

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	Ba ²⁺ , Ca ²⁺ , 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

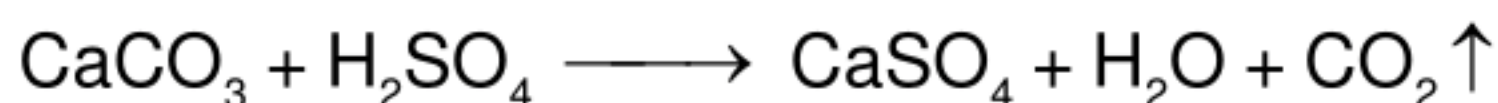
Borax Bead test :

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

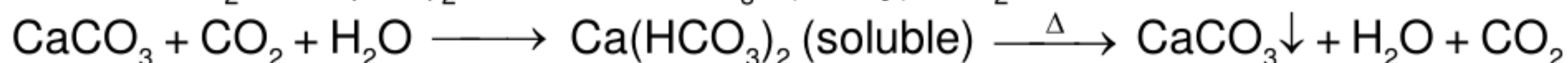
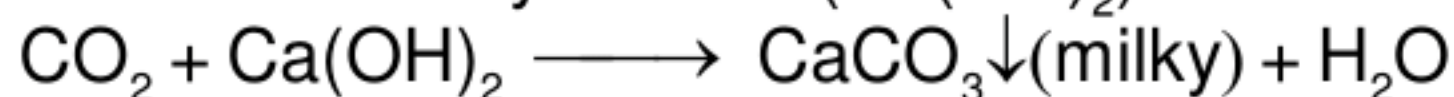
Analysis of ANIONS (Acidic Radicals) :

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

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

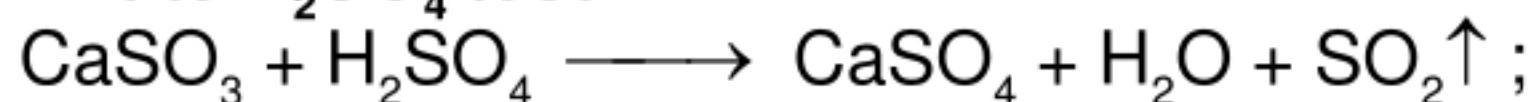


- Lime water/Baryta water ($\text{Ba}(\text{OH})_2$) test :



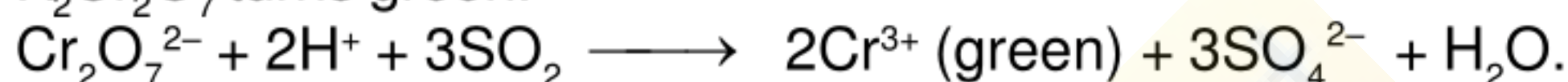
2. SULPHITE ION (SO_3^{2-}) :

- **Dilute H_2SO_4 test :**

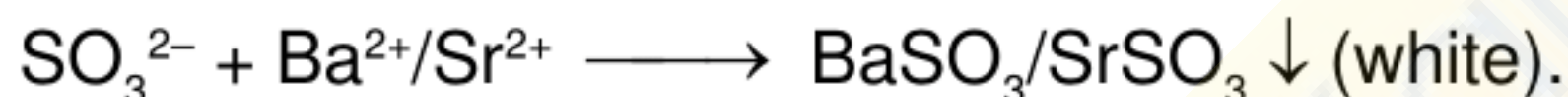


SO_2 has suffocating odour of burning sulphur.

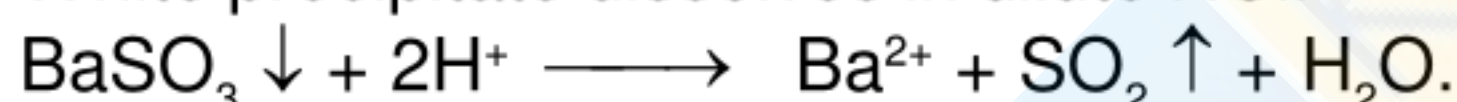
- **Acidified potassium dichromate test :** The filter paper dipped in acidified $\text{K}_2\text{Cr}_2\text{O}_7$ turns green.



- **Barium chloride/Strontium chloride solution :**

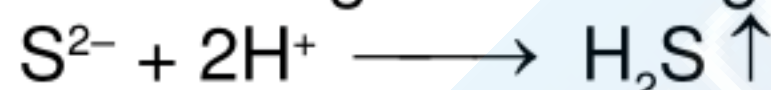


☞ White precipitate dissolves in dilute HCl.



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

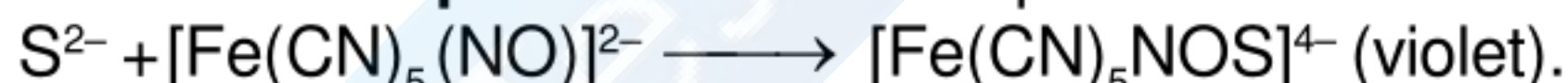
- **Dilute H_2SO_4 test :** Pungent smelling gas like that of rotten egg is obtained.



- **Lead acetate test :**



- **Sodium nitroprusside test :** Purple coloration is obtained.

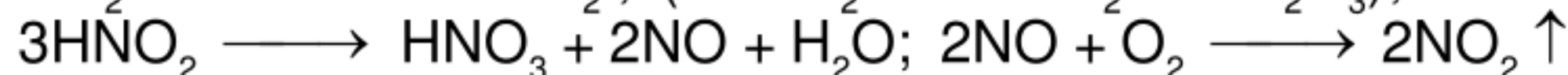
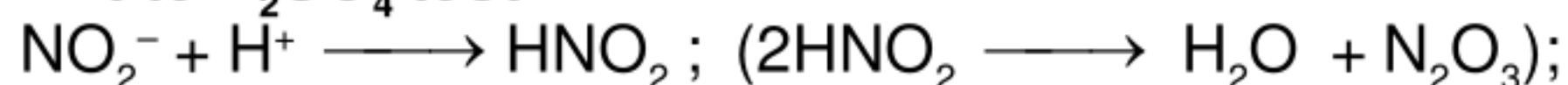


- **Cadmium carbonate suspension/ Cadmium acetate solution:**

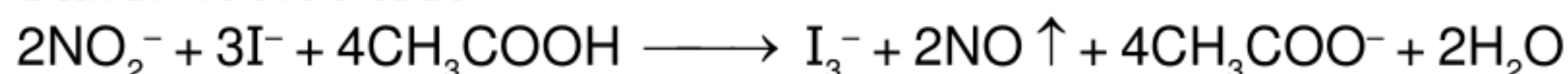


4. NITRITE ION (NO_2^-) :

- **Dilute H_2SO_4 test :**



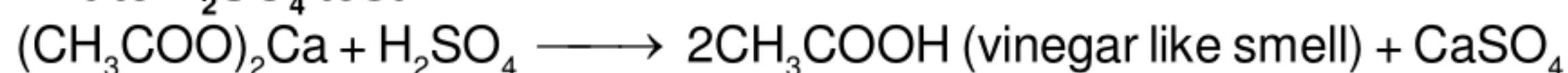
- **Starch iodide test :**



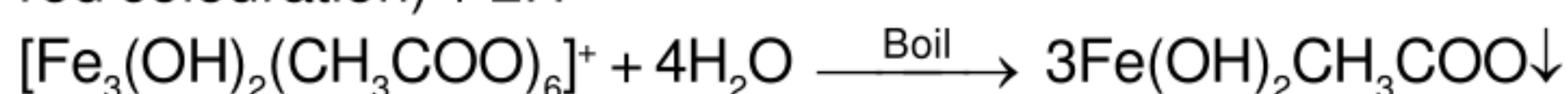
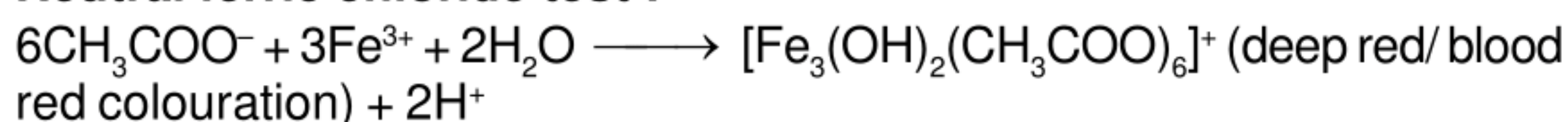
Starch + I_3^- \longrightarrow Blue (starch iodine adsorption complex)

5. ACETATE ION (CH_3COO^-)

- **Dilute H_2SO_4 test :**



- **Neutral ferric chloride test :**



(brownish red) + $3\text{CH}_3\text{COOH} + \text{H}^+$

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 .
 $\text{AgCl} + 2\text{NH}_4\text{OH} \longrightarrow [\text{Ag}(\text{NH}_3)_2]\text{Cl}$ (Soluble) + $2\text{H}_2\text{O}$;
 $[\text{Ag}(\text{NH}_3)_2]\text{Cl} + 2\text{H}^+ \longrightarrow \text{AgCl} \downarrow + 2\text{NH}_4^+$.
- **Chromyl chloride test :**
 $4\text{Cl}^- + \text{Cr}_2\text{O}_7^{2-} + 6\text{H}^+$ (conc.) $\longrightarrow 2\text{CrO}_2\text{Cl}_2$ (deep red vapours) + $3\text{H}_2\text{O}$
 $\text{CrO}_2\text{Cl}_2 + 4\text{OH}^- \longrightarrow \text{CrO}_4^{2-} + 2\text{Cl}^- + 2\text{H}_2\text{O}$;
 $\text{CrO}_4^{2-} + \text{Pb}^{2+} \longrightarrow \text{PbCrO}_4 \downarrow$ (yellow)

2. BROMIDE ION (Br^-):

- **Concentrated H_2SO_4 test :**
 $2\text{NaBr} + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + 2\text{HBr}$;
 $2\text{HBr} + \text{H}_2\text{SO}_4 \longrightarrow \text{Br}_2 \uparrow$ (reddish-brown) + $2\text{H}_2\text{O} + \text{SO}_2$
- **Silver nitrate test :**
 $\text{NaBr} + \text{AgNO}_3 \longrightarrow \text{AgBr} \downarrow$ (pale yellow) + NaNO_3
- ☞ Yellow precipitate is partially soluble in dilute aqueous ammonia but readily dissolves in concentrated ammonia solution.
 $\text{AgBr} + 2\text{NH}_4\text{OH} \longrightarrow [\text{Ag}(\text{NH}_3)_2]\text{Br} + \text{H}_2\text{O}$
- **Chlorine water test (organic layer test) :**
 $2\text{Br}^- + \text{Cl}_2 \longrightarrow 2\text{Cl}^- + \text{Br}_2 \uparrow$.
 $\text{Br}_2 + \text{CHCl}_3 / \text{CCl}_4 \longrightarrow \text{Br}_2$ dissolve to give reddish brown colour in organic layer.

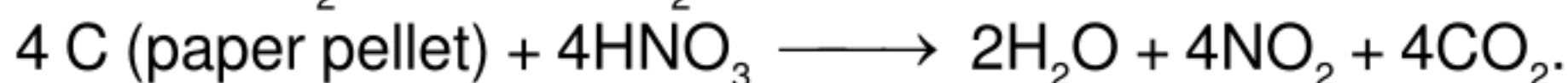
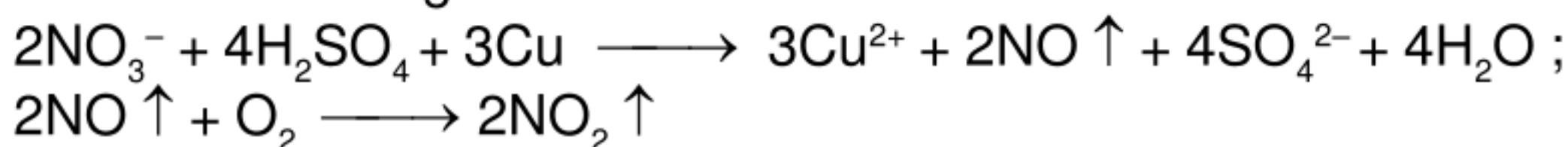
3. IODIDE ION (I^-):

- **Concentrated H_2SO_4 test :** $2\text{NaI} + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + 2\text{HI}$
 $2\text{HI} + \text{H}_2\text{SO}_4 \longrightarrow \text{I}_2 \uparrow$ (pungent smelling dark violet) + $2\text{H}_2\text{O} + \text{SO}_2$
- **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.
 $3\text{I}^- + 2\text{NO}_2^- + 4\text{H}^+ \longrightarrow \text{I}_3^- + 2\text{NO} \uparrow + 2\text{H}_2\text{O}$.
- **Silver nitrate test :** Bright yellow precipitate is formed.
 $\text{I}^- + \text{Ag}^+ \longrightarrow \text{AgI} \downarrow$
- ☞ Bright yellow precipitate is insoluble in dilute aqueous ammonia but is partially soluble in concentrated ammonia solution.
- **Chlorine water test (organic layer test) :**
 $2\text{NaI} + \text{Cl}_2 \longrightarrow 2\text{NaCl} + \text{I}_2$
 $\text{I}_2 + \text{CHCl}_3 \longrightarrow \text{I}_2$ dissolves to give violet colour in organic layer.

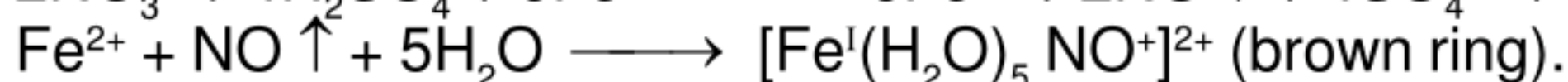
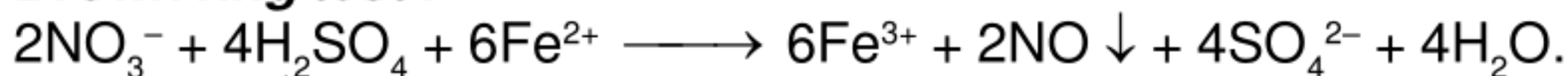
- **Concentrated H₂SO₄ test :** Pungent smelling reddish brown vapours are evolved.



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



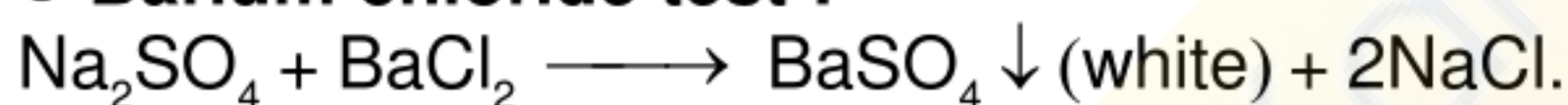
- **Brown ring test :**



5 Miscellaneous Group :

1. SULPHATE ION (SO₄²⁻) :

- **Barium chloride test :**



☞ White precipitate is insoluble in warm dil. HNO₃ as well as HCl but moderately soluble in boiling concentrated hydrochloric acid.

- **Lead acetate test :**

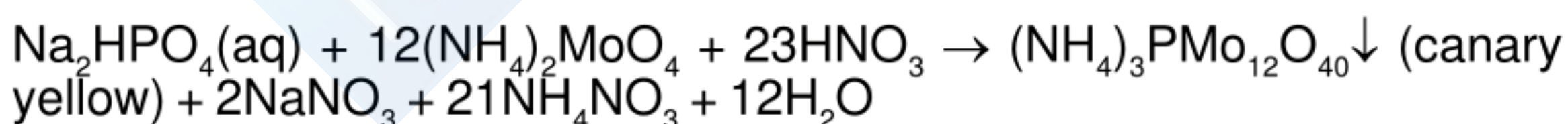


☞ White precipitate soluble in excess of hot ammonium acetate.



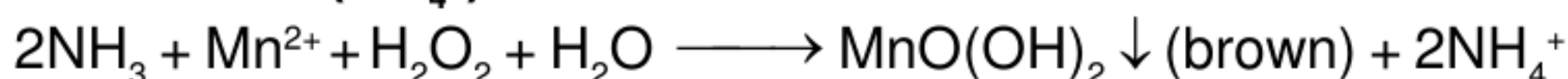
2. PHOSPHATE ION (PO₄³⁻) :

- **Ammonium molybdate test :**

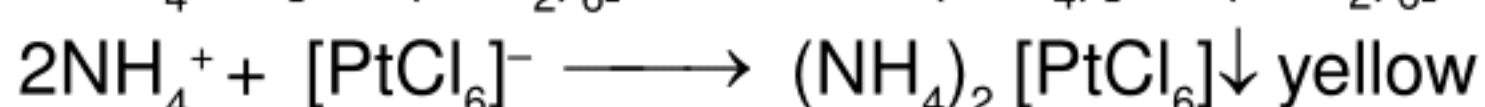
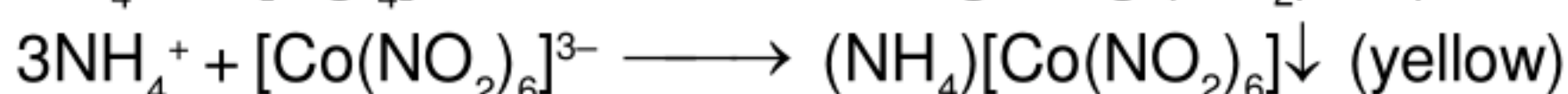


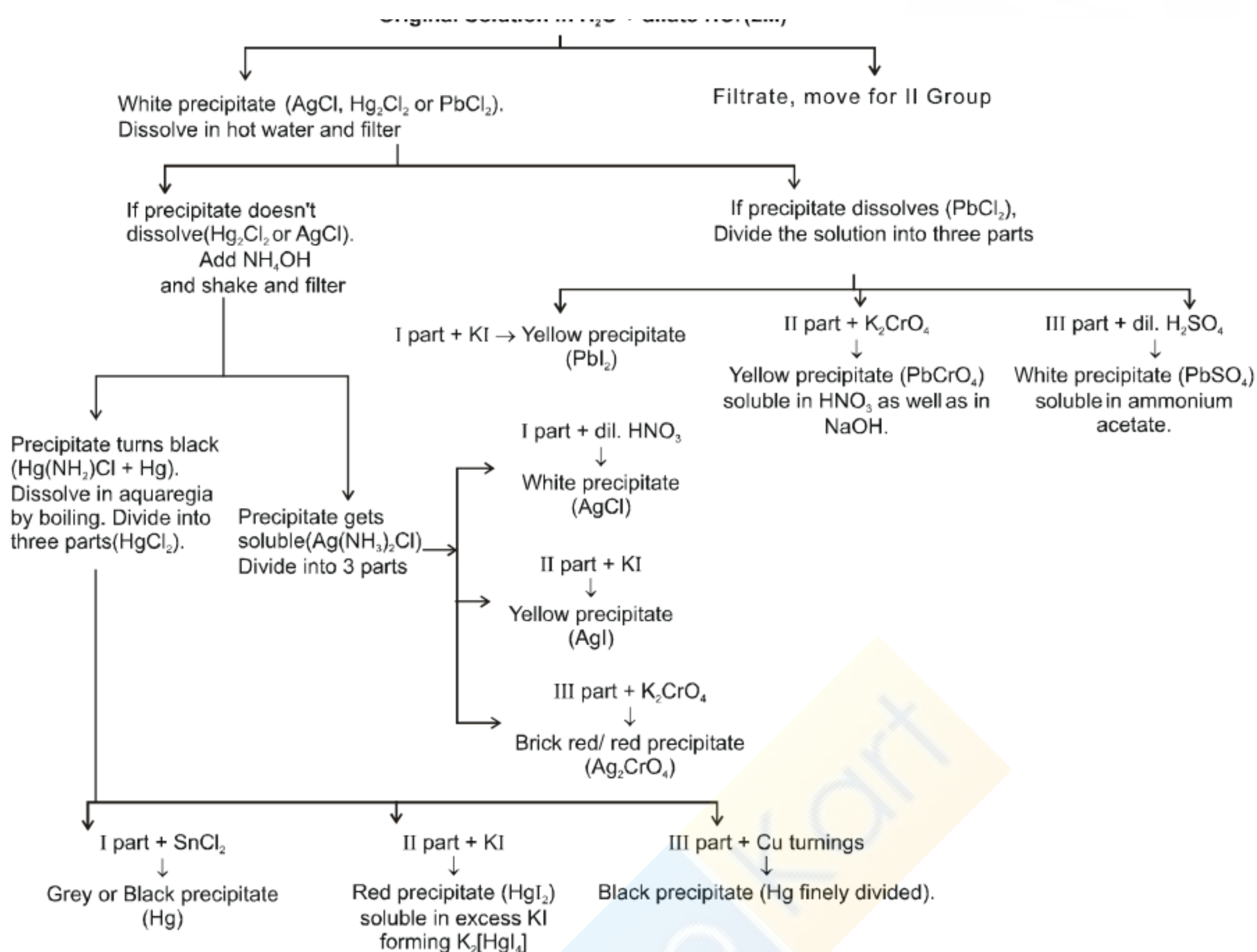
ANALYSIS OF CATIONS

1. AMMONIUM ION (NH₄⁺) :

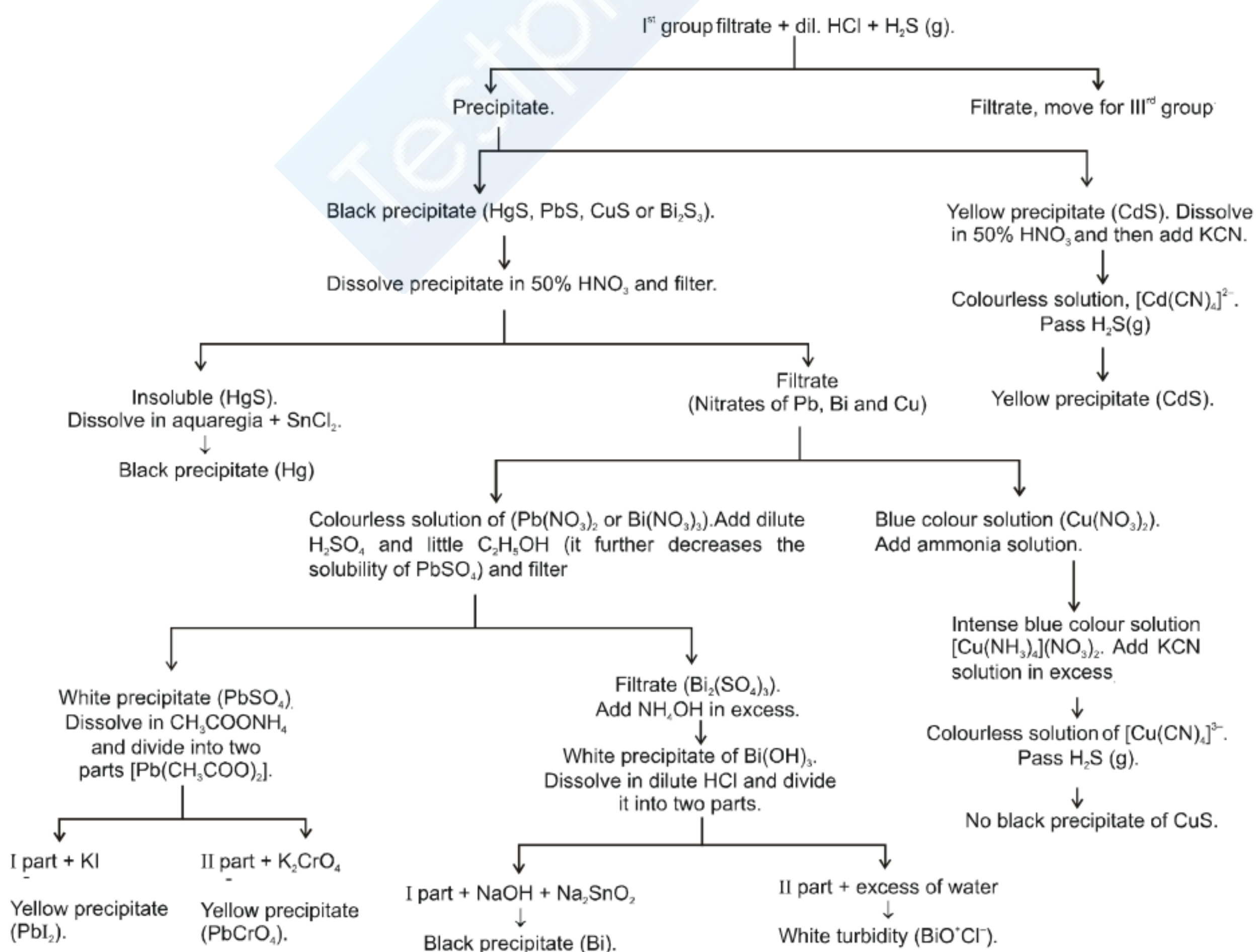


Nessler's reagent (Alkaline solution of potassium tetraiodomercurate(II)) :

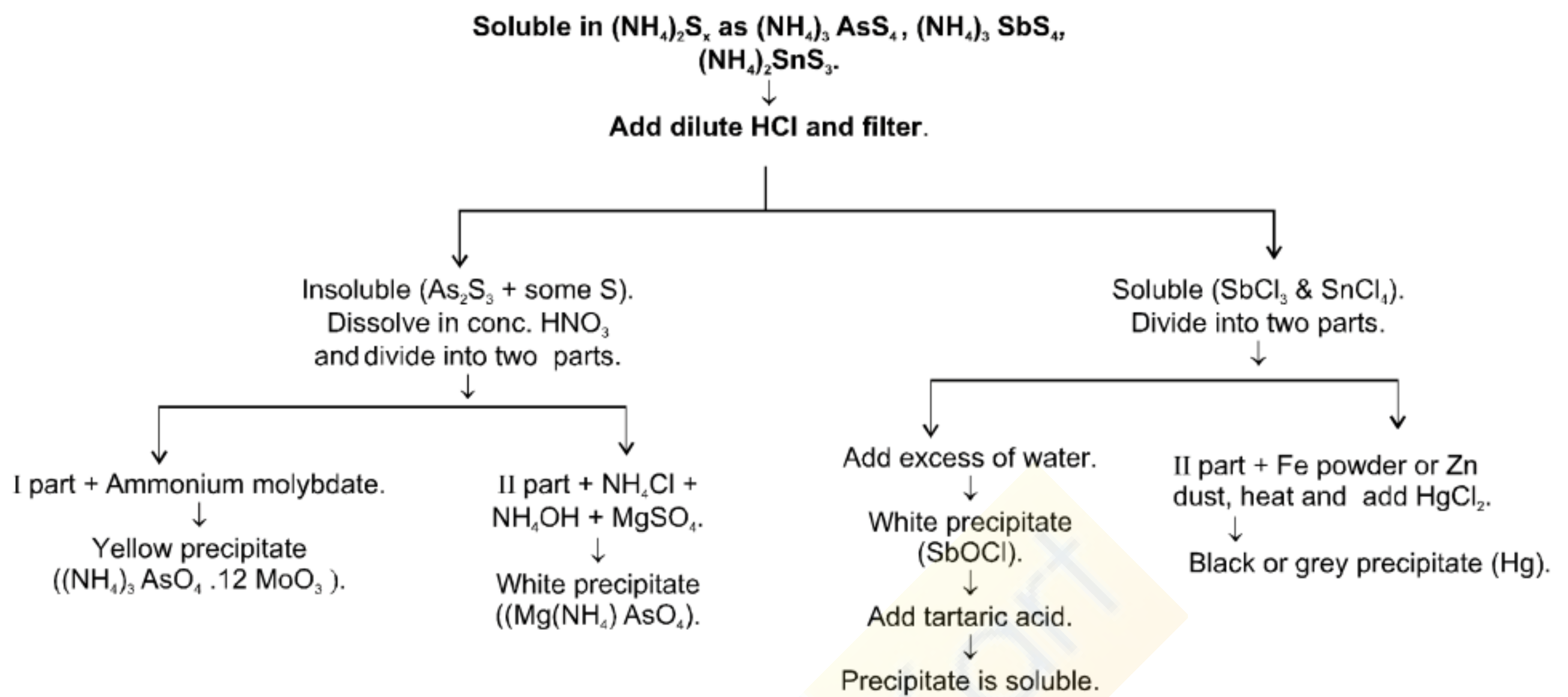




IIA Group (Hg^{2+} , Pb^{2+} , Bi^{3+} , Cu^{2+} , Cd^{2+})

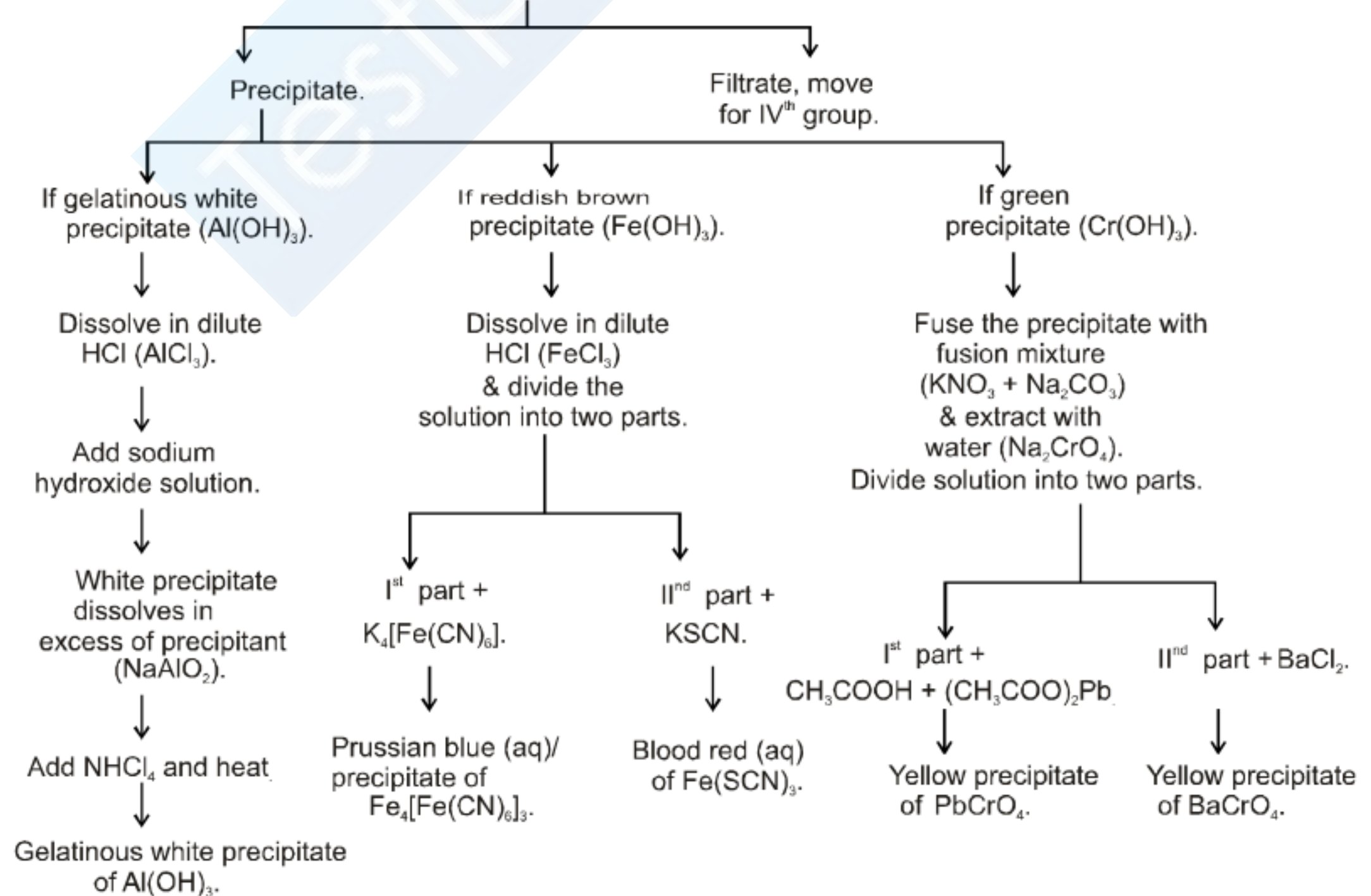


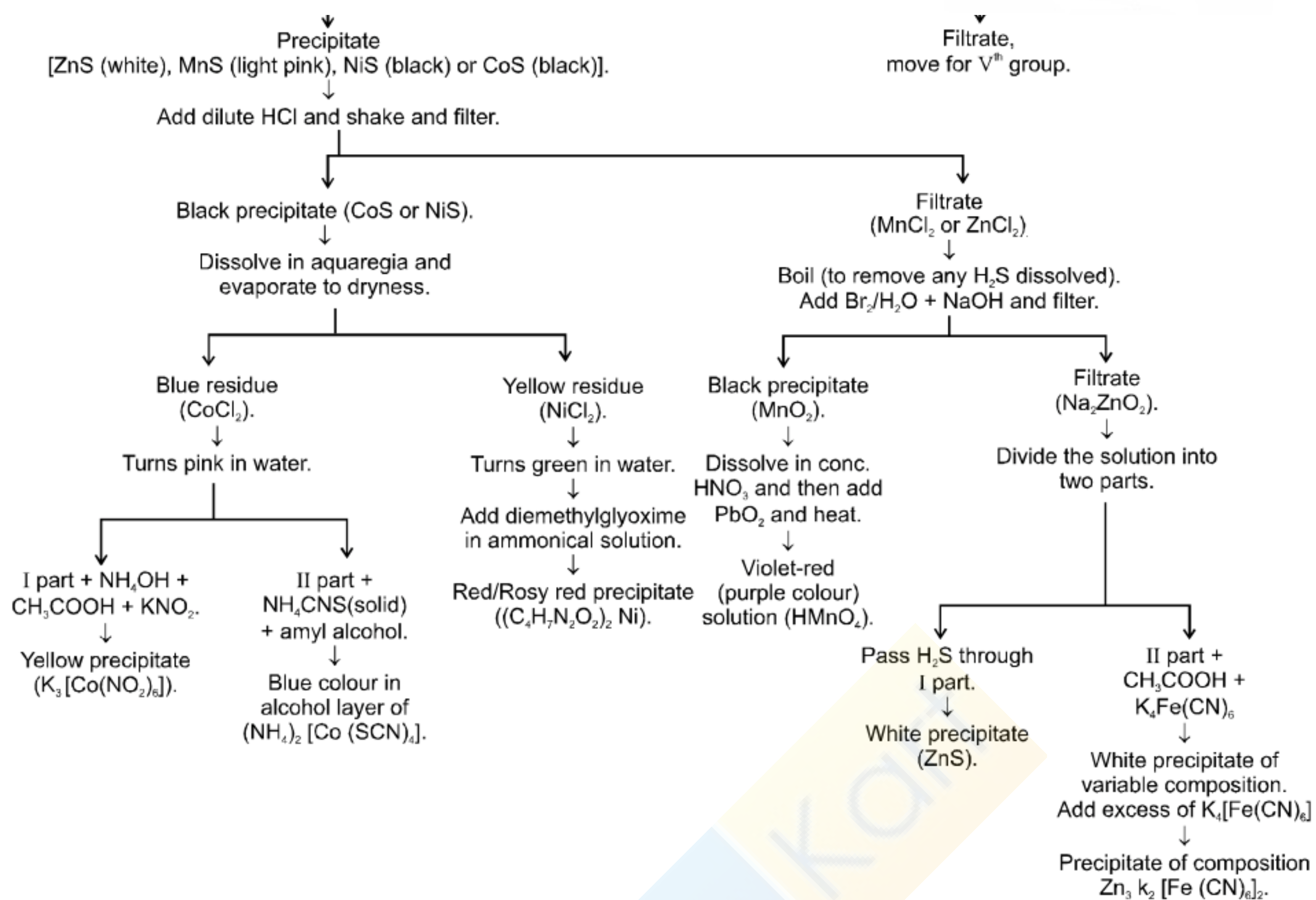
IIB Group (As^{3+} , Sb^{3+} , Sn^{2+} , Sn^{4+})



IIIrd Group (Al^{+3} , Cr^{+3} , Fe^{+3})

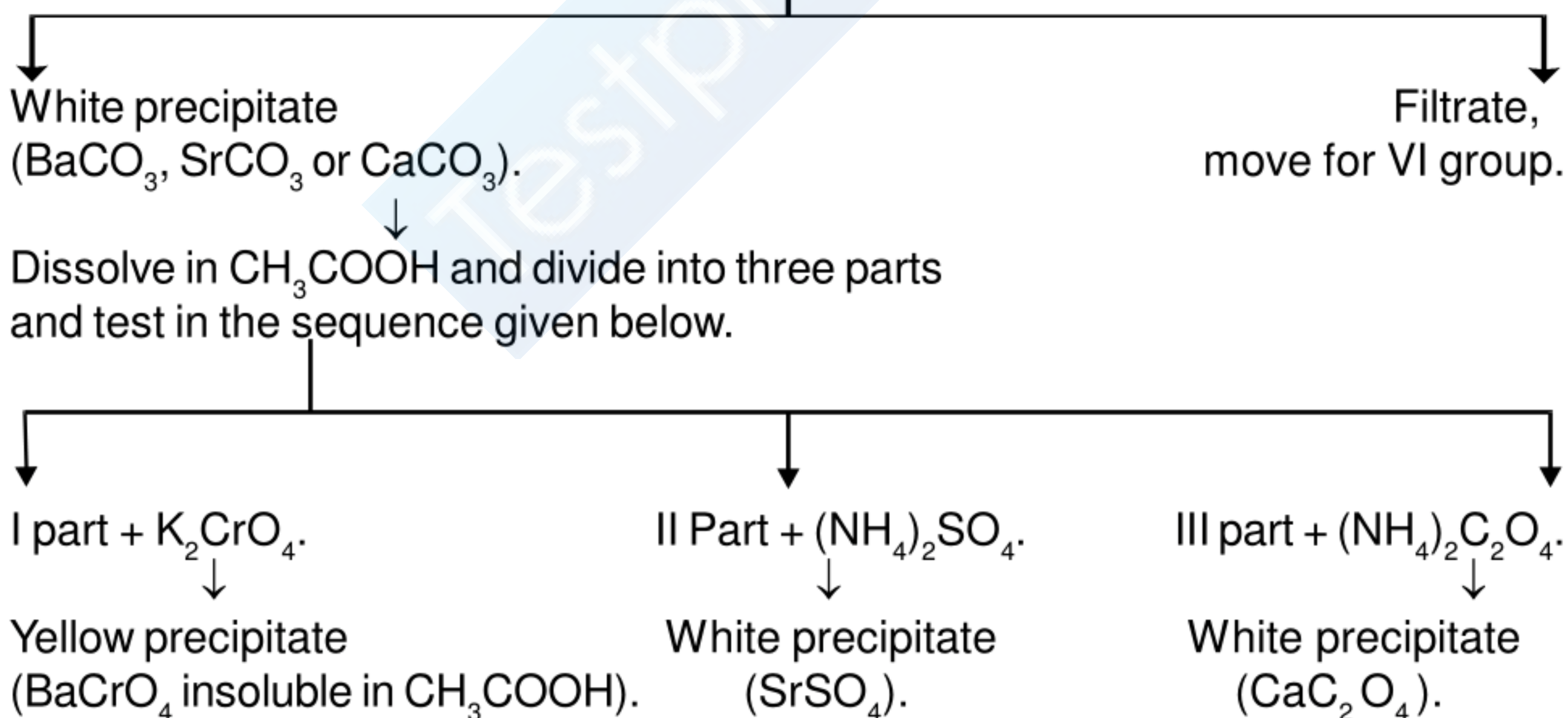
II Group Filtrate $\xrightarrow{\text{Boil off}}$ $\text{H}_2\text{S} \uparrow$ then add conc. HNO_3 (1-2) drops + NH_4Cl (solid) + NH_4OH





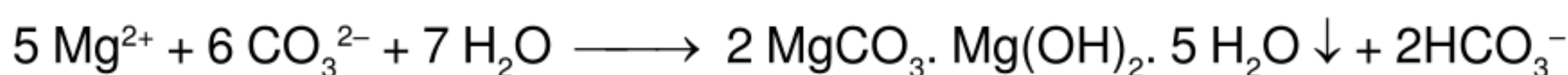
Vth Group (Ba²⁺, Sr²⁺, Ca²⁺) :

IV Group filtrate → Boil off H₂S then add (NH₄)₂CO₃ (aq), NH₄OH & NH₄Cl (s)



VIth GROUP :

MAGNESIUM ION (Mg²⁺) :



Titan Yellow (a water soluble yellow dyestuff) :

It is adsorbed by Mg(OH)₂ producing a deep red colour or precipitate.