals. For LiF, size of  $\text{Li}^+$  is small. Hence covalency in the ionic bond is possible. As the size of  $\text{Cl}^-$ ,  $\text{Br}^-$  and  $\text{I}^-$  are greater than that of  $\text{F}^-$ , polarization by  $\text{Li}^+$  will be greater, leading to the increase of covalent nature in the bond. Thus LiCl, LiBr and LiI are soluble in organic solvents when compared to LiF.

#### Question-5

Why does  $\text{LiNO}_3$  give  $\text{Li}_2\text{O}$ ,  $\text{NO}_2$  and  $\text{O}_2$  while  $\text{NaNO}_3$  gives  $\text{NaNO}_2$  and  $\text{O}_2$ ?

#### Solution:

$\text{Li}^+$  polarizes the  $\text{NO}_3^-$  ion and attract valency electrons of  $\text{NO}_3^-$  towards it. Thus covalency in ionic bond between  $\text{Li}^+$  and  $\text{NO}_3^-$  arises. Covalency causes less stability. On heating it gives  $\text{Li}_2\text{O} + \text{NO}_2 + \text{O}_2$ . But for  $\text{NaNO}_3$  polarisation in the ionic bond is not much and hence bond between  $\text{Na}^+$   $\text{NO}_3^-$  is more ionic and stronger. On heating it gives  $\text{NaNO}_2$  and  $\text{O}_2$ .

### Question-6

Be and Mg salts do not give colour to the flame. Give reasons.

#### Solution:

The electrons of  $nS^2$  orbital in Ca, Sr and Ba are excited to higher energy electrons and returns to their original energy level (s orbital). The absorbed energy is emitted back in the form of visible light by the S electrons. Hence salts of Ca, Sr, and Ba gives red, crimson and apple green colours respectively.

Be and Mg are made of atoms of small size. They have high ionisation energy. Hence, two paired electrons cannot be excited to higher energy level by the energy of the flame. Hence Be and Mg do not give colour to the flame.

### Question-7

How is the solubility of ionic crystal depends on the lattice energy and hydration energy?

#### Solution:

Smaller the lattice energy more will be the solubility. Smaller the size of cation and anion, stronger will be the ionic bond, greater will be lattice energy, smaller will be a solubility. (E.g. LiF). KI is more soluble than  $F^-$ ,  $Cl^-$  and  $Br^-$  of K. Greater the size of halides, lesser will be the bond strength, lesser will be lattice energy, more will be the solubility.

Smaller the size of cation greater will be a hydration energy, more will the solubility. When hydration energy exceeds the lattice energy, dissolution of the ionic compound takes place. When solvation / hydration energy is not enough to counteract the lattice energy, the substance remains insoluble (e.g. LiF).

### Question-8

Stability of carbonates of alkaline earth metal increases on moving down the group. Give reason.

#### Solution:

Be CO<sub>3</sub> on heating gives BeO and CO<sub>2</sub>. BeO is more stable as the size of Be<sup>2+</sup> and O<sup>2-</sup> are nearly same. As BeO is more stable than BeCO<sub>3</sub>, BeCO<sub>3</sub> on heating it decomposes readily.

But BaCO<sub>3</sub> on heating gives BaO and CO<sub>2</sub>. BaO is less stable due to the larger size of Ba<sup>2+</sup>.

In short, it is the increasing size of the cation that destabilizes the oxides and hence does not favour the decomposition of the heavier alkaline earth metal carbonates.

### Question-9

Although Li<sup>+</sup> ion is the smallest among the alkali metal ions, its conductivity in aqueous solution is less than that of Cs<sup>+</sup> ion. Give reasons.

#### Solution:

Smallest Li<sup>+</sup> ion forms biggest hydrated Li<sup>+</sup> ion. Cs<sup>+</sup> ion forms only smaller V hydrated ions than that of Li<sup>+</sup> ion. Hence, due to greater size of hydrated Li<sup>+</sup> ion, mobility will be small. Hence conductance will be small and less than that of Cs<sup>+</sup> ion in aqueous solution.

## Question-10

Why doesn't sodium and potassium ion form complex ions?

### Solution:

In order to form complex compounds, a metal should have following characteristics.

(a) Small size (b) High nuclear size (c) Tendency to accept pair of electrons (the presence of empty orbital).

Size of Na & K are not of small size, when compared to Li. Charge on the nucleus is also not very high. They do not have empty orbital.

## CBSE Class 11 Chemistry

### Important Questions

#### Chapter 10

#### The s-Block Elements

#### 1 Marks Questions

**1. Why is Group I elements known as the most electropositive element?**

**Ans.** 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.

**2. Why is lithium salts mostly hydrated?**

**Ans.**  $Li^+$  has maximum degree of hydration and for this reason lithium salts are mostly hydrated eg.  $LiCl, 2H_2O$ .

**3. Why are melting and boiling points of alkali metals low?**

**Ans.** 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.

**4. What do you mean by diagonal relationship in the periodic table?**

**Ans.** The diagonal relationship is due to the similarity in ionic sizes and /or charge / radius ratio of the elements.

**5. Why is lithium kept under kerosene oil?**

**Ans.** Because of their high reactivity towards air and water, they are normally kept in kerosene oil.

**6. Name the lightest metal.**

**Ans.** Lithium is the Lightest known metal (density 0.534g (cm<sup>3</sup>))

**7. Why alkali metal hydroxides are make the strongest bases?**

**Ans.** The alkali metal hydroxides are the strongest of all bases because they dissolve freely in water with evolution of much heat on account of intense hydration.

**8. Why are peroxides and super oxides stable in comparison to other oxides?**

**Ans.** The stability of peroxides and super oxides is due to the stabilization of large anions by larger cations through lattice energy effects.

**9. Name the anomalous properties of lithium.**

**Ans.** The anomalous behaviors of lithium is due to the following-

(i) Exceptionally small size of its atom and ion., Li<sup>+</sup>

(ii) High polarizing power (I, e; charge / radius ratio)

**10. Why are lithium compounds soluble in organic solvents?**

**Ans.** Due to high polarizing power, there is increased covalent character of lithium compounds which is responsible for their solubility in organic solvents.

**11. How is sodium carbonate prepared?**

**Ans.** Sodium carbonate is generally prepared by Solvay's process.

**12. What is sodium amalgam?**

**Ans.** Sodium metal discharged at the cathode combines with mercury to form sodium amalgam.

**13. Why is sodium hydrogen carbonate known as baking powder?**

**Ans.** Sodium hydrogen carbonate is known as baking soda because it decomposes on heating to generate bubbles of  $\text{CO}_2$  (leaving holes in cakes and bread)

**14. Why does table salt get wet in rainy season?**

**Ans.** Table salts contains impurities of  $\text{CaCl}_2$  and  $\text{MgCl}_2$  which being deliquescent compounds absorbs moisture from the air in rainy reason.

**15. What is the formula of soda ash?**

**Ans.**  $\text{Na}_2\text{CO}_3$

**16. Why do alkaline earth metals have low ionization enthalpy?**

**Ans.** The alkaline earth metals have low ionization enthalpies due to fairly large size of atoms.

**17. State one reason for alkaline earth metals in general having a greater tendency to form complexes than alkali metals.**

**Ans.** Because of small size and high charge, the alkaline earth metals have a tendency to form complexes.

**18. Compounds of alkaline earth metals are more extensively hydrated than those of alkali metals. Give reason.**

**Ans.** The hydration enthalpies of alkaline earth metal ions are larger than those of alkali metal ions because of smaller size.

**19. The melting and boiling points of alkaline earth metals are higher than alkali metals. Give reason.**

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



**20. What is the nature of oxide formed by Be?**

**Ans.** BeO is covalent and amphoteric while oxides of other elements are ionic and basic in nature.

**21. Why does beryllium show similarities with Al?**

**Ans.** Because of their similarity in charge / radius ratios

$(Be^{2+}, 2/31 = 0.064 \text{ and } Al^{3+}, 3/50 = 0.66).$

**22. Why is beryllium carbonate unusually unstable thermally as compared to the other carbonates of this group?**

**Ans.** This is due to strong polarizing effect of small  $Be^{2+}$  on the large  $CO_3^{2-}$  anion and leading to the formation of more stable BeO.

**23. Why sulphates of Mg and Be soluble in water?**

**Ans.** The greater hydration enthalpies of  $Be^{2+}$  and  $Mg^{2+}$  ions overcome the lattice enthalpy factor and therefore their sulphates are soluble in water.

**24. Why beryllium is not attacked by an acid easily?**

**Ans.** Beryllium is not readily attacked by acids because of the presence of an oxide film on the metal.

**25. Mention the main compounds which constitute Portland cement.**

**Ans.** The main compounds present in Portland cement are-

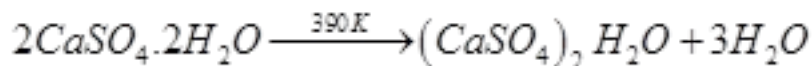
**(i)** Dicalcium silicate  $(Ca_2SiO_4) - 26\%$

**(ii)** Tricalcium silicate  $(Ca_3SiO_5) - 51\%$

(iii) Tricalcium aluminate ( $Ca_3Al_2O_6$ ) – 11%

**26. What happens when gypsum is heated to 390K?**

**Ans.** Plaster of Paris is formed



**27. Anhydrous calcium sulphate can not be used as plaster of Paris. Give reason.**

**Ans.** Because it does not have the ability to set like plaster of Paris.

**28. Mention the natural sources of calcium carbonate.**

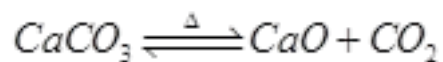
**Ans.** Calcium carbonate occurs in nature in several forms like limestone, chalk, marble etc.

**29. What is milk of lime?**

**Ans.** A suspension of slaked lime in water is known as milk of lime.

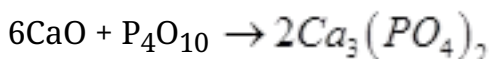
**30. What happens when  $CaCO_3$  is subjected to heat?**

**Ans.** On heating  $CaCO_3$ , quick lime is obtained



**31. Show with an example that CaO is a basic oxide?**

**Ans.** CaO combines with acidic oxides at high temperature



**CBSE Class 12 Chemistry**  
**Important Questions**  
**Chapter 10**  
**The s-Block Elements**

**2 Marks Questions**

**1. Why are lithium halides covalent in nature?**

**Ans.** Lithium halides are covalent because of the high polarization capability of lithium ion. The  $\text{Li}^+$  ion is very small in size and has high tendency to distort electron cloud around the negative halide ion.

**2. What makes lithium show properties different from rest of the alkali metals?**

**Ans.** Lithium is a small atom and it forms smaller  $\text{Li}^+$ . As a result, it has very high charge to radius ratio. This is primarily responsible for the anomalous behavior of lithium.

**3. Why do alkali metals and salts impart color to an oxidizing flame?**

**Ans.** This is because the heat from the flame excites the outer orbital electron to a higher energy level.

**4. What type of oxide is made by sodium?**

**Ans.** Sodium mostly form peroxide when reacted with oxygen



**5. Why is potassium lighter than sodium?**

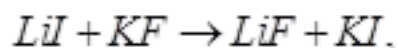
**Ans.** Potassium is lighter than sodium probably because of an unusual increase in atomic size of potassium.

**6.Name the alkali metals that form super oxides when heated in excess of air.**

**Ans.**Potassium, rubidium and caesium form super oxides when heated in excess of air.

**7.Write a reaction to show that bigger cat ions stabilize bigger anions.**

**Ans.**In the reaction



The larger Cation  $K^+$  stabilizes the larger anion  $I^-$

**8.Lithium shows similarities with magnesium in its chemical behavior. What is the cause of these similarities?**

**Ans.**Due to (diagonal relationship)

**(i)** Similarity in atomic size

**(ii)** Similar charge to size ratio.

**9.Why metals like potassium and sodium can not be extracted by reduction of their oxides by carbon?**

**Ans.**Potassium and sodium are strong electropositive metals and have great affinity for oxygen than that of carbon. Hence they Cannot be extracted from their oxides by reduction with carbon.

**10.Give the important uses of sodium carbonate.**

**Ans.**

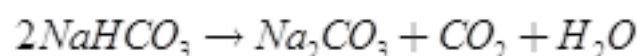
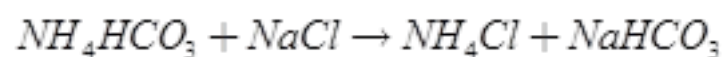
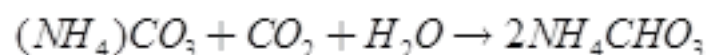
**(i)** It is used in water softening laundering and cleaning

**(ii)** It is used in the manufacture of glass, soap, borax and caustic soda.

**11.What is the difference between baking soda and baking powder?**

**Ans.** Baking soda is sodium bicarbonate ( $\text{NaHCO}_3$ ). Which baking powder is a mixture of sodium bicarbonate ( $\text{NaHCO}_3$ ) and potassium hydrogen tartar ate.

**12. Discuss the various reactions that occur in the solvay process**



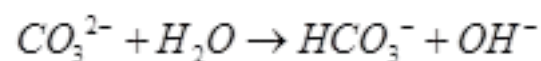
**13. Give two uses of sodium carbonate?**

**Ans.(i)** It is used in the manufacture of soap, glass, paper, borax and caustic soda etc.

**(ii)** It is used in textile industry and also in petroleum refining.

**14. Solution of  $\text{Na}_2\text{CO}_3$  is alkaline. Give reason.**

**Ans.** The solution of  $\text{Na}_2\text{CO}_3$  is alkaline in nature because when  $\text{Na}_2\text{CO}_3$  is treated with water, it gets hydrolyzed to form an alkaline solution:



**15. Name the elements present in Group 2**

**Ans.** Beryllium, Magnesium, Calcium, Strontium, Barium and Radium.

**16. The atomic radii of alkaline earth metals are smaller than those of the corresponding alkali metals. Explain why?**

**Ans.** The atomic and ionic radii of the alkaline earth metals are smaller than those of the corresponding alkali metals in the same period because of the increased nuclear charge in these elements.

**17. The second ionization enthalpy of calcium is more than the first. How is that calcium forms  $\text{CaCl}_2$  and not  $\text{CaCl}$  give reasons.**

**Ans.** The higher value of second ionization enthalpy is more than compensated by the higher enthalpy of hydration of  $\text{Ca}^{2+}$ . Therefore formation of  $\text{CaCl}_2$  becomes more favorable than  $\text{CaCl}$  energetically.

**18. Name the metal amongst alkaline earth metals whose salt do not impart colour to a non-luminous flame.**

**Ans.** Beryllium does not impart colour to a non-luminous flame.

**19. Which member of the alkaline earth metals family has:**

**(i) least reactivity**

**(ii) lowest density**

**(iii) highest boiling point**

**(iv) maximum reduction potential**

**Ans. (i) Be**

**(ii) Ca**

**(iii) Be**

**(iv) Be**

**20. The alkaline earth metals are called s – block elements. Give reasons.**

**Ans.** Alkaline earth metals are called s – block elements because the last electron in their electronic configuration occupies the s – orbital of their valence shells.

**21. Why is Calcium preferred over sodium to remove last traces of moisture from alcohol?**

**Ans.** Both sodium and calcium react with water forming their respective hydroxides. In contrast, sodium reacts with alcohol to form sodium alkoxide but Ca does not.

**22. Name the metal amongst alkaline earth metals whose salt do not impart colour to a non – luminous flame.**

**Ans.** Beryllium does not impart colour to a non – luminous flame.

**23. Give the reaction of magnesium with air?**

**Ans.** Magnesium burns with dazzling brilliance in air to give Mg O and Mg<sub>3</sub>N<sub>2</sub>

**24. Beryllium is reducing in nature. Why?**

**Ans.** Reducing nature is due to large hydration energy associated with the small size of Be<sup>2+</sup> ion and relatively large value of the atomization enthalpy of the metal.

**25. Give two uses of**

**(i) caustic soda**

**(ii) quick lime**

**Ans.(i)** Caustic soda –

**(a)** It is used in the manufacture of soap, paper, artificial silk and a number of chemicals.

**(b)** It is used in petroleum refining and purification of bauxite

**(ii)** Quick lime –

**(a)** It is used in the manufacture of dye stuffs.

**(b)** It is used in the manufacture of sodium carbonate from caustic soda.

**26. What is quick lime? What happens when we add water to it?**

**Ans.** Ca O is quick lime. When we add water to it slaked limes Ca (OH)<sub>2</sub> is formed.

**27. What is the formulae of caustic potash?**

**Ans.** KOH.



## s-Block Elements (Alkali & Alkaline Earth Metals)

### Short Answer Type Questions

1. How do you account for the strong reducing power of lithium in aqueous solution?
2. When heated in air, the alkali metals form various oxides. Mention the oxides formed by Li, Na and K.
3. Complete the following reactions  
(i)  $\text{O}_2^{2-} + \text{H}_2\text{O} \longrightarrow$                       (ii)  $\text{O}_2^- + \text{H}_2\text{O} \longrightarrow$
4. Lithium resembles magnesium in some of its properties. Mention two such properties and give reasons for this resemblance.
5. Name an element from Group 2 which forms an amphoteric oxide and a water soluble sulphate.
6. Discuss the trend of the following:
  - (i) Thermal stability of carbonates of Group 2 elements.
  - (ii) The solubility and the nature of oxides of Group 2 elements.
7. Why are  $\text{BeSO}_4$  and  $\text{MgSO}_4$  readily soluble in water while  $\text{CaSO}_4$ ,  $\text{SrSO}_4$  and  $\text{BaSO}_4$  are insoluble?
8. All compounds of alkali metals are easily soluble in water but lithium compounds are more soluble in organic solvents. Explain.
9. In the Solvay process, can we obtain sodium carbonate directly by treating the solution containing  $(\text{NH}_4)_2\text{CO}_3$  with sodium chloride? Explain.
10. Write Lewis structure of  $\text{O}_2^-$  ion and find out oxidation state of each oxygen atom? What is the average oxidation state of oxygen in this ion?
11. Why do beryllium and magnesium not impart colour to the flame in the flame test?
12. What is the structure of  $\text{BeCl}_2$  molecule in gaseous and solid state?

## Long Answer Type Questions

1. The s-block elements are characterised by their larger atomic sizes, lower ionisation enthalpies, invariable +1 oxidation state and solubilities of their oxosalts. In the light of these features describe the nature of their oxides, halides and oxosalts.
2. Present a comparative account of the alkali and alkaline earth metals with respect to the following characteristics:
  - (i) Tendency to form ionic / covalent compounds
  - (ii) Nature of oxides and their solubility in water
  - (iii) Formation of oxosalts
  - (iv) Solubility of oxosalts
  - (v) Thermal stability of oxosalts
3. When a metal of group 1 was dissolved in liquid ammonia, the following observations were obtained:
  - (i) Blue solution was obtained initially.
  - (ii) On concentrating the solution, blue colour changed to bronze colour.
4. How do you account for the blue colour of the solution? Give the name of the product formed on keeping the solution for some time.
5. The stability of peroxide and superoxide of alkali metals increase as we go down the group. Explain giving reason.
6. When water is added to compound (A) of calcium, solution of compound (B) is formed. When carbon dioxide is passed into the solution, it turns milky due to the formation of compound (C). If excess of carbon dioxide is passed into the solution milky disappears due to the formation of compound (D). Identify the compounds A, B, C and D. Explain why the milky disappears in the last step.
7. Lithium hydride can be used to prepare other useful hydrides. Beryllium hydride is one of them. Suggest a route for the preparation of beryllium hydride starting from lithium hydride. Write chemical equations involved in the process.

8. An element of group 2 forms covalent oxide which is amphoteric in nature and dissolves in water to give an amphoteric hydroxide. Identify the element and write chemical reactions of the hydroxide of the element with an alkali and an acid.
9. Ions of an element of group 1 participate in the transmission of nerve signals and transport of sugars and aminoacids into cells. This element imparts yellow colour to the flame in flame test and forms an oxide and a peroxide with oxygen. Identify the element and write chemical reaction to show the formation of its peroxide. Why does the element impart colour to the flame?