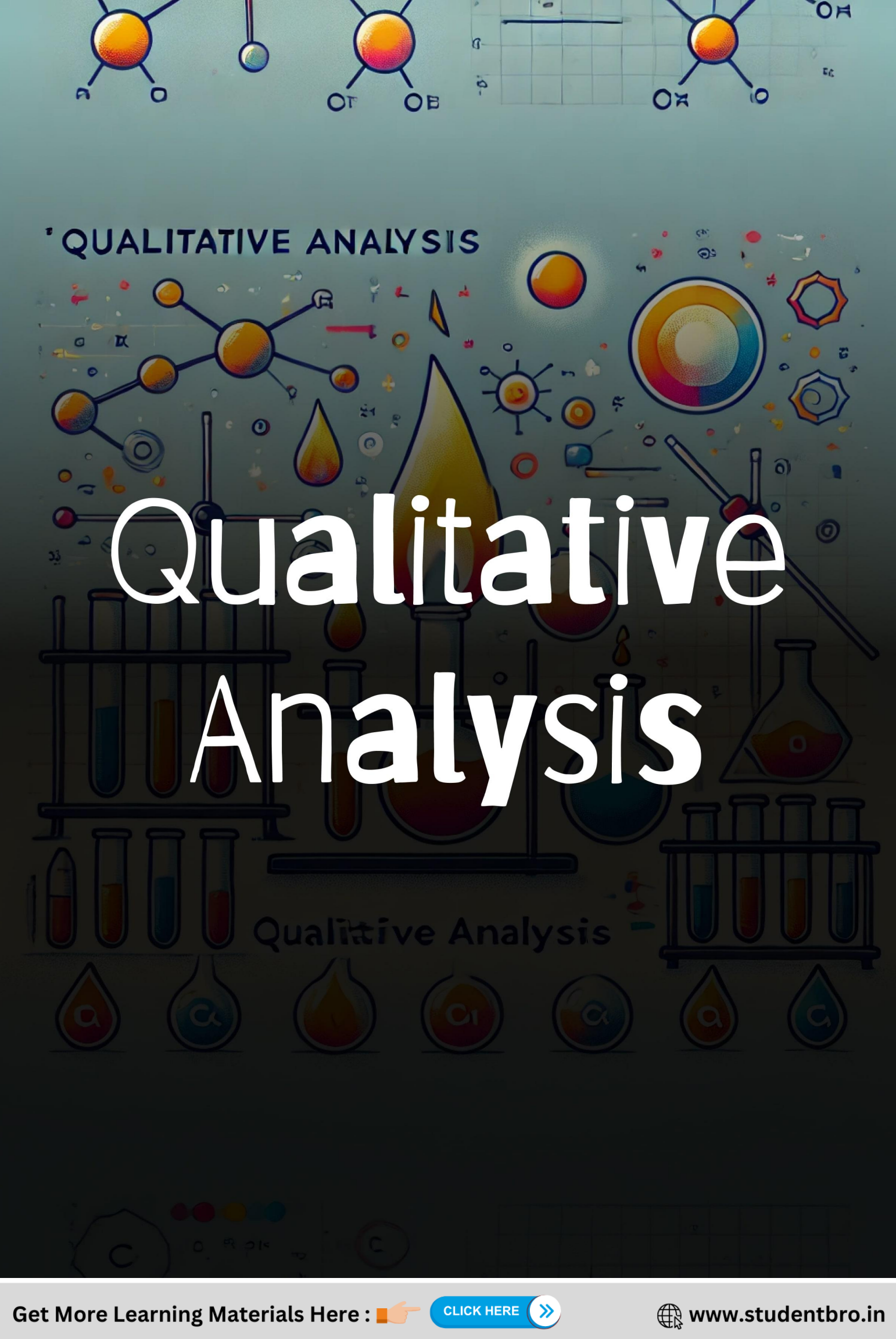


Qualitative Analysis

QUALITATIVE ANALYSIS

Systematic approach to analyse cation and anion in a given salt is known as "Qualitative analysis"

Eg: $CaCl_2$ → Acidic radical
↓
Basic radical

(a) PHYSICAL STATE

(i) Amorphous - Carbonates
(ii) Crystalline - Nitrites and nitrats
(iii) Hygroscopic - Alkali and alkaline earth metals

(b) SMELL

(i) Rotten egg - H_2S
(ii) Vinegar like smell - CH_3COO^-
(iii) Ammonical smell - NH_4^+
(iv) Irritating smell - SO_2

(c) COLOUR

S.NO.	COLOUR	IONS / COMPOUNDS
(i)	Blue	Cu^{+2}, $Co^{+2}(aq)$
(ii)	Green	Fe^{+2}, Cr^{+3}, Ni^{+2}, MnO_4^{-2}, Hg_2I_2
(iii)	Yellow	CrO_4^{-2}, AgI, AgBr, SnS_2, As_2S_3, cds, Fe^{+3}, HgO, PbO
(iv)	Pink	Co^{+2} (non aq.), MnO_4^-
(v)	Red	HgI_2, Pb_3O_4, Cu_2O
(vi)	Brown	Ag_2O, PbO_2, $Cu_2[Fe(CN)_6]$, SnS
(vii)	Orange	$Cr_2O_7^{-2}$, Sb_2S_3, Sb_2S_5, $K[BiI_4]$, SnI_2
(viii)	Black	Sulphides Pb^{+2}, Hg_2^{+2}, Bi^{+3}, Cu^{+2}, Hg_2O, CoS, NiS, I^-, Ag, CuS

Soluble implies both fully and partially soluble.

(ix)	White	Fe^{+2}, Fe^{+3}, Mn^{+2}, Cr^{+3}, Co^{+2}, Ni^{+2}, Cu^{+2} → these transition metal ions are absent.

(d) SOLUBILITY

1. All salts of Na^{+2}, K^+, Rb^+, Cs^+, NH_4^+ are soluble.

2. All metal nitrates, nitrides acetates, bicarbonates are soluble. but still soluble.

3. Except (Na, K, Rb, Cs, NH_4^+) carbonates; all carbonates are insoluble.

4. Except (Na, K, Rb, Cs, NH_4^+), all phosphates are insoluble.

5. All hydroxides except ($Na, K, Rb, Cs, NH_4^+, Ba^{+2}, Sr^{+2}$) are insoluble. LiOH and $Ca(OH)_2$ is partially soluble. Except (silver sulphate; all sulphates are soluble, Li_2SO_4 is partially soluble.

6. All halides except ($Ag^{+1}, Pb^{+2}, Hg_2^{+2}, Cu^{+1}$) {Almost}

Soluble ← AgF AgCl AgBr AgI → Insoluble

$MgF_2 < MgCl_2 < MgBr_2 < MgI_2$ (soluble)

Hg_2I_2 → Greend

@. DRY HEAT TEST

Fusion may occur (Alkali and alkaline earth metals) may be present in the given salt.

Cracking noise → (Nitrite and Nitrate)

Sublimation → white sublimate $NH_4Cl, AlCl_3$

Grey sublimate → $AsCl_3$, with garlic odour.

Red sublimate → AgI_2

Brown sublimate → $FeCl_3$

Corrosive sublimate → $HgCl_2$

Colomal → Hg_2Cl_2 → used in electrodes

Salts on decomposition on heating gives volatile product or gaseous product.

@. CO_2 – $MCO_3, M(HCO_3)_2$

PROPERTIES – CO_2 is colourless, odourless. It is acidic towards litmus. It is soluble in water. It doesn't support combustion, but some active metals burn in CO_2.

$2Mg + CO_2 \longrightarrow 2MgO + C$

$LiNa + CO_2 \longrightarrow 2Na_2O + C$

It doesn't give the permangate test, it doesn't give the dischromate test. It gives lime water test.

$Ca(OH)_2 + CO_2 \longrightarrow \underset{\text{(white turbidity)}}{CaCO_3\downarrow} + H_2O \xrightarrow[CO_2]{\text{excess}} \underset{\text{(soluble colourless)}}{Ca(HCO_3)_2}$

Carbonate and bicarbonate ion present in a given salt.

(b) **CO** → Metal oxalates

PROPERTIES: $M_2C_2O_4 \longrightarrow MO + CO\uparrow + CO_2\uparrow$

It is colourless gas. Burns with blue flame. Insoluble in water neutral towards litmus. It dissolve in NaOH at higher temp and pressure.

$$CO + NaOH \xrightarrow[200^\circ C]{5\text{-}10 atm} H-\overset{O}{\overset{\|}{C}}-O^- Na^+$$

It is poisonous gas. It gives +ve permanganate test.

$$\underset{(O.A)}{2KMnO_4} + 3H_2SO_4 + \underset{(R.A)}{5CO} \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5CO_2\uparrow$$

It gives +ve dichromate test.

$$\underset{(O.A)}{K_2Cr_2O_7} + 4H_2SO_4 + \underset{(R.A)}{3CO} \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O + 3CO_2\uparrow$$

It gives tollen's test.

$$AgNO_3 + NH_4OH \longrightarrow NH_4NO_3 + AgOH$$

$$2AgOH \xrightarrow{\Delta} Ag_2O + H_2O \qquad Ag_2O + CO \longrightarrow CO_2 + 2Ag$$

Fehling A + Fehling B

$CuSO_4 + Na^+O^- - \overset{O}{\overset{\|}{C}} - CH(OH) - CH(OH) - \overset{O}{\overset{\|}{C}} - O^- K^+ \longrightarrow Cu(OH)_2$

$$2Cu(OH)_3 \longrightarrow 2CuO + 2H_2O$$

$$2CuO + CO \longrightarrow CO_2 + Cu_2O$$

$$2Cu(OH)_2 + CO \xrightarrow{\Delta} CO_2 + 2H_2O + Cu_2O\ (Red)\downarrow$$

(c) **SO_2**

$MSO_3 \xrightarrow{\Delta} MO + SO_2\uparrow$ except (Na, K, Rb, Cs)

$CaSO_3 \xrightarrow{\Delta} CaO + SO_2\uparrow$

$NH_4SO_3 \longrightarrow 2NH_3 + SO_2\uparrow + H_2O\uparrow$

It is a colourless and irritating gas.
It is acidic towards litmus.
It is soluble in water.
It doesn't support combustion, but reactive metals burn in SO_2.

$$3Mg + SO_2 \longrightarrow 2MgO + MgS$$

It gives lime water test.

$$Ca(OH)_2 + SO_2 \longrightarrow CaSO_3 \downarrow + H_2O$$

(white turbidity)

It gives the dichromate +ve permanganate test.

$$K_2Cr_2O_7 + 4H_2SO_4 \longrightarrow Cr_2(SO_4)_3 + K_2SO_4 + 4H_2O + 3(O)$$

$$3SO_2 + 3(O) \longrightarrow 3SO_3$$
$$3SO_3 + 3H_2O \longrightarrow 3H_2SO_4$$

$$K_2Cr_2O_7 + H_2SO_4 + 3SO_2 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O$$

(orange) (green)

It gives the permanganate test.

$$2KMnO_4 \quad 3H_2SO_4 \quad K_2SO_4 \quad 2MnSO_4 \quad 3H_2O \quad 5(O)$$
$$5H_2O \quad 5(SO_2) \quad 5(O) \quad 5H_2SO_4$$
$$2KMnO_4 \quad 2H_2O \quad 5SO_2 \quad 2H_2SO_4 \quad K_2SO_4 \quad 2MnSO_4$$

(pink) (colourless)

SO_2 is given out, it shows that SO_3^{-2} or HSO_3^{-1} may be present in the given solution.

(d) H_2S

$$FeS + H_2SO_4(dil.) \longrightarrow H_2S\uparrow + FeSO_4$$

It is colourless, rotten egg smell, acidic towards litmus, soluble in water. It gives the permanganate dichromate test.

$$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5(O)$$
$$5H_2S + 5(O) \longrightarrow 5H_2O + 5(S)$$
$$2KMnO_4 + 3H_2SO_4 + 5H_2S \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + S\downarrow$$

(Yellow)

$K_2Cr_2O_7 + 4H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O + 3(O)$

$3H_2S + 3(O) \longrightarrow 3H_2O + 3S$

$K_2Cr_2O_7 + 4H_2SO_4 + 3H_2S \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O + 3S$

(orange) (green)

$\longrightarrow (CH_3COO)_2Pb + H_2S \longrightarrow 2CH_3COOH + PbS\downarrow$ (Black)

"March Test" is for arsonic Arsenic is/ Poisonous.

Sodium nitroprusside – $Na_2^{+2}[Fe^{+2}(CN)_5^{-5}Na^{+1}]$ (Red)

$Na_2[Fe_{+2}(CN)_5NO] + H_2S \longrightarrow Na_2H_2[Fe_{+2}(CN)_5NOS]$

O.S remains same — violet

NH_3

$NH_4OH \xrightarrow{\Delta} NH_3 + H_2O$

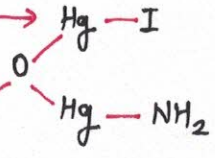
$(NH_4)_2CO_3 \xrightarrow{\Delta} 2NH_3 + CO_2\uparrow + H_2O\uparrow$

$(NH_4)SO_3 \xrightarrow{\Delta} 2NH_3 + SO_2\uparrow + H_2O\uparrow$

Colourless, pungent, soluble in H_2O, basic in nature towards litmus, changes it from red to blue.

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

It gives brown ppt with Nessler's reagent

$2K_2HgI_4 + 3KOH + NH_3 \longrightarrow$  $+ KI + 2H_2O$

Brown! (Iodide of Million's Base)

It forms deep blue solution with $CuSO_4$

$CuSO_4 + 4NH_4OH \longrightarrow [Cu(NH_3)_4]SO_4 + 4H_2O$

(dr.)

dsp^2, square planar

Dissolves cellulox acetate ← (Swelzer's Reagent)

Gives black ppt. with mercurous salt.

$Hg_2(NO_3)_2 + 2NH_3 \longrightarrow (Hg)(NH_3)(NO_3)(Hg)\downarrow + NH_4NO_3$

(Black)

Gives white ppt. with chloroplatinic acid

$$2NH_3 + H_2[PtCl_6] \longrightarrow (NH_4)_2[PtCl_6]\downarrow \text{ (Yellow)}$$

NH_4^+ ion present in the given salt.

CO - Sol in NaOH
NO - Insol

(f) **N_2O**

$$NH_4NO_3 \xrightarrow{\Delta} 2H_2O + N_2O \text{ (Nitrous oxide)}$$

Colourless, neutral towards litmus.

$$N_2O + H_2O \longrightarrow H_2N_2O_2$$

(Hyponitrous acid)

% of oxygen by mass is more than air in N_2O

If N_2O then ammonium ion and nitrate ion may be present in the given salt.
It gives +ve dichromate, +ve permangate test.

(g) **N_2**

$$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2\uparrow + Cr_2O_3 + 4H_2O$$

$$NH_4NO_2 \xrightarrow{\Delta} N_2\uparrow + 2H_2O$$

Colourless gas, inert (less reactive)
If $N_2\uparrow$ then NH_4^+ and NO_2^- ion may be present.

(h) **NO_2**

$$M(NO_3)_2 \xrightarrow{\Delta} MO + 2NO_2 + \tfrac{1}{2}O_2 \text{ (except Na, K, Rb, Cs)}$$

$$Ca(NO_3)_2 \xrightarrow{\Delta} CaO + 2NO_2 + \tfrac{1}{2}O_2$$

(Brown)

Pungent smell, brown, acidic towards litmus. It dissolves in alkali and forms two salts ($NaNO_2$, $NaNO_3$).

aNO_3 ion may be present if $NO_2\uparrow$
↳ confirmatory test = Brown ring.

(i) **NO**

$$3Cu + 8\,\text{dil.}\,HNO_3 \longrightarrow 3Cu(NO_3)_2 + 2NO\uparrow + 4H_2O$$

Colourless, neutral, insoluble in NaOH.
Not air
NO_2 (Brown)
Less reactive metal (Cu, Pb, Ag, Hg)

$Fe(SO_4).7H_2O \longrightarrow Fe_2O_3 + SO_2\uparrow + SO_3\uparrow$

(Red Brown)

Brown $\rightarrow FeCl_3$

(j) Cl_2 / HCL

$AlCl_3\ 6H_2O \qquad Cl(OH)_3 \quad 3HCl \quad 3H_2O$

$MgCl_2 \cdot 6H_2O \qquad Mg(OH)Cl \quad HCl \quad 5H_2O$

dry HCl $\longrightarrow MgCl_2 \quad 6H_2O$

(Anhydrous $MgCl_2$)

HCL - white, pungent smell, acidic, its aqueous soln is acidic towards litmus. It reacts with NH_3 to give dense white fumes (NH_4Cl)

$AgNO_3 + HCL \longrightarrow AgCl\downarrow + HNO_3$

(white ppt.)

$AgCl + 2NH_4OH \longrightarrow [Ag(NH_3)]Cl \quad 2H_2O$

(sol. complex)

Covalent metal chlorides on heating gives Cl_2 gas.

$PbCl_4 \longrightarrow PbCl_2 + Cl_2\uparrow$

$SnCl_2 \longrightarrow SnCl_2 + Cl_2\uparrow$

$2HgCl_2 \longrightarrow Hg_2Cl_2 + Cl_2\uparrow$

$2CuCl_2 \longrightarrow Cu_2Cl_2 + Cl_2$

(Yellow - green)

$F_2 \rightarrow$ Yellow | $I_2 \rightarrow Cl_2$

$Br_2 \rightarrow$ Brown / violet

$Cl_2 \rightarrow$ Pungent smell gas

If HCL/Cl_2 gas evolves, then chlorides ion may be present in the salt given.

(k) HBr/Br_2

HBr is acidic towards litmus, (aqueous). It reacts with NH_3 to give dense white fumes.

$NH_3 + HBr \longrightarrow NH_4Br + (\text{Dense white fumes})$

$AgNO_3 + HBr \longrightarrow HNO_3 + AgBr\ (\text{Yellow})$

$AgBr + 2NH_4OH \longrightarrow [Ag(NH_3)_2]Br + H_2O$

↳ Partial soluble

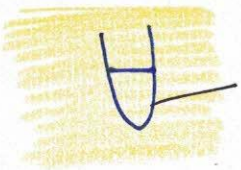
$AgCl \xrightarrow{AgNO_3}$ In NH_4OH sol. complex

$AgBr \xrightarrow{AgNO_3}$ In NH_4OH sol. partially sol.

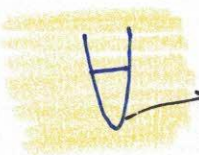
$AgI \xrightarrow{AgNO_3}$ In NH_4OH sol. insoluble

$2FeBr_3 \longrightarrow 2FeBr_2 + Br_2$ (Brown)

$2HBr \longrightarrow H_2 + Br_2$



$NaCl + Conc.\ H_2SO_4 \longrightarrow HCl \longrightarrow X$



$NaBr + Conc.\ H_2SO_4 \longrightarrow HBr \longrightarrow H_2 + Br_2$

(l) HI/I_2

Acidic nature towards litmus. It reacts with NH_3 to form dense white fumes of NH_4I.

$AgNO_3 + HI \longrightarrow AgI\downarrow + HNO_3$

(Dark yellow)

BY HEATING

$ZnCO_3 \quad ZnO \quad CO_2 \quad (Zn^{+2})$

In hot atmosphere, ZnO — yellow

In cold atmosphere, ZnO — white

SnO, In atmospheric holness → Brown

(Sn^{+2}) In cold atmosphere → yellow

Fe_2O_3, In hot atmosphere → Black

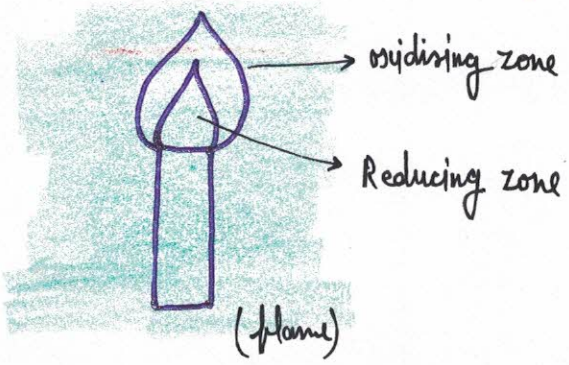
In cold atmosphere → Brown

BORAX BEAD TEST

$Na_2B_4O_7 \cdot 10H_2O \xrightarrow{\Delta} 2NaBO_2 + B_2O_3$ (Basic anhydride)

$B_2O_3 + MO \longrightarrow M(BO)_2$ (coloured meta borates)

(only coloured transition metal ion give this test)



In reducing zone, the rxn. is with carbon.

In oxidising flame

$CuSO_4 \longrightarrow CuO + SO_3$

$Na_2B_4O + 10H_2O \longrightarrow 2NaBO_2 + B_2O_3 + 10H_2O$

$CuO + B_2O_3 \longrightarrow Cu(BO_2)_2$ → Blue colour

(copper (+2) meta borate)

In Reducing flame

$2Cu(BO_2)_2 + C \longrightarrow Cu_2(BO_2)_2 + CO$ → Hot

Colourless

$Cu_2(BO_2)_2 + C \longrightarrow 2Cu + B_2O_3 + CO$

In cold

Red

In oxidising flame

$Ca(NO_3)_2 \xrightarrow{\Delta} CaO + 2NO_2\uparrow + \frac{1}{2}O_2\uparrow$

$Na_2B_4O_7 \cdot 10H_2O \xrightarrow{\Delta} 2NaBO_2 + B_2O_3 + 10H_2O$

$CoO + B_2O_3 \longrightarrow Co(BO_2)_2$

Blue Bead

In Reducing flame

$Co(BO_2)_2 \xrightarrow{C} Co(BO_2)_2$ Blue Bead

In oxidising flame

$Fe_2(SO_4)_3 \xrightarrow{\Delta} Fe_2O_3 + 3SO_3$

$Na_2B_4O_7 \xrightarrow{\Delta} 2NaBO_2 + B_2O_3 + 10H_2O$

$Fe_2O_3 + 3B_2O_3 \rightarrow 2Fe(BO_2)_3$ (Yellow Bead)

(Ferric metaborate)

In Reducing flame

$2Fe(BO_2)_3 \longrightarrow 2Fe(BO_2)_2 + CO + B_2O_3$

green

$FeSO_4 \xrightarrow{\Delta} Fe_2O_3 + SO_2 + SO_3$

Oxidising flame

$2MnSO_4 \longrightarrow 2MnO + 2SO_3$

$SO_3 \longrightarrow SO_2 + \frac{1}{2}O_2$

$2MnO + \frac{1}{2}O_2 \longrightarrow Mn_2O_3$

$MnSO_4 \longrightarrow Mn_2O_3 + SO_2 + SO_3$

$Mn_2O_3 + 3B_2O_3 \rightarrow 2Mn(BO_2)_3$ Pink

Reducing flame

$2Mn(BO_2)_3 \longrightarrow Mn(BO_2)_2 + B_2O_3 + CO\uparrow$

Colourless

Oxidising flame

$Cr_2(SO_4)_3 \xrightarrow{\Delta} Cr_2O_3 + 3SO_3\uparrow$

$Na_2B_4O_7 \cdot 10H_2O \rightarrow 2NaBO_2 + B_2O_3 + 10H_2O$

$Cr_2O_3 + 3B_2O_3 \rightarrow 2Cr(BO_2)_3$ green

Reducing flame

$2Cr(BO_2)_3 \xrightarrow{C} 2Cr(BO_2)_3$

green

Oxidising flame

$NiSO_4 \xrightarrow{\Delta} NiO + SO_3$

$Na_2B_4O_7 \cdot 10H_2O \rightarrow 2NaBO_2 + B_2O_3 + 10H_2O$

$NiO \; B_2O_3 \rightarrow Ni(BO_2)_2$ Red

Reducing flame

$Ni(BO_2)_2 \longrightarrow Ni + CO + B_2O_3$

ash

Wrong :- $FeCl_3$ - Yellow

$Fe(OH)_3$ - Rush brown

FLAME TEST

Inorganic salt + conc. HCL (3-4 drops) ⟶ Volatile chloride

BASIC RADICALS

For precification, ionic product of salt > Ksp.

↳ This is the way of dividing into groups

S.No.	GROUP	GROUP REAGENT	ION	PPt.
(i)	Zero	—	NH_4^+	NH_3 ↑ gas
(ii)	I Group	dil HCL	Pb^{+2}, Ag^{+1}, Hg_2^{+2}	$PbCl_2$ $AgCl$, Hg_2Cl_2 (White) Ksp – $PbCl_2 > AgCl > Hg_2Cl_2$
(iii)	II Group	dil. HCL + H_2S (common ion effect) Conc^n of S^{-2} ↓	IIA:- Pb^{+2}, Hg^{+2} Bi^{+3} Cd^{+2}, Cu^{+2}	PbS, HgS, Bi_2S_3 CuS (Black PPt) CdS - Yellow
			IIB:- Sn^{+2} Sn^{+4} As^{+3} As^{+5}, Sb^{+3} Sb^{+5} (least sol)	SnS - Brown SnS_2 - Yellow As_2S_3 As_2S_5 → Dirty yellow Sb_2S_3, Sb_2S_5 → Orange
(iv)	III Group	$NH_4Cl(s)$ + NH_4OH (common ion) $[OH^-]$ ↓	Al^{+3}, Fe^{+3} Cr^{+3}	$Fe(OH)_3$ → Rust Brown $Al(OH)_3$ → Gelatinous $Cr(OH)_3$ → White Dirty green

(v) IV group $NH_4Cl(s) + NH_4OH + H_2S$ $[S^{-2}] \uparrow$ $Zn^{+2}, Mn^{+2}, Ni^{+2}, Co^{+2}$

$ZnS \rightarrow$ white ppt
$MnS \rightarrow$ Buff. ppt
$CoS, NiS \rightarrow$ Black ppt

(vi) V group $NH_4Cl(s), + NH_4OH + (NH_4)_2CO_3$ $CO_3^{-2} \downarrow$ $Ba^{+2}\ Sr^{+2}\ Ca^{+2}$

$BaCO_3, SrCO_3\ CaCO_3$ white

(vii) VI group $NH_4Cl(s). + NH_4OH + (NH_4)_2CO_3$ $CO_3^{-2} \downarrow$ Mg^{+2} → $NH_4OH + NH_2PO_4$

$Mg\ NH_4\ PO_4$ (white ppt.)

Castron

ZERO GROUP

$(NH_4)_2CO_3 + 2NaOH \longrightarrow Na_2CO_3 + 2NH_3 \uparrow + 2H_2O$

$(NH_4)_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2NH_3 \uparrow + 2H_2O$

$NH_4.NO_3 + NaOH \longrightarrow NaNO_3 + NH_3 \uparrow + H_2O$

$NH_4.NO_2 + NaOH \longrightarrow NaNO_2 + NH_3 \uparrow + H_2O$

Any ammonium salt + $NaOH \longrightarrow NH_3 \uparrow$ (gas)

Test

[a] NH_3 turns (red to blue) litmus

[b] $NH_3 + HCl \longrightarrow NH_4Cl$ (Dense white fumes)

[c] $NH_3 + 2K_2HgI_4 + 3KOH \longrightarrow$ $O(Hg-I) + 7KI$; $Hg-NH_2 + 2H_2O$

[d] $4NH_3 + CuSO_4 \longrightarrow [Cu(NH_3)_4]SO_4$ (deep blue soln)

(Switzer's Reagent)

$HgCl_2 + 2NH_3 \longrightarrow NH_4Cl + Hg\begin{matrix}NH_2\\Cl\end{matrix}$ (white ppt)

$Hg_2(NO_3)_2 + 2NH_3 \longrightarrow Hg(NH_2)(NO_3)Hg + NH_4NO_3$ (Black ppt.)

$H_2[PtCl_6] + 2NH_3 \longrightarrow (NH_4)_2[PtCl_6]$ (Yellow ppt.)

I GROUP

Group Reagent - dil. HCL

Pb^{+2}

a. $Pb(NO_3)_2(aq) + 2HCl(dil.) \longrightarrow PbCl_2$ (White) $+ 2HNO_3$

$PbCl_2 + \text{hot } H_2O \longrightarrow$ PPt. dissolves

$PbCl_2 + 2HNO_3 \longrightarrow Pb(NO_3)_2$ (soluble) $+ 2HCl$

$Pb(NO_3)_2 + 2KI \longrightarrow PbI_2$ (Yellow) $+ 2KNO_3$

$PbI_2 + 2KI \longrightarrow K_2(PbI_4)$ (colourless)

b. $Pb(NO_3)_2 + K_2CrO_4 \longrightarrow PbCrO_4\downarrow$ (Yellow) $+ 2KNO_3$

c. $Pb(NO_3)_2 + 2NaOH \longrightarrow 2NaNO_3 + Pb(OH)_2$ (White)

d. $Pb(OH)_2 + 2NaOH \longrightarrow Na_2PbO_2 + 2H_2O$

e. $Pb(NO_3)_2 + \text{dil. } H_2SO_4 \longrightarrow PbSO_4$ White $+ 2HNO_3$

Ag^{+1}

a. $AgNO_3(aq) + \text{dil. } HCl \longrightarrow AgCl + HNO_3$

b. $AgCl\downarrow + \text{hot } H_2O \longrightarrow$ Insoluble

c. $AgCl\downarrow + 2NH_4OH \longrightarrow [Ag(NH_3)]Cl + 2H_2O$

excess of (sol. complex)

$2AgCl + Na_2C_2O_3 \longrightarrow 2NaCl + Ag_2C_2O_3\downarrow$ (White)

$AgCl + 2Na_2C_3O_3$ (excess) $\longrightarrow Na_3[Ag(CO_3)]$ (soluble)

$[Ag(NH_3)]Cl + 2HNO_3 \longrightarrow NH_4NO_3 + AgCl\downarrow$

$AgNO_3 + KI \longrightarrow \underset{\text{(Yellow)}}{AgI\downarrow} + KNO_3$

$2AgNO_3 + NO_2S_2O_3 \longrightarrow \underset{\text{white ppt}}{Ag_2S_2O_3}$ $\quad 2NaNO_3 \xrightarrow{\text{on long standing}} SO_2\downarrow + Ag_2S$ (Black)

$2AgNO_3 + K_2CrO_4 \longrightarrow \underset{\text{(Red)}}{Ag_2CrO_4\downarrow} + 2KNO_3$

SOLUBILITY:- $AgI < AgBr < AgCl < Ag_2CrO_4$ (Red)

AgI → Dark Yellow; AgBr → Yellow; AgCl → White; Ag_2CrO_4 → More soluble

Hg_2^{+2}

$Hg_2(NO_3)_2 + \underset{\text{(dil.)}}{2HCl} \longrightarrow \underset{\text{(White ppt.)}}{Hg_2Cl_2} + 2HNO_3$

Hg_2Cl_2 + hot water → Insol.

Conc. HCl → Insol.

Conc. HNO_3 → Insol.

$2HNO_3 + 6HCl$ (Aqua regia) → Sol.

$6\,\text{Conc. } HCl + 2\,\text{Conc. } HNO_3 \longrightarrow 2NaCl + 4H_2O + 4Cl$

$2Hg_2Cl_2 + 4Cl \longrightarrow 4HgCl_2$

$6HCl + 2HNO_3 + 2Hg_2Cl_2 \longrightarrow 4HgCl_2 + 2NOCl + 4H_2O$

Solubility $HgCl_2 > Hg_2Cl_2$

Reaction with $SnCl_2$

$SnCl_2$ (R.A) + $2HgCl_2$ (O.A) → $Hg_2Cl_2 + SnCl_4 \xrightarrow{+SnCl_2} SnCl_4 + 2Hg\downarrow$ (grey)

on long time, it becomes black.

$\downarrow HgCl_2$

Sol ($PbCl_2 > AgCl > Hg_2Cl_2$)

$HgCl_2 + 2KI \longrightarrow 2HCl + HgI_2$ (scarlet Red)

$HgI_2 + 2KI \longrightarrow K_2(HgI_4)$

$HgCl_2 + Cu \longrightarrow Hg_2Cl_2 + CuCl_2$

$Hg_2Cl_2 + FeCrO_4 \longrightarrow Hg_2CrO_4 + 2KCl$ (Red)

II A GROUP

Group reagent dil. HCL + H_2S

Pb^{+2}

a. $Pb(NO_3)_2 + H_2S\ (dil.\ HCL) \longrightarrow \underset{(Black)}{PbS\downarrow} + 2HNO_3$

$PbS + 50\%\ 2HNO_3 \longrightarrow Pb(NO_3)_2 + H_2S$

b. $Pb(NO_3)_2$ →
- $\xrightarrow{KI} PbI_2 \xrightarrow[KI]{excess} K_2[PbI_4]$
- $\xrightarrow{K_2CrO_4} PbCrO_4$
- $\xrightarrow{NaOH} Pb(OH)_2 \xrightarrow{NaOH} Na_2PbO_2$
- $\xrightarrow[H_2SO_4]{dil.} PbSO_4\downarrow$

Hg^{+2}

a. $Hg(NO_3)_2 + H_2S \longrightarrow \underset{(Black\ PPt).}{HgS} + 2HNO_3$

$HgS + 56\%\ HNO_3 \longrightarrow$ Insoluble

$2HgS + \underbrace{6HCL + 2HNO_3}_{Conc^{n}} \longrightarrow 2NaCl + 2S + 2HgCl_2\downarrow + 4H_2O$

$HgCl_2$ →
- $\xrightarrow{KI} HgI_2 \xrightarrow[KI]{excess} K_2[HgI_4]$
- $\xrightarrow{Cu} Hg_2Cl_2 \xrightarrow{K_2CrO_4} Hg_2CrO_4$ (Red)
- $\xrightarrow{SnCl_2} Hg_2Cl_2 \xrightarrow{SnCl_4} 2Hg\downarrow$ (green/Black)

Cu^{+2}

a. $Cu(NO_3)_2 + H_2S \longrightarrow CuS\downarrow$ (Black) $+ 2HNO_3$

b. $CuS + 50\%\ HNO_3 \longrightarrow Cu(NO_3)_2$ (sol.) $+ H_2S$

c. $Cu(NO_3)_2 + 4NH_4OH\ (excess) \longrightarrow \underset{deep\ blue}{[Cu(NH_3)_4](NO_3)_2} + 4H_2O$

$2Cu(NO_3)_2 + K_4[Fe(CN)_6] \longrightarrow \underset{(choc.\ brown)}{Cu_2[Fe(CN)_6]} + 4KNO_3$

d. $2Cu(NO_3)_2 + 2KCN \longrightarrow Cu(CN)_2 + 2KNO_3$

$Cu_2(CN)_2 \longrightarrow Cu(CN)_2 \quad (CN)_2$

$Cu_2(CN)_2 + 6KCN \longrightarrow 2K_3[Cu(CN)_4]$

$2Cu(NO_3)_2 + 10KCN \longrightarrow 2K_3[Cu(CN)_4] + 4KNO_3 + (CN)_2$

Cd^{+2}

a. $Cd(NO_3)_2 + H_2S \longrightarrow CdS\,(yellow)\downarrow + 2HNO_3$

b. $CdS + 50\%\ HNO_3 \longrightarrow Cd(NO_3)_2\,(sol) + H_2S$

c. $2Cd(NO_3)_2 + K_4[Fe(CN)_6] \longrightarrow 4KCNO_3 + Cd_2[Fe(CN)_6]$ (white ↓)

d. $Cd(NO_3)_2 + 2KCN \longrightarrow \downarrow Cd(CN)_2\,(white) + 2KNO_3$

$Cd(CN)_2 + 2KCN \longrightarrow K_2[Cd(CN)_4]\ (sol.)$

$Cd(NO_3)_2 + 4KCN \longrightarrow K_2[Cd(CN)_4] + 2KNO_3$

Bi^{+3}

IIB $\xrightarrow{(NH_4)_2Sx}$ Yellow ppt.

IIB $\xrightarrow{(NH_4)_2Sx}$ soluble (yellow sol.)

a. $Bi(NO_3)_2 + 3H_2S \longrightarrow Bi_2S_3\,(Black)\downarrow + 6HNO_3$

b. $Bi(NO_3)_3 + 3H_2S \longrightarrow 2Bi_2S_3\,(Black) + 6HNO_3$

c. $Bi_2S_3 + 6HNO_3\,(50\%) \longrightarrow 2Bi(NO_3)_2 + 3H_2S$

d. $Bi(NO_3)_3 + 3HCL \longrightarrow BiCl_3 \quad 3HClO_3$

e. $BiCl_3 + 3KI \longrightarrow BiI_3\,(Black) + 3KCL$

f. $BiI_3 + excess\ KI \longrightarrow K[BiI_4] \longrightarrow$ orange

g. $BiCl_3 + H_2O \longrightarrow BiOCl\downarrow + 2HCL$ (white turbidity)

h. $2[BiCl_3 + 3NaOH \longrightarrow 3NaCl + Bi(OH)_3]$

$2Bi(OH)_3 \xrightarrow{\Delta} Bi_2O_3 + 3H_2O$

$Bi_2O_3 + 3Na_2SnO_2 \longrightarrow 3Na_2SnO_3 + 2Bi \downarrow$

$2BiCl_3 + 6NaOH + 3Na_2SnO_2 \longrightarrow 3NaCl + 3Na_2SnO_3 + 2Bi$ (grey)

II B GROUP

a. Sn^{+2}, Sn^{+4}

$SnCl_2 \quad H_2S \quad SnS \quad 2HCl$

$SnS + (NH_4)_2S_2 \longrightarrow (NH_4)_2SnS_3$ (soluble)

$SnS + 2HCl$ (conc.) $\longrightarrow SnCl_2 + H_2S \uparrow$

$SnCl_2 + 2HgCl_2 \longrightarrow HgCl_2 + SnCl_4 \xrightarrow{+SnCl_2} SnCl_4 + 2Hg$

(grey Black)

$SnCl_2 \quad 2KI \quad 2KCl \quad SnI_2$

$3[SnCl_2 + 2H_2O \longrightarrow Sn(OH)_2 + 2HCl]$

$3[2HCl + 2NaOH \longrightarrow 2NaCl + 2H_2O]$

$3[Sn(OH)_2 + 2NaOH \longrightarrow Na_2SnO_2 + 2H_2O]$

$3SnCl_2 + 12NaOH \longrightarrow 6NaCl + 6H_2O + 3Na_2Sn_2$

(Green - Black)

$3SnCl_2 + 2Bi(OH)_3 + 12NaOH \longrightarrow NaCl + H_2O + NaSnO_3 + Bi$ (Black) $\downarrow$

$SnCl_4 + H_2S \longrightarrow SnS_2 + 4HCl$ (yellow)

$SnS_2 + (NH_4)_2S_2 \longrightarrow (NH_4)_2SnS_3 + S$

b. Sb^{+3} and Sb^{+5}

$2SbCl_3 + 3H_2S \longrightarrow Sb_2S_3$ (orange) $+ 6HCl$

$Sb_2S_3 + 3(NH_4)_2S_2 \longrightarrow 2(NH_4)_3SbS_4 + S$

$Sb_2S_3 + 6HCl \longrightarrow H_2S + 3SbCl_3$

$SbCl_3 + H_2O \longrightarrow \downarrow SbOCl$ (white) $+ 2HCl$

$SbCl_5 + 5H_2S \longrightarrow Sb_2S_5$ (orange) $+ 10HCl$

$Sb_2S_5 + 3(NH_4)_2S_3 \longrightarrow 2(NH_4)_3SbS_4 + 6S$

c. As^{+3}

$2AsCl_3 + 3H_2S \longrightarrow As_2S_3 + 6HCl$

$As_2Cl_3 + 3(NH_4)_2S_2 \longrightarrow 2(NH_4)_3AsS_4 + S$

$As_2S_3 + HCl\ (conc^n) \longrightarrow X$ {As_2S_3 is insol in conc. HCl}

$As_2S_3 + 22HNO_3\ (conc.) \longrightarrow 2H_3AsO_4 + 3SO_2 + 22NO_2 + 8H_2O + (NH_4)_2MoO_4$

Yellow ppt

III GROUP

Group reagent $NH_4Cl + NH_4OH$

1. Fe^{+3}

$FeCl_3 + 3NH_4OH \longrightarrow 3NH_4Cl + Fe(OH)_3\downarrow$ Rust Brown

$Fe(OH)_3 + 3HCl \longrightarrow FeCl_3\ (sol.) + 3H_2O$

(Brown/Red)

$4FeCl_3 + 3K_4[Fe(CN)_6] \longrightarrow 12KCl + Fe_4[Fe(CN)_6]_3$

(Prussian blue)

$FeCl_3 + 3CH_3COOH \longrightarrow (CH_3COO)_3Fe + 3HCl$

Red soln

$CH_3COO(OH)_2Fe$ (Basic Ferric acetate) $\longrightarrow$ Red PPt.

$FeCl_3 + 3NH_4SCN \longrightarrow 3NH_4Cl + Fe(SCN)_3\downarrow$

(Blood Red PPt.)

only amphoteric dissolve in NaOH

$Ca(NO_3)_2 \xrightarrow{\Delta} CaO + NO_2\uparrow + \frac{1}{2}O_2$

2. Al^{+3}

$Al(OK)_3$ is amphoteric

a. $AlCl_3 + 3NH_4OH \longrightarrow 3NH_4Cl + Al(OH)_3\downarrow$ (gelatinous white ppt.)

b. $Al(OH)_3 + 3HCl\ (dil.) \longrightarrow AlCl_3 + 3H_2O$

(sol.)

$Al(OH)_3 + 3NH_4Cl \longrightarrow 3NaCl + Al(OH)_3\downarrow + NH_3\uparrow$

(sol)

c. $3H_2O + 2NaAlO_3 + 3CO_2 \longrightarrow 3Na_2CO_3 + 2Al(OH)_3\downarrow$

(gelatinous white ppt.)

If we add $Co(NO_3)_2$, then we get a blue colour as $Co(NO_3)_2$ will give us (CoO) on heating.

$$2Al(OH)_3 + Co(NO_3)_2 \xrightarrow{\Delta} \text{Blue ppt. } (Al_2O_3.CoO)$$

Cr^{+3}

(a) $CrCl_3 + 3NH_4OH \longrightarrow 3NH_4Cl + Cr(OH)_3\downarrow$ (Dirty green)

(b) $Cr(OH)_3 + 3HCl \longrightarrow \underset{\text{soluble}}{CrCl_3} + 3H_2O$

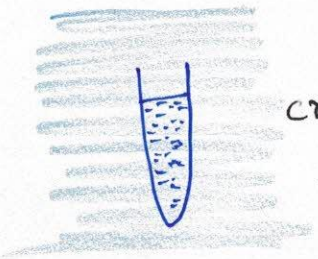
(c) $CrCl_3 + 3NaOH \longrightarrow 3NaCl + Cr(OH)_3\downarrow$

(d)

$$2Cr(OH)_3 \longrightarrow Cr_2O_3 + 3H_2O$$
$$Cr_2O_3 + 3H_2O \longrightarrow 2CrO_3 + 3H_2O$$
$$2CrO_3 + 4NaOH \longrightarrow Na_2CrO_4 + 2H_2O$$

$$2Cr(OH)_3 + 3H_2O_2 + NaOH \longrightarrow \underset{\text{(Yellow)}}{Na_2CrO_4} + 8H_2O$$

$$Na_2CrO_4 + \underset{\text{(Acidified lead acetate)}}{Pb(CH_3COO)_2} \longrightarrow \underset{\text{(Yellow)}}{PbCrO_4} + 2CH_3COO^-Na^+$$



$$Cr_2O_3 + H_2O_2 + NaOH \longrightarrow + (H_3COO)_2Pb$$ Yellow ppt.

IV GROUP

Group reagent :- $NH_4Cl(s) + NH_4OH + H_2S$

Zn^{+2} (Amphoteric)

(a) $ZnCl_2 + H_2S \longrightarrow \underset{\text{(white)}}{ZnS}\downarrow + 2HCl$

(b) $ZnS + 2HCl \longrightarrow ZnCl_2 + H_2S$ (sol.)

$ZnS + 2NaOH \longrightarrow Na_2ZnO_2 + H_2S$ (sol.)

(c) $2ZnCl_2 + K_4[Fe(CN)_6] \longrightarrow 4KCl + Zn_2[Fe(CN)_6]\downarrow$ (white)

(d) $ZnCl_2 + 2KCN \longrightarrow 2KCl + Zn(CN)_2$ (white)

$Zn(CN)_2 + KCN \longrightarrow K_2[Zn(CN)_4]$

$ZnCl_2$ $\quad$ $4KCN$ (excess) $\quad$ $2KCl$ $\quad$ $K_2[Zn(CN)_4]$ (soluble)

2. Mn^{+2}

(a) $MnSO_4 + H_2S \longrightarrow MnS + H_2SO_4$ (Buff. ppt. / Peach)

OR

$MnCl + H_2S \longrightarrow 2HCL + MnS$

(b) $MnS + 2HCL \longrightarrow MnCl_2 + H_2S$ (dil.)

(c) $MnCl_2 + 2H_2O \longrightarrow Mn(OH)_2 + 2HCL$

$Mn(OH)_2 \xrightarrow{\Delta} MnO + H_2O$

$MnO + 2H_2O_2 \longrightarrow MnO_3 + 2H_2O$

$MnO_3 + 2H_2O_2 \longrightarrow K_2MnO_4 + H_2O$

$MnCl_2 + 2H_2O_2 + 2KOH \longrightarrow K_2MnO_4 + 2HCL + 2H_2O$ (green)

$2K_2MnO_4 + Cl_2 \longrightarrow 2KCl + KMnO_4$

(Cl_2: O.A) $\quad$ ($KMnO_4$: Pink - violet)

(d) $Pb_3O_4 + MnCl_2 \longrightarrow HMn^{+7}O_4$

(Red lead) $+ HNO_3$

$2[Mn^{+2}Cl_2 + 2HNO_3 \longrightarrow Mn(NO_3)_2 + 2HCl]$ (HNO_3: O.A)

$MnCl_2 + H_2O \longrightarrow MnO + 2HCL$

$2HNO_3 \longrightarrow H_2O + 2NO_2 + (O)$

$2[MnO + (O) \longrightarrow MnO_2]$

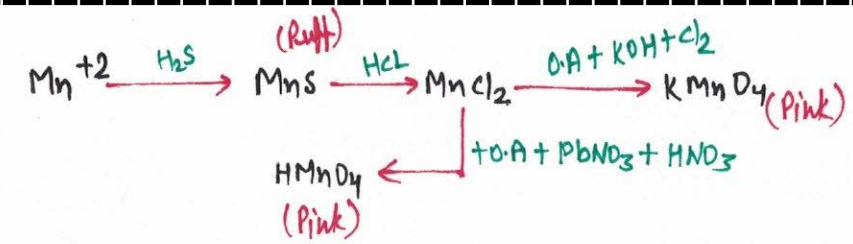
$3[Pb_3O_4 \longrightarrow 3(PbO) + (O)]$

$2[MnO_2 + (O) \longrightarrow (MnO_3)]$

$3[3PbO + 6HNO_3 \longrightarrow 3Pb(NO_3)_2 + 3H_2O]$

$2MnO_3 + H_2O + (O) \longrightarrow 2HMnO_4$

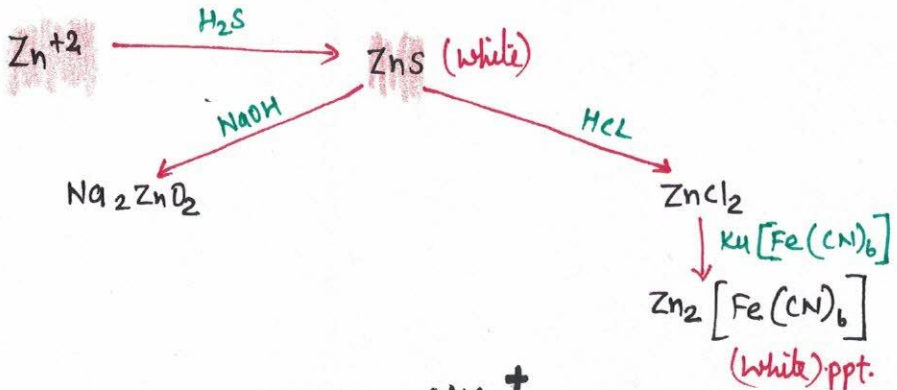
$2MnCl_2 + 3Pb_3O_4 + 22HNO_3 \longrightarrow 9Pb(NO_3)_2 + 4NO_2 + 4HCL + 2HMnO_4 + 8H_2O$ ($HMnO_4$: Pink)

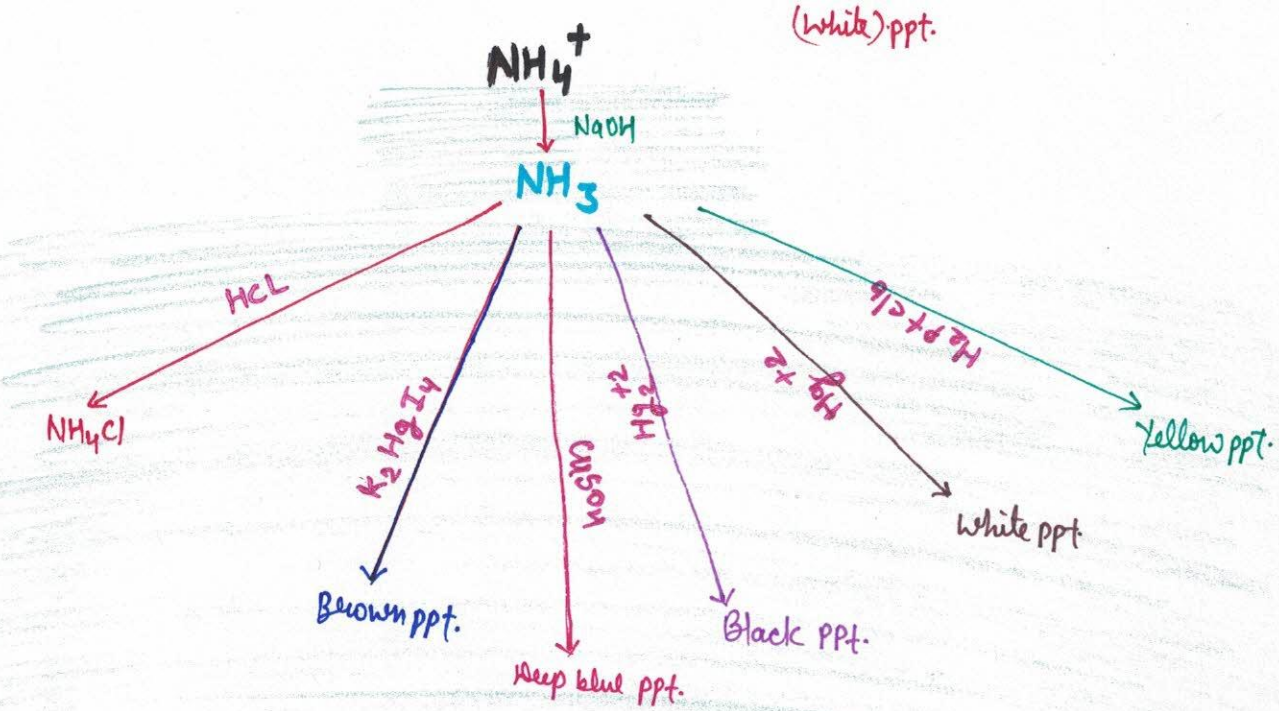


$(NH_4)_2 SnCl_6$ is pink in colour

Mohr's salt - Light green $\xrightarrow[NaOH]{\Delta} NH_3$

PbO (Yellow) → Litharge





Compounds which produces blue mass in cobalt nitrate test and forms a brown ring with $FeSO_4$ and con. H_2SO_4 ⟶ $Al(NO_3)_2$

$NaF + H_2SO_4 + SiO_2 \longrightarrow$ white fumes

$Hg(NO_3)_2$ ⟶ Hg NO_2 O_2

In estimation of CO, we use I_2O_5, but we use tests like permanganate test etc.

$$I_2O_5 + CO \longrightarrow 5CO_2 + I_2$$

$$2Na_2S_2O_3 + I_2 \longrightarrow 2NaI + Na_2S_4O_6$$

3. Ni^{+2}

a. $NiSO_4 + H_2S \longrightarrow NiS\downarrow + H_2SO_4$
(Black ppt.)

b. $NiS + 6HCL + 2HNO_3 \longrightarrow ?$
(Aqua regia)

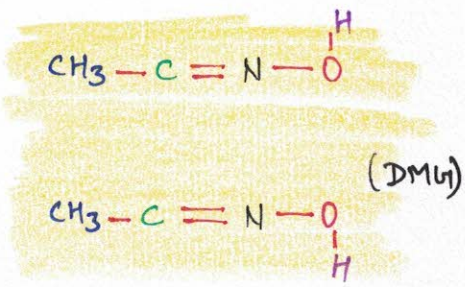
$6HCL + 2HNO_3 \longrightarrow 2NOCl + 4H_2O + 4Cl$

$2NiS + 4Cl \longrightarrow 2NiCl_2 + 2S$

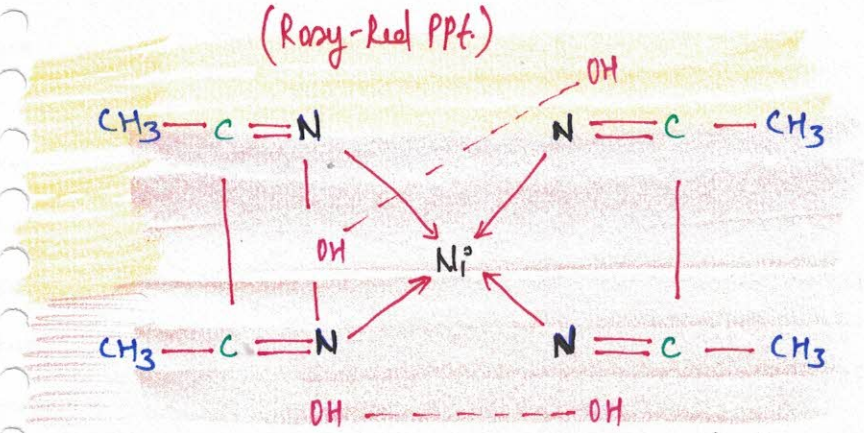
$2NiS + 6HCL + 2HNO_3 \longrightarrow 2Nacl + 2NiCl_2 + 2S\downarrow + 4H_2O$

c. $NiCl_2 + 2NH_4OH \longrightarrow Ni(OH)_2 + 2NH_4Cl$
(green ppt.)

d. $NiCl_2 + DMG \longrightarrow ?$
(Demethyle glyoxime)



(Rosy-Red Ppt.)



The donor is nitrogen atom and

dsp2

O.S = +2

4. Co^{+2}

a. $CoCl_2 + H_2S \longrightarrow 2HCL + CoS\downarrow$

b. $CoS + HCL + 2HNO_3 \longrightarrow 2NOCl + 2CoCl + 4H_2O + 2S\downarrow$

c. $CoCl_2 + 2NH_4OH \longrightarrow Co(OH)_2\downarrow + 2NH_4Cl$
(Red ppt.)

d. $CoCl_2 + KNO_2 \xrightarrow{CH_3COOH} K_3[Co(NO_2)_6]$ (Yellow)$\downarrow$

We don't use nameer as it gives soluble. (Potassium cobaltinitrate compound).

e. $CaCl_2 + 4NH_4SCN \longrightarrow (NH_4)_2[Co(SCN)_4] + 2NH_4Cl$

(In presence of NH_4OH)

↓

(Blue colour in either or non polar solvent)

V GROUP

Group reagent is $NH_4Cl\,(s) + NH_4OH + (NH_4)_2CO_3$

common ion effect is used to decrease the conc^n of CO_3^{-2} via $[NH_4^+]$ common ion effect.

a. $BaCl_2$

(i) $BaCl_2(aq) + (NH_4)_2CO_3 \longrightarrow BaCO_3\downarrow + NH_4Cl$

(ii) $BaCO_3 + 2CH_3COOH \longrightarrow (CH_3COO)_2Ba + H_2O + CO_2\uparrow$

(Any weak acid) — soluble

(iii) $(CH_3COO)_2Ba + K_2CrO_4 \longrightarrow BaCrO_4\downarrow + 2CH_3COO^{\ominus}K^{\oplus}$

yellow

(iv) $(CH_3COO)_2Ba + (NH_4)_2SO_4 \longrightarrow BaSO_4\downarrow + 2CH_3COO^{\ominus}NH_4^{\oplus}$

white

(v) Flame test:- $BaCl_2$ → Apple green

Sol. of alkaline earth metal chromates down the group ↓

Sol. of metal oxalates down the group ↑

b. $SrCl_2$

(i) $SrCl_2 + (NH_4)_2CO_3 \longrightarrow SrCO_3\downarrow + 2NH_4Cl$

(white)

(ii) $SrCO_3 + 2CH_3COOH \longrightarrow (CH_3COO)_2Sr + H_2O + CO_2\uparrow$

(Sol.)

(iii) $(CH_3COO)_2Sr + (NH_4)_2SO_4 \longrightarrow SrSO_4\downarrow + 2CH_3COONH_4$

(white)

(iv) Flame test → Crimson Red

c. $CaCl_2$

(i) $CaCl_2 + (NH_4)_2CO_3 \longrightarrow \underset{\text{(White)}}{CaCO_3\downarrow} + 2NH_4Cl$

(ii) $CaCO_3 + 2CH_3COOH \longrightarrow \underset{\text{(soluble)}}{(CH_3COO)Ca} + H_2O + CO_2\uparrow$

(iii) $(CH_3COO)Ca + (NH_4)_2C_2O_4 \longrightarrow \underset{\text{(White)}}{CaC_2O_4\downarrow} + 2CH_3COONH_4$

(iv) Flame test :- Brick Red

VI GROUP

a. Na

$NaCl + KH_2SbO_4 \longrightarrow KCL + \underset{\text{(White ppt.)}}{NaH_2SbO_4\downarrow}$

(KH_2SbO_4: soluble)

This sodium salt is insoluble

Flame colour :- Golden yellow

$2NH_4NO_3 \xrightarrow{\Delta} 2H_2O + N_2O(g)$

$N_2O(g) \xrightarrow{\Delta} N_2 + \frac{1}{2}O_2$

$NaNO_3 + NH_3 + H_2O \xrightarrow[Hg_2(Na)_{1/2}]{} \text{Black ppt.}$

($NaNO_3$ is obtained by $NaOH$)

$NH_4NO_3 + NaOH \downarrow NaNCO_3 + NH_3$

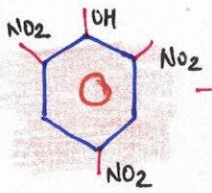
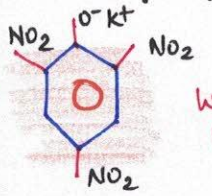
b. K

(i) $3KCl + Na_3[Co(NO_2)_6] \longrightarrow 3NaCl + K_3[Co(NO_2)_6]$

($Na_3[Co(NO_2)_6]$: soluble; $K_3[Co(NO_2)_6]$: yellow ppt.)

Thus, $[Co(NO_2)_6]^{-3}$, solubility down the group ↓

Thus, $[H_2SbO_4]^{-1}$ solubility down the group ↑

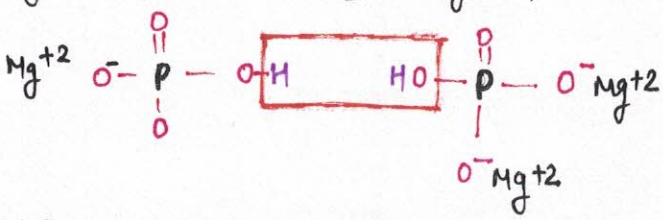
(ii) $KCl +$  $\longrightarrow$  White ppt. $+ HCl$

(iii) Flame - (lilac / violet)

c. Mg^{+2}

$MgSO_4 + NH_4OH + Na_2HPO_4 \longrightarrow MgNH_4PO_4$ (white ppt) $+ NaHSO_4$

$MgNH_4PO_4 \longrightarrow NH_3 + MgHPO_4$



$\longrightarrow Mg_2P_2O_7$ (white) $\downarrow + H_2O$

$MgSO_4 + Na_2CO_3 \longrightarrow MgCO_3 . Mg(OH)_2 + Na_2SO_4$

(white ppt) $\downarrow$

$MgSO_4 + 2NaHCO_3 \longrightarrow MgCO_3 + Na_2SO_4 + CO_2\uparrow \quad H_2O$

with cobalt nitrate :-

$MgSO_4 + Co(NO_3)_2 \xrightarrow{\Delta} ?$

$MgSO_4 \xrightarrow{\Delta} MgO + SO_3$

$Ca(NO_3)_2 \xrightarrow{\Delta} CoO + 2NO_2 + \frac{1}{2}O_2$

$CaO \quad MgO \longrightarrow CoO . MgO$

ACIDIC RADICALS

(Na_2CO_3 extract) medium is the best for the acidic radical section.

1. Decomposed by dil. H_2SO_4

Salt + dil. H_2SO_4

Salts must be in solid phase.

- Ca_2 gas (CO_3^{-2})
- SO_2 gas (SO_3^{-2}) suffocating irritating
- H_2S gas Rotten egg (S^{-2})
- Brown gas ($NO \rightarrow NO_2$) (NO_2^{-1})
- Vinegar like smell (CH_3COO^-)
- $SO_2 + S\downarrow$ ($S_2O_3^{-2}$)

CARBONATE $MCO_3 + dil.\ H_2SO_4 \longrightarrow MSO_4 + CO_2\uparrow + H_2O$

$Na_2CO_3 + dil.\ H_2SO_4 \longrightarrow Na_2SO_4 + CO_2\uparrow + H_2O$

$CO_2 + Ca(OH)_2 \longrightarrow CaCO_3\downarrow + H_2O \xrightarrow{\text{excess } CO_2} Ca(HCO_3)_2$ Soluble

SULPHITE

(a) $Na_2SO_3 + dil.\ H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + SO_2\uparrow$

(b) $K_2Cr_2O_7 + H_2SO_4 + 3SO_2 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + H_2O$
(orange) → (green)

SULPHIDE

(a) $Na_2S + dil.\ H_2SO_4 \longrightarrow Na_2SO_4 + H_2S$

(b) $H_2S + (CH_3COO)_2Pb \longrightarrow PbS\downarrow + 2CH_3COOH$

(c) $H_2S + Na_2[Fe(CN)_5NO] \longrightarrow Na_2H_2[Fe(CN)_5NOS]$
(Red) → (violet)

$CaC_2O_4 \longrightarrow CO_2 + CO + CaO \longrightarrow$ Basic
CO_2: Acidic; CO: Neutral

NO_2^-

(a) $NaNO_2 + dil.\ H_2SO_4 \longrightarrow Na_2SO_4 + 2HNO_2$

$2HNO_2 \longrightarrow H_2O + 2NO + \frac{1}{2}O_2$

$2NaNO_2 + dil.\ H_2SO_4 \longrightarrow Na_2SO_4 + 2NO\uparrow + \frac{1}{2}O_2 + H_2O$

(Brown) NO_2 ← (colourless gas) NO

(b) **BROWN RING TEST**

$FeSO_4 + H_2SO_4 + NaNO_2 \longrightarrow Na_2SO_4 + Fe(SO_4)_3 + 2[FeSO_4 \cdot NO] + H_2O$
(Brown ring)

MECHANISM

$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2$

$2NaNO_2 + 2H_2O \longrightarrow 2NaOH + 2HNO_2$

$2HNO_2 \longrightarrow H_2O + 2NO + (O)$

$2FeSO_4 + H_2SO_4 + (O) \longrightarrow Fe(SO_4)_3 + H_2O$

$2FeSO_4 + 2NO \longrightarrow 2[FeSO_4 \cdot NO]$

$4FeSO_4 + 2NaNO_2 + 2H_2SO_4 \longrightarrow Fe_2(SO_4)_3 + Na_2SO_4 + 2[FeSO_4 \cdot NO] + 2H_2O$

(c) It gives I_2 with KI $\xrightarrow[KI]{\text{excess}}$ KI_3 (Brown)

$2NaNO_2 + 2H_2SO_4 + 2KI \longrightarrow Na_2SO_4 + K_2SO_4 + I_2\ (\text{violet}) + 2NO + 2H_2O$
Brown ← excess KI

ACETATE (CH_3COO^-)

$2CH_3COO^-Na^+ + H_2SO_4(dil.) \longrightarrow Na_2SO_4 + 2CH_3COOH$

(sodium acetate) (vinegar like smell)

$3CH_3COOH + FeCl_3 \longrightarrow (CH_3COO)_3Fe + 3HCl$

(Blood Red Ferric acetate)

$Cd(NO_3)_2 + NH_4OH \longrightarrow [Cd(NH_3)_4](NO_3)_2 \xrightarrow{H_2S} CdS + NH_3 + 2HNO_3$

(excess) (yellow)

H_2O

MECHANISM $[Cd(NH_3)_4](NO_3)_2 \longrightarrow Cd(NO_3)_2 + 4NH_3$

$2CH_3COO^-Na^+ + H_2C_2O_4 + H_2O \longrightarrow Na_2C_2O_4 + 2CH_3COOH$

$CH_3-\overset{O}{\overset{\|}{C}}-OH + HO-let \xrightarrow[H_2SO_4]{dil.} CH_3-\overset{O}{\overset{\|}{C}}-O-let + H_2O$

Ester (Fruity Smell)

$S_2O_3^{-2}$ (thio-sulphate)

$Na_2S_2O_3 + dil\ H_2SO_4 \longrightarrow Na_2SO_4 + H_2S_2O_3$

$H_2S_2O_3 \longrightarrow H_2O + SO_2\uparrow + S\downarrow$

A pungent smelling gas and a yellow turbidity.

$Na_2S_2O_3 + 2AgNO_3(excess) \longrightarrow Ag_2S_2O_3\downarrow + 2NaNO_3$

(white)

$Ag_2S_2O_3 \longrightarrow Ag_2S\downarrow + SO_3\uparrow$

(Black)

$3Na_2S_2O_3 + 2FeCl_3 \longrightarrow Fe_2(S_2O_3)_2 + 6NaCl$

(Pink colour solution)

After sometimes, pink colour disappears.

$2\overset{+2}{Na_2}S_2O_3 + 2FeCl_3 \longrightarrow 2FeCl_2 + 2NaCl + \overset{+2.5}{Na_2S_4O_6}$

O.S = +2 O.S = 2.5

Decomposed by Conc. H_2SO_4

Salt + Conc. H_2SO_4

- White gas, Pungent smell (HCl) → Cl_2 (yellow green gas) → Cl^- ion
- White gas, Pungent smell (HBr) → Br_2 (orange Brown / Red) → Br^- ion
- White gas, Pungent smell (HI) → I_2 (violet) → I^- ion
- Brown gas (NO_2) → NO_3^{-1} (Nitrate) → Pungent smell

$\longrightarrow$ CO↑ + CO_2↑ (colourless) $\longrightarrow$ $C_2O_4^{-2}$ ion present

(CO) burns with a blue flame

Cl^- ion

a. $2NaCl + H_2SO_4$ (conc.) $\longrightarrow Na_2SO_4 + 2HCl\uparrow$ (white)

$4HCl + MnO_2 \longrightarrow MnCl_2 + 2H_2O + Cl_2\uparrow$ (yellow green)

(R.A) (O.A)

b. Na_2CO_3 extract of salt + dil. HNO_3 $\longrightarrow$ To neutralise

$NaCl + AgNO_3 \longrightarrow AgCl\downarrow + NaNO_3$ (white ppt)

Also can be done in Na_2CO_3 extract or aqueous sol^n.

$AgCl + 2NH_4OH \longrightarrow [Ag(NH_3)]Cl + 2H_2O$ (soluble)

Cl^- is present

chromyl chloride test – only ionic chlorides will give this test.

$NaCl$ (solid) + $K_2Cr_2O_7$ (s) + conc. $H_2SO_4 \longrightarrow$?

$K_2Cr_2O_7 + H_2SO_4 \longrightarrow K_2SO_4 + H_2Cr_2O_7$

$H_2Cr_2O_7 \longrightarrow H_2O + 2CrO_3$

$2[2NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2HCl]$

$4HCl + 2CrO_3 \longrightarrow 2CrO_2Cl_2 + 2H_2O$

$K_2Cr_2O_7 + 4NaCl + 3H_2SO_4 \longrightarrow 2CrO_2Cl_2 + Na_2SO_4 + K_2SO_4 + 3H_2O$

(Red orange vapours)

$CrO_2Cl_2 + 2NaOH \longrightarrow Na_2CrO_4 + 2HCl$ (Yellow sol^n) $\xrightarrow[CH_3COOH]{\text{Acidified buffer}} PbCrO_4$ (Yellow)

$NH_3 + 3Cl_2 \longrightarrow NCl_3 + 3HCl$ (excess)

$8NH_3 + 3Cl_2 \longrightarrow 6NH_4Cl + N_2\uparrow$ (excess)

Br^- ion

a. $2NaBr + H_2SO_4$ (conc.) $\longrightarrow Na_2SO_4 + 2HBr\uparrow \longrightarrow + H_2 + Br_2$ (white) (orange Brown gas)

b. Na_2CO_3 extract of salt + dil. HNO_3 $\longrightarrow$

$NaBr + AgNO_3 \longrightarrow AgBr\downarrow + NaNO_3$ (aq) (Yellow)

$AgBr + 2NH_4OH \longrightarrow [Ag(NH_3)_2]Br + 2H_2O$ (Partially sol.)

I^- ion

a. $2NaI + Conc.\ H_2SO_4 \longrightarrow Na_2SO_4 + 2HI \longrightarrow I_2$

b. $NaI + AgNO_3 \longrightarrow AgI\downarrow + NaNO_3 \xrightarrow{NH_4OH}$ Insoluble

(Yellow)

NO_3^- ion

a. $2NaNO_3 \quad H_2SO_4 \quad Na_2SO_4 \quad 2NO_2 \quad \frac{1}{2}O_2 \quad H_2O$

b. It gives I_2 with KI.

c. Brown ring test.

$2NaNO_3 + FeSO_4 + H_2SO_4 \longrightarrow Fe_2(SO_4)_3 + [Fe(SO_4).NO] + H_2O + Na_2SO_4$

Oxalate ion

a. $Na_2C_2O_4 + Conc.\ H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + CO + CO_2$

b. Collen's test, $2AgNO_3 + 2NH_4OH \longrightarrow 2NH_4NO_3 + 2AgOH$

$2AgOH \longrightarrow H_2O + Ag_2O$

- $Hg_2Cl_2 + NH_4OH \longrightarrow Hg(NH_2)(Cl)\ Hg\downarrow \quad NH_4Cl$
- $HgCl_2 + NH_4OH \longrightarrow Hg\begin{cases} NH_2 \\ Cl \end{cases}\downarrow + NH_4Cl_2$ (White)

$2AgNO_3 + Ag_2O + CO \longrightarrow 2Ag + CO_2$

$2NH_4OH + CO \longrightarrow 2NH_4NO_3 + 2Ag + CO_2 + H_2O$

Liberary mirror

SPECIAL GROUP

A. SULPHATES

a. $Na_2SO_4(aq.) + BaCl_2(aq.) \longrightarrow \underset{\text{(White)}}{BaSO_4}\downarrow + 2NaCl$

b. $BaSO_4$ (Part I) + Conc. HCL $\longrightarrow$ Insoluble

c. $BaSO_4$ (Part II) + Conc. HCL $\longrightarrow$ Insoluble

B. PHOSPHATES (PO_4^{-3})

a. $Na_3PO_4(aq.)$ or NaH_2PO_4 or any phosphate + Conc. HNO_3 + $(NH_4)_2MoO_4$ (Ammonium molybdate)

$\longrightarrow$ Yellow ppt (Ammonium Phospho molybdate)

C. BORATE (BO_3^{-3})

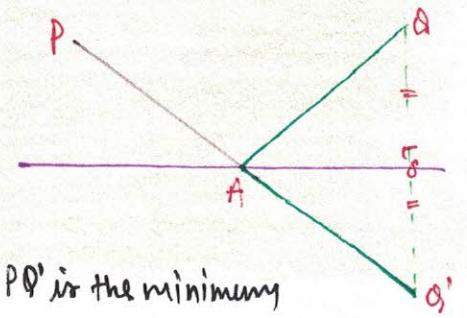
a. $Na_3BO_3 \longrightarrow H_3BO_3$

$H_3BO_3 + 3C_2H_5OH \longrightarrow (C_2H_5)_3BO_3 + 3NaOH$

Brown with green edge flame.

When 'P' is a point and line through it falls at a pt. A on the line "L=0" and passes through "Q" after reflection then $(PA+QA)_{min^m} = ?$

Ans.



PQ' is the minimum

since Q' is the image of Q' in line L=0

$PA + QA = (PA + Q'A') = PQ'_{min}$

To get pt. A solve PQ' with Line L=0

$CaCN_2 + H_2O \longrightarrow NH_3 + Ca(OH)_2$

Hg_2I_2 – Green

$LiAlH_4 + H_2O \longrightarrow ?$

$LiAlH_4 \longrightarrow LiH + AlH_3 \xrightarrow{H_2O} LiOH + Al(OH)_3 + H_2\uparrow$

$CaNH_2 + 2H_2O \longrightarrow Ca(OH)_2 + 2NH_3\uparrow$

$Ca_3P_2 + 6H_2O \longrightarrow 3Ca(OH)_2 + 2PH_3\uparrow$

$CaCN_2 + 3H_2O \longrightarrow CaCO_3 + 2NH_3$

$2NH_3 + NaOCl \longrightarrow NaCl + H_2O + NH_2{-}NH_2$

$Na + NH_3 \longrightarrow NaNH_2 \xrightarrow{H_2O} NaN_3 \xrightarrow{H_2O} (N_3H)$

$NH_4NO_3 + NaOH \longrightarrow NaNO_3 + NH_4OH \xrightarrow{Al} NH_3\uparrow$

Mechanism:–

$NaNO_3 + H_2O \longrightarrow HNO_3 + NaOH$

$NaOH + Al \longrightarrow Na_3AlO_3 + H_2$

$HNO_3 + 2H \longrightarrow NH_3 + 3H_2O$

Yellow percipitate obtained in test for phosphate using ammonium molybdate

$(NH_4)_3[PMo_{12}O_{40}]$ or $(NH_4)_3[PO_4' Mo_{12}O_{36}]$

Sn^{+2} can't be ppt. by both HCL and H_2S.

$PbI_2 \xrightarrow[KI]{excess} K_2[PbI_4]$

(PbI_2 Insoluble) ($K_2[PbI_4]$ soluble)

$Fe^{+2} \xrightarrow[HNO_3]{dil.} Fe^{+3}$

$Fe^{+3} > Cr^{+3} > Al^{+3}$ (soluble)

[FCA]