The s block elements

SUBJECTIVE PROBLEMS:

Q 1.

Give reasons for the following

(i) Sodium carbonate is made by Solvay process but the same process is not extended to the manufacture of potassium carbonate. **(IIT JEE 1981 – 1 Marks)**

(ii) Hydrogen peroxide is a better oxidizing agent than water. **(IIT JEE 1986 – 1 Marks)**

(iii) Magnesium oxide is used for the lining of steel making furnace. **(IIT JEE 1987 – 1 Marks)**

(iv) Why is sodium chloride added during electrolysis of fused anhydrous magnesium chloride? **(IIT JEE 1987 – 1 Marks)**

(v) Hydrogen peroxide acts as an oxidizing as well as a reducing agent. **(IIT JEE 1992 – 1 Marks)**

(vi) The crystalline salts of alkaline earth metals contain more water of crystallization than the corresponding alkali metal slats. **(IIT JEE 1997 – 2 Marks)**

(vii) $BeCl_2$ can be easily hydrolyses. **(IIT JEE 1999 – 2 Marks)**

Q 2.

How will you prepare bleaching powder from slaked lime **(IIT JEE 1982 – 1 Marks)**

Q 3.

Write down the balanced equations for the reactions when:

(i) Calcium phosphate is heated with a mixture of sand and carbon; **(IIT JEE 1985 – 1 Marks)**

(ii) An alkaline solution of potassium ferricyanide is reacted with hydrogen peroxide. **(IIT JEE 1982 – 1 Marks)**

(iii) Carbon dioxide is passed through a concentrated aqueous solution of sodium chloride saturated with ammonia. **(IIT JEE 1988 – 1 Marks)**

(iv) Potassium ferricyanide reacts with hydrogen peroxide in basic solution. **(IIT JEE 1989 – 1 Marks)**

(v) Carbon dioxide is passed through a suspension of lime stone in water. **(IIT JEE 1991 – 1 Marks)**

Q 4. Give briefly the isolation of magnesium from sea water by the Dow process. Give equations for the steps involved. **(IIT JEE 1993 – 3 Marks)**

Q 5.

Complete and balanced the following reactions:

$Ca_5(PO_4)_3F + H_2SO_4 + H_2O$

$\xrightarrow{heat}$ …… + $5CaSO_4.2H_2O$ +…… **(IIT JEE 1994 – 1 Marks)**

Q 6.

A 5.0 cm^3 solution of H_2O liberates 0.508 g of iodine from an acidified KI solution. Calculate the strength of H_2O_2 solution in terms of volume strength at STP. **(IIT JEE 1995 – 2 Marks)**

Q 7.

Explain the difference in the nature of bonding in LiF and LiI. **(IIT JEE 1996 – 2 Marks)**

Q 8.

Write the reaction involved in manufacture of triple superphosphate from Fluor apatite.

(IIT JEE 1997C – 1 Marks)

Q 9.

To a 25 ml H_2O_2 solution, excess of acidified solution of potassium iodide was added. The iodine liberated required 20 ml of 0.3 N sodium thiosulphate solution. Calculate the volume strength of H_2O_2 solution. **(IIT JEE 1997 – 5 Marks)**

Q 10.

Give reactions for the oxidation of hydrogen peroxide with potassium permanganate in acidic medium. **(IIT JEE 1997 – 1 Marks)**

Q 11.

Element A burns in nitrogen to give an ionic compound B. Compound B reacts with water to give C and D. A solution of C becomes 'milky' on bubbling carbon dioxide. Identify A, B, C and D.

(IIT JEE 1997 – 3 Marks)

Q 12.

Arrange the following sulphates of alkaline earth metals in order of decreasing thermal stability. $BeSO_4$, $MgSO_4$, $CaSO_4$, $SrSO_4$ **(IIT JEE 1997 – 1 Marks)**

Q 13.

Work out the following using chemical equation: Chlorination of calcium hydroxide produces bleaching powder. **(IIT JEE 1998 – 2 Marks)**

Q 14.

Hydrogen peroxide acts both as an oxidizing and as a reducing agent in alkaline solution towards certain first row transition metal ions. Illustrate both these properties of H_2O_2 using chemical equations. **(IIT JEE 1998 – 4 Marks)**

The s block elements-solutions

SUBJECTIVE PROBLEMS:

Sol 1.

(i) Potassium carbonate cannot be manufactured by Solvay process, since; unlike sodium hydrogen carbonate, potassium hydrogen carbonate is rather too soluble in water to be precipitated like $NaHCO_3$.

(ii) H_2O_2 is a better oxidizing agent than H_2O because oxidation number of oxygen in H_2O_2 is – 1 and that in water it is -2. So H_2O easily reduces to -2 oxidation number.

(iii) MgO is used for the lining of steel making furnace because it acts as basic flux and facilitates the removal of acidic impurities of Si, P and S from steel through slag formation.

(iv) The anhydrous magnesium chloride is fused with NaCl to provide conductivity to the electrolyte and to lower the fusion temperature of anhydrous $MgCl_2$.

NOTE: NaCl prevents hydrolysis of $MgCl_2$

(v) The oxidation state of oxygen in H_2O_2 (i.e. -1) can be changed to 0 or -2 i. e oxygen in H_2O_2 exists in an intermediate oxidation state with respect to O_2 and O^{2-}. Hence it acts both as an oxidizing and reducing agent.

(vi) **NOTE**: Smaller the size of cation, higher gill be hydration tendency because hydration energy of cation is inversely proportional to size of cation: The size of alkaline earth metal ions are smaller than the size of alkali metal ions. So in crystalline form the salts of alkaline earth metals have more water molecules than those, of alkali metals.

(vii) $BeCl_2$ is hydrolyses due to high polarizing power and presence of vacant p-orbitals in Be-atom.

(Be = $1s^2$, $2s^2 2p_x^1\ 2p_y^0\ 2p_z^0$)

Sol 2.

Bleaching powder, $Ca(OCl)_2$, can be prepared by passing chlorine through $Ca(OH)_2$ solution.

$3Ca(OH)_2 + 2Cl_2 \xrightarrow[35\ C]{\text{below}} Ca(OCl)_2.\ CaCl_2.Ca(OH)_2.2H_2O$

Slaked lime Bleaching Powder

Sol 3.

(i) $2Ca_3(PO_4)_2 + 6SiO_2 + 10C \xrightarrow[\text{furnace}]{\text{electric}} 6CaSiO_3 + 10CO + P_4$

This is the **electro thermal process** to extract phosphorus from phosphorite or bone ash $[Ca_3(PO_4)_2]$.

(ii) Ferricyanide is oxidized to Ferro cyanide on treatment with alkali

$2K_3[Fe(CN)_6] + H_2O_2 + 2KOH \rightarrow 2K_4[Fe(CN)_6] + 2H_2O + O_2$

(iii) $NaCl + NH_4OH + CO_2 \rightarrow NH_4Cl + NaHCO_3$

(iv) $2K_3[Fe(CN)_6] + H_2O_2 + 2KOH \rightarrow 2K_4[Fe(CN)_6] + 2H_2O + O_2$

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

Calcium bicarbonate

NOTE: Suspension of lime stone is $CaCO_3$.

Sol 4.

In sea water Mg exists as $MgCl_2$.

On treating sea water wit slaked lime $Mg(OH)_2$ is obtained.

$MgCl_2$ + $Ca(OH)_2$ → $Mg(OH)_2\downarrow + CaCl_2$

In sea water slaked lime

On reacting $Mg(OH)_2$ with HCl, $MgCl_2$ is obtained.

$Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + H_2O$

From $MgCl_2$, Mg is obtained by reduction of $MgCl_2$ with $CaCl_2$.

$MgCl_2 + CaC_2 \rightarrow Mg + CaCl_2 + 2C$

Sol 5.

$Ca_5(PO_4)_3F + 5h_2SO_4 + 10H_2O \xrightarrow{\Delta} 3H_3PO_4 + 5CaSO_4.2H_2O + HF$

Sol 6.

H_2O_2	$+ H_2SO_4$	+	2KI	→	K_2SO_4	+	I_2	$+2H_2O$
34 gm			Acidified				254 gm	
3			KI sol				0.508	
							gm	

$5\ cm^3$
or ml

i. e. 254 gm of I_2 is released by 34 gm H_2O_2

∴ 0.508 gm of I_2 will be released by

= 34/254 * 0.508 = 0.608

5 ml of H_2O_2 sol. Contains 0.068 gm of H_2O_2

∴ 1 ml of H_2O_2 contains 0.068/5 gm H_2O_2

NOTE: The strength of H_2O_2 is generally calculate in terms of **volume strength.** According to which 10 volume of H_2O_2 means that 1 ml of H_2O_2 sol gives 10 ml of O_2 at STP.

$2H_2O_2 \rightarrow 2H_2O +$ O_2

2*34 gm 32 gm or

22,400 ml at STP

i.e., 68 gm of H_2O_2 gives 22, 400 ml of O_2 at STP or 1 ml of H_2O_2 sol

Or 0.068/5 gm of H_2O_2 sol gives 4.48 ml of O_2 i.e. strength of H_2O_2 sol is **4.48 volumes**

Sol 7.

LiF has more ionic character while Lil has more covalent character. The latter is due to the greater polarizability of larger iodide ion than the fluoride ion.

Sol 8.

$[Ca_3(PO_4)_2.CaF_2] + 6H_3PO_4 \rightarrow 4\ Ca(H_2PO_4)_2 + HF$

(Triple super phosphate)

Sol 9.

Meq. Of H_2O_2 = Meq. Of $Na_2S_2O_3$

$W/17 * 1000 = 20 * 0.3$ $\therefore w = 0.102$ g

$H_2O_2 \rightarrow H_2O + 1/2\ O_2$

$\therefore$ Volume of $O_2 = 11200 * 0.102/34 = 33.6$ mL

$\therefore$ Volume strength $= 33.6/25 = 1.344$

Sol 10.

$2KMnO_4 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5\ [O]$

$[H_2O_2 + [O] \rightarrow H_2O + O_2] * 5$

$2KMnO_4 + 5H_2O_2 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$

Sol 11.

$3M + N_2 \rightarrow M_3N_2$

'A' 'B'

$M_3N_2 + 6H_2O \rightarrow 3M(OH)_2 + 2NH_3$

'B' 'C' 'D'

$M(OH)_2 + CO_2 \rightarrow MCO_3 + H_2O$

'C' 'D'

M may be either Ca or Ba

NOTE: It is not magnesium because $Mg(OH)_2$ has very low solubility in water.

If we consider Ba as M then A is **Ba,** B is **Ba_3N_2,** C is **$Ba(OH)_2$,** D is **$BaCO_3$.**

Sol 12.

$SrSO_4 > CaSO_4 > MgSO_4 > BeSO_4$ (Based upon size of cation or ionic character)

Sol 13.

$3Ca(OH)_2 + 2Cl_2 \rightarrow Ca(OCl)_2 + Ca(OH)_2.CaCl_2.2H_2O$

Bleaching powder

(A mixture of $Ca(OCl)_2$ and basic chloride)

Sol 14.

When H_2O_2 acts as oxidizing agent, following reaction takes place:

$H_2O_2 + 2e^- \rightarrow 2OH^-$

While regarding its action as reducing agent, the following reaction takes place:

$H_2O_2 + 2OH^- \rightarrow O_2 + 2H_2O + 2e^-$