Chapter 10

The *s*-Block Elements

Solutions (Set-1)

Very Short Answer Type Questions:

1. Write general electronic configuration of alkaline earth metal.

Sol. E.C.: (n–1) s^2, p^6, ns^2.

2. What is the chemical formula of plaster of Paris?

Sol. $CaSO_4 \cdot \frac{1}{2}H_2O$.

3. Name the product and its use, when calcium hydroxide reacts with chlorine.

Sol. Calcium hydroxide reacts with chlorine to form hypochlorite, which is a constituent of bleaching powder.

4. How many water of crystallisation are there in magnesium chloride?

Sol. Magnesium chloride crystallises with six molecules of water.

5. Write two uses of baking soda.

Sol. Baking soda is a mild antiseptic for skin infections. It is used in fire extinguishers.

6. Which elements are used as cathode and anode in electrolysis of sodium chloride in Castner-Kellner cell?

Sol. Cathode is made of mercury and carbon as anode.

7. With which metal lithium shows diagonal relationship?

Sol. Magnesium.

8. Which of the alkali metals is used as coolant in nuclear reactors?

Sol. Liquid sodium metal is used as a coolant in nuclear reactors.

9. Among halides of lithium, which one is the most covalent in nature?

Sol. Lithium iodide is the most covalent in nature.

10. What is the trend of melting and boiling points of fluoride, chloride, bromide and iodide of an alkali metal?

Sol. Fluoride > Chloride > Bromide > Iodide

Short Answer Type Questions :

11. The E^o for Cl^-/Cl_2 is +1.36, for I^-/I_2 is +0.53, for Ag^+/Ag is +0.79, Na^+/Na is –2.71 and for Li^+/Li is –3.04. Arrange the ionic species in decreasing order of reducing power.

Sol. The species having greater negative reduction potential (E^o) is stronger reducing agent. Therefore, the decreasing order of reducing strength is Li > Na > I^- > Ag > Cl^-

12. Explain why
    (a) Lithium on being heated in air mainly forms the monoxide and not peroxide.
    (b) An aqueous solution of sodium carbonate gives alkaline tests.

Sol. (a) Li^+ ion is smaller in size. It is stabilized more by smaller anion, oxide ion (O^{2-}) as compared to peroxide ion (O_2^{2-}).

(b) An aqueous solution of sodium carbonate gives alkaline tests because Na_2CO_3 undergoes hydrolysis forming sodium hydroxide.

$$Na_2CO_3 + H_2O \longrightarrow NaHCO_3 + NaOH$$

13. Why KO_2 is paramagnetic?

Sol. The superoxide ion contains one unpaired electron in one of the π antibonding molecular orbital. Due to the presence of this unpaired electron KO_2 is paramagnetic.

$O_2^- : (\sigma_{1s})^2, (\sigma_{1s}^*)^2, (\sigma_{2s})^2, (\pi_{2px})^2 = (\pi_{2py})^2, (\pi_{2px}^*)^2 = (\pi_{2py}^*)^1$

14. Explain what happens when
    (a) Sodium hydrogen carbonate is heated.
    (b) Sodium amalgam reacts with water.
    (c) Fused sodium metal reacts with ammonia.

Sol. (a) On heating sodium bicarbonate it forms sodium carbonate

$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$$

(b) When sodium amalgam reacts with water NaOH is formed and the vigorousity of reaction of sodium with water decreases.

$$2Na/Hg + 2H_2O \longrightarrow NaOH + H_2$$

(c) Sodium reacts with ammonia to form amide.

$$2Na + 2NH_3 \xrightarrow{\Delta} 2NaNH_2 + H_2$$

15. (a) Why $BeCl_2$ is covalent in nature?
    (b) Why sodium is prepared by electrolytic method and not by chemical method?

Sol. (a) Due to small size and high charge polarising power of Be^{2+} is very high so its compounds are mostly covalent in nature.

(b) Sodium is a very strong reducing agent, therefore at cannot be extracted by the reduction of its ore (chemical method). Thus, the best way to prepare sodium is by carrying electrolysis of its molten salt containing impurities of calcium chloride.

16. When Mg metal is burnt in air, a white powder is left behind as ash. What is this white powder?

Sol. Mg on burning in air reacts with oxygen and nitrogen resulting in the formation of magnesium oxide and magnesium nitride.

$$2Mg + O_2 \rightarrow 2MgO$$

$$3Mg + N_2 \rightarrow Mg_3N_2$$

17. Write the reactions when
    (a) Beryllium carbide reacts with water
    (b) Sodium sulphate solution is added to an aqueous solution of barium nitrate

Sol. (a) Beryllium carbide on reactions with water undergoes hydrolysis and liberates methane gas.

$$Be_2C + 4H_2O \longrightarrow 2Be(OH)_2 + CH_4$$

(b) A white ppt. of barium sulphate is formed.

$$Na_2SO_4 + Ba(NO_3)_2 \longrightarrow BaSO_4\downarrow + 2NaNO_3$$

18. Complete the following equations for the reaction between

(a) $Ca + H_2O$ (b) $Ca(OH)_2 + Cl_2$

(c) $BeO + NaOH$ (d) $BaO_2 + H_2SO_4$

Sol. (a) $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$

(b) $2Ca(OH)_2 + Cl_2 \longrightarrow CaCl_2 + Ca(ClO_2)_2 + 2H_2O$

(c) $BeO + NaOH \longrightarrow Na_2BeO_2 + H_2O$

(d) $BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$

19. Mg_3N_2 when reacted with water gives off NH_3 but HCl is not obtained from $MgCl_2$ on reaction with water at room temperature. Explain.

Sol. Mg_3N_2 is a salt of a strong base, $Mg(OH)_2$ and a weak acid (NH_3) and hence gets hydrolysed to give NH_3. In contrast, $MgCl_2$ is a salt of a strong base, $Mg(OH)_2$ and a strong acid, HCl and hence does not undergo hydrolysis to give HCl.

20. The crystalline salts of alkaline earth metals contain more water of crystallization than the corresponding alkali metal salt. Why?

Sol. Due to smaller size and higher nuclear charge, alkaline earth metals have a higher tendency than alkali metals to attract H_2O molecules and thus contain more water of crystallization than alkali metals. For example, $LiCl\cdot 2H_2O$ and $MgCl_2\cdot 6H_2O$

21. Chlorination of calcium hydroxide produces bleaching powder. Write its chemical equation.

Sol.. Bleaching powder is obtained by passing Cl_2 into $Ca(OH)_2$. Although bleaching powder is written as $Ca(OCl)_2$, it is actually a mixture.

$$3Ca(OH)_2 + 2Cl_2 \longrightarrow \underset{\text{Bleaching powder}}{Ca(OCl)_2\cdot Ca(OH)_2\cdot CaCl_2\cdot 2H_2O}$$

22. Explain why

(a) Potassium is more reactive than sodium.

(b) Alkali metals do not form divalent ions.

Sol. (a) As we know reactivity of metals depends on their ionization enthalpy; smaller the ionization enthalpy, greater is the reactivity. Potassium has lower ionization enthalpy than sodium and hence is more reactive.

(b) The second ionization enthalpy of alkali metals is very high because the M^+ ions have stable noble gas configuration. Hence, alkali metals do not form divalent (M^{2+}) ions.

23. Explain what happens in the following cases (give balanced chemical equations)

(a) When carbon dioxide gas is passed through an aqueous solution of sodium carbonate.

(b) When potassium carbonate is heated with milk of lime.

(c) When lithium nitrate is heated.

Sol. (a) In this case, sodium bicarbonate is formed

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

(b) In this case, potassium hydroxide is formed whereas calcium carbonate precipitates out.

$$K_2CO_3 + Ca(OH)_2 \longrightarrow 2KOH + CaCO_3\downarrow$$

(c) Lithium nitrate decomposes to give a reddish brown gas, nitrogen dioxide.

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

24. Give reasons for the following

(a) Why sodium metal is stored under kerosene

(b) Why sodium wire is used to dry benzene but cannot be used to dry ethanol.

Sol. (a) Because of its reactivity with moisture and oxygen present in the air, sodium metal is stored under kerosene

$$4Na + O_2 \longrightarrow 2Na_2O$$

$$Na_2O + H_2O \longrightarrow 2NaOH$$

(b) Sodium metal removes moistures from benzene by reacting with water. However, ethanol cannot be dried by using sodium because it reacts with sodium.

$$2Na + C_2H_5OH \longrightarrow 2C_2H_5ONa + H_2$$

25. Why do alkali metals impart characteristic colours to the flame of a bunsen burner? What is the colour imparted to the flame by each of the following metals? Lithium, sodium and potassium.

Sol. When an alkali metal or any of its compounds is introduced into a flame, the electrons absorb energy from flame and get excited to higher energy levels. When these electrons come to ground state, the absorbed energy is given out in the form of radiations in the visible region. Lithium imparts crimson red, sodium gives yellow and potassium impart violet colour to the flame.

26. (a) Why magnesium metal is harder than sodium?

(b) Why magnesium oxide is used as a refractory material?

Sol. (a) Magnesium has stronger metallic bond than sodium due to its smaller atomic size and more number of valence electrons. Hence, it is harder than sodium.

(b) Magnesium oxide has very high lattice enthalpy due to greater charge and smaller ionic size of Mg^{2+} and O^{2-} ions. As, result it has very high melting point and is used as a refractory materials.

27. How does the basic character of hydroxide of alkali metals vary on descending the group? Explain.

Sol. The basic character of alkali metal hydroxides increases on going down the group. This can be explained in terms of decreasing lattice energy as we move down the group. The decrease in lattice energy leads to the weakening of the bond between alkali metal and hydroxide ion. This results in the increased concentration of hydroxyl ions, in solution, *i.e.*, increased basic character.

Long Answer Type Questions :

28. (a) What is quick lime, slaked lime and lime water? What happens when carbon dioxide gas is passed through lime water?

(b) Explain why $BeCO_3$ is less stable than $MgCO_3$.

(c) K_2CO_3 cannot be prepared by Solvay's process.

Sol. (a) Quick lime is calcium oxide, CaO, slaked lime is calcium hydroxide $Ca(OH)_2$, lime water is a clear solution of calcium hydroxide in water.

When carbon dioxide gas is passed through lime water, it becomes milky due to formation of calcium carbonate.

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3\downarrow + H_2O$$

If carbon dioxide gas is passed in excess, the milkiness disappears due to formation of $Ca(HCO_3)_2$, which is soluble in water.

$$CaCO_3 + CO_2 + H_2O \longrightarrow Ca(HCO_3)_2$$

(b) Be^{2+} ion is smaller in size than Mg^{2+} ion. Be^{2+} ion does not form a stable lattice with carbonate ion, which is quite large is size, Mg^{2+} ion, being larger, form relatively stable lattice with carbonate ion.

(c) K_2CO_3 cannot be prepared by Solvay's process because $KHCO_3$ being more soluble would not be precipitated in carbonation tower.

29. How can you differentiate the following based on their change in properties on heating and dissolving in water?

(a) Mg and Ca (b) $BeSO_4$ and $BaSO_4$

(c) KNO_3 and $LiNO_3$ (d) Na_2CO_3 and $NaHCO_3$

Sol. (a) Magnesium on heating in a flame does not impart any characteristic colour to the flame whereas calcium imparts brick red colour to the flame.

(b) $BeSO_4$ is soluble in water whereas $BaSO_4$ is insoluble in water.

(c) $LiNO_3$ on heating gives reddish brown fumes of NO_2 whereas KNO_3 on decomposition gives colourless O_2 gas.

(d) $NaHCO_3$ on heating decomposes and gives out CO_2 gas which can be identified by passing through lime water.

$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$$

Na_2CO_3 is stable to heat.

30. Give reasons for the following

(a) The hydroxide and carbonates of sodium and potassium are very easily soluble in water but that of magnesium and calcium are not

(b) When NaOH solution is added to a solution of $ZnCl_2$ a white precipitate is formed and this precipitate dissolves when excess of NaOH is added.

Sol. (a) The hydroxide and carbonates of calcium and magnesium have quite high lattice enthalpy which is not compensated by hydration enthalpy. Hence, they are sparingly soluble in water. On the other hand, hydroxides and carbonates of sodium and potassium have smaller lattice enthalpy which is more than compensated by their hydration enthalpy. Hence they are easily soluble in water.

(b) $ZnCl_2$ reacts with NaOH to give a white precipitate of $Zn(OH)_2$ which later dissolves in excess of NaOH and form soluble sodium zincate.

$$ZnCl_2 + 2NaOH \longrightarrow \underset{\text{(Insoluble)}}{Zn(OH)_2} + 2NaCl$$

$$Zn(OH)_2 + 2NaOH \longrightarrow \underset{\substack{\text{Sodium zincate}\\\text{(Soluble)}}}{Na_2ZnO_2} + 2H_2O$$

31. Give reasons for the following

(a) Barium hydroxide is soluble in water whereas Beryllium hydroxide is insoluble in water

(b) Beryllium hydroxide is amphoteric in nature whereas magnesium hydroxide is basic.

Sol. (a) With increase in size from Beryllium to Barium, the lattice enthalpy decreases significantly but hydration enthalpy remains almost constant that is why Barium hydroxide is soluble in water whereas Beryllium hydroxide is insoluble in water.

(b) Be has smaller size, so it is less ionised to release OH^- due to more covalent character or we can say that the higher sum of $(\Delta_i H)_I$ and $(\Delta_i H)_{II}$ of Be than that of Mg, the metal –OH bond can break less easily in $Be(OH)_2$ than in $Mg(OH)_2$. In other words, $Be(OH)_2$ acts as a weak base even weaker than $Mg(OH)_2$.

32. (a) Name the products formed when magnesium is burnt in air.

(b) Write the products formed when beryllium carbide reacts with water.

Sol. (a) Magnesium on burning in air reacts with oxygen and nitrogen resulting in the formation of magnesium oxide and magnesium nitride.

$2Mg + O_2 \longrightarrow 2MgO$

$3Mg + N_2 \longrightarrow Mg_3N_2$

(b) Beryllium carbide on reaction with water undergoes hydrolysis and liberates methane gas.

$Be_2C + 4H_2O \longrightarrow 2Be(OH)_2 + CH_4$

33. Solubility of the sulphates, and carbonates of alkaline earth metals decreases from Be to Ba. Explain.

Sol. The solubility of an ionic compound depends upon lattice energy and the hydration energy. These two factors oppose each other. If lattice energy is high, the ions will be highly packed in the crystal, therefore, solubility will be low. If hydration energy is high, the ions will have greater tendency to be hydrated, therefore, the solubility will be high.

In the case of carbonates, sulphates the anions are larger in size and small changes in cation size do not alter the lattice energies, i.e., lattice energies are about the same. However, the hydration energies decrease from Ca^{2+} to Ba^{2+}. Hence, the solubility of carbonates, sulphates and chromates decreases from calcium to barium.

34. Lithium forms normal oxide, sodium forms peroxide and other alkali metals form superoxide, why?

Sol. Lithium as well as the oxide ion i.e., O^{2-} have same ionic radii and high charge densities. Hence these small ions pack together forming a very stable lattice of Li_2O. Similarly, formation of sodium peroxide, Na_2O_2 and superoxides of larger alkali metals (e.g., potassium superoxide, KO_2) can be explained on the basis of the stable lattice formed by the packing of bigger cations and bigger anions. In short we can say that the increasing stability of peroxides and superoxide of alkali metals from Li to Cs is due to the stabilisation of larger anions by larger cations through lattice energy.

35. Write the constituents, composition, preparation and uses of cement.

Sol. 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 a common cement or portland cement is

$CaO \rightarrow 50 - 60\%$, $SiO_2 \rightarrow 20 - 25\%$, $Al_2O_3 \rightarrow 5 - 10\%$, $MgO \rightarrow 2 - 3\%$, $Fe_2O_3 \rightarrow 1 - 2\%$, and $SO_3 \rightarrow 1 - 2\%$.

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.

When clay and lime are strongly heated together they fuse and react to form 'cement klinker'. This clinker is mixed with 2-3% by weight of gypsum ($CaSO_4 \cdot 2H_2O$) 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%.

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.

36. Write the biological importance of magnesium and calcium.

Sol. 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 play important role 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. Calcium ions in bones exchange readily with those in the blood plasma. About 0.4 g of Ca^{2+} enters and leaves your bones every day.

37. Write preparation, properties and uses of $Ca(OH)_2$

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

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

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$$

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

$$CaCO_3 + CO_2 + H_2O \longrightarrow Ca(HCO_3)_2$$

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

$$2Ca(OH)_2 + 2Cl_2 \longrightarrow \underset{}{CaCl_2} + \underset{\text{Bleaching power}}{Ca(OCl)_2} + 2H_2O$$

Uses of calcium hydroxide are

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

→ It is used in white wash due to its disinfectant nature.

→ It is used in glass making, in tanning industry, for the preparation of bleaching powder and for purification of sugar.

38. Explain the anomalous behaviour of Beryllium.

Sol. 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 which is discussed subsequently.

(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

39. A compound 'B' is formed when water is added to a compound 'A'. When carbon dioxide is passed into the compound B, it turns milky due to the formation of compound 'C'. If excess of CO_2 is passed into the solution, milkiness disappears due to the formation of compound 'D'. Identify the compounds A, B, C and D. Explain why the milkiness disappears in the last step?

Sol. When carbon dioxide gas is passed through solution of compound B, it becomes milky. We can be sure that the solution of compound B is lime water or $Ca(OH)_2$ solution and the milkiness is due to the formation of insoluble $CaCO_3$ which is compound C. Compound A must be quick lime CaO because it dissolved in water to form compound B having properties as mentioned above.

$$\underset{\text{Calcium Oxide (Compound A)}}{CaO} + H_2O \longrightarrow \underset{\text{Lime water (Compound B)}}{Ca(OH)_2}$$

$$\underset{\text{Lime water (Compound B)}}{Ca(OH)_2} + CO_2 \longrightarrow \underset{\text{Calcium carbonate (Compound C) Milkiness}}{CaCO_3} + H_2O$$

When excess of CO_2 is passed, milkiness disappears due to the formation of soluble calcium bicarbonate (D).

$$\underset{\text{(Compound C)}}{CaCO_3} + CO_2 + H_2O \longrightarrow \underset{\text{Calcium bicarbonate (Soulble in } H_2O)}{Ca(HCO_3)_2}$$

Thus, compound A = CaO, B = $Ca(OH)_2$, C = $CaCO_3$ and D = $Ca(HCO_3)_2$

40. Write about ionization and hydration enthalpies of alkaline earth metals and compare them with those of alkali metals.

Sol. 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. The second ionisation enthalpies of the alkaline earth metals are smaller than those of the corresponding alkali metals.

The hydration enthalpies of alkaline earth metal ions decreases 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 these 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 $MgCl_2 \cdot 6H_2O$ and $CaCl_2 \cdot 6H_2O$ while NaCl and KCl do not form such hydrates.

41. Write the differences between the properties of lithium and other alkali metals.

Sol. (i) Lithium is much harder. Its melting points and boiling points 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, $LiCl \cdot 2H_2O$ whereas other alkali metal chloride do not form hydrates.

(iv) Lithium hydrogen carbonate 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 metals nitrates decompose to give the corresponding nitrite.

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

$$2NaNO_3 \longrightarrow 2NaNO_2 + O_2$$

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

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Chapter 10

The s-Block Elements

Solutions (Set-2)

1. Which of the following does not exist in solid state?

   (1) $NaHCO_3$ (2) $NaHSO_3$ (3) $LiHCO_3$ (4) $CaCO_3$

Sol. Answer (3)

$LiHCO_3$ exist in liquid state.

2. On adding excess of NaOH solution to aluminium hydroxide solution, we obtain

   (1) Precipitate of $Al(OH)_3$ (2) Solution containing Na_2AlO_2

   (3) Solution containing $NaAlO_2$ (4) Mixture of $Al(OH)_3$ and $NaAlO_2$

Sol. Answer (3)

$Al(OH)_3 + NaOH \rightarrow NaAlO_2 + 2H_2O$

3. A pair of metals which dissolves in sodium hydroxide solution is

   (1) Cu, K (2) Fe, Mg (3) Ag, Cu (4) Sn, Zn

Sol. Answer (4)

Sn and Zn metals are soluble in NaOH by forming Na_2SnO_3 and Na_2ZnO_2 respectively.

4. Among KO_2, AlO_2^-, BaO_2 and NO_2^+ unpaired electron is present in

   (1) NO_2^+ and BaO_2 (2) KO_2 and AlO_2^- (3) KO_2 only (4) BaO_2 only

Sol. Answer (3)

O_2^{-1} has one unpaired e^-.

5. KO_2 (potassium superoxide) is used in oxygen cylinders in space and submarines because it

   (1) Absorbs CO_2 and increases O_2 concentration (2) Eliminates moisture

   (3) Absorbs CO_2 (4) Produces ozone

Sol. Answer (1)

KO_2 absorb CO_2 and produce O_2.

$4KO_2 + 2CO_2 \rightarrow 2K_2CO_3 + 3O_2$

6. Which of the following carbonate decompose on heating to evolve CO_2?

   (1) Na_2CO_3 (2) Li_2CO_3 (3) K_2CO_3 (4) Rb_2CO_3

Sol. Answer (2)

$Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$

It decompose because Li_2O have very high lattice energy.

7. Which of the following has the highest solubility product ?

(1) KOH (2) CsOH (3) LiOH (4) RbOH

Sol. Answer (2)

CsOH is highly soluble.

8. Which ions are produced when anhydrous KF is mixed with conc. HF?

(1) K^+, H^+, F^- (2) $\{KF^+ (HF^-)\}$ (3) KH^+, F^- (4) K^+, HF_2^-

Sol. Answer (4)

$KF + HF \rightarrow KHF_2$

KHF_2 dissociate as K^+ and HF_2^-.

[Note that HF_2^- contains symmetric hydrogen bonding $[F\cdots\cdots H\text{---}F]^-$].

9. The ionic character of alkali metal chlorides follow the order

(1) LiCl > KCl > NaCl > CsCl (2) CsCl > KCl > NaCl > LiCl

(3) NaCl > KCl > LiCl > CsCl (4) LiCl > CsCl > NaCl > KCl

Sol. Answer (2)

Fajan's rule.

10. Which of the following is a hypothetical molecular formula?

(1) $CsBr_3$ (2) CsI_3 (3) CsCl (4) CsF_3

Sol. Answer (4)

F_2 does not react with F^- to form F_3^-.

11. $BaC_2 + N_2 \xrightarrow{\Delta}$ (A)

$CaC_2 + N_2 \xrightarrow{\Delta}$ (B)

The compound (A) and (B) are

(1) $BaCN_2$, $CaCN_2$ (2) $Ba(CN)_2$, $Ca(CN)_2$ (3) $Ba(CN)_2$, $CaCN_2$ (4) $Ba_3N_2 + Ca(CN)_2$

Sol. Answer (3)

$$BaC_2 + N_2 \xrightarrow{\Delta} \underset{(A)}{Ba(CN)_2}$$

$$CaC_2 + N_2 \longrightarrow \underset{(B)}{CaCN_2}$$

12. One mole of a substance (X) was treated with an excess of water. Two moles of readily combustile gas was produced along with a solution which when treated with CO_2 produced a white turbidity. The substance (X) could be

(1) Ca (2) CaH_2 (3) $Ca(OH)_2$ (4) $Ca(NO_3)_2$

Sol. Answer (2)

$CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$

$Ca(OH)_2 + CO_2 \rightarrow \underset{\text{milkiness}}{CaCO_3} + H_2O$

13. The oxidation state of the most electronegative elements in the products of the reaction, BaO_2 with dil. H_2SO_4 are.

(1) 0 and – 1 (2) – 1 and – 2 (3) – 2 and 0 (4) – 2 and + 1

Sol. Answer (2)

$BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$

Oxidation state of O in $BaSO_4$ is –2 and that of O in H_2O_2 is –1.

14. The compound insoluble in acetic acid is

(1) Calcium oxide (2) Calcium carbonate (3) Calcium oxalate (4) Calcium hydroxide

Sol. Answer (3)

Calcium oxalate is insoluble in acetic acid while other are soluble in CH_3COOH.

15. Solubilities of group (II) carbonates, sulphates, phosphates decreases down the group, this is due to

(1) Entropy of solution formation (2) Lattice energies of solids

(3) Hydration energy of cations (4) Inter-ionic attraction

Sol. Answer (3)

When hydration energy of ions decrease more rapidly as compared to decrease in lattice energy, then solubility decreases down the group.

16. A compound (X) on heating gives a colourless gas. The residue is dissolved in water to obtain (Y). Excess CO_2 is bubbled through aqueous solution of (Y) and formation of (Z) is observed. (Z) on gently heating gives back (X). The compound (X) is

(1) $CaCO_3$ (2) Na_2CO_3 (3) $Ca(HCO_3)_2$ (4) K_2CO_3

Sol. Answer (1)

$\underset{x}{CaCO_3} \xrightarrow{\Delta} CaO + CO_2$

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

$Ca(OH)_2 + CO_2 \rightarrow^{y} Ca(HCO_3)_2$

$Ca(HCO_3)_2 \xrightarrow[\Delta]{excess} \underset{x}{CaCO_3}^{z} + CO_2 + H_2O$

17. Which of the following substances can be used for drying non-acidic gas?

(1) Calcium carbonate (2) Sodium carbonate

(3) Sodium bicarbonate (4) Calcium oxide

Sol. Answer (4)

CaO is used as a strong drying agent.

18. The solubility of hydroxides of alkaline earth metals increases down the group because

(1) The decrease in lattice energy is more prominent than the decrease in hydration energy

(2) The decrease in lattice energy is less prominent than the decrease in hydration energy

(3) The salts become less ionic

(4) Lattice energy increases and hydration energy decreases as one move from Be^{2+} to Ba^{2+}

Sol. Answer (1)

In alkaline earth metal hydroxides and fluorides decrease in lattice energy is more prominent than decrease in hydration energy.

19. The basic character of the oxides, MgO, SrO, K_2O, NiO, Cs_2O increases in the order

(1) MgO < SrO < K_2O < NiO < Cs_2O (2) Cs_2O < K_2O < MgO < SrO < NiO

(3) NiO < MgO < SrO < K_2O < Cs_2O (4) K_2O < NiO < MgO < SrO < Cs_2O

Sol. Answer (3)

$Cs_2O + H_2O \longrightarrow CsOH$

Most soluble in water

$\therefore$ Most basic.

$Cs_2O > K_2O > SrO > MgO > NiO$

20. Which of the following are arranged in increasing order of solubilities?

(1) $CaCO_3 < KHCO_3 < NaHCO_3$ (2) $NaHCO_3 < KHCO_3 < CaCO_3$

(3) $KHCO_3 < NaHCO_3 < CaCO_3$ (4) $CaCO_3 < NaHCO_3 < KHCO_3$

Sol. Answer (4)

Alkali metal bicarbonates are soluble in water and solubility increases while descending in the group. However alkaline earth metal carbonates are insoluble in water.

21. In photoelectric cell best metal to be used is

(1) Li (2) K (3) Rb (4) Cs

Sol. Answer (4)

Electrons are easily removed by incident light.

22. Correct among the following

(1) Cs is best oxidising agent due to lowest I.E. (2) Li is best reducing agent due to highest $|\Delta_{hyd}H^o|$

(3) Li is best reducing agent due to highest $\Delta_{hyd}H^o$ (4) Cs^+ is best oxidising agent due to low $|\Delta_{hyd}H^o|$

Sol. Answer (2)

Fact.

23. In Castner-Kellner cell when brine is electrolysed, 23 g of sodium is released at cathode, volume of $Cl_2(g)$ released at 380 mm Hg at 0°C will be

(1) 22.4 L (2) 11.2 L (3) 5.6 L (4) 44.8 L

Sol. Answer (1)

$$v = \frac{nRT}{P}$$

$$= \frac{0.5 \times 0.0821 \times 273}{380/760} = 22.4 \text{ L}$$

24. $Na(s) \xrightarrow{air/\Delta} ?$

Products will be

(1) Na_2O (2) Na_2O_2 (3) NaOH (4) All of these

Sol. Answer (4)

$$Na \xrightarrow{O_2} Na_2O \xrightarrow{H_2O} NaOH$$

$$Na_2O \xrightarrow{O_2} Na_2O_2$$

25. Which of the chloride shows least solubility in water?

(1) LiCl (2) NaCl (3) KCl (4) RbCl

Sol. Answer (3)

Factual

26. Order of magnitude of lattice enthalpy is as

(1) $BeF_2 > MgF_2 > CaF_2 > SrF_2$ (2) $BeF_2 < MgF_2 < CaF_2 < SrF_2$

(3) LiF < LiCl < LiBr < LiI (4) LiI < LiBr < CsBr < CsI

Sol. Answer (1)

27. Solvay-ammonia process is used to manufacture

(1) $NaHCO_3$ (2) $Na_2CO_3.10H_2O$ (3) Na_2CO_3 (4) All of these

Sol. Answer (4)

$NaCl + NH_3 + CO_2 + H_2O \xrightarrow{\Delta} NaHCO_3 + NH_4Cl$

In solvay ammonia soda process,

$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$

28. Alkali earth metals in Liq.NH_3 produce a blue coloured solution, due to

(1) Polarisability of NH_3 (2) Charge transfer

(3) d $\rightarrow$ d transition (4) Ammoniated electrons

Sol. Answer (4)

It is possible by only presence of ammoniated electrons.

29. Which of the following do not forms superoxide?

(1) Cs (2) Ba (3) K (4) Rb

Sol. Answer (2)

Ba belongs to group 2. with +2 O.S. Its superoxide is not formed.

30. Mercury cathode is used in the extraction of Na from aq. NaCl as

(1) Hg has greater affinity towards Na(s)

(2) Hg is a better cathode

(3) Na is easy to separate from Hg

(4) $Na^+(aq)$ is above $H^+(aq)$ in E.C.S.

Sol. Answer (1)

Factual

31. $Mg \xrightarrow{\text{dry air}/\Delta} A + B$

(1) A & B are MgO & MgO_2 (2) A & B are MgO_2 & $Mg(OH)_2$

(3) A + B are MgO + Mg_3N_2 (4) A & B are MgO_2 & Mg_3N_2

Sol. Answer (3)

Mg does not form peroxide or superoxide.

32. BeO reacts with

(1) HCl (2) NaOH (3) CO (4) Both (1) & (2)

Sol. Answer (4)

As it is amphoteric.

33. s-block contains the elements

(1) With stable nuclei (2) With unstable nuclei

(3) With radio-active nuclei (4) A ll of the above

Sol. Answer (4)

As $\frac{n}{p}$ ratio increase down the group.

34. Mg_3P_2 on hydrolysis produces gas

(1) $Mg(OH)_2$ (2) MgO (3) PH_3 (4) P_2O_3

Sol. Answer (3)

$Mg_3P_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2PH_3$.

35. NaOH is a

(1) Hygroscopic substance (2) Anti caking agent

(3) Dehydration agent (4) Liquid at room temperature

Sol. Answer (1)

Factual

36. Identify the correct statements among the following :

I. Potassium carbonate cannot be prepared by Solvay process due to its high solubility in water.

II. Castner–Kellner cell is used to prepare caustic soda.

III. Washing soda is decahydrate sodium carbonate.

(1) Only II and III (2) Only I and III (3) Only I (4) I, II and III

Sol. Answer (4)

All the given statements are correct.

37. Compare the magnitude of hydration energy of alkaline earth metal ions (M^{2+}) in aqueous solution

(1) Increases down the group

(2) Remains same down the group

(3) Decreases down the group

(4) Alkaline earth metal ions do not get hydrated

Sol. Answer (3)

Hydration energy of metal ion is directly proportional to its charge density which decreases down the group.

38. Identify the incorrect option regarding the reaction of alkaline earth metal with air and H_2O.

(1) Be and Mg are kinetically inert due to formation of thin layer of oxide on surface.

(2) Powdered Be burns in air to give BeO and Be_3N_2

(3) Powered Mg burns in air to give MgO, but not Mg_3N_2

(4) On the reaction with water other group metals (except Be and Mg) give hydroxide

Sol. Answer (3)

Mg on heating in air gives MgO and Mg_3N_2.

39. Alkali metals are strong reducing agents. From the following pairs select the one containing most and least powerful reducing agents respectively.

(1) Li, Cs (2) Li, Na (3) Na, Cs (4) Na, K

Sol. Answer (2)

Among alkali metals, Li is most and Na is least powerful reducing agent.

40. Not all alkali metals or alkaline earth metals impart characteristic colour during flame test. From the following metals select the one which will not give characteristic colour during flame test.

(1) Li (2) Cs (3) Mg (4) Ba

Sol. Answer (3)

Mg and Be do not impart characteristic colour during flame test.

41. Identify the incorrect statement.

(1) Solvay process can be used to prepare both washing soda and baking soda

(2) Hypo solution is used as an antichlor

(3) Pearl ash (K_2CO_3) cannot be manufactured by same method of preparation of Na_2CO_3 (Solvay Process)

(4) NaOH is not deliquescent in nature

Sol. Answer (4)

In Solvay process $NaHCO_3$ is prepared in intermediate step.

$NaCl + NH_3 + H_2O + CO_2 \rightarrow NaHCO_3 + NH_4Cl$

Na_2CO_3 is prepared in last step.

$NaHCO_3 \xrightarrow{250°C} Na_2CO_3 + H_2O + CO_2$

Hypo solution $Na_2S_2O_3 . 5H_2O$ is used to remove excess of chlorine from bleached fabrics

Pearl ash K_2CO_3 cannot be obtained from solvay since $KHCO_3$ is fairly soluble in water.

NaOH is deliquescent in nature.

42. Identify the incorrect order.

(1) $BeO < MgO < CaO < SrO < BaO$ (Basic strength)

(2) $BeCO_3 < MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$ (thermal stability)

(3) $MgCl_2 < CaCl_2 < BaCl_2$ (tendency to give hydrate)

(4) $BeCO_3 > MgCO_3 > CaCO_3 > SrCO_3 > BaCO_3$ (solubility in water)

Sol. Answer (3)

Tendency to give hydrate decreases down the group.

Basic nature of oxide increases down the group, thermal stability of carbonate increases down the group, solubility in water of carbonate decreases down the group.

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