Analytical Chemistry

Radical : - A charged atom or groups of atoms which participates in chemical reactions.

$Cu(OH)_2 + H_2SO_4 \rightarrow CuSO_4 + H_2O$

Base Acid salt

Cu^{2+} SO_4^{2-}

Basic radical Acidic radical

* Positive radical – Basic radical

* Negative radical – Acid radical

Valency - The magnitude of charge on a radical.

IDENTIFICATION OF ACIDIC RADICALS

Group I : This group consists of radical which are detected by dilute H_2SO_4 or dilute HCl.
These are (i) Carbonate, (ii) Sulphite, (iii) Sulphide, (iv) Acetate and (v) Nitrite

Group II: This group consists of radicals which are detected by concentrated H_2SO_4.
These are (i) Chloride, (ii) Bromide, (iii) Iodide, (iv) Nitrate and (v) Oxalate

Group III : The radicals which do not give any characteristic gas with dilute and concentrated H_2SO_4.
These are (i) Sulphate, (ii) Phosphate, (iii) Borate and (iv) Fluoride.

(A) Observation of Dil. HCl / H_2SO_4 + little amount of substance on slow heating.

Radical	Test/Observation/Analysis	Reaction
(1) CO_3^{-2} (Carbonate)	(i) Sharp bubbling of colourless gas (CO_2) (ii) Gas truns milky to lime water. (iii) On passing excess gas through lime water, milky colour disappears.	$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2\uparrow$ $CO_2 + Ca(OH)_2 \rightarrow CaCO_3\downarrow$ (Milky) $+ H_2O$ $CaCO_3 + CO_2 + H_2O \rightarrow Ca(HCO_3)_2$ (soluble)
(2) SO_3^{-2} (Sulphite)	(i) Colourless gas (SO_2) in which very unpleasant smell of burnt sulphur (ii) Gas turns green to moist acidic $K_2Cr_2O_7$ paper (iii) Sulphite gives white ppt. with $BaCl_2$, which is soluble in dil. HCl	$CaSO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + SO_2\uparrow$ $K_2Cr_2O_7 + H_2SO_4 + 3SO_2 \rightarrow$ $K_2SO_4 + Cr(SO_4)_3$ (green) $+ H_2O$ $Na_2SO_3 + BaCl_2 \rightarrow 2NaCl + BaSO_3\downarrow$
(3) S^{-2} (Sulphide)	(i) Colourless gas with rotten egg smell (H_2S) (ii) Gas turns black to lead-acetate paper (iii) Sulphide turns violet colour to Sodiumnitroprusside soln.	$CaS + H_2SO_4 \rightarrow CaSO_4 + H_2S\uparrow$ $(CH_3COO)_2Pb + H_2S \rightarrow PbS$-(black) $2CH_3COOH$ $Na_2S + Na_2[FeNO(CN)_5] \rightarrow Na_4[Fe(NOS)(CN)_5$ (violet)
(4) CH_3COO^- (Acetate)	(i) Vinegar smell, acetate may be (ii) Acetate gives blood red colour with neutral $FeCl_3$ soln.	$(CH_3COO)_2Ca + H_2SO_4 \rightarrow 2CH_3COOH + CaSO_4$ (Vinegar smell) $3(CH_3COO)_2Ca + 2FeCl_3$ $\rightarrow 2Fe(CH_3COO)_3 + 3CaCl_2$
(5) NO_2^- (Nitrite)	(i) Red, brown NO_2 vapour comes out. Nitrite may be (i) Gas turns blue to acidic KI strach paper	$2KNO_2 + H_2SO_4 \rightarrow K_2SO_4 + 2HNO_2$ $3HNO_2 \rightarrow HNO_3 + 2NO\uparrow + H_2O$ $2NO + O_2 \rightarrow 2NO_2\uparrow$ $2KI + 2NO_2 \rightarrow 2KNO_2 + I_2\uparrow$ Starch $+ I_2 \rightarrow$ blue colour

(B) Observation of Conc. H_2SO_4 + little amount of substance of slow heating

Radical	Test/ observation/ Analysis	Reaction
(6) Cl^- (Chloride)	(i) Colourless fuming gas (HCl) with fast smell (ii) Chloride gives white ppt. with $AgNO_3$, which is soluble in NH_4OH (iii) Chromyl chloride test **(v.imp.)** (a) Sodium chloride when heated with $K_2Cr_2O_7$ & conc. H_2SO_4 then orange red vapour of chromyl chloride CrO_2Cl_2 comes out. (b) This vapour when passed with NaOH gives yellow solution (Na_2CrO_4) (c) Acidic solution of Na_2CrO_4 gives yellow ppt. with $(CH_3COO)_2$ Pb	$2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl \uparrow$ $NaCl + AgNO_3 \rightarrow AgCl \downarrow + NaNO_3$ (white) $AgCl + 2NH_4OH \rightarrow Ag(NH_3)_2Cl + 2H_2O$ (Soluble) $4NaCl + K_2Cr_2O_7 + 3H_2SO_4 \rightarrow$ $2CrO_2Cl_2 + 2Na_2SO_4 + K_2SO_4 + 3H_2O$ (orange red) $CrO_2Cl_2 + 4NaOH \rightarrow$ $Na_2CrO_4 + 2NaCl + 2H_2O$ $Na_2CrO_4 + (CH_3COO)_2Pb \rightarrow$ $2CH_3COONa + PbCrO_4 \downarrow$ (yellow ppt)
(7) Br– (Bromide)	(i) Brown vapour comes out of $(Br_2)Br^-$ or NO_3^- may be (ii) Bromides gives light yellow ppt. with $AgNO_3$ which is partially soluble in NH_4OH. (iii) Brown vapour of Br_2 when passed with H_2O gives brown colouration wheras NO_2 vapour don't give any colour with NO_2 vapour	$2NaBr + H_2SO_4 \rightarrow Na_2SO_4 + 2HBr$ $2HBr + H_2SO_4 \rightarrow Br_2 \uparrow + 2H_2O + SO_2 \uparrow$ $NaBr + AgNO_3 \rightarrow AgBr \downarrow + NaNO_3$ (light yellow)
(8) I^- (Iodide)	(i) Dark violet fume of I_2 comes out. (ii) Gives blue colouration with starch . (iii) Iodides gives yellow ppt. with $AgNO_3$ which is insoluble in NH_4OH (iv) Iodine with chloroform gives violet coloured chloroform	$2NaI + H_2SO_4 \rightarrow Na_2SO_4 + 2HI$ $2HI + H_2SO_4 \rightarrow I_2 \uparrow + 2H_2O + SO_2 \uparrow$ (violet) I_2 + starch $\rightarrow$ Blue colour (complex) $NaI + AgNO_3 \rightarrow AgI + NaNO_3$ (yellow) $2KI + Cl_2$ (water) $\rightarrow 2KCl + I_2$ I_2 + chloroform $\rightarrow$ violet coloured chloroform
(9) NO_3^- (Nitrate)	(i) Brown smoke comes out (NO_2) (ii) Ring test **(v. imp.)** aq. solution of salt is mixed in fresh $FeSO_4$ and conc. H_2SO_4 is passed through corners of test tube, brown ring is formed.	$NaNO_3\ H_2SO_4 \rightarrow NaHSO_4 + HNO_3$ $4HNO_3 \rightarrow 2H_2O + O_2 + 4NO_2 \downarrow$ $NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$ $6FeSO_4 + 2HNO_3 + 3H_2SO_4 \rightarrow$ $3Fe_2(SO_4)_3 + 2NO + 4H_2O$ $FeSO_4 + NO \rightarrow [Fe(NO)]SO_4$ (brown ring of nitrosoferrous sulphate)

Radical	Test/ observation/ Analysis	Reaction
(10) $C_2O_4^{-2}$ (Oxalate)	(i) Colourless gas ($CO + CO_2$) comes out. (ii) These gases burns with blue flame on the moutn of test tube. (ii) Oxalate solution gives – (a) White ppt. with $CaCl_2$ (b) This ppt. is soluble in H_2SO_4 (c) This ppt. decolourise $KMnO_4$ soln.	$Na_2C_2O_4+H_2SO_4 \rightarrow H_2O+CO+CO_2+Na_2SO_4$ $2CO + O_2 \rightarrow 2CO_2$ (a) $Na_2C_2O_4 + CaCl_2 \rightarrow CaC_2O_4\downarrow + 2NaCl$ (b) $CaC_2O_4+H_2SO_4 \rightarrow CaSO_4 + H_2C_2O_4$ (V. imp.) (c) $2KMnO_4 + 3H_2SO_4 + 5H_2C_2O_4 \rightarrow 2MnSO_4 + K_2SO_4 + 8H_2O + 10CO_2$
(11) SO_4^{-2} (Sulphate)	Small amount of substance + conc. HNO_3 mixtures is heated & now adding $BaCl_2$ white ppt comes which is insoluble in acid or base sulphate confirmed	$Na_2SO_4 + 2HNO_3 \rightarrow 2NaNO_3 + H_2SO_4$ $H_2SO_4 + BaCl_2 \rightarrow BaSO_4\downarrow + 2HCl$ (white)
(12) PO_4^{-2} (Phosphate)	(b) Small amount of substance + conc. HNO_3 mixture is heated & (b) Ammonium molybdate is mixed, yellow ppt. comes which confirms the presence of phosphate	(a) $Na_3PO_4 + 3HNO_3 \rightarrow 3NaNO_3 + H_3PO_4$ (b) $H_3PO_4 + 12(NH_4)_2MoO_4 + 21HNO_3 \rightarrow (NH_4)_3.PO_4 12MoO_3\downarrow + 12H_2O + 21NH_4NO_3$ [ammonium phosphomolybdate (yellow ppt)]
(13) BO_3^{-3} (Borate)	To a small quantity of the substance (salt or mixture), add a few mL of ethyl alcohol and conc. H_2SO_4. Stir the contents with a glass rod. Heat the test tube and bring the mouth of the test tube near the flame. The formation of green edged flame indicates the presence of borate.	$2Na_3BO_3 + 3H_2SO_4 \rightarrow 3Na_2SO_4 + 2H_3BO_3$ $H_3BO_3 + 3C_2H_5OH \rightarrow (C_2H_5)_3\,BO_3 + 3H_2O$ Ethyl borate
(14) F^- (Fluoride)	Take a small amount of the substance in a dry test tube and add an equal amount of sand. Mix the contents and add conc. H_2SO_4 Heat the contents and place a glass rod moistened with water over the mouth of the test tube. A waxy white deposite on the rod is Formed.	$2NaF + H_2SO_4 \rightarrow Na_2SO_4 + H_2F_2$ $SiO_2 + 2H_2F_2 \rightarrow SiF_4 + 4H_2O$ $3SiF_4 + 4H_2O \rightarrow H_4SiO_4 + 2H_2SiF_6$ (white) Fluoride is comfirm

TEST OF BASIC RADICALS

Group I
Redicals : Pb^{2+}, Ag^{+}, Hg_2^{2+} (ous)
Group reagent : Dil HCl

Group II
Redicals : Hg^{2+}, Pb^{+2}, Br^{3+}, Cu^{2+}, Cd^{2+} **Group II A**
As^{3+}, Sb^{3+}, Sn^{2+}, Sn^{4+} **Group IIB**
Group reagent : H_2S gas in presence of dil. HCl

Group III
Radicals : Fe^{3+}, Al^{3+}, Cr^{3+}
Group reagent : $NH_4OH + NH_4Cl$

Group IV
Radicals : Ni^{+2}, Co^{+2}, Mn^{+2}, Zn^{+2}
Group reagent : H_2S gas in presence of NH_4Cl & NH_4OH

Group V
Radicals : Ba^{2+} , Sr^{2+}, Ca^{2+}
Group reagent : $(NH_4)_2CO_3$ in presence of NH_4OH

Group VI
Radical : Mg^{+2}
Group reagent : Na_2HPO_4 in presence of NH_4OH

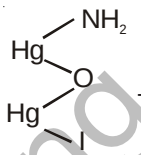
Group No./ Radical	**Test/ observation/ Analysis**	**Reaction**
I group / Hg^{+2},Ag^{+},Pb^{+2}	In solution of substance mixting dil. HCl white ppt. comes out which confirms the presence of Hg^{+}, Ag^{+} or Pb^{+2}	$2HgNO_3 + 2HCl \rightarrow HgCl_2\downarrow + 2HNO_3$ $AgNO_3 + HCl \rightarrow AgCl^{-} + HNO_3$ $Pb(NO_3) + 2HCl \rightarrow PbCl_2\downarrow + 2HNO_3$
Imp. $PbCl_2$ is soluble in hot water (but insoluble in cold water) Whereas insoluble in both AgCl & $HgCl_2$		
(1) Pb^{+2}	Pb^{+2} ion gives yellow ppt. with K_2CrO_4 & KI soln. separately.	$PbCl_2 + K_2CrO_4 \rightarrow PbCrO_4$(yellow)$\downarrow + 2KCl$ $PbCl_2 + 2KI \rightarrow PbI_2\downarrow$(yellow) + 2KCl
(2) Hg_2^{+2}	Hg_2^{+2} gives black ppt. with NH_3	$Hg_2Cl_2 + 2NH_4OH \rightarrow Hg(NH_2)Cl + Hg\downarrow$ $+ NH_4Cl + 2H_2O$
(3) Ag^{+}	(i) AgCl is soluble in NH_4OH (ii) Ag^{+} ion gives yellow ppt. with KI	$AgCl + 2NH_4OH \rightarrow [Ag(NH_3)_2]Cl + 2H_2O$ $Ag^{+} + I^{-} \rightarrow AgI\downarrow$ (yellow)
II group/ Hg^{+2},Ag^{+2},Pb^{+2} Cd^{+2},Bi^{+3}(IIA) As^{+3},Sb^{+3}(Sn^{+2}) Sn^{+4}(IIB)	Passing H_2S in presence of HCl these gives ions	
Cd^{+2},As^{+3},Sn^{+4}	Yellow ppt. (CdS, As_2S_3, SnS_2) Orange ppt. (Sb_2S_3) Brown ppt. (SnS)	
Sb^{+3} **Sn^{+2}**	Black ppt.	
Hg^{+2}, Pb^{+2}, Bi^{+3} **Cu^{+2}**	(HgS, PbS, Bi_2S_3, CuS)	

Note : Obtained ppt. is differentiated by the reaction of $(NH_4)_2S$ which is insoluble in the ppt. obtained of IIA and soluble in II B ppt.

Radical	Test/ observation/ Analysis	Reaction
II–A group/ (4) Hg^{+2}	Adding Hg^{+2} ion white ppt. obtained which turns black	$2Hg^{+2} + SnCl_2 + Sn^{+4} \rightarrow Sn^{+4} + Hg_2Cl_2 \downarrow$ (white) $HgCl_2 + SnCl_2 \rightarrow SnCl_4 + 2Hg \downarrow$ (black)
(5) Pb^{+2}	(i) In solution, Pb^{+2} gives white ppt. with H_2SO_4 (ii) In solution Pb^{+2} ion gives yellow ppt. with K_2CrO_4 & KI	$Pb^{+2} + H_2SO_4 \rightarrow PbSO_4 \downarrow + 2H^+$ (white) $Pb^{+2} + Cr_2O_4^{-2} \rightarrow PbCrO_4 \downarrow$ (yellow) $Pb^{+2} + 2I^- \rightarrow PbI_2 \downarrow$ (yellow)
(6) Cu^{+2}	(i) These ion gives dark blue colour with excess NH_4OH (ii) Cu^{+2} ion gives chocolate colour with $K_4Fe(CN)_6$	$Cu^{+2} + NH_4OH \rightarrow [Cu(NH_3)_4]^{+2} + H_2O$ (dark blue colour) $2Cu^{+2} + K_4Fe(CN)_6 \rightarrow Cu_2[Fe(CN)_6] \downarrow + 4k$ (chocolate or red brown ppt.)
(7) Bi^{+3}	Bi^{+3} ion gives white ppt. while adding water In HCl soln.	$BiCl_3 + H_2O \rightarrow BiOCl \downarrow + 2HCl$ (white bismuth oxychloride) $BiCl_3 + 3Na_2SnO_2 + 6NaOH \rightarrow$ (sodium stanite) $2Bi \downarrow + 3Na_2SnO_3 + 6NaCl + 3H_2O$ (black sodium stanate)
(8) Cd^{+2}	(i) The yellow precipitate is dissolved in 50% HNO_3. To the resulting solution, NH_4OH is added slowly. A white ppt. appears which dissolve in excess of NH_4OH. (ii) When H_2S gas is passed in this solution a yellow ppt. a pears	$3Cds + 8HNO_3 \rightarrow 3Cd(NO_3)_2 + 4H_2O + 2NO + 3S$ (50%) $Cd(NO_3)_2 + 2NH_4OH \rightarrow 2NH_4NO_3 + Cd(OH)_2 \downarrow$ white ppt. $Cd(OH)_2 + 2NH_4OH + 2NH_4NO_3 \rightarrow [Cd(NH_3)_4](NO_3)_2 aq. + 4H_2O$ $[Cd(NH_3)_4](NO_3)_2 + H_2S \rightarrow CdS \downarrow 2NH_4NO_3 + 2NH_3$ (yellow ppt.)
II–B group/ (9) As^{+3}	In solution As^{+3} ion turns yellow ppt. with ammonium molybdate and HNO_3	$As^{+3} \xrightarrow{HNO_3} As^{+5}$ (as H_3AsO_4) $H_3AsO_4 + 12(NH_4)_2MoO_4 + 21HNO_3 \rightarrow (NH_4)_3AsO_4 + 12MoO_3 \downarrow \rightarrow 21NH_4NO_3 + 12H_2O$
(10) Sn^{+2}	Sn^{+2} ion in solution gives white ppt. in form of $SnCl_2$ with $HgCl_2$, which frequently turns black	$SnCl_2 + 2HgCl_2 \rightarrow SnCl_4 + HgCl_2 \downarrow$ $Hg_2Cl_2 + SnCl_2 \rightarrow SnCl_4 + 2Hg \downarrow$ (back)
(11) Sn^{+4}	Al turns Sn^{+4} to Sn^{+2} After it Sn^{+2} is examined by $HgCl_2$	$SnCl_4 + HgCl_2 \rightarrow$ No reaction $3SnCl_4 + 2Al \rightarrow 2AlCl_3 + 3SnCl_2$
(12) Sb^{+3}	On adding water in solution, Sb^{+3} ion forms white ppt. in the form of $SbCl_3$	$SbCl_3 + H_2O \rightarrow SbOCl \downarrow$ (white) + 2HCl
III group/ Fe^{+3}, Cr^{+3} & Al^{+3}	These ion precipts in the form of hydroxide on adding NH_4Cl & NH_4OH	$Fe^{+3} + 3OH^- \rightarrow Fe(OH)_3$ (red ppt.) $Cr^{+3} + 3OH^- \rightarrow Cr(OH)_3$ (green ppt.) $Al^{+3} + 3OH^- \rightarrow Al(OH)_3$ (white ppt.)
Note : In the analysis of III group, some drops of conc. HNO_3 are also added before oxidising Fe^{+2} to Fe^{+3}.		
(13) Al^{+3}	White ppt. of $Al(OH)_3$ is soluble in NaOH	Imp. $Al(OH)_3 + NaOH \rightarrow NaAlO_2 + 2H_2O$ (sodium metaaluminate)
(14) Cr^{+3}	ppt. of $Cr(OH)_3$ is soluble in NaOH + Br_2 water soln. in this soln. when $BaCl_2$ is added yellow ppt. is obtained	$Br_2 + H_2O \rightarrow 2HBr + O$ $2Cr(OH)_3 + 4NaOH + 3O \rightarrow 2Na_2CrO_4 + 5H_2O$ $Na_2CrO_4 + BaCl_2 \rightarrow BaCrO_4 \downarrow$ (yellow ppt.) + 2NaCl

(15) Fe^{+3}	(i) (a) Brown ppt. of $Fe(OH)_3$ is soluble in HCl (b) When KCNS is added in this soln. soln. blood red colouration is obtained (ii) In this soln., on adding $K_4[Fe(CN)_6]$, prussian blue colour is obtained	$Fe(OH)_3 + 3HCl \rightarrow FeCl_3 + 3H_2O$ $FeCl_3 + 3KCNS \rightarrow Fe(CN)S_3 + 3KCl$ (ferric thiocyanate) (blood red) $4FeCl_3 + 3K_4[Fe(CN)_6 \rightarrow Fe_4[Fe(CN)_6]_3 + 12KCl$ (ferric ferrocyanide prussian blue)
IV group/ Zn^{+2}, Mn^{+2} Co^{+2}, Ni^{+2} Co^{+2}, Ni^{+2} Zn^{+2} Mn^{2}	These ions in presence of NH_4OH preciptitate on passing H_2S. Black (CoS, Nis) Ppt., (soluble in aqua–ragia) White (ZnS) (soluble in HCl) Pink or buff (MnS), soluble in HCl	$MCl_2 + H_2S \rightarrow MS \downarrow + 2HCl$
(16) Ni^{+2}	In presence of NH_4OH, Ni salt on reaction with dimethyl glyoxime (DMG) turns red ppt. of nickel dimethyl glyxoime	**V. Imp.** $CH_3–C(=NOH)–C(=NOH)–CH_3 + NiCl_2 + 2NH_4OH$ $\rightarrow$ Nickel dimethyl glyoxime (red ppt)
(17) Co^{+2}	Cobalt salt turns blue colouration with NH_4CNS	$CoCl_2 + 4NH_4CNS \rightarrow$ $(NH_4)_2[Co(CNS)_4] + 2NH_4Cl$ (ammonium cobalt thiocyanate) (blue colour)
(18) Zn^{+2}	In solution, Zn^{+2} ion turns white ppt. with NaOH which is soluble in excess NaOH	**V. Imp** $Zn^{+2} + 2NaOH \rightarrow Zn(OH)_2 \downarrow$ (white) + 2Na $Zn(OH)_2 + 2NaOH \rightarrow Na_2ZnO_2 + 2H_2O$
(19) Mn^{+2}	(a) Mn^{+2} ion gives pink ppt. with NaOH (b) On heating turns black or brown	**V. Imp** $Mn^{+2} + 2NaOH \rightarrow Mn(OH)_2 \downarrow + 2Na$ (Pink) $Mn(OH)_2 + O \xrightarrow{\Delta} MnO_2 + H_2O$ (brown and black)
V group/ Ba^{+2}, Sr^{+2}, Ca^{+2}	On adding $(NH_4)_2CO_3$, these precipitates in the form of carbonates.	$M^{+2} + (NH_4)_2CO_3 \rightarrow MCO_3 + 2NH_4^+$ $BaCO_3$, $CaCO_3$, $SrCO_3$ (white) soluble in CH_3COOH
(20) Ba^{+2}	Gives Ba^{+2} ion in solution (i) Yellow ppt. with K_2CrO_4 (ii) white ppt. with $(NH_4)_2SO_4$ (iii) white ppt. with $(NH_4)_2C_2O_4$	$Ba^{+2} + K_2CrO_4 \rightarrow BaCrO_4 \downarrow$ (yellow) + 2K $Ba^{+2} + (NH_4)_2SO_4 \rightarrow BaSO_4 \downarrow$(white) + $2NH_4^+$ $Ba^{+2} + (NH_4)_2C_2O_4 \rightarrow BaC_2O_4 \downarrow$(white)+ $2NH_4^+$
(21) Sr^{+2}	Sr^{+2} ion with (i) $(NH_4)_2SO_4$ gives white precipitate	$Sr^{+2}(NH_4)_2SO_4 \rightarrow SrSO_4 \downarrow + 2NH_4^+$ (white ppt.)
(22) Cr^{+2}	Ca^{+2} ion gives white ppt. only with $(NH_4)_2C_2O_4$	$Ca^{+2} + (NH_4)_2C_2O_4 \rightarrow CaC_2O_4 \downarrow + 2NH_4^+$ (white) $Sr^{+2} + (NH_4)_2C_2O_4 \rightarrow SrC_2O_4 \downarrow + 2NH_4^+$ (white ppt.)

Note : The order of that is same as above Ba^{+2}, Sr^{+2}, Ca^{+2}

VI Group / (23) Mg^{+2}	Mg^{+2} ion gives white ppt. with NH_4OH $(NH_4)_2HPO_4$	$Mg^{+2} + (NH_4)_2HPO_4 + NH_4OH \rightarrow MgNH_4PO_4 \downarrow$ (white) $+ 2NH_4^+ + H_2O$
Zero group/ (24) NH_4^+	(i) (a) All ammonium salts on reacting with base like (NaOH), gives smell of NH_3 (b) Gas evolved (NH_3) gives white fume with HCl (c) On passing NH_3 in $Hg_2(NO_3)_2$, blakc colour is obtained (b) Brown ppt. is obtained with nesseler's reagent	(a) $NH_4Cl + NaOH \rightarrow NaCl + NH_3\uparrow + H_2O$ (b) $NH_3 + HCl \rightarrow NH_4Cl \uparrow$ (white fume) (c) $Hg_2(NO_3)_2 + 2NH_3 \rightarrow$ $Hg + Hg(NH_2)NO_3 + NH_4NO_3$ (black) $\rightarrow$ (d) $2K_2HgI_4 + 4KOH + NH_4Cl \rightarrow$ (Nesseler's reagent)  $+ 7KI + KCl.\ 3H_2O$ (Iodide solution brown ppt.)

BORAX BEAD TEST

On heating borax the colourless glass bead fromed consists of sodium metaborate and boric anhydride.

$$Na_2B_4O_7.10H_2O \xrightarrow{Heat} Na_2B_4O_7 \xrightarrow{Heat} \underbrace{2NaBO_2 + B_2O_3}_{\text{Glassy bead}}$$

On heating with a coloured salt, the glassy bead froms a coloured metaborate in oxidising flame.

$CuSO_4 \rightarrow CuO + SO_3$

$CuO + B_2O_3 \rightarrow Cu(BO_2)_2$

Copper metaborate
(Blue)

Metal	Oxidising - flame		Reducing - flame	
	Hot	Cold	Hot	Cold
Copper	Green	Blue	Colourless	Brown-red
Iron	Brown-yellow	Pale-yellow	Bottle green	Bottle green
Chromium	Green	Green	Green	Green
Cobalt	Blue	Blue	Blue	Blue
Nickel	Violet	Brown	Grey	Grey

Physical Appearance or inorganic salt

S.No.	Inorganic Salt	Colour
1.	Cu^{+2}	Blue
2.	Cr^{+3}, Cr^{+6}	Dark green
3.	Fe^{+3}	Green
4.	Fe^{+2}	Yellow or Brown
5.	Mn^{+2}	Light Pink
6.	Co^{+2}	Pink
7.	Ni^{+2}	Green or Blue
8.	HgO, HgI_2, Pb_3O_4	Red
9.	Pb, Hg and Ba salts	Comparatively heavy

ACTION OF HEAT

1. Except (Na, K, Rb and Cs) all carbonates on heating decomposes to give CO_2.

$LiCO_3 \xrightarrow{\Delta} Li_2O + CO_2\uparrow$

$MgCO_3 \xrightarrow{\Delta} MgO + CO_2\uparrow$

2. Generally all bicarbonates decomposes to give carbonates and CO_2

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

3. Generally halides are stable on heating but some halides decomposes.

$2FeCl_3 \xrightarrow{\Delta} 2FeCl_2 + Cl_2$

$MgCl_2.6H_2O \xrightarrow{\Delta} MgO + 2HCl + 5H_2O$

$Hg_2Cl_2 \xrightarrow{\Delta} HgCl_2 + Hg$

$NH_4Cl \xrightarrow{\Delta} NH_3 + HCl$

4. Nitrates decomposes on heating.

$NH_4NO_3 \rightarrow N_2O + 2H_2O$

$2MnO_3 \rightarrow 2MnO_2 + O_2$ (except Li)

$2LiNO_3 \rightarrow Li_2O + 2NO_2 + \frac{1}{2}O_2$ **imp.**

$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O$

$2Cu(NO_3)_2 \rightarrow CuO + 4NO_2 + O_2$ } (except Hg all bivalent nitrates)

$Hg(NO_3)_2 \rightarrow Hg + 2NO_2 + O_2$

5. Silver salts on heating gives Ag.

$Ag_2CO_3 \rightarrow 2Ag + CO_2 + \frac{1}{2}O_2$

$2AgNO_3 \rightarrow 2Ag + 2NO_2 + O_2$

CHARACTERISTIC FLAME COLOUR

(1) Pb → yeallow, green	(2) Cu salt, BO_3^{-3} → Blue or green
(3) Li → red	(4) Na → golden red
(5) K → violet	(6) Rb → boilet red
(7) Cs → voilet blue	(8) Ca → brick red
(9) Sr → krimson red	(10) Ba → apple green

Imp. Note ; (1) Be & Mg don't give flame test

(2) Colourless white salt dont' possess Cu, Ni, Co, Fe, Mn, Cr etc.

(3) White substances which swells are alum, borate and phosphate.

SUBLIMATION ACTION OF A SUBSTANCE AND COLOUR

White	$HgCl_2$, Hg_2Cl_2, As_2O_3, Sb_2O_3
Yellow	$AlCl_3$ and NH_3 halides
Brown	HgO, $Hg(NO_3)_2$
Blue, Balck and Voilet	Iodides
Black	As, Sb, Hg sulphides and iodides.