

QUALITATIVE ANALYSIS

Charcoal Cavity Test :

Observation		Inference
Incrustation or Residue	Metallic bead	
Yellow when hot, white when cold	None	Zn^{2+}
Brown when hot, yellow when cold	Grey bead which marks the paper	Pb^{2+}
No characteristic residue	Red beads or scales	Cu^{2+}
White residue which glows on heating	None	$\text{Ba}^{2+}, \text{Ca}^{2+}, \text{Mg}^{2+}$
Black	None	Nothing definite—generally coloured salt

Cobalt Nitrate Test :

S.No.	Metal	Colour of the mass
1	Zinc	Green
2	Aluminium	Blue
3	Magnesium	Pink
4	Tin	Bluish-green

Flame test :

Colour of Flame	Inference
Crimson Red / Carmine Red	Lithium
Golden yellow	Sodium
Violet/Lilac	Potassium
Brick red	Calcium
Crimson	Strontium
Apple Green/Yellowish Green	Barium
Green with a Blue centre/Greenish Blue	Copper

Borax Bead test :

Metal	Colour in oxidising flame		Colour in reducing flame	
	When Hot	When Cold	When Hot	When Cold
Copper	Green	Blue	Colourless	Brown red
Iron	Brown yellow	Pale yellow/Yellow	Bottle green	Bottle green
Chromium	Yellow	Green	Green	Green
Cobalt	Blue	Blue	Blue	Blue
Manganese	Violet/Amethyst	Red/Amethyst	Grey/Colourless	Grey/Colourless
Nickel	Violet	Brown/Reddish brown	Grey	Grey

Analysis of ANIONS (Acidic Radicals) :

(a) DILUTE SULPHURIC ACID/DILUTE HYDROCHLORIC ACID GROUP:

1. CARBONATE ION (CO_3^{2-}) :

- Dilute H_2SO_4 test : A colourless odourless gas is evolved with brisk effervescence.

$$\text{CaCO}_3 + \text{H}_2\text{SO}_4 \longrightarrow \text{CaSO}_4 + \text{H}_2\text{O} + \text{CO}_2 \uparrow$$
- Lime water/Baryta water ($\text{Ba}(\text{OH})_2$) test :

$$\text{CO}_2 + \text{Ca}(\text{OH})_2 \longrightarrow \text{CaCO}_3 \downarrow (\text{milky}) + \text{H}_2\text{O}$$

$$\text{CaCO}_3 + \text{CO}_2 + \text{H}_2\text{O} \longrightarrow \text{Ca}(\text{HCO}_3)_2 (\text{soluble}) \xrightarrow{\Delta} \text{CaCO}_3 \downarrow + \text{H}_2\text{O} + \text{CO}_2$$

2. SULPHITE ION (SO_3^{2-}) :

- **Dilute H_2SO_4 test :**

$$\text{CaSO}_3 + \text{H}_2\text{SO}_4 \longrightarrow \text{CaSO}_4 + \text{H}_2\text{O} + \text{SO}_2 \uparrow ;$$
 SO_2 has suffocating odour of burning sulphur.
- **Acidified potassium dichromate test :** The filter paper dipped in acidified $\text{K}_2\text{Cr}_2\text{O}_7$ turns green.

$$\text{Cr}_2\text{O}_7^{2-} + 2\text{H}^+ + 3\text{SO}_2 \longrightarrow 2\text{Cr}^{3+} (\text{green}) + 3\text{SO}_4^{2-} + \text{H}_2\text{O}.$$
- **Barium chloride/Strontium chloride solution :**

$$\text{SO}_3^{2-} + \text{Ba}^{2+}/\text{Sr}^{2+} \longrightarrow \text{BaSO}_3/\text{SrSO}_3 \downarrow (\text{white}).$$

☞ White precipitate dissolves in dilute HCl.

$$\text{BaSO}_3 \downarrow + 2\text{H}^+ \longrightarrow \text{Ba}^{2+} + \text{SO}_2 \uparrow + \text{H}_2\text{O}.$$

3. SULPHIDE ION (S^{2-}) :

- **Dilute H_2SO_4 test :** Pungent smelling gas like that of rotten egg is obtained.

$$\text{S}^{2-} + 2\text{H}^+ \longrightarrow \text{H}_2\text{S} \uparrow$$
- **Lead acetate test :**

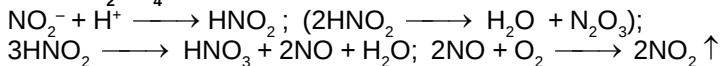
$$(\text{CH}_3\text{COO})_2\text{Pb} + \text{H}_2\text{S} \longrightarrow \text{PbS} \downarrow (\text{black}) + 2\text{CH}_3\text{COOH}.$$
- **Sodium nitroprusside test :** Purple coloration is obtained.

$$\text{S}^{2-} + [\text{Fe}(\text{CN})_5(\text{NO})]^{2-} \longrightarrow [\text{Fe}(\text{CN})_5\text{NOS}]^{4-} (\text{violet}).$$
- **Cadmium carbonate suspension/ Cadmium acetate solution:**

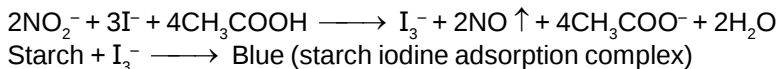
$$\text{Na}_2\text{S} + \text{CdCO}_3 \longrightarrow \text{CdS} \downarrow (\text{Yellow}) + \text{Na}_2\text{CO}_3$$

4. NITRITE ION (NO_2^-) :

- **Dilute H_2SO_4 test :**

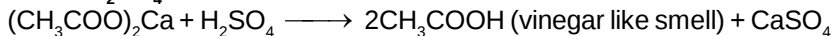


- **Starch iodide test :**

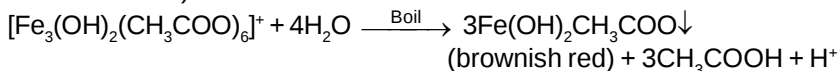
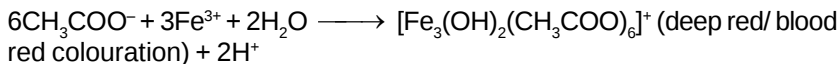


5. ACETATE ION (CH_3COO^-)

- **Dilute H_2SO_4 test :**



- **Neutral ferric chloride test :**



(b) CONC. H_2SO_4 GROUP :

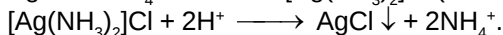
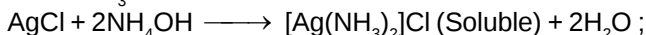
1. CHLORIDE ION (Cl^-) :

- **Concentrated H_2SO_4 test :** $\text{Cl}^- + \text{H}_2\text{SO}_4 \longrightarrow \text{HCl}$ (colourless pungent smelling gas) + HSO_4^-

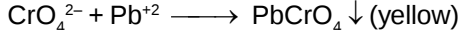
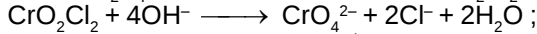
- $\text{NH}_4\text{OH} + \text{HCl} \longrightarrow \text{NH}_4\text{Cl} \uparrow$ (white fumes) + H_2O .

- **Silver nitrate test :** $\text{Cl}^- + \text{Ag}^+ \longrightarrow \text{AgCl} \downarrow$ (white)

☞ White precipitate is soluble in aqueous ammonia and precipitate reappears with HNO_3 .

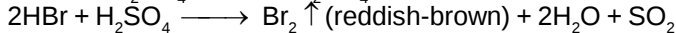
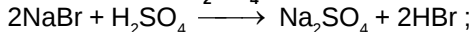


- **Chromyl chloride test :**



2. BROMIDE ION (Br^-) :

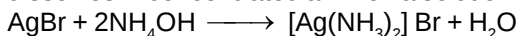
- **Concentrated H_2SO_4 test :**



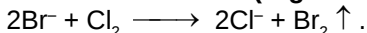
- **Silver nitrate test :**



☞ Yellow precipitate is partially soluble in dilute aqueous ammonia but readily dissolves in concentrated ammonia solution.



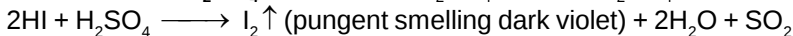
- **Chlorine water test (organic layer test) :**



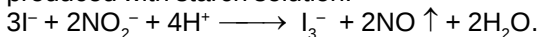
$\text{Br}_2 + \text{CHCl}_3 / \text{CCl}_4 \longrightarrow \text{Br}_2$ dissolve to give reddish brown colour in organic layer.

3. IODIDE ION (I^-) :

- **Concentrated H_2SO_4 test :** $2\text{NaI} + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + 2\text{HI}$



- **Starch paper test :** Iodides are readily oxidised in acid solution to free iodine; the free iodine may then be identified by deep blue colouration produced with starch solution.

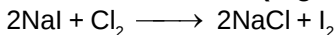


- **Silver nitrate test :** Bright yellow precipitate is formed.



Bright yellow precipitate is insoluble in dilute aqueous ammonia but is partially soluble in concentrated ammonia solution.

- **Chlorine water test (organic layer test) :**



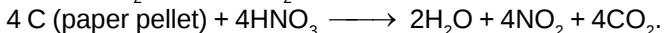
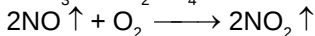
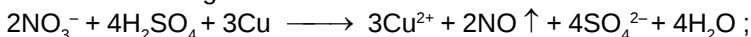
$\text{I}_2 + \text{CHCl}_3 \longrightarrow \text{I}_2$ dissolves to give violet colour in organic layer.

4. NITRATE ION (NO_3^-) :

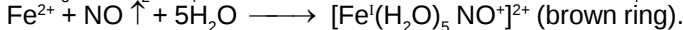
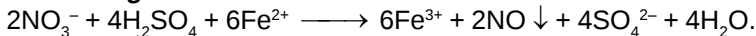
- **Concentrated H_2SO_4 test :** Pungent smelling reddish brown vapours are evolved.



Addition of bright copper turnings or paper pellets intensifies the evolution of reddish brown gas.



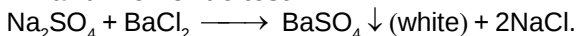
- **Brown ring test :**



3. Miscellaneous Group :

1. SULPHATE ION (SO_4^{2-}) :

- **Barium chloride test :**



White precipitate is insoluble in warm dil. HNO_3 as well as HCl but moderately soluble in boiling concentrated hydrochloric acid.

● Lead acetate test :

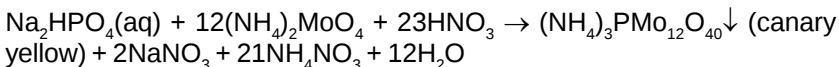


White precipitate soluble in excess of hot ammonium acetate.



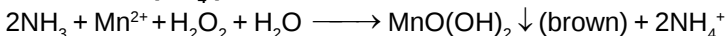
2. PHOSPHATE ION (PO_4^{3-}) :

● Ammonium molybdate test :

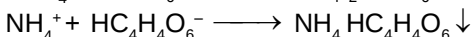
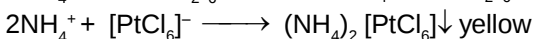
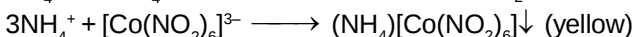


ANALYSIS OF CATIONS

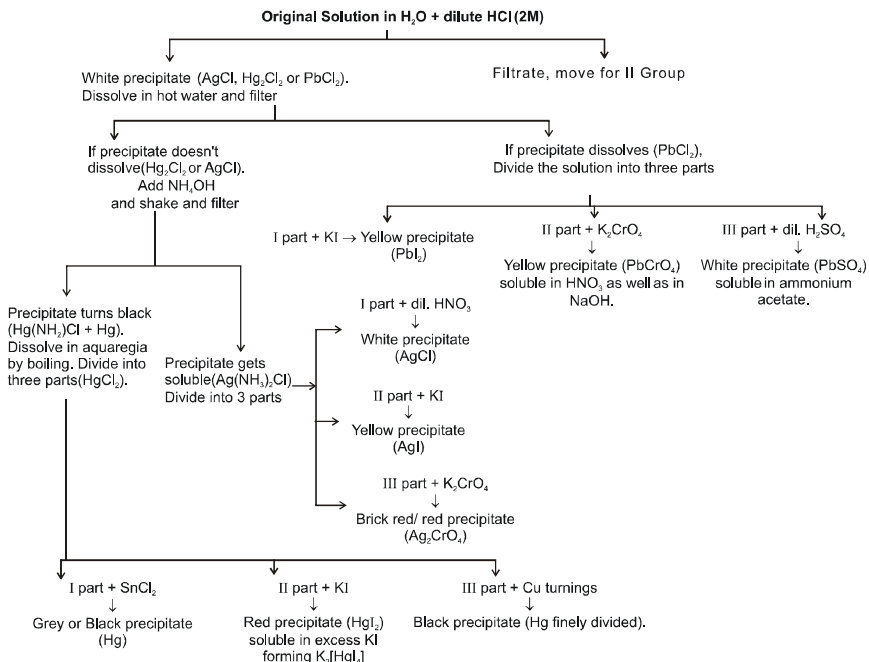
1. AMMONIUM ION (NH_4^+) :



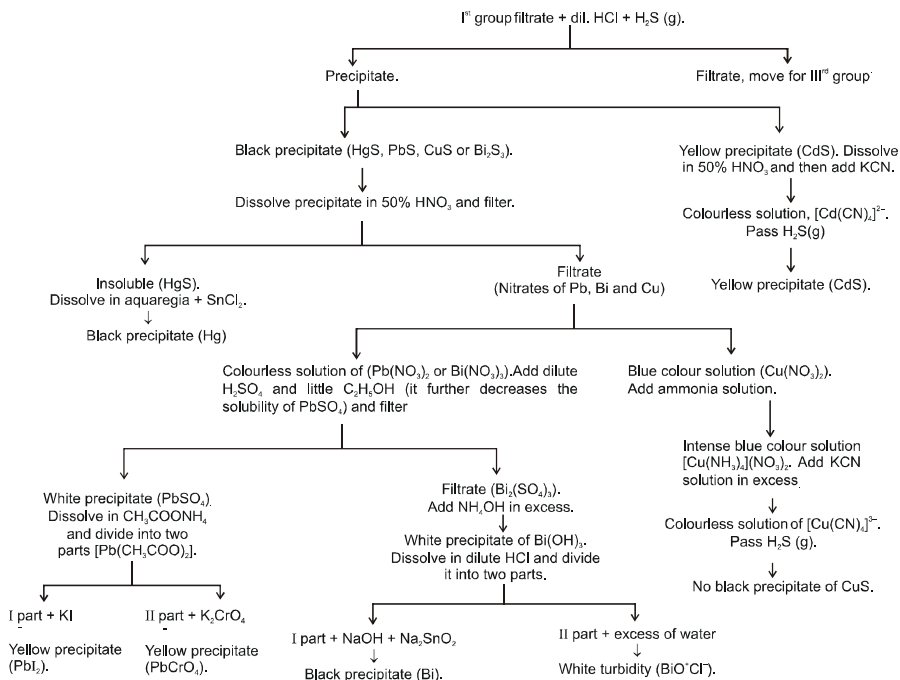
Nessler's reagent (Alkaline solution of potassium tetraiodomercurate(II)) :



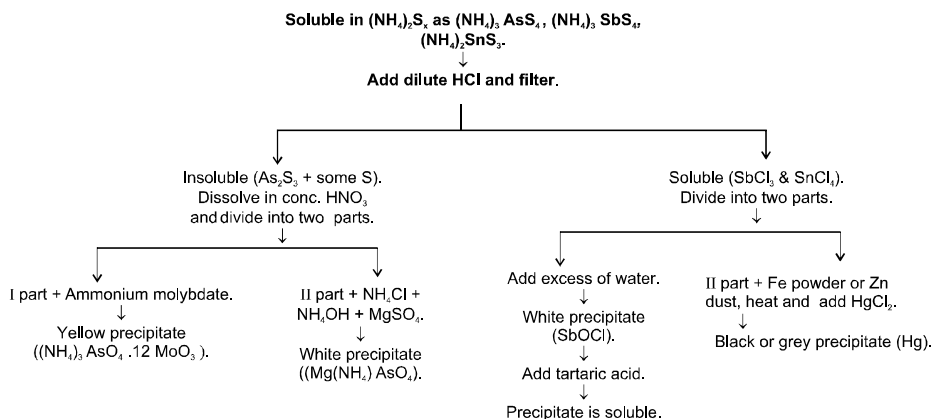
Ist GROUP (Pb^{2+} , Hg^{2+} , Ag^+) :



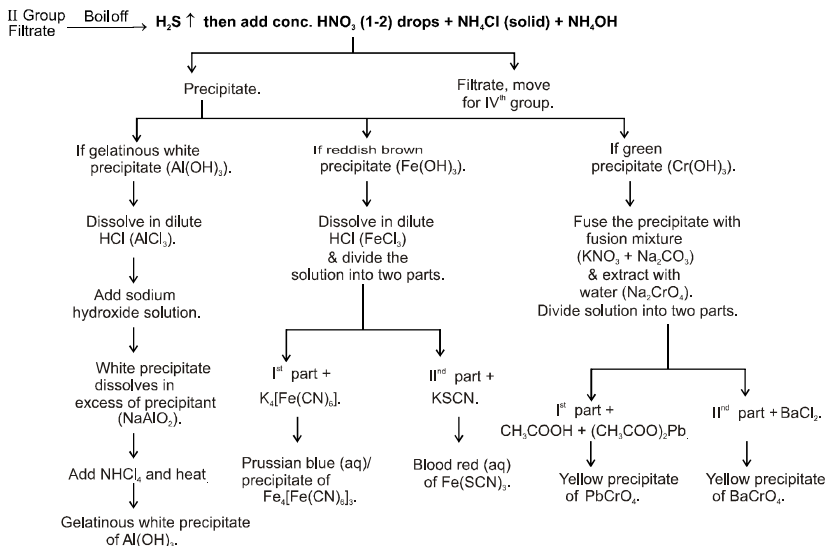
IIA Group (Hg^{2+} , Pb^{2+} , Bi^{3+} , Cu^{2+} , Cd^{2+})



IIB Group (As^{3+} , Sb^{3+} , Sn^{2+} , Sn^{4+})

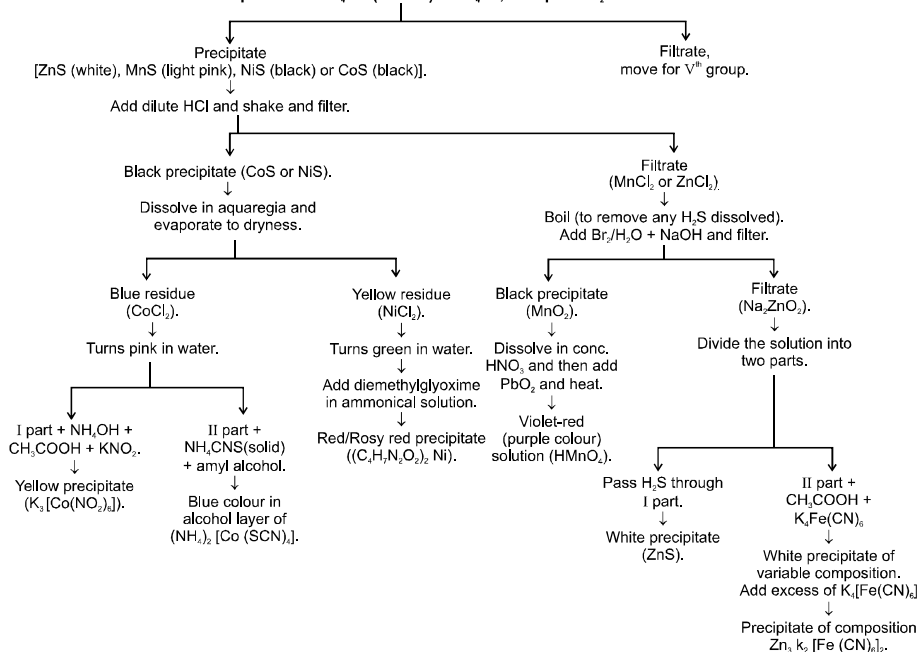


IIIrd Group (Al³⁺, Cr³⁺, Fe³⁺)



IVth GROUP (Zn^{2+} , Mn^{2+} , Ni^{2+} , Co^{2+}) :

III Group filtrate + NH_4OH (excess) & NH_4Cl , then pass H_2S



Vth Group (Ba^{2+} , Sr^{2+} , Ca^{2+}) :

IV Group filtrate $\longrightarrow$ Boil off H_2S then add $(\text{NH}_4)_2\text{CO}_3$ (aq), NH_4OH & NH_4Cl (s)

White precipitate
(BaCO_3 , SrCO_3 or CaCO_3).

Filtrate,
move for VI group.

Dissolve in CH_3COOH and divide into three parts
and test in the sequence given below.

I part + K_2CrO_4 .

Yellow precipitate
(BaCrO_4 insoluble in CH_3COOH).

II Part + $(\text{NH}_4)_2\text{SO}_4$.

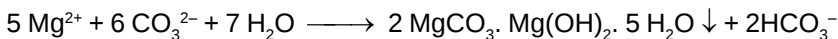
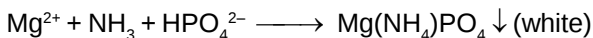
White precipitate
(SrSO_4).

III part + $(\text{NH}_4)_2\text{C}_2\text{O}_4$.

White precipitate
(CaC_2O_4).

VIth GROUP :

MAGNESIUM ION (Mg^{2+}) :



Titan Yellow (a water soluble yellow dyestuff) :

It is adsorbed by $\text{Mg}(\text{OH})_2$ producing a deep red colour or precipitate.