Section: Senior **QUALITATIVE ANALYSIS** **Date: 18-06-2020**

TABLE: REACTION OF METALS WITH FOUR REGENTS

		Reagent $NaOH\,(OR)\,KOH$		**Reagent** NH_4OH	
SL.No	**Metal ion**	**Not excess**	**Excess of reagent**	**Not excess**	**Excess of reagent**
1	Pb^{2+}	$Pb(OH)_2$ $(amphoteric)$	Soluble and forms $Na_2\left[Pb(OH)_4\right] \xrightarrow[OR(NH_4)_2S_2O_8]{H_2O_2} \underset{black\ ppt}{PbO_2} + H_2O$	$Pb(OH)_2$	Insoluble remains as $Pb(OH)_2$
2.	Hg_2^{+2}	Hg_2O	Insoluble but on boiling. $Hg_2O \xrightarrow{boiling} \underbrace{Hg + HgO}_{grey}$	Black ppt $(HgO\,Hg\,NH_2\,NO_3 + H$	Insoluble
3	Ag^+	Ag_2O Brown ppt	Insoluble	Ag_2O Brown ppt	Soluble $\left[Ag(NH_3)_2\right]^+$
4	Hg^{+2}	HgO (yellow)	Insoluble	White ppt $(HgO\,Hg\,NH_2\,NO_3)$	Insoluble
5.	Cu^{+2}	$Cu(OH)_2$ (Blue)	Insoluble but on heating changes to CuO (Black)	$Cu(OH)_2$ (Blue)	Soluble forms $\left[Cu(NH_3)_4\right]^{+2}$
6.	Bi^{+3}	$Bi(OH)_3$ (white ppt)	Slightly soluble or insoluble.	$Bi(OH)_3\ ppt$	Insoluble
7.	Cd^{+2}	$Cd(OH)_2$ (white ppt)	Insoluble	$Cd(OH)_2$ white ppt	Soluble $\left[Cd(NH_3)_4\right]^{+2}$

8.	Al^{+3}	$Al(OH)_3$ (white ppt)	Soluble $\left[Al(OH)_4\right]^-$	$Al(OH)_3$ white ppt	Insoluble
9.	Fe^{+3}	$Fe(OH)_3$ R.B ppt	Insoluble	$Fe(OH)_3$ R.B ppt	Insoluble
10.	Cr^{+3}	$Cr(OH)_3$ Green ppt	Soluble $\left[Cr(OH)_4\right]$ green solution	$Cr(OH)_3$ Green ppt	Slightly soluble and form pink or violet $\left[Cr(NH_3)_6\right]^{+3}$
11.	Mn^{+2}	$Mr(OH)_2$ White ppt	Insoluble but exposed to air form $MnO(OH)_2$ *or* $MnO_2.H_2O$		
12	Zn^{+2}	$Zn(OH)_2$ white ppt	Soluble $\left[Zn(OH)_4\right]^{-2}$	$Zn(OH)_2$ white ppt	Soluble $\left[Zn(NH_3)_4\right]^{+2}$
13.	Co^{+2}	$Co(OH)_2$ Pink ppt	Insoluble	$Co(OH)_2$	Soluble $\left[Co(NH_3)_6\right]^{+2}$
14.	Ni^{+2}	$Ni(OH)_2$ green ppt	Insoluble	$Ni(OH)_2$ green ppt	Soluble $\left[Ni(NH_3)_6\right]^{+2}$

		Reagent KCN or NaCN		**Reagent KI**	
SL.N	**Metal ion**	**Not excess**	**Excess of reagent**	**Not excess**	**Excess of KI**
1	Pb^{+2}	$Pb(CN)_2$ White ppt	Insoluble	PbI_2 (Yellow ppt)	*Soluble in more conc. KI. $K_2\left[PbI_4\right]$
2.	Hg_2^{+2}	$Hg\downarrow + Hg(CN)_2$ Grey ppt	Insoluble	* Hg_2I_2 (Green ppt)	*Disproportionates: $\left[HgI_4\right]^{-2} + Hg\downarrow$
3	Ag^+	$AgCN$ (White ppt)	Soluble $[Ag(CN)_2]^{-1}$	AgI (Yellow ppt)	Insoluble but soluble in KCN and Hypo
4	Hg^{+2}	$Hg(CN)_2$ soluble	No change	HgI_2 (Brown ppt)	Soluble: $\left[HgI_4\right]^{-2}$ C.L solution
5.	Cu^{+2}	$CuCN$ (ppt)	Soluble $K_3\left[Cu(CN)_4\right]$	CuI (White ppt)	Insoluble
6.	Bi^{+3}			BiI_3 (Black ppt)	Soluble: $\left[BiI_4\right]^-$ orange solution

7.	Cd^{+2}	$Cd(CN)_2$ White ppt	Soluble $[Cd(CN)_4]^{-2}$	No ppt	Distinction from Cu^{+2}
8.	Fe^{+3}	$Fe(CN)_3$ *R.B ppt*	$\left[Fe(CN)_6\right]^{-3}$ yellow soluble	$Fe^{+2} + I_3^-$ (B.solution)	
9.	Fe^{+2}	$Fe(CN)_2$ brown ppt	Soluble $\left[Fe(CN)_6\right]^{-4}$ Pale yellow solution		
10.	Co^{+2}	$CO(CN)_2$ R.B ppt	Soluble $[CO(CN)_6]^{-4}$		
11	Ni^{+2}	$Ni(CN)_2$ Green ppt	Soluble $\left[Ni(CN)_4\right]^{-2}$		
12.	Zn^{+2}	$Zn(CN)_2$ ppt.	Soluble: $\left[Zn(CN)_4\right]^{-2}$		

SL.NO	Metal ion	Colour	Solubility
1	Ag^+	AgS (black)	Hot Conc. Nitric acid decomposes 'S' remains in the form of ppt. it the mixture is boiled 'S' oxidizes to SO_4^{-2} and ppt of 'S' disappears.
2.	Pb^{+2}	PbS(black)	Decomposed by Conc. HNO_3: 2M. HNO_3 conc. HCl
3	Hg_2^{+2}	Black formed by passing H_2S through solution of Hg_2^{+2}	Which is mixture of Hgs +Hg. But not Hg_2S
4	Hg^{+2}	Hgs(black)	Soluble in aquaregia; Na_2S;$\left[HgS_2\right]^{-2}$, $\left[HgS_2\right]^{-2}$ solution $\xrightarrow[dil.acid]{H^+} H_2S + HgS\downarrow(Black\ ppt)$
5.	Cu^{+2}	CuS (black)	*Soluble in 2M HNO_3(hot. Conc. HNO_3) insoluble in boiling dil. H_2SO_4 [distinction from Cd]
6.	Bi^{+3}	Bi_2S_3 (Black) or (dark brown)	Soluble in boiling Conc. HCl and dil. HNO_3

7.	Cd^{+2}	Cds (yellow)	Soluble in conc. HCl and 2M HNO_3
8.	Fe^{+2}	FeS (black)	Readily soluble in acids with evolution of H_2S.
9.	Fe^{+3}	Fe_2S_3 (black)	Readily dissolves in HCl forms Fe(II) and 'S'
10.	$Cr^{+3}, Al^{+3}, Mg^{+2}$		* Cant form sulphides in aqueous solution as they are completely hydrolysed. These sulphides canbe prepared only under dry conditions
11.	Co^{+2}	CoS(black)	Soluble in hot conc. HNO_3**;** aqua regia; leaving 'S' ppt, Conc Hcl in presence of oxidizing agent.
12	Ni^{+2}	NiS(black)	Soluble in hot conc. HNO_3**;** aqua regia; leaving 'S' ppt. Conc HCl in presence of oxidizing agent
13.	Mn^{+2}	MnS(black)	Soluble in mineral acid even in *CH_3COOH
14.	Zn^{+2}	ZnS(white ppt)	*Insoluble in CH_3COOH. Soluble in mineral acid.

Note: $Co^{+2}, Ni^{+2}, Mn^{+2}, Zn^{+2}$ **are precipitate by** H_2S **in neutral or slightly alkaline medium.**

1. Alkali metal sulphides : Normal and poly sulphides of alkali metals are soluble in water
2. Alkaline earth metal sulphides: Normal sulphides are sparingly soluble but changes by contact with water gradually to soluble hydrogen sulphides: $\left[CaS + H_2O \rightarrow Ca^{+2} + SH^- + OH^-\right]$

   Most of other metal sulphides are Insoluble in water.

DECOMPOSITION OF SULPHIDES BY ACID:

1. Most of the metal sulphides are decomposed by dil. HCl with the evolution of H_2S.
2. Sulphides of Pb, Cd, Ni, Co, Sb and Sn(IV) are required Conc.HCl for decomposition to evolve H_2S.
3. HgS dissolves aquaregia, with separation of sulphur