Exercise-1

Marked Questions may have for Revision Questions.

OBJECTIVE QUESTIONS

Section (A) : Dry test

A-1. **Sol.** $CuSO_4.5H_2O \xrightarrow{\Delta} CuSO_4$

(due to no crystal field splitting)

Blue White

A-2. **Sol.** $2NaNO_3(s) \xrightarrow[\Delta]{800°C} Na_2O(s) + N_2(g) + \frac{5}{2}O_2(g)$

$MgCO_3(s) \xrightarrow{\Delta} MgO(s) + CO_2(g)$

$2FeSO_4(s) \xrightarrow{\Delta} Fe_2O_3(s) + SO_2(g) + SO_3(g)$

$(NH_4)_2Cr_2O_7(s) \xrightarrow{\Delta} N_2(g) + 2H_2O(g) + Cr_2O_3(s)$

A-3. **Sol.** $ZnCO_3 \xrightarrow[\Delta]{} ZnO + CO_2\uparrow$.

ZnO is becomes yellow when hot and on cooling, turns white.

A-4. **Sol.** $Ag_2CO_3 \longrightarrow Ag_2O + CO_2\uparrow$

Carbonates of Na, K, Rb, Cs do not decompose on heating.

Section (B) : Flame and borax bead test

B-1. **Sol.** Chlorides of metals are more volatile as compared to other salts.

B-3. **Sol.** Li → crimson red colour

Ca → Brick red colour

Sr → crimson red colour but its halide is not deliquescent

Ba → Apple green

B-4. **Sol.** Example : $CuO + B_2O_3 \longrightarrow Cu(BO_2)_2$

BO_2^- → metaborate ion

B-6. **Sol.** $CoO + B_2O_3 \longrightarrow Co(BO_2)_2$

Section (C) : Dilute H_2SO_4 group

C-1. **Sol.** Carbonates of alkali metals and ammonium are soluble in water. All other carbonates are insoluble in water.

C-2.

Sol. $SO_3^{2-} + Ba(OH)_2 \longrightarrow BaSO_3 \downarrow$ (white) $+ 2OH^-$.

$3SO_2 + Cr_2O_7^{2-} + 2H^+ \longrightarrow 2Cr^{3+}$ (green colour solution) $+ 3SO_4^{2-} + H_2O$.

C-3. **Sol.** $CH_3COO^- + H^+ \longrightarrow CH_3COOH \uparrow$ (smells like vinegar).

C-4.

Sol. SO_3^{2-} reduces $KMnO_4$ to colourless Mn^{+2}

$5SO_3^{2-} + 2MnO_4^- + 6H^+ \longrightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$

C-5.

Sol. $X^{2-} = S^{2-}$

(P) H_2S (Q) PbS

(R) $[Fe(CN)_5(NO)]^{-4}$ (S) CdS

Section (D) : Concentrated H_2SO_4 group

D-1. **Sol.** $4Cl^- + Cr_2O_7^{2-} + 6H^+ \longrightarrow 2CrO_2Cl_2 \uparrow$ (deep red) $+ 3H_2O$.

D-2. **Sol.** $AgCl + 2NH_3 \longrightarrow [Ag(NH_3)_2]^+ Cl^-$ (soluble complex).

D-3. **Sol.** $2NaI + H_2SO_4 \longrightarrow Na_2SO_4 + 2HI$

$2HI + H_2SO_4 \longrightarrow I_2 \uparrow$ (dark violet) $+ 2H_2O + SO_2$

The free iodine may than be identified by deep blue colouration produced with starch paste solution.

D-4. **Sol.** $2NO_3^- + 4H_2SO_4 + 6Fe^{2+} \longrightarrow 6Fe^{3+} + 2NO\uparrow + 4SO_4^{2-} + 4H_2O$.

$Fe^{2+} + NO\uparrow + SO_4^{2-} \longrightarrow [Fe(H_2O)_5(NO)]^{2+}SO_4^{2-}$.

D-5. **Sol.** $Cl^- + H_2SO_4 \longrightarrow HCl \uparrow$ (colourless) $+ HSO_4^-$

$MnO(OH)_2 + 2H_2SO_4 + 2Cl^- \longrightarrow Mn^{2+} + Cl_2 \uparrow$ (yellowish green) $+ 2SO_4^{2-} + 3H_2O$

$Cl_2 + H_2O \longrightarrow 2HCl + [O]$

Litmus + [O] $\longrightarrow$ colourless oxidised form

Cl_2 is a yellowish green gas which bleaches litmus paper by oxidation.

D-6. Sol. $CrO_2Cl_2 + 2H_2O \longrightarrow H_2CrO_4 + 2HCl$

$H_2CrO_4 + (CH_3COO)_2Ba \longrightarrow BaCrO_4\downarrow$ (Yellow) ihyk $+ 2CH_3COOH$

Section (E) : Precipitation Reactions

E-1. Sol. $SO_4^{2-} + Ba^{2+} \longrightarrow BaSO_4 \downarrow$ (white) ¼'osr½

E-2. Sol. $AgNO_3 + PO_4^{3-} \longrightarrow Ag_3PO_4\downarrow$(yellow ppt.)

$Ag_3PO_4\downarrow + 6NH_3 \longrightarrow 3[Ag(NH_3)_2]^+$ (soluble) $+ PO_4^{3-}$

$Ag_3PO_4\downarrow + H^+ \longrightarrow H_2PO_4^-$ (soluble) $+ 3Ag^+$

Section (F) : zero Group

F-1. Sol. It is alkaline solution of $K_2[HgI_4]$.

F-2. Sol. $NH_4^+ + 2[HgI_4]^{2-} + 4OH^- \longrightarrow HgO.Hg(NH_2)I \downarrow$ (brown) ¼Hkwjk½ $+ 7I^- + 3H_2O$

F-3. Sol. $NH_4^+ + OH^- \xrightarrow{\Delta} NH_3 \uparrow + H_2O$.

(1) NH_3, alkaline in nature turns red litmus blue;

$NH_3 + HCl \longrightarrow NH_4Cl$ (white fumes)

(2) $2Hg\,NO_3 + 2NH_3 \longrightarrow \underset{\text{black}}{Hg(NH_2)NO_3} + Hg + NH_4NO_3$

(3) $2K_2(HgI_4) + NH_3 + 3KOH \longrightarrow HgOHgNH_2I\downarrow$ (brown) $+ 7KI + 2H_2O$

(4) $CuSO_4 + 4NH_3 \longrightarrow [Cu(NH_3)_4]\,SO_4$ (intense blue)

Section (G) : I_{st} Group

G-1. Sol. Dilute HCl (2M) is the group reagent for I^{st} group radicals.

G-2. Sol. $Ag^+ + HCl \longrightarrow AgCl \downarrow$ (white) $+ H^+$; $Cu^{2+} + 2HCl \longrightarrow CuCl_2$ (soluble) $+ 2H^+$.

G-3. Sol. $Pb^{2+} + 2Cl^- \longrightarrow PbCl_2 \downarrow$ (soluble in hot water) ; $PbCl_2 + CrO_4^{2-} \longrightarrow PbCrO_4 \downarrow$ (yellow) $+ 2Cl^-$

G-4. **Sol.** $Hg_2Cl_2 + 2NH_3 \longrightarrow Hg\begin{matrix}Cl\\ NH_2\downarrow\end{matrix}$ (white) + $Hg\downarrow$ (black) + NH_4Cl

Black

G-5. **Sol.** $Pb(NO_3)_2 + 2NH_4OH \longrightarrow Pb(OH)_2\downarrow$ (white) + $2NH_4NO_3$

$Pb(NO_3)_2 + 2NaCl \longrightarrow PbCl_2\downarrow$ (white) + $2NaNO_3$

$Pb(NO_3)_2 + H_2S \longrightarrow PbS\downarrow$ (black) + $2NaNO_3$

G-6. **Sol.** $Ag^+ + 2Cl^- \longrightarrow [AgCl_2]^-$ (soluble complex) ; $Ag^+ + Cl^-$ (dilute HCl) $\longrightarrow AgCl\downarrow$ (white)

$2Ag^+ + CrO_4^{2-} \longrightarrow Ag_2CrO_4\downarrow$ (red) ; $Ag_2CrO_4\downarrow + NH_3 \longrightarrow 2[Ag(NH_3)_2]^+ + CrO_4^{2-}$

$3Ag^+ + HPO_4^{2-} \longrightarrow Ag_3PO_4\downarrow$ (yellow) + H^+ ; $Ag_3PO_4\downarrow + 6NH_3 \longrightarrow [Ag(NH_3)_2]^+ + PO_4^{3-}$

Section (H) : II$_{nd}$ Group

H-1. **Sol.** $H_2S \rightleftharpoons 2H^+ + S^{2-}$; $HCl \rightleftharpoons H_2^+ + Cl^-$.

Due to common ion effect, the ionisation of H_2S is suppressed and thus low concentration of S^{2-} ions is obtained. This much of S^{2-} ions concentration is enough to precipitate only IInd group cations (because of the low K_{SP} of IInd group sulphides).

H-2. **Sol.** $2Bi^{3+} + 3H_2S \longrightarrow Bi_2S_3$ (black)

H-3. **Sol.** HgS dissolves in aqua regia

$3HgS\downarrow + 6HCl + 2HNO_3 \longrightarrow 3HgCl_2 + 3S\downarrow + 2NO + 4H_2O$.

H-4. **Sol.** $Pb^{2+} + CrO_4^{2-} \longrightarrow PbCrO_4\downarrow$ (yellow) ; $PbCrO_4\downarrow + 4OH^- \longrightarrow [Pb(OH)_4]^{2-} + CrO_4^{2-}$

H-5. **Sol.** $2Hg^{2+} + SnCl_2 \rightarrow Hg_2Cl_2\downarrow$ (silky white) + Sn^{4+}.

H-6. **Sol.** $Cu^{2+} + 4NH_4OH \rightarrow [Cu(NH_3)_4]^{2+} + 4H_2O$.

H-7. **Sol.** $H_2S \rightleftharpoons 2H^+ + S^{2-}$; $H_2S \rightleftharpoons 2H^+ + S^{2-}$

On account of common ion effect the ionization of H_2S is suppressed. K_{sp} of 2nd group sulphides are lower, so, only those basic radicals get precipitated.

H-8. **Sol.** Both Cd^{2+} and Sn^{2+} are precipitated as yellow sulphides in the presence of dilute HCl.

H-9. **Sol.** $2Cu^{2+} + 4I^- \longrightarrow Cu_2I_2\downarrow + I_2$

$Cu^{2+} + 3CN^- \longrightarrow CuCN \downarrow + (CN)_2$

Section (I) : IIIrd Group

I-1.

Sol. $NH_4Cl \rightleftharpoons NH_4^+ + Cl^-$; $NH_4OH \rightleftharpoons NH_4^+ + OH^-$.

Because of common ion effect, the ionisation of NH_4OH is suppressed.

I-2. **Sol.** $[Al(OH)_4]^- + NH_4^+ \xrightarrow{\Delta} Al(OH)_3 + \downarrow NH_3 \uparrow + H_2O$

Hydroxide ion concentration is reduced owing to the formation of ammonia (a weak base) which escapes on boiling.

I-3. **Sol.** $Fe(OH)_3 + OH^- \longrightarrow$ No reaction. dksbZ vfHkfØ;k ughaA

I-4. **Sol.** To oxidise ferrous ion into ferric ion otherwise Fe^{2+} is not completely precipitated as $Fe(OH)_2$.

I-5.

Sol. $Cr^{3+} + 3OH^- \longrightarrow Cr(OH)_3 \downarrow$ (green) $+ OH^- \longrightarrow [Cr(OH)_4]$ (soluble green complex)

$Fe^{3+} + 3OH^- \longrightarrow Fe(OH)_3 \downarrow$ (brown)

$Fe(OH)_3$ is not affected by concentrated NaOH.

I-6. **Sol.** $Fe^{2+} + 2K^+ + [Fe(CN)_6]^{4-} \longrightarrow K_2Fe[Fe(CN)_6] \downarrow$ (white).

$Fe^{2+} + 2K^+ + [Fe(CN)_6]^{4-} \longrightarrow K_2Fe[Fe(CN)_6] \downarrow$ ('osr).

I-7. **Sol.** $Fe^{3+} + [Fe(CN)_6]^{3-} \longrightarrow Fe[Fe(CN)_6]$ brown colouration (Hkwjk jax)

$3Fe^{3+} + 6CH_3COO^- + 2H_2O \rightleftharpoons [Fe_3(OH)_2(CH_3COO)_6]^+ + 2H^+$.

Section (J) : IVth Group

J-1. **Sol.** Zn^{2+}, Mn^{2+}, Co^{2+} and Ni^{2+} are placed in IV group.

J-2. **Sol.** $Mn^{2+} + H_2S \longrightarrow MnS \downarrow$ (buff colour) ¼cQ~ jax½ $+ 2H^+$

J-3. **Sol.** (1) MnS – buff coloured (i.e. light pink coloured) (2) ZnS – white
(3) HgS – black (4) CdS – yellow

J-4. **Sol.** $ZnS + 2HCl \longrightarrow ZnCl_2 + H_2S \uparrow$

$ZnCl_2$ is soluble while HgS is insoluble in HCl.

J-6. **Sol.** The filter paper ash test is substitute for cobalt nitrate charcoal cavity test. Double oxide ZnO.CoO formed is green in colour. It is called Rinmann's green.

J-7.

Sol. (1) $Zn(OH)_2\downarrow + 2OH^- \rightleftharpoons [Zn(OH)_4]^{2-}$

(2) and (3) $Zn(OH)_2\downarrow + 4NH_3 \rightleftharpoons [Zn(NH_3)_4]^{2+} + 2OH^-$

or NH_4^+

J-8. **Sol.** $Ni^{2+} + 2OH^- \longrightarrow Ni(OH)_2 \downarrow$ (green)

$Ni(OH)_2 \downarrow$ is insoluble in excess of NaOH solution

$Pb^{2+} + 2OH^- \longrightarrow Pb(OH)_2 \downarrow$ (white) ; $Pb(OH)_2 \downarrow + 2OH^- \longrightarrow [Pb(OH)_4]^{2-}$ colourless solution.

Section (K) : V_{th} and VI_{th} Group

K-2.

Sol. $Fe^{2+} + [Fe(CN)_6]^{4-} \rightarrow$ white precipitate ; $Fe^{3+} + [Fe(CN)_6]^{4-} \rightarrow$ prussian blue precipitate.

$Zn^{2+} + [Fe(CN)_6]^{4-} \rightarrow$ Bluish white/white precipitate ; $Cu^{2+} + [Fe(CN)_6]^{4-} \rightarrow$ chocolate brown precipitate

$Ag^+ + [Fe(CN)_6]^{4-} \rightarrow$ white precipitate ; $Ca^{2+} + K_4[Fe(CN)_6]^{4-} \rightarrow$ white precipitate.

K-3. **Sol.** Strontium chloride gives crimson colour flame in Bunsen burner.
$BaCl_2$ -apple green, $CaCl_2$ -brick red, KCl - lilac(violet).

K-4. **Sol.** Ca salts impart brick red colour to the flame.

K-5. **Sol.** (1) titan yellow is absorbed by magnesium hydroxide producing a deep-red colour or precipitate.

(2) $Mg^{2+} + NH_3 + HPO_4^{2-} \longrightarrow Mg(NH_4)PO_4 \downarrow$ (white).

(3) Blue lake is formed by the adsorption of reagent on $Mg(OH)_2$.

K-6. **Sol.** (1) $Pb(NO_3)_2 + 2NaCl \longrightarrow PbCl_2\downarrow$ (white) $+ 2NaNO_3$

$Ba(NO_3)_2 + 2NaCl \longrightarrow BaCl_2 + 2NaNO_3$; $BaCl_2$ is soluble in water

(2) $Pb^{2+} + SO_4^{2-} \longrightarrow PbSO_4 \downarrow$ (white) ; $Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4 \downarrow$ (white)

(3) $2KI + Pb^{2+} \longrightarrow PbI_2 \downarrow$ (yellow) $+ 2K^+$; No precipitation with Ba^{2+}.

K-7. Sol. $BaCl_2 + 2AgNO_3 \longrightarrow 2AgCl\downarrow$ (white) $+ BaNO_3$

$BaCl_2 + H_2SO_4 \longrightarrow BaSO_4\downarrow$ (white) $+ 2HCl$

K-8. Sol. (1) No precipitate with K_2CrO_4 in acetic acid as its k_{sp} is high.

(2) $Ca^{2+} + 2K^+ + [Fe(CN)_6]^{4-} \longrightarrow K_2Ca[Fe(CN)_6]\downarrow$ (white)

(3) $Ca(OH)_2$ formed is water soluble.

(4) $Ca(HCO_3)_2$ is formed which is water soluble.

K-9. Sol. Ba^{2+} salts gives yellow precipitate with K_2CrO_4 solution and this precipitate is not soluble in CH_3COOH. Ba^{2+} ions gives apple green colour in the flame test.

Exercise-2

Marked Questions may have for Revision Questions.

OBJECTIVE QUESTIONS

1. Sol. Anion is SO_3^{2-} which has trigonal pyramidal structure.

2.

Sol. (1) Both gives yellow precipitate.

(2) $Pb^{2+} + 2I^- \longrightarrow PbI_2 \downarrow$ (yellow)

$Pb^{2+} + 2Br^- \longrightarrow PbBr_2 \downarrow$ (white)

(3) $Ag^+ + Br^- \longrightarrow AgBr \downarrow$ (yellow); $AgBr + Na_3AsO_3 \longrightarrow$ No effect

$Ag^+ + I^- \longrightarrow AgI \downarrow$ (yellow) ; $AgI + Na_3AsO_3 \longrightarrow$ No effect

(4) No reaction is observed with Br^- and I^-.

5. Sol. $SO_3^{2-} + 2H^+ \longrightarrow SO_2 + H_2O$

$SO_2 + 2IO_3^- + 4H_2O \longrightarrow I_2 + 5SO_4^{-2} + 8H^+$

Thus the gas B and compound A are SO_2 and Na_2SO_3 respectively.

6. **Sol.** $Fe^{3+} + 3SCN^- \longrightarrow Fe(SCN)_3$ (deep red colouration).

7. **Sol.**

$2I^- + Cl_2 \longrightarrow I_2 + 2Cl^-$, I_2 being covalent dissolves in chloroform giving purple or violet solution.

$Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4 \downarrow$ (white).

8. **Sol.** The K_{SP} of $Al(OH)_3$ is low as compared to that of the hydroxides of other metals. The OH^- concentration provided by ammonium hydroxide in presence of NH_4Cl is just sufficient to precipitate Al^{3+} as $Al(OH)_3$.

$Al^{3+} + NH_3 + H_2O \xrightarrow{NH_4Cl} Al(OH)_3 \downarrow$ (gelatinous white) + NH_4^+.

9. **Sol.** $Ba^{2+} + CrO_4^{2-} \longrightarrow BaCrO_4 \downarrow$ (yelllow) ; $Ba^{2+} + SO_4 \longrightarrow BaSO_4$ (white).

$Ba^{2+} + 2Cl^- \longrightarrow BaCl_2$ (soluble in water).

K_{sp} of $SrCrO_4$ is high in acetic acid, so no precipitate is formed.

Lead carbonate and basic lead carbonate both gives precipitate with K_2CrO_4 and NaCl.

10. **Sol.** As the concentration of CO_3^{2-} ions provided by $(NH_4)_2CO_3$ in presence of NH_4Cl and ammonia is not just sufficient to precipitate the Mg as $MgCO_3$ because of its high K_{SP} value.

Exercise-3

PART - I :JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

OFFLINE JEE-MAIN

1. **Sol.** $NH_4OH \rightleftharpoons NH_4^+ + OH^-$

$NH_4Cl \longrightarrow NH_4^+ + Cl^-$

Common ion effect of NH_4^+ supresses the dissociation of NH_4OH. Thus low concentration of OH^- is obtained which is just sufficient to exceed the K_{sp} of $Fe(OH)_3$ (as K_{sp} of $Fe(OH)_3$) is less than $Cr(OH)_3$.

2. **Sol.**

(1) $AgCl + 2NH_3 \longrightarrow [Ag(NH_3)_2]Cl$ (colourless soluble complex); $AgI + 2NH_3 \longrightarrow$ No reaction

(2) $Fe^{3+} + [Fe(CN)_6]^{4-} \longrightarrow Fe_4[Fe(CN)_6]_3$ (prussian blue colouration or ppt.)

(3) $2KHCO_3 \xrightarrow{\Delta} K_2CO_3 + H_2O + CO_2$; $Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 + H_2O + CO_2$

(4) In reducing flame the bead is colourless. It is violet in oxidising flame.

3. **Sol.** $HgI_2 \downarrow + 2I^- \longrightarrow [HgI_4]^{2-}$ (colourless soluble complex)

$HgI_2 \xrightarrow{\Delta} Hg + I_2 \uparrow$ (violet colour)

4. **Sol.** $Zn_2[Fe(CN)_6]$ is white.

ONLINE JEE-MAIN

1. **Sol.** Co^{2+} is precipitated when we have sufficient S^{2-} concentration.

2.

Sol. $FeCl_3$ gives chromyl chloride test,

$Fe^{3+} + SCN^- \longrightarrow$ blood red color.

and $Fe^{3+} + K_4[Fe(CN)_6] \longrightarrow \underset{\text{(blue)}}{Fe_4[Fe(CN)_6]_3}$

3. **Sol.** $[CoCl_4]^{2-}$ is formed which is blue in colour.

4. **Sol.** Zn^{2+} salts are white usually Fe^{2+} salts are rarely pink. Cu^{2+} salts are usually blue in hydrated form. Co^{2+} is pink in aqueous solution.

5. **Sol.** Fact

6. **Sol.** NaF: $Na^+ = 1s^2 2s^2 2p^6$

$F^- = 1s^2 2s^2 2p^6$

7. **Sol.** $Zn^{2+} + H_2S \longrightarrow \underset{\text{white ppt}}{ZnS} + 2H^+$

$ZnS \xrightarrow[NaOH]{HCl} \underset{\text{white ppt}}{Zn(OH)_2}$

$Zn^{2+} + [Fe(CN)_6]^{4-} \longrightarrow K_2Zn_3 \underset{\text{white ppt}}{[FeCN]_2}$

PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

1. **Sol.** Fe^{II} and Fe^{III} have different magnetic moment due to different number of unpair electrons.

2. **Sol.** Sulphate is estimated as $BaSO_4$, not as $MgSO_4$ because $MgSO_4$ is soluble in water and does not form a precipitate.

The ionic radius of Mg^{2+} is smaller than that of Ba^{2+} because of moving down in a group ionic radic increases.

3. **Sol.** Cl_2 (X) + $H_2O \longrightarrow$ 2HCl + [O] ;

$HCl + AgNO_3 \longrightarrow AgCl \downarrow$ (white) ('osr) + HNO_3 ;

$2HCl + Mg \longrightarrow MgCl_2 + H_2$ (Y)

4.

Sol. $SO_3^{2-} + 2H^+ \longrightarrow SO_2 + H_2O$; $Cr_2O_7^{2-} + 3SO_2 + 2H^+ \longrightarrow 2Cr^{3+}$ (Green solution) + $3SO_4^{2-} + H_2O$.

5.

Sol. $Mg^{2+} + 2HCO_3^-$ (from sodium salt) $\longrightarrow Mg(HCO_3)_2$ (soluble) $\xrightarrow{\Delta} MgCO_3 \downarrow$ (White) + $H_2O + CO_2$

6. **Sol.** Hg^{2+} gives red precipitate of HgI_2 which dissolves in excess KI forming colourless $[HgI_4]^{2-}$ ions.

$Bi^{3+} + 3I^- \longrightarrow BiI_3 \downarrow$ (black) ; $BiI_3 + I^- \longrightarrow [BiI_4]^-$ (orange solution)

Pb^{2+} gives yellow precipitate of PbI_2 . Cu^{2+} gives white precipitate of Cu_2I_2 with evolution of iodine.

7. **Sol.** $H_2O + CO_2 \longrightarrow H_2CO_3$ $H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$ $HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$

8. **Sol.** $[Zn(OH)_4]^{2-} \xrightarrow{H_2O-boiled} Zn(OH)_2 \downarrow$ (white) + $2OH^-$

$Zn(OH)_2$ precipitate is readily soluble in excess of ammonia and in solutions of ammonium salts due to the formation of tetraamminezinc(II).

$Zn(OH)_2 + 4NH_3 \longrightarrow [Zn(NH_3)_4]^{2+}$ (soluble complex) + $2OH^-$

or

$Zn(OH)_2 + 4NH_4OH \xrightarrow{NH_4Cl} [Zn(NH_3)_4]^{2+} + 4H_2O + 2OH^-$.

But $Al(OH)_3$, $Mg(OH)_2$ and $Ca(OH)_2$ don't dissolves in excess of NH_3 solution.

9. **Sol.** $Cu^{2+} + 6CN^- \longrightarrow [Cu^+(CN)_4]^{3-} + (CN)_2$

$Cu^{2+} + 2CN^- \longrightarrow Cu(CN)_2 \downarrow$ (yellow); $2Cu(CN)_2 \downarrow \longrightarrow 2CuCN \downarrow$ (white) + $(CN)_2 \downarrow$

$CuCN \downarrow + CN^- \longrightarrow [Cu^I(CN)_4]^{3-}$ (colourless soluble complex).

10.

Sol. $MgSO_4$ on reaction with Na_2HPO_4 in presence of NH_4OH gives white precipitate of $Mg(NH_4)PO_4$.

$MgSO_4 + Na_2HPO_4 + NH_4OH \longrightarrow Mg(NH_4)PO_4 \downarrow + Na_2SO_4 + H_2O$.

11. **Sol.** $Hg^{2+} + 2I^- \longrightarrow HgI_2 \downarrow$ (scarlet / red)

$HgI_2 + 2I^-$ (excess) $\longrightarrow [HgI_4]^{2-}$ (soluble complex)

$Hg^{2+} + Co(SCN)_2 \longrightarrow Co[Hg(SCN)_4] \downarrow$ (deep blue)

12. **Sol.** In presence of acidic medium, ionisation of H_2S is supressed so less number of S^{2-} ions are produced. So only those sulphides are precipitated which have low solubility product (K_{SP}) value, For example CuS and HgS.

13. **Sol.** HNO_3 decomposes by giving NO_2, O_2, H_2O

$4HNO_3 \longrightarrow 2H_2O + 2NO_2 + 3O_2$

So, Ans is (B).

14. **Sol.** Ammoniacal H_2S is group reagent of fourth group cationic radicals. Fe^{3+} & Al^{3+} will precipitate $Fe(OH)_3$ and $Al(OH)_3$ respectively. Only Zinc will form white precipitate of ZnS.

15. **Ans.** **(A) or (A) and (C)**

Sol. (A) $Cu^{2+} + S^{2-} \longrightarrow CuS \downarrow$

Black ppt

$Cu^{2+} + SO_4^{2-} \longrightarrow$ No. ppt

(B) $Ba^{2+} + S^{2-} \longrightarrow$ No. ppt

$Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4 \downarrow$

White ppt

(C) $Pb^{2+} + S^{2-} \longrightarrow PbS\downarrow$ $K_{sp}(PbS) = 10^{-28}$

Black ppt

$Pb^{2+} + SO_4^{2-} \longrightarrow PbSO_4$ $K_{sp}(PbSO_4) = 1.6 \times 10^{-8}$

white ppt

(D) No ion is precipitated.

So Ans is A & C or A.

** In option C as the differernce in Ksp of PbS & $PbSO_4$ is large.

so only PbS is selectively precipitated.

16. **Sol.** $Ag^+ + S_2O_3^{2+} \longrightarrow [Ag(S_2O_3)_2]^{3-} \xrightarrow{Ag^+} Ag_2S_2O_3 (\downarrow) \xrightarrow{\text{(with time)}} Ag_2S (\downarrow)$

(X) White ppt. (Y) Black (Z)

Additional Problems For Self Practice (APSP)

PART - I : PRACTICE TEST PAPER

JEE(Main) Pattern Practice paper (30 SCQ, 1 hr, 120 Marks).

This Section is not meant for classroom discussion. It is being given to promote self-study and self testing amongst the Resonance students.

Max. Marks : 120 **Max. Time : 1 Hr.**

Important Instructions

1. The test is of **1 hour** duration.
2. The Test Booklet consists of **30** questions. The maximum marks are **120.**
3. Each question is allotted **4 (four)** marks for correct response.
4. Candidates will be awarded marks as stated above in Instructions No. 3 for correct response of each question.
   ¼ (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.
5. There is only one correct response for each question. Filling up more than one response in any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instructions 4 above.

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1. **Sol.** SO_3^{2-} reduces $KMnO_4$ to colourless Mn^{2+}

$$5SO_3^{2-} + 2MnO_4^- + 6H^+ \longrightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$$

2. **Sol.** Nitrite ion liberates I_2 from potassium iodide turning starch blue.

$$2NO_2^- + 3I^- + 4CH_3COOH \longrightarrow I_3^- + 2NO\uparrow + 4CH_3COO^- + 2H_2O$$

$$I_2 + \text{starch} \longrightarrow \text{blue colour}$$

3.

Sol. NO_3^- gives NO_2 with concentrated H_2SO_4 which on passing through water form colourless $HNO_3(\ell)$ and $HNO_2(\ell)$. Br^- + MnO_2 on heating with concentrated H_2SO_4 gives Br_2 gas which on passing through water imparts it a reddish brown colour.

4. **Sol.** $Fe^{2+} + NO + 5H_2O \longrightarrow [Fe(H_2O)_5NO]^{2+}$ (brown complex)

5. **Sol.** $2NO_2^- + 3I^- + 4CH_3COOH \longrightarrow I_3^- + 2NO\uparrow + 4CH_3COO^- + 2H_2O$.

I_3^- + starch $\longrightarrow$ blue colouration.

6. **Sol.** $Ba^{2+} + CrO_4^{2-} \longrightarrow BaCrO_4 \downarrow$ (yellow) ; $Ag^+ + Cl^- \longrightarrow AgCl \downarrow$ (white).

7. **Sol.** Zn^{2+} is colourless and borax bead test is given by coloured ions such as Cu^{2+}, Mn^{2+}, Fe^{3+} etc.

8. **Sol.** Ca salts impart brick red colour to the flame.

9. **Sol.** $Al_2O_3.CoO$ formed in the test is blue in colour. It is called as thenard's blue.

10.

Sol. $Ba^{2+} + SO_3^{2-} \longrightarrow BaSO_3 \downarrow$ (white)

$BaSO_3 + 2HCl \longrightarrow BaCl_2 + SO_2$(colourless pungent smelling gas) + H_2O

SO_3^{2-} and SO_2 both act as bleaching agent.

11. **Sol.** (1) $5SO_3^{2-} + 2MnO_4^- + 6H^+ \longrightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$

(2) $2MnO_4^- + 5NO_2^- + 6H^+ \longrightarrow 2Mn^{2+} + 5NO_3^- + 3H_2O$

(3) $2MnO_4^- + H_2S + 6H^+ \longrightarrow 2Mn^{2+} + 5S \downarrow + 8H_2O$

12. **Sol.** $NO_2^- + 2I^- + 4CH_3COOH \rightarrow I_2 + 2NO\uparrow + 4\ CH_3COO^- + 2H_2O$

13. **Sol.** $SO_3^{2-} + Zn + 8H^+ \longrightarrow H_2S \uparrow + 3Zn^{2+} + 3H_2O$

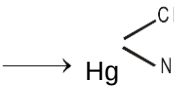
$Pb^{2+} + S^{2-} \longrightarrow PbS \downarrow$ (black)

$Ag^+ + S^{2-} \longrightarrow Ag_2S \downarrow$ (black)

14.

Sol. $SO_3^{2-} + Ba(OH)_2 \longrightarrow BaSO_3 \downarrow$ (white) + $2OH^-$.

$3SO_2 + Cr_2O_7^{2-} + 2H^+ \longrightarrow 2Cr^{3+}$ (green colour solution) + $3SO_4^{2-} + H_2O$.

16. **Sol.** $Hg_2Cl_2 + 2NH_3 \longrightarrow$  (white) + $Hg\downarrow$ (black) + NH_4Cl

Black

17. **Sol.** The white precipitate obtained with H_2SO_4 is that of $PbSO_4$. The white crystalline substance may be that of $Pb(NO_3)_2$.

$Pb^{2+} + S^{2-} \longrightarrow PbS \downarrow$ (black) ; $3PbS \downarrow + 8HNO_3 \longrightarrow 3Pb^{2+} + 6NO_3^- + 3S \downarrow + 2NO + 4H_2O$

$Pb^{2+} + SO_4^{2-} \longrightarrow PbSO_4 \downarrow$ (white)

$PbSO_4 + 2CH_3COONH_4 \longrightarrow (NH_4)_2[Pb(CH_3COO)_4] + (NH_4)_2SO_4$

BaS and SrS are not precipitated. Ag_2SO_4 is white precipitate but does not dissolve in ammonium acetate.

18. **Sol.** PbI_2 is yellow (known as golden spangles).

19. **Sol.** AgBr has the highest solubility in 10^{-3} M NH_4OH
AgBr dissolves in all other solvents poorly.

20. **Sol.** Both Cd^{2+} and Sn^{2+} are precipitated as yellow sulphides in the presence of dilute HCl.

21. **Sol.** $Cd^{2+} + H_2S \longrightarrow CdS\downarrow + 2H^+$, reaction is reversible; if the concentration of strong acid in the solution is above 0.5 M, precipitation is incomplete. Concentrated acid dissolves the precipitate for the same reason.

22. **Sol.** $2Cu^{2+} + 4I^- \longrightarrow Cu_2I_2\downarrow + I_2$

$Cu^{2+} + 3CN^- \longrightarrow CuCN \downarrow + (CN)_2$

23.

Sol. (1) $Bi^{3+} + 3NH_4OH \longrightarrow Bi(OH)_3\downarrow$ (white) $+ 3NH_4^+$

(2) $Bi^{3+} + NO_3^- + H_2O \longrightarrow BiO(NO_3) \downarrow$ (white) $+ 2H^+$

$Bi^{3+} + Cl^- + H_2O \longrightarrow BiOCl \downarrow$ (white) $+ 2H^+$

(3) $Bi^{3+} + 3I^- \longrightarrow BiI_3\downarrow$ (black) ; $BiI_3 + I^- \longrightarrow [BiI_4]^-$ (orange solution)

(4) $Bi^{3+} + 3OH^- \longrightarrow Bi(OH)_3\downarrow$ (white) ; $2Bi(OH)_3\downarrow + 3[Sn(OH)_4]^{2-} \longrightarrow 2Bi\downarrow$□(black) $+ 3[Sn(OH)_6]^{2-}$

24.

Sol. (i) $Cu^{+2} + 2OH^- \rightarrow Cu(OH)_2 \xrightarrow{\Delta} CuO \downarrow + H_2O$

black ppt.

(ii) $Zn^{+2} + 2OH^- \rightarrow Zn(OH)_2$

white ppt.

(iii) $Al^{+3} + 3OH^- \rightarrow Al(OH)_3$

white ppt.

(iv) $Pb^{+2} + 2OH^- \rightarrow Pb(OH)_2 \xrightarrow{\Delta} PbO \downarrow$

white ppt. red yellow ppt.

25. **Sol.** On adding H_2O_2 in alkaline medium or $SnCl_2$ solution in acidic medium, the $[Fe(CN)_6]^{3-}$ part of the compound is reduced and prussian blue is precipitated.

26. **Sol.** $CrO_4^{2-} + 2H^+ + 2H_2O_2 \longrightarrow CrO_5$ (chromium peroxide) $+ 3H_2O$

It in etheral layer develops blue colouration.

27. **Sol.** $Mn(OH)_2 + 2HNO_3 \longrightarrow Mn(NO_3)_2 + 2H_2O$.

$2Mn(NO_3)_2 + 5PbO_2 + 6HNO_3 \longrightarrow 2HMnO_4$ (red – violet or purple colour) $+ 5Pb(NO_3)_2 + 2H_2O$.

28. **Sol.** (1) $Zn(OH)_2\downarrow + 2OH^- \rightleftharpoons [Zn(OH)_4]^{2-}$

(2) and (3) $Zn(OH)_2\downarrow + 4NH_3 \rightleftharpoons [Zn(NH_3)_4]^{2+} + 2OH^-$

or NH_4^+

29. **Sol.** (1) No precipitate with K_2CrO_4 in acetic acid as its K_{sp} is high.

(2) $Ca^{2+} + 2K^+ + [Fe(CN)_6]^{4-} \longrightarrow K_2Ca[Fe(CN)_6]\downarrow$ (white)

(3) It imparts brick red colour to Bunsen flame.

(4) $Ca(HCO_3)_2$ is formed which is water soluble.

30. **Sol.** (2) $BaCO_3$ + ZnS mixture dissolves in HCl but is insoluble in water. Further the solution in HCl will be colourless due to the formation of soluble $BaCl_2$ and $ZnCl_2$.

(2) $BaCO_3$ + ZnS feJ.k HCl esa foy;'khy gS ysfdu ty esa vfoy;'khy gSA foy;'khy $BaCl_2$ rFkk $ZnCl_2$ ds fuekZ.k ds dkj.k HCl esa foy;u jaxghu gksrs gSaA

PART - II : PRACTICE QUESTIONS

1. **Sol.** NH_3 is basic

2. **Sol.** E^0_{SRP} of Ag = 0.80 V , E^0_{SRP} of Cl^- = 1.36 V , E^0_{SRP} of H^+ = 0.00 V , So Ag can not oxidize Cl^- and can not reduce H^+.

3. **Sol.**

$S_2O_3^{2-}$ + dil.H_2SO_4 $\xrightarrow{\Delta}$ $SO_2\uparrow$ (Suffocating gas) $2Cl^- + S\downarrow$ (yellow turbidity or white turbidity) + H_2O

4. **Sol.** HCO_3^- + Mg^{2+} → Mg $(HCO_3)_2$ (No PPtdksbZ vo{ksi ugha) $\xrightarrow{\Delta}$ Mg $CO_3\downarrow$

5. In the test for iodine, I_2 is treated with sodium thiosulphate ($Na_2S_2O_3$) :

$Na_2S_2O_3 + I_2 \longrightarrow NaI$ + ...

8. **Sol.** KBr + H_2SO_4 → $KHSO_4$ + HBr , 2HBr +9 H_2SO_4 → Br_2 + $2H_2O$ + SO_2

9. **Sol.** Some nitrates on heating give NO_2 which bleaches moist litmus paper due to its oxidizing nature.

10. **Sol.** Solubility order ; Ag F > AgCl > AgBr > AgI

11. **Sol.** S^{2-} + 2HCl $\xrightarrow{\Delta}$ $H_2S\downarrow$ + $2Cl^-$

Rotten egg smell (Specific smell)

CO_3^{2-} + 2HCl $\xrightarrow[\text{or cold}]{\Delta}$ $CO_2\uparrow$ (Odourless gas)+ H_2O + $2Cl^-$

NO_2^- + HCl $\xrightarrow{\Delta}$ HNO_2 + Cl^- → NO ↑ (colourless) $\xrightarrow{\text{atmospheric air}}$ $NO_2\uparrow$ (Brown colour gas)

12. **Sol.** KCl + H_2SO_4 + $K_2Cr_2O_7$ → CrO_2Cl_2 (Chromyl Chloride test)

13. **Sol.** K → violet colour in flame test

$2I^-$ + conc. H_2SO_4 → HI + SO_4^{2-} ; HI + H_2SO_4 → I_2 + H_2O + SO_2

I_2 + starch → blue colour.

14. **Sol.** HBr and HI are strong reducing agents and are oxidized by H_2SO_4 to Br_2 and I_2, respectively.

15.

Sol. Ba^{2+} salts gives yellow precipitate with K_2CrO_4 solution and this precipitate is not soluble in CH_3COOH. Ba^{2+} ions gives apple green colour in the flame test.

16. **Sol.** The K_{SP} of $Al(OH)_3$ is low as compared to that of the hydroxides of other metals. The OH^- concentration provided by ammonium hydroxide in presence of NH_4Cl is just sufficient to precipitate Al^{3+} as $Al(OH)_3$.

Al^{3+} + NH_3 + H_2O $\xrightarrow{NH_4Cl}$ $Al(OH)_3\downarrow$ (gelatinous white) + NH_4^+ .

17. **Sol.** Group 3rd radicals are precipitated as hydroxides and the addition of NH_4Cl suppresses the ionisation of NH_4OH so that only the group 3 cations are precipitated as hydroxides because of their low solubility products.

18. **Sol.** MnO_4^- in acidic medium oxidises Fe^{2+} to Fe^{3+}.

19.

Sol. (1) $2Fe^{3+} + H_2S \longrightarrow 2Fe^{2+} + 2H^+ + S\downarrow$ (white)

(2) $2Fe^{3+} + 3S^{2-} \longrightarrow 2FeS\downarrow$ (black) $+ S\downarrow$

(3) $Fe^{3+} + 3SCN^- \longrightarrow Fe(SCN)_3$ deep red colouration

20. **Sol.** Ni^{2+} and Fe^{2+} both on reaction with alkaline solution of dimethyl glyoxime give red precipitate and red solution respectively but not zinc.

21. **Sol.** $Ag_2S + 2HCl \longrightarrow AgCl\downarrow + 2H_2S$; HgS is also insoluble in 2N HCl so silver and mercury do not pass into filtrate while ZnS, MnS and FeS dissolve in 2N HCl forming their soluble chlorides and thus pass into filtrate.

22.

Sol. (1) $Pb^{+2} + CrO_4^{-2} \longrightarrow PbCrO_4$ (yellow ppt)

(2) $Ba^{+2} + CrO_4^{-2} \longrightarrow BaCrO_4$ (Yellow ppt)

(3) $Ag^{\oplus} + CrO_4^{-2} \longrightarrow Ag_2CrO_4$ (Brick like red ppt)

(4) $Ca^{+2} + CrO_4^{-2} \longrightarrow CaCrO_4$ (soluble)

23._ **Sol.** CaS belongs to Vth group and precipitate by H_2S in presence of NH_4OH and NH_4Cl

24._ **Sol.** $AgI + NaCN \longrightarrow Na[Ag(CN)_2]$ (soluble)

25._ **Sol.** (1) $Cu^{2+} + H_2S \longrightarrow CuS$ (ppt.)

$Ag^{2+} + H_2S \longrightarrow Ag_2S$ (ppt.)

(2) $Cu^{2+} + HCl \longrightarrow CuCl_2$ (soluble)

$Ag^{2+} + HCl \longrightarrow AgCl$ (ppt.)

with HNO_3 and $(NH_4)_2NO_3$ both Ag^+ and Cu^{2+} form soluble compound.

26._ Sol. $2Ag^{+} + CrO_4^{2-} \rightarrow \underset{\text{(red ppt.)}}{Ag_2CrO_4}\downarrow \xrightarrow{NH_3} \underset{\text{(Soluble)}}{[Ag(NH_3)_2]^{+}} + CrO_4^{2-}$

27._ Sol. Because NH_4^+ form soluble compounds.

28._ Sol. $CuSO_4 + NH_4OH \longrightarrow [Cu(NH_3)_4]SO_4 + H_2O$

29._ Sol. $2Al_2O_3 + 2Co^{+2} + 4NO_3^- \longrightarrow 2CoAl_2O_4$ (thenard blue) $+ 4NO_2 + O_2$

30._

Sol. $CrCl_3 + NaOH \longrightarrow Cr(OH)_3\downarrow \underset{}{\overset{OH^-}{\rightleftharpoons}} [Cr(OH_4)]^-$ (soluble)

$AlCl_3 + NaOH \longrightarrow Al(OH)_3\downarrow \underset{}{\overset{OH^-}{\rightleftharpoons}} [Al(OH_4)]^-$ (soluble)

$ZnCl_2 + NaOH \longrightarrow Zn(OH)_2\downarrow \underset{}{\overset{OH^-}{\rightleftharpoons}} [Zn(OH_4)]^{2-}$ (soluble)

$CuCl_2 + NaOH \longrightarrow Cu(OH)_2\downarrow \underset{}{\overset{OH^-}{\rightleftharpoons}}$ (not soluble in excess NaOH)