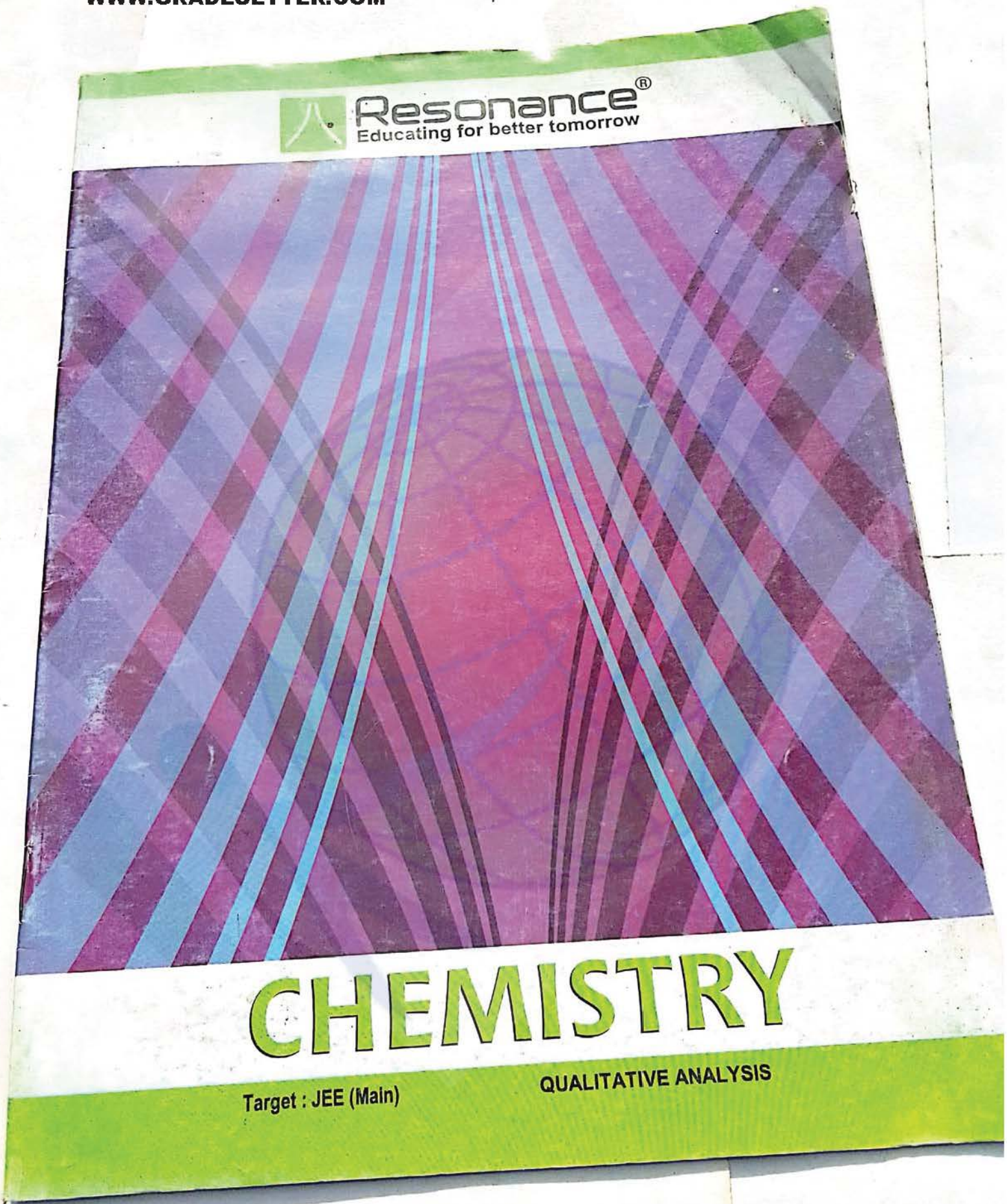


QUALITATIVE ANALYSIS

CONTENTS

JEE (MAIN) SYLLABUS

Chemical Principle involved in the qualitative salt analysis :

Cations - Pb^{2+}, Cu^{2+}, Al^{3+}, Fe^{3+}, Zn^{2+}, Ni^{2+}, Ca^{2+}, Ba^{2+}, Mg^{2+}, NH_4^+.

Anions - CO_3^{2-}, S^{2-}, SO_4^{2-}, NO_3^-, NO_2^-, Cl^-, Br^-, I^-. (Insoluble salts excluded).

JEE(ADVANCED) SYLLABUS

Principles of Qualitative Analysis : Groups I to V (only Ag^+, Hg^{2+}, Cu^{2+}, Pb^{2+}, Bi^{3+}, Fe^{3+}, Cr^{3+}, Al^{3+}, Ca^{2+}, Ba^{2+}, Zn^{2+}, Mn^{2+} and Mg^{2+}); Nitrate, halides (excluding fluoride), sulphate and sulphide.

Qualitative Analysis

Introduction :

Qualitative analysis involves the detection of cation(s) and anion(s) of a salt or a mixture of salts.
The systematic procedure for qualitative analysis of an inorganic salt involves the following steps :

(a) Preliminary tests

- Physical appearance (colour and smell).
- Flame test.
- Dilute sulphuric acid test.
- Concentrated sulphuric acid test.
- Dry heating test.
- Borax bead test.
- Potassium permanganate test.
- Tests for sulphate, phosphate and borate.

(b) Wet tests for acid radicals.

(c) Wet tests (group analysis) for basic radicals.

Physical Examination of the Mixture :

1. The physical examination of the unknown mixture involves the study of colour, smell and density.

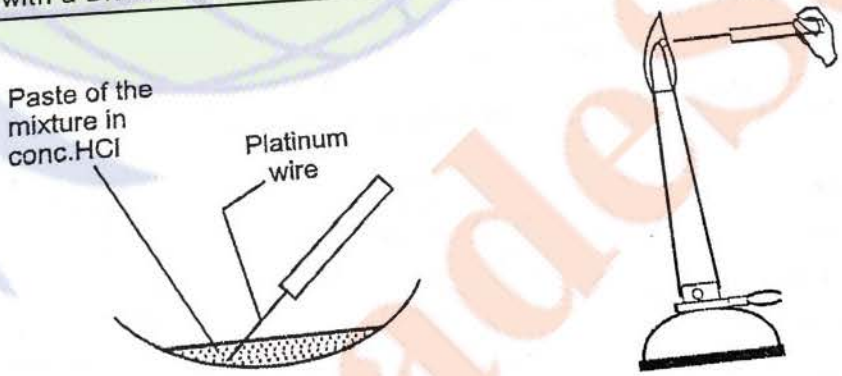
Dry Heating Test :

2. This test is performed by heating a small amount of mixture in a dry test tube. Quite valuable information can be generated by carefully performing and noting the observations here. On heating some salts undergo decomposition thus evolving the gases or may undergo characteristic changes in the colour of residue.

Flame test :

3. The chlorides of the metals are more volatile as compared to other salts and these are prepared in situ by mixing the compounds with a little concentrated hydrochloric acid. On heating in a non-luminous Bunsen flame they are volatilized and impart a characteristic colour to the flame as these absorb energy from the flame and transmit the same as light as characteristic colour .

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



(A) Dipping the platinum wire in the paste of salt and HCl.

(B) Introducing the wire in the flame

4. Borax Bead test :

On heating borax forms a colourless glassy bead of $NaBO_2$ and B_2O_3.

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

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

For example, in oxidising flame copper salts give blue bead.

$CuSO_4 \longrightarrow CuO + SO_3$; $CuO + B_2O_3 \longrightarrow Cu(BO_2)_2$ (blue bead)

However, in reducing flame the colours may be different due to different reactions.

$2Cu(BO_2)_2 + C \longrightarrow 2CuBO_2 + B_2O_3 + CO$

$2Cu(BO_2)_2 + 2C \longrightarrow 2Cu$ (brown red/red and opaque bead) $+ 2B_2O_3 + 2CO$.

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.

  $CaCO_3 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + CO_2\uparrow$

- Lime water/Baryta water ($Ba(OH)_2$) test : The liberated gas can be identified by its property of rendering lime water (or baryta water) turbid.

  $CO_2 + Ca(OH)_2 \longrightarrow CaCO_3\downarrow$ (milky) $+ H_2O$

  On prolonged passage of CO_2 the milkiness disappears.

  $CaCO_3 + CO_2 + H_2O \longrightarrow Ca(HCO_3)_2$ (soluble)

☞ Soluble bicarbonates give white precipitate with $MgSO_4$ (aq) / $MgCl_2$(aq) only on heating.

$Mg^{2+} + 2HCO_3^- \longrightarrow Mg(HCO_3)_2 \xrightarrow{\Delta} MgCO_3\downarrow + H_2O + CO_2$

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

- ***Dilute H_2SO_4 test :*** Decomposition of salt is more rapidly on warming, with the evolution of sulphur dioxide.

  $CaSO_3 + H_2SO_4 \longrightarrow CaSO_4 + H_2O + SO_2\uparrow$

  SO_2 has suffocating odour of burning sulphur.

- ***Acidified potassium dichromate test :*** The filter paper dipped in acidified $K_2Cr_2O_7$ turns green.

  $Cr_2O_7^{2-} + 2H^+ + 3SO_2 \longrightarrow 2Cr^{3+}$ (green) $+ 3SO_4^{2-} + H_2O$.

- ***Barium chloride/Strontium chloride solution :*** White precipitate of barium (or strontium) sulphite is obtained.

  $SO_3^{2-} + Ba^{2+}/Sr^{2+} \longrightarrow BaSO_3/SrSO_3\downarrow$ (white).

☞ White precipitate is soluble in dilute HCl forming SO_2.

$BaSO_3 + 2HCl \longrightarrow BaCl_2 + SO_2 + H_2O$

- ***Lime water test :*** A white precipitate is formed. The precipitate dissolves on prolonged passage of the gas, due to the formation of hydrogen sulphite ions.

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

  $CaSO_3\downarrow + SO_2 + H_2O \longrightarrow Ca(HSO_3)_2$ (soluble)

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

- **Dilute H_2SO_4 test :** Pungent smelling gas like that of rotten egg is obtained.
  $S^{2-} + 2H^+ \longrightarrow H_2S \uparrow$
- **Lead acetate test :** Filter paper moistened with lead acetate solution turns black.
  $(CH_3COO)_2Pb + H_2S \longrightarrow PbS \downarrow$ (black) $+ 2CH_3COOH$.
- **Sodium nitroprusside test :** Purple coloration is obtained.
  $S^{2-} + [Fe(CN)_5(NO)]^{2-} \longrightarrow [Fe(CN)_5NOS]^{4-}$ (violet).
- **Cadmium carbonate suspension/ Cadmium acetate solution :** Yellow precipitate is formed.
  $Na_2S + CdCO_3 \longrightarrow CdS \downarrow + Na_2CO_3$

4. NITRITE ION (NO_2^-) :

- **Dilute H_2SO_4 test :** Solid nitrite in cold produces a transient pale blue liquid (due to the presence of free nitrous acid, HNO_2 or its anhydride, N_2O_3) first and then evolution of pungent smelling reddish brown vapours of NO_2 takes place.
  $NO_2^- + H^+ \longrightarrow HNO_2$; $(2HNO_2 \longrightarrow H_2O + N_2O_3)$;
  $3HNO_2 \longrightarrow HNO_3 + 2NO + H_2O$; $2NO + O_2 \longrightarrow 2NO_2 \uparrow$
- **Starch iodide test :** The addition of a nitrite solution to a solution of potassium iodide, followed by acidification with acetic acid or with dilute sulphuric acid, results in the liberation of iodine, which may be identified by the blue colour produced with starch paste. A similar result is obtained by dipping potassium iodide–starch paper moistened with a little dilute acid into the solution.
  $2NO_2^- + 3I^- + 4CH_3COOH \longrightarrow I_3^- + 2NO \uparrow + 4CH_3COO^- + 2H_2O$
  Starch $+ I_3^- \longrightarrow$ Blue (starch iodine adsorption complex)
- **Ferrous sulphate test (Brown ring test) :** When the nitrite solution is added carefully to a concentrated solution of iron(II) sulphate acidified with dilute acetic acid or dilute sulphuric acid, a brown ring appears due to the formation of $[Fe(H_2O)_5NO]SO_4$ at the junction of the two liquids. If the addition has not been made slowly and caustiously, a brown colouration results.
  $NO_2^- + CH_3COOH \longrightarrow HNO_2 + CH_3COO^-$
  $3HNO_2 \longrightarrow H_2O + HNO_3 + 2NO \uparrow$
  $Fe^{2+} + SO_4^{2-} + NO \uparrow \longrightarrow [Fe, NO]SO_4$
- **Thiourea test :** When a dilute acetic acid solution of a nitrite is treated with a little solid thiourea, nitrogen is evolved and thiocyanic acid is produced. The latter may be identified by the red colour produced with dilute HCl and $FeCl_3$ solution.
  $NaNO_2 + CH_3COOH \longrightarrow HNO_2 + CH_3COONa$
  $HNO_2 + H_2NCSNH_2$(s) (thiourea) $\longrightarrow N_2 + HSCN + 2H_2O$
  $FeCl_3 + 3HSCN \xrightarrow{\text{dil HCl}} Fe(SCN)_3$ (blood red colouration) $+ 3HCl$

5. ACETATE ION (CH_3COO^-)

- With dilute H_2SO_4 a vinegar like smell is obtained.
  $(CH_3COO)_2Ca + H_2SO_4 \longrightarrow 2CH_3COOH + CaSO_4$
- ***Neutral ferric chloride test :*** A deep red/ blood red colouration (no precipitate) indicates the presence of acetate.
  $6CH_3COO^- + 3Fe^{3+} + 2H_2O \longrightarrow [Fe_3(OH)_2(CH_3COO)_6]^+ + 2H^+$

☞ When solution is diluted with water and boiled, brownish red precipitate of basic iron (III) acetate is obtained.

$[Fe_3(OH)_2(CH_3COO)_6]^+ + 4H_2O \xrightarrow{\text{Boil}} 3Fe(OH)_2CH_3COO^- + 3CH_3COOH + H^+$

Solved Examples

.1 An aqueous solution of salt containing an anion X^{n-} gives the following reactions :
(i) It gives the purple or violet colouration with sodium nitroprusside solution.
(ii) It liberates a colourless unpleasant smelling gas with dilute H_2SO_4 which turns lead acetate paper black.
Identify the anion (X^{n-}) and write the chemical reactions involved.

Sol. X^{n-} is S^{2-} because

$[Fe(CN)_5NO]^{2-} + S^{2-} \longrightarrow [Fe(CN)_5NOS]^{4-}$ (purple or violet colouration)

(i) $S^{2-} + H_2SO_4 \longrightarrow H_2S \uparrow$ (colourless unpleasant smelling) $+ SO_4^{2-}$

(ii) $H_2S + Pb(CH_3COO)_2 \longrightarrow PbS \downarrow$ (black) $+ 2CH_3COOH$

Ex.2 Sulphite on treatment with dil. H_2SO_4 liberates a gas which :
(1) turns lead acetate paper black (2) burns with blue flame
(3) smells like vinegar (4) turns acidified $K_2Cr_2O_7$ solution green

Sol. $SO_3^{2-} + H_2SO_4 \longrightarrow SO_2 + SO_4^{2-} + H_2O$

SO_2 turns acidified $K_2Cr_2O_7$ solution green.

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

Therefore, (4) option is correct.

(b) CONC . H_2SO_4 GROUP :

1. CHLORIDE ION (Cl^-) :

- **Concentrated H_2SO_4 test :** Colourless pungent smelling gas is evolved which gives fumes of NH_4Cl when a glass rod dipped in dil. HCl is brought in contact with evolving gas.

$$Cl^- + H_2SO_4 \longrightarrow HCl + HSO_4^-$$

- $NH_4OH + HCl \longrightarrow NH_4Cl \uparrow$ (white fumes) $+ H_2O$.

☞ $2NaCl + MnO_2 + 2H_2SO_4$ (conc.) $\longrightarrow Na_2SO_4 + MnSO_4 + 2H_2O + Cl_2$

- **Silver nitrate test :**

$$Cl^- + Ag^+ \longrightarrow AgCl \downarrow \text{ (white)}$$

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

$$AgCl + 2NH_4OH \longrightarrow [Ag(NH_3)_2]Cl \text{ (Soluble)} + 2H_2O$$

$$[Ag(NH_3)_2]Cl + 2H^+ \longrightarrow AgCl \downarrow + 2NH_4^+.$$

- **Chromyl Chloride test :**

$$4Cl^- + Cr_2O_7^{2-} + 6H^+ \text{ (conc.)} \longrightarrow 2CrO_2Cl_2 \text{ (deep red vapours)} + 3H_2O$$

When deep red vapours are passed into sodium hydroxide solution, a yellow solution of sodium chromate is formed, which when treated with lead acetate gives yellow precipitate of lead chromate.

$$CrO_2Cl_2 + 4OH^- \longrightarrow CrO_4^{2-} + 2Cl^- + 2H_2O$$

$$CrO_4^{2-} + Pb^{+2} \longrightarrow PbCrO_4 \downarrow \text{(yellow)}$$

☞ **Heavy metal chlorides** such as Hg_2Cl_2, $HgCl_2$, $SnCl_2$, AgCl, $PbCl_2$ and $SbCl_3$ do not respond to this test as they are partially dissociated. This test is given generally by **ionic chlorides.**

☞ Test should be carried out in a dry test tube otherwise chromic acid will be formed.

$$CrO_2Cl_2 + 2H_2O \longrightarrow H_2CrO_4 + 2HCl$$

2. BROMIDE ION (Br^-) :

- **Concentrated H_2SO_4 test :** First a reddish-brown solution is formed, then reddish-brown bromine vapour accompanies the hydrogen bromide (fuming in moist air) is evolved.

$$2NaBr + H_2SO_4 \longrightarrow Na_2SO_4 + 2HBr$$

$$2HBr + H_2SO_4 \longrightarrow Br_2 \uparrow + 2H_2O + SO_2$$

☞ $2KBr + MnO_2 + 2H_2SO_4 \longrightarrow Br_2 \uparrow + K_2SO_4 + MnSO_4 + 2H_2O$

- **Silver Nitrate test :** Pale yellow precipitate is formed

$$NaBr + AgNO_3 \longrightarrow AgBr \downarrow + NaNO_3$$

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

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

- **Chlorine water test (organic layer test) :** When to a sodium carbonate extract of metal bromid containing CCl_4, $CHCl_3$ or CS_2, chlorine water is added and the content is shaken and then allow settle down reddish brown colour is obtained in organic layer.

$$2Br^- + Cl_2 \longrightarrow 2Cl^- + Br_2 \uparrow .$$

$Br_2 + CHCl_3 / CCl_4 \longrightarrow Br_2$ dissolve to give reddish brown colour in organic layer.

With excess of chlorine water, the bromine is converted into yellow bromine monochloride and a pale yellow solution results.

$Br_2 \uparrow + Cl_2 \uparrow \longrightarrow 2BrCl$

3. IODIDE ION (I^-) :

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

$2NaI + H_2SO_4 \longrightarrow Na_2SO_4 + 2HI$

$2HI + H_2SO_4 \longrightarrow I_2 \uparrow$ (dark violet) $+ 2H_2O + SO_2$

☞ Evolution of dark violet fumes intensifies on adding a pinch of MnO_2.

$3I^- + MnO_2 + 2H_2SO_4 \longrightarrow I_3^- \uparrow + Mn^{2+} + 2SO_4^{2-} + 2H_2S$

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

$3I^- + 2NO_2^- + 4H^+ \longrightarrow I_3^- + 2NO \uparrow + 2H_2O.$

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

$I^- + Ag^+ \longrightarrow AgI \downarrow$

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

- **Chlorine water test (organic layer test) :** When chlorine water is added to a solution of iodide, free iodine is liberated which colours the solution brown and on shaking with CS_2, $CHCl_3$ or CCl_4, it dissolves in organic layer forming a violet solution, which settles below the aqueous layer.

$2NaI + Cl_2 \longrightarrow 2NaCl + I_2$

$I_2 + CHCl_3 \longrightarrow I_2$ dissolves to give violet colour in organic layer.

If excess of chlorine water is added, I_2 is oxidised to iodic acid (colourless).

$I_3^- + 8Cl_2 \uparrow + 9H_2O \longrightarrow 3IO_3^- + 16Cl^- + 18\ H^+$

4. NITRATE ION (NO_3^-) :

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

$4NO_3^- + 2H_2SO_4 \longrightarrow 4NO_2 \uparrow + O_2 + 2SO_4^{2-} + 2H_2O$

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

$2NO_3^- + 4H_2SO_4 + 3Cu \longrightarrow 3Cu^{2+} + 2NO \uparrow + 4SO_4^{2-} + 4H_2O$; $2NO \uparrow + O_2 \longrightarrow 2NO_2 \uparrow$

$4\ C$ (paper pellet) $+ 4HNO_3 \longrightarrow 2H_2O + 4NO_2 + 4CO_2$.

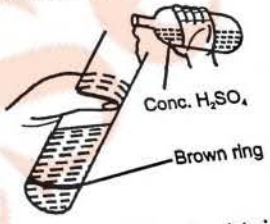
- **Brown ring test :** When a freshly prepared saturated solution of iron (II) sulphate is added to nitrate solution and then concentrated H_2SO_4 is added slowly from the side of the test tube, a brown ring is obtained at the junction of two layers.

$NaNO_3 + H_2SO_4 \longrightarrow NaHSO_4 + HNO_3$

$6FeSO_4 + 2HNO_3 + 3H_2SO_4 \longrightarrow 3Fe_2(SO_4)_3 + 2NO + 4H_2O$

or $2NO_3^- + 4H_2SO_4 + 6Fe^{2+} \longrightarrow 6Fe^{3+} + 2NO \downarrow + 4SO_4^{2-} + 4H_2O.$

$Fe^{2+} + NO \uparrow + 5H_2O \longrightarrow [Fe^{I}(H_2O)_5\ NO^+]^{2+}$ (brown ring).



☞ On shaking and warming the mixture, NO escapes and a yellow solution of iron(iii) ions is obtained.

(B) GROUP 'B' RADICALS :

Group of anions which do not give any gas with dilute as well as concentrated H_2SO_4 in cold but give precipitate with certain reagents :

These acid radicals are identified in inorganic salts by their individual tests as given below

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

- **Barium chloride test :**

W.E. or S.E. + Barium chloride (aq) $\longrightarrow$ White precipitate

$Na_2SO_4 + BaCl_2 \longrightarrow BaSO_4 \downarrow$ (white) $+ 2NaCl.$

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

- **Lead acetate test :**

$$W.E. \text{ or } S.E. + \text{Lead acetate} \longrightarrow \text{white precipitate}$$
$$Na_2SO_4 + (CH_3COO)_2Pb \longrightarrow PbSO_4 \downarrow (White) + 2CH_3COONa$$

☞ White precipitate soluble in excess of hot ammonium acetate.

$$PbSO_4 + 2CH_3COONH_4 \longrightarrow (CH_3COO)_2Pb \text{ (soluble)} + (NH_4)_2SO_4$$

- **Match stick test :**

(a) W.E. or S.E. + Barium chloride $\longrightarrow$ white precipitate

$$Na_2SO_4 + BaCl_2 \longrightarrow 2NaCl + BaSO_4 \downarrow (white)$$

(b) White precipitate + $Na_2CO_3(s)$ mix and apply the paste on the end of the carbonized match stick or a wooden splinter. Put it in the reducing flame.

$$BaSO_4(s) + Na_2CO_3(s) \longrightarrow Na_2SO_4 + BaCO_3 \downarrow (white)$$
$$Na_2SO_4 + 4C \longrightarrow Na_2S + 4CO$$

(c) Now dip the match stick in sodium nitroprusside solution, purple colour near the fused mass is developed.

$$Na_2S + Na_2[Fe(CN)_5NO] \longrightarrow Na_4[Fe(CN)_5NOS] \text{ (purple)}$$

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

- **Ammonium molybdate test :**

$$Na_2HPO_4(aq) + 12(NH_4)_2MoO_4 + 23HNO_3 \rightarrow (NH_4)_3PMo_{12}O_{40} \downarrow \text{(canary yellow)} + 2NaNO_3 + 21NH_4NO_3 + 12H_2O$$

☞ Some times ammonium phosphomolybdate is also represented by the formula $(NH_4)_3PO_4 \cdot 12MoO_3$

- **Magnesium nitrate or magnesia mixture test :** W.E. or S.E + Magnesium nitrate reagent (3-4 mL) and allows to stand for 4-5 minutes, white crystalline precipitate is formed.

$$Na_2HPO_4(aq) + Mg(NO_3)_2(aq) + NH_4OH(aq) \longrightarrow Mg(NH_4)PO_4 \downarrow \text{(white)} + 2NaNO_3 + H_2O$$

Magnesia mixture is a solution containing $MgCl_2$, NH_4Cl and a little aqueous NH_3.

☞ PO_4^{3-} also gives $BaCl_2$ test due to the formation of white precipitate of $Ba_3(PO_4)_2$. So phosphate test should be carried out first and then conclude if PO_4^{3-} is present or absent before proceeding with the test for SO_4^{2-}.

- **Silver nitrate solution :** Yellow precipitate is formed which is soluble in dilute ammonia and in dilute nitric acid.

$$PO_4^{3-} + 3Ag^+ \longrightarrow Ag_3PO_4 \downarrow$$
$$Ag_3PO_4 \downarrow + 6NH_3 \longrightarrow 3[Ag(NH_3)_2]^+ + PO_4^{3-}; \quad Ag_3PO_4 \downarrow + 2H^+ \longrightarrow H_2PO_4^- + 3Ag^+$$

3. BORATE ION (BO_3^{3-}) :

Salt (0.2 g) + conc. H_2SO_4 (1 mL) + Ethyl alcohol (4-5 mL) mix in a test tube and then heat. Ignite the evolved vapours with the help of Bunsen flame, green edged flame is obtained.

$$Na_3BO_3 + 3H_2SO_4 \longrightarrow 3Na_2SO_4 + 2H_3BO_3$$
$$3C_2H_5OH + H_3BO_3 \longrightarrow (C_2H_5)_3BO_3 + 3H_2O$$

Solved Examples

Ex.3 A compound (A) of S, Cl and O has vapour density of 67.5 (approx.). It reacts with water to form two acids and reacts with KOH to form two salts (B) and (C) while (B) gives white precipitate with $AgNO_3$ solution and (C) gives white precipitate with $BaCl_2$ solution. Identify (A), (B) & (C).

Sol. As mixture give white precipitate with $BaCl_2$ and $AgNO_3$, it should contain SO_4^{2-} and Cl^- ions. As SO_2Cl_2 when dissolved in water gives, a mixture of H_2SO_4 & HCl which then react with KOH to form KCl and K_2SO_4. Therefore, (A) is SO_2Cl_2 and (B) & (C) are K_2SO_4 and KCl respectively.

Vapour density of SO_2Cl_2 = molecular weight / 2.

Vapour density of SO_2Cl_2 = 135 / 2 = 67.5.

Ex.4 Bromine vapours turn moist starch iodide paper :
(1) brown (2) red (3) blue (4) colourless

Sol. $2I^- + Br_2 \longrightarrow I_2 + 2Br^-$; I_2 + starch $\longrightarrow$ blue starch iodine adsorption complex.
Therefore, (3) option is correct.

Ex.5 $Na_2S_2O_3 + I_2 \longrightarrow NaI + \ldots\ldots\ldots [X]$, [X] is :
(1) $Na_2S_4O_6$ (2) Na_2SO_4 (3) Na_2S (4) Na_3ISO_4

Sol. $2Na_2S_2O_3 + I_2 \longrightarrow 2NaI + Na_2S_4O_6$.
Therefore, (1) option is correct.

Analysis of CATIONS (Basic Radicals) :

Group	Group reagent	Basic radical	Composition and colour of precipitate
Zero	NaOH or $Ca(OH)_2$, heat if required	NH_4^+	Ammonia gas is evolved.
1.	Dil HCl	Ag^+ Hg_2^{2+} Pb^{2+}	AgCl ; White Hg_2Cl_2 ; White $PbCl_2$; White
2.(A)	H_2S in presence of dil HCl (Insoluble in YAS)	Hg^{2+} Pb^{2+} Bi^{3+} Cu^{2+} Cd^{2+}	HgS ; Black PbS ; Black Bi_2S_3 ; Black CuS ; Black CdS ; Yellow
2.(B)	H_2S in presence of dil HCl (Soluble in YAS)	As^{3+} Sb^{3+} Sn^{2+} Sn^{4+}	As_2S_3 ; Yellow Sb_2S_3 ; Orange SnS ; Brown SnS_2 ; Yellow
3.	NH_4OH in presence of NH_4Cl	Fe^{3+} Cr^{3+} Al^{3+}	$Fe(OH)_3$; Reddish brown $Cr(OH)_3$; Green $Al(OH)_3$; Gelatinous white
4.	H_2S in presence of NH_4OH and NH_4Cl	Zn^{2+} Mn^{2+} Co^{2+} Ni^{2+}	ZnS ; White MnS ; Buff (or Pink) CoS ; Black NiS ; Black
5.	$(NH_4)_2CO_3$ in presence of NH_4OH	Ba^{2+} Sr^{2+} Ca^{2+}	$BaCO_3$; White $SrCO_3$; White $CaCO_3$; White
6.	Na_2HPO_4 in presence of NH_4OH	Mg^{2+}	$Mg(NH_4)PO_4$; White

☞ [YAS = Yellow ammonium sulphide. $(NH_4)_2S_x$].

ZERO GROUP :

1. AMMONIUM ION (NH_4^+) :

Sodium hydroxide solution : Ammonia gas is evolved on warming the solution containing ammonium salt and sodium hydroxide.

$$NH_4Cl + NaOH \longrightarrow NH_3 + H_2O + NaCl$$

☞ The gas can be identified by the following characteristics / reactions.

— Its characteristics smell.

— The evolution of the white fumes of ammonium chloride when a glass rod dipped in dilute HCl is held in the vapour. $NH_3 + HCl \longrightarrow NH_4Cl \uparrow$ (white fumes)

RESONANCE STUDY CENTRES (Self Owned)

KOTA (Head Office):
Pre Engineering Division: JEE (Advanced)
Pre Engineering Division: JEE (Main)
Pre Medical Division: AIIMS/ AIPMT
Tel.: 0744-3012222, 3192222, 6635555
e-mail: contact@resonance.ac.in

Commerce & Law Program Division (CLPD)
Tel.: 0744-3192229, 6060663
e-mail: clpd@resonance.ac.in

PCCP
J-2 Campus: Tel.: 0744-2434727, 8824078330
e-mail: pccp@resonance.ac.in

Station Campus: Tel.: 0744-3192223, 2440488
e-mail: pccp.stn@resonance.ac.in

PSPD/ MEx Division: Tel.: 0744-2422030
e-mail: pspd@resonance.ac.in, mex@resonance.ac.in

DLPD
Tel.: 0744-6635556, 3012222
e-mail: dlpd@resonance.ac.in

eLPD
Tel.: 0744-3058242
e-mail: elpd@resonance.ac.in

JAIPUR
Tel.: 0141-6060661/ 64, 3103666, 6060662/63
e-mail: jaipurc@resonance.ac.in

BHOPAL
Tel.: 0755-3206353, 3192222
e-mail: bhopal@resonance.ac.in

NEW DELHI
Tel.: 011-60606601/ 2/ 3/ 4/ 5/ 6/ 7
e-mail: delhi@resonance.ac.in

LUCKNOW
Tel.: 0522-3192222, 3192223, 6060660/ 61/ 62
e-mail: lko@resonance.ac.in

KOLKATA
Tel.: 033-31922222, 6060[illegible] 01/ 02
email: kolkata@resonance.ac.in

NAGPUR
Tel: 0712-3192222, 6060660
e-mail: nagpur@resonance.ac.in

NANDED
Tel.: 02462-250220
e-mail: nanded@resonance.ac.in

MUMBAI
Tel.: 022-31922222, 60606600
e-mail: andheri@resonance.ac.in

UDAIPUR
Tel.: 0294-6060660, 5107858, 6060662
e-mail: udaipur@resonance.ac.in

BHUBANESWAR
Tel.: 0674-3192222, 3274919, 6060660/ 61
e-mail: bbsr@resonance.ac.in

AHMEDABAD
Tel.: 079-31922222/ 3/ 4 & 079-60606600/ 1/ 2
e-mail: abad@resonance.ac.in

PATNA
Tel.: 0612-3192222/ 3
e-mail: patna@resonance.ac.in

JODHPUR
Tel.: 0291- 6060660
e-mail: jodhpur@resonance.ac.in

AJMER
Tel.: 0145-3192222, 6060660/ 65
e-mail: ajmer@resonance.ac.in

INDORE
Tel: 0731-4039100, 6060660
e-mail: indore@resonance.ac.in

SIKAR
Tel: 01572-319222, 606066
e-mail: sikar@resonance.ac.in

AGRA
Tel: 0562-3192222
e-mail: agra@resonance.ac.in

RANCHI
Tel.: 0651-6060660
e-mail: ranchi@resonance.ac.in

[illegible]BAD
Tel.: 0532-[illegible]
e-mail: [illegible]@resonance.ac.in

NASIK
Tel.: [illegible]
e-mail: nashik@resonance.ac.in

RAIPUR
Tel.: 0771- 6060660
e-mail: raipur@resonance.ac.in

AURANGABAD
Tel.: 0240-6060660
e-mail: aurangabad@resonance.ac.in

JABALPUR
Tel.: 0761- 6060660
e-mail: jabalpur@resonance.ac.in

GWALIOR
Tel.: 0751-6060660
e-mail: gwalior@resonance.ac.in

CHANDRAPUR
Tel.: 07172-6060065
e-mail: chandrapur@resonance.ac.in

SURAT
Tel.: 0261-6060660
e-mail: surat@resonance.ac.in

RAJKOT
Tel.: 0281-6002011
e-mail: rajkot@resonance.ac.in

VADODARA
Tel.: 0265-6060660
e-mail: vadodara@resonance.ac.in

BASE STUDY CENTRES

Base Education Service Pvt. Ltd.
Bengaluru (Main Branch):
Reg. Office : No.27, Next to Indian Oil Petrol Bunk, Bull Temple Road, Basavanagudi, Bengaluru- 560004
Tel. No.: 42604600/ 95381 41504
E-Mail : info@base-edu.in
Website: www.base-edu.in

BANASANKARI II STAGE
Tel : 26710835/26710836

BELAGAVI
Tel : 0831- 4208687 | Mobile : 9845228000

CHITRADURGA
Mobile : 9886464755, 9972413844

HUBLI
Tel : 0836- 2252685 | Mobile : 9844118615

INDIRANAGAR
Tel : 41179342/25201306

KALYAN NAGAR
Tel : 080-25443363/25443364

KORAMANGALA
Tel : 40925512/40925534

MALLESHWARAM
Tel : 41400008

MYSURU
Tel : 0821-4242100 /4258100/4243100

RAJAJINAGAR
Tel: 08023327588/41162135

SHIVAMOGGA
Tel : 08182-223980, 8884849590

TUMAKURU
Tel :0816-2252387

UDUPI
Tel : 0820-2522449, 2522994, 9986663074

VIJAYANAGAR
Tel : 23111333/23111334

YELAHANKA
Tel: 08028463922/42289643

CHIKKAMAGALURU
Mobile : 7411329369, 9448396890

HASSAN
Mobile : 9481392014, 9972038283

J P NAGAR
Tel : 26595151/26595153.

KALABURGI
Tel : 08472-230914
Mobile : 9845905200/9844510914

Resonance®
Educating for better tomorrow

Corporate Office: CG Tower, A-46 & 52, IPIA, Near City Mall, Jhalawar Road, Kota (Rajasthan)- 324005
Reg. Office: J-2, Jawahar Nagar Main Road, Kota (Raj.)- 05 | **Tel. No.:** 0744-3192222, 3012222, 6635555 | **CIN:** U80302RJ2007PLC024029
To Know more: sms **RESO** at **56677** | **E-mail:** contact@resonance.ac.in | **Website:** www.resonance.ac.in

Toll Free : 1800 258 5555

facebook.com/ResonanceEdu | twitter.com/ResonanceEdu | www.youtube.com/resowatch | blog.resonance.ac.in