SYSTEMATIC QUALITATIVE ANALYSIS OF SIMPLE INORGANIC SALT

A] PRELIMINARY TEST

1. Nature of the salt: Amorphous/Crystalline
2. Colour of the salt: Colourless/pale pink
3. Solubility:

Water(Cold/Hot)	Dil. HCl	Dil. HNO_3

B] ANALYSIS OF ACID RADICALS:

DETECTION OF GROUP I ACID RADICALS

EXPERIMENT	OBSERVATION	INFERENCE
Salt + Dil. HCl	Brisk effervescence is observed. A colorless gas is liberated.	Group I acid radical is present.
The above gas is passed through lime water.	The lime water turns milky.	Carbonate (CO_3^{-2}) may be present.
CONFIRMATORY TEST FOR CO_3^{-2}:		
Salt + water. Boil and pass the gas through lime water.	Lime water does not turn milky.	CO_3^{-2} is confirmed.
$CO_3^{-2} + HCl \rightarrow CO_2 \uparrow + H_2O + Cl^-$ $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 \downarrow + H_2O$ (milkiness)		
DETECTION OF GROUP II ACID RADICALS:		
Salt + conc. H_2SO_4 in a dry test tube.	a) Colourless gas is evolved. It gives dense white fumes with glass rod dipped in NH_4OH.	Group II acid radical is present. Cl^- may be present.
	b) Reddish brown fumes and the solution turns brown.	Bromide (Br^-) may be present.
	c) Colourless vapours with vinegar smell.	CH_3COO^- may be present.

Above solution + Copper turnings. Heated strongly.	d) Reddish brown fumes and the solution turns blue.	II group acid radical is present. Nitrate (NO_3^-) may be present.
CONFIRMATORY TEST FOR CHLORIDE (Cl^-)		
1.Silver Nitrate test: Clear salt solution in dilute Nitric acid + few drops of silver nitrate solution.	A curdy white precipitate soluble in excess of ammonium hydroxide	Chloride is confirmed.
$Cl^- + AgNO_3 \rightarrow NO_3^- + \underset{\text{white ppt.}}{AgCl\downarrow}$ $AgCl + 2NH_4OH \rightarrow \underset{\text{soluble complex}}{[Ag(NH_3)_2]Cl} + 2H_2O$		
2.Chromyl Chloride test: A pinch of salt + potassium dichromate crystals + few drops of conc.H_2SO_4. Pass the above vapours into NaOH solution. To the yellow solution add acetic acid and lead acetate solution.	Reddish brown vapours of Chromyl Chloride are evolved. Yellow solution. Yellow precipitate.	Chloride is confirmed.
$2Cl^- + K_2Cr_2O_7 + 3H_2SO_4 \rightarrow SO_4^{-2} + K_2SO_4 + \underset{\text{chromyl chloride}}{2CrO_2Cl_2} + 3H_2O$ $CrO_2Cl_2 + 4NaOH \rightarrow Na_2CrO_4 + 2H_2O + 2NaCl$ $Na_2CrO_4 + Pb(CH_3COO)_2 \rightarrow \underset{\text{Yellow ppt.}}{PbCrO_4\downarrow} + 2CH_3COONa$		
CONFIRMATORY TEST FOR BROMIDE (Br^-)		
1.Silver Nitrate test: Clear salt solution in dilute nitric acid boil & cool + few drops of silver nitrate solution.	A pale yellow precipitate partially soluble in excess of ammonium hydroxide.	Br^- is confirmed.
$Br^- + AgNO_3 \rightarrow NO_3^- + \underset{\text{pale yellow ppt.}}{AgBr\downarrow}$		

2.Orange globule test: Clear salt solution in water + few drops of carbon tetrachloride + Chlorine water, shaken well.	Orange brown globule separates out.	Bromide is confirmed.
$Br^- + Cl_2 \rightarrow Cl^- + Br_2$ Bromine being soluble in CCl_4 imparts orange colour to CCl_4 layer.		
CONFIRMATORY TEST FOR ACETATE(CH_3COO^-):		
Oxalic acid test: Salt on watch glass + solid oxalic acid. Make a paste wit few drops of water. Rub the paste and smell. **Ester test:** Salt + conc. H_2SO_4. Heat. Add ethanol and shake. Pour the contents in a beaker full of water. Stir.	Smell of vinegar. Pleasant fruity smell.	CH_3COO^- is confirmed.
1. $(COOH)_2 + 2\ CH_3COO^- \rightarrow (COONa)_2 + CH_3COOH$ (vinegar smell) 2. $2\ CH_3COO^- + H_2SO_4 \rightarrow Na_2SO_4 + 2\ CH_3COOH$ $CH_3COOH + C_2H_5OH \rightarrow CH_3COOC_2H_5 + H_2O$ (fruity smell)		
CONFIRMATORY TEST FOR NITRATE(NO_3^-):		
Brown ring test: Salt solution in dil.H_2SO_4 +freshly prepared saturated solution of Mohr's salt + conc.H_2SO_4 added carefully along the sides of the test tube.	A brown ring is formed at the junction of two liquids.	Nitrate (NO_3^-) is confirmed.
$NO_3^- + H_2SO_4 \rightarrow HSO_4^- + HNO_3$ $2HNO_3 + 3H_2SO_4 + 6FeSO_4 \rightarrow 3Fe_2(SO_4)_3 + 2NO + 4H_2O$ $FeSO_4 + NO + 5H_2O \rightarrow [Fe(H_2O)_5(NO)]SO_4 + H_2O$ (brown ring)		

DETECTION OF GROUP III ACID RADICAL(SO_4^{2-}):		
1. Clear solution of the salt in dil.HCl+ Barium chloride solution.	A white precipitate is formed. It is insoluble in excess of dil.HCl	III group acid radical SO_4^{2-} is present and confirmed
$SO_4^{-2} + BaCl_2 \rightarrow BaSO_4 \downarrow + 2Cl^-$ white ppt.		
2. Lead acetate test: Clear solution of the salt in water + acetic acid + lead acetate solution.	A white precipitate soluble in ammonium acetate solution	SO_4^{2-} is present and confirmed.
$SO_4^{-2} + Pb(CH_3COO)_2 \rightarrow PbSO_4 \downarrow + 2CH_3COO^-$ white ppt.		
DETECTION OF GROUP III ACID RADICAL(PO_4^{3-}):		
Salt solution in water + conc. HNO_3 + solution of ammonium molybdate. Heat to boil.	A canary yellow precipitate is formed.	III group acid radical phosphate is present and confirmed
$Na_3PO_4 + 3HNO_3 \rightarrow H_3PO_4 + 3NaNO_3$ $H_3PO_4 + 12(NH_4)_2MoO_4 + 21HNO_3 \rightarrow (NH_4)_3[P(Mo_3O_{10})_4] + 21NH_4NO_3 + 12H_2O$		
C] ANALYSIS OF BASIC RADICALS (CATIONS):		
TEST FOR AMMONIUM (NH_4^+) RADICAL: (ZERO GROUP ANALYSIS)		
A pinch of the salt is heated with 5 drops of sodium hydroxide.	A pungent smell of ammonia which gives dense white fumes with a glass rod dipped in conc.HCl.	NH_4^+ may be present.
CONFIRMATORY TEST FOR AMMONIUM (NH_4^+) RADICAL:		
Salt solution in water + few drops of Nessler's reagent.	Brown precipitate is formed.	NH_4^+ is confirmed.
$2K_2[HgI_4] + NH_3 + 3KOH \rightarrow H_2N.HgO.HgI \downarrow + 7KI + 2H_2O$ Nessler's reagent brown ppt.		
PREPARATION OF ORIGINAL SOLUTION: The given salt is taken in a test tube and it is dissolved in minimum amount of water or dil.HCl.		

DETECTION OF GROUP I BASIC RADICALS		
Original solution + dil.HCl in a test tube.	White precipitate	I group basic radical present. Pb^{+2} may be present.
<u>CONFIRMATORY TEST FOR Pb^{+2} RADICAL:</u>		
Dissolve the precipitate in hot water and divide the solution into two parts. i) Part 1 + KI solution ii) Part 2 + potassium chromate solution.	 Yellow precipitate is formed. Yellow precipitate is formed.	 Pb^{+2} is confirmed.
i) $Pb^{+2} + 2KI \rightarrow \underset{\text{yellow ppt.}}{PbI_2\downarrow} + 2K^+$ ii) $Pb^{+2} + K_2CrO_4 \rightarrow \underset{\text{yellow ppt.}}{PbCrO_4\downarrow} + 2K^+$		
<u>DETECTION OF GROUP II BASIC RADICALS</u>		
Original solution + dil.HCl + H_2S solution is added.	Black precipitate.	II group basic radical present. Pb^{+2} or Cu^{+2} may be present.
<u>CONFIRMATORY TEST FOR Pb^{+2} RADICAL:</u>		
Black precipitate + dil. HNO_3. Boil, cool + few drops of alcohol + dil. H_2SO_4.	White precipitate is formed.	Pb^{+2} is confirmed.
$3PbS + 8HNO_3 \rightarrow 3Pb(NO_3)_2 + 4H_2O + NO + 3S$ $Pb(NO_3)_2 + H_2SO_4 \rightarrow 2\ HNO_3 + \underset{\text{white ppt.}}{PbSO_4\downarrow}$		
<u>CONFIRMATORY TEST FOR Cu^{+2} RADICAL:</u>		
Original solution + excess NH_4OH. Acidify with acetic acid. Add potassium ferrocyanide solution.	Blue solution. Chocolate brown precipitate.	Cu^{+2} is confirmed.

DETECTION OF GROUP III BASIC RADICALS		
Original Solution + NH_4Cl solid + NH_4OH solution in excess.	A gelatinous white precipitate.	III group basic radical present. Al^{3+} may be present.
CONFIRMATORY TEST FOR ALUMINIUM(Al^{3+})		
a) Original solution + NaOH solution dropwise. Above solution is treated with NH_4Cl solid. b) **Lake test:** Original solution + blue litmus solution + NH_4OH solution in excess.	Gelatinous white precipitate soluble in excess of NaOH. White gelatinous precipitate reappears. Bluish white precipitate, floating like lake is formed.	Al^{3+} is confirmed.

a) $Al^{3+} + 3\ OH^- \rightarrow \underset{\text{white ppt.}}{Al(OH)_3\downarrow}$

$Al(OH)_3 + OH^- \rightarrow \underset{\text{soluble complex}}{Al(OH)_4^-}$

b) $Al^{3+}(aq) + 3NH_4OH \rightarrow \underset{\text{blue color adsorbs on this ppt.}}{Al(OH)_3\downarrow} + 3NH_4^+$

DETECTION OF GROUP IV BASIC RADICALS		
Original solution + NH_4Cl solid +NH_4OH solution in excess + H_2S	i) White precipitate. ii) Buff precipitate.	IV group basic radical present. Zn^{+2} may be present. Mn^{+2} may be present.
CONFIRMATORY TEST FOR ZINC (Zn^{2+})		
i) Original solution + NaOH solution dropwise. To the above solution acidify with Dil. HCl and add H_2S ii) Original solution + NH_4OH solution + potassium ferrocyanide solution.	White precipitate is soluble in excess of NaOH. White precipitate reappears. White (or bluish white) precipitate.	Zn^{+2} confirmed.

a) $Zn^{2+} + 2NaOH \rightarrow Zn(OH)_2\downarrow + 2Na^+$

$Zn(OH)_2 + 2NaOH \rightarrow Na_2ZnO_2 + 2H_2O$

b) $2Zn^{2+} + K_4[Fe(CN)_6] \rightarrow Zn_2[Fe(CN)_6] \downarrow + 4K^+$

CONFIRMATORY TEST FOR MANGANOUS (Mn^{2+})		
Original solution + NH_4Cl solid +NH_4OH solution in excess + H_2S Add dil.HCl and boil. Add sodium hydroxide solution in excess	Buff / flesh coloured precipitate. Precipitate dissolves. White precipitate formed and turns brown on exposure to air.	Mn^{2+} is confirmed.

$MnS + 2HCl \rightarrow Mn\ Cl_2 + H_2S$

$Mn^{2+} + 2NaOH \rightarrow \underset{\text{white ppt.}}{Mn(OH)_2} \downarrow + 2Na^+$

$Mn\ (OH)_2 + [O] \rightarrow \underset{\text{Hydrated manganese dioxide (Brown colour)}}{MnO(OH)_2}$

DETECTION OF GROUP V BASIC RADICALS		
Original solution + NH_4Cl solid + NH_4OH solution in excess+$(NH_4)_2CO_3$ solution.	A white precipitate.	IV group basic radical present. Ba^{2+}, Sr^{2+}, or Ca^{2+} may be present.

CONFIRMATORY TEST FOR BARIUM (Ba^{2+})		
Original solution +acetic acid + potassium chromate solution.	Yellow precipitate.	Ba^{2+} is confirmed.

$Ba^{2+} + 2CH_3COO^- \rightarrow (CH_3COO)_2Ba$

$(CH_3COO)_2Ba + K_2CrO_4 \rightarrow BaCrO_4 \downarrow + CH_3COOK$

Flame test: A pinch of salt +few drops conc.HCl and made into a paste. The paste is held to the flame with the help of a platinum wire.	Apple green colour is imparted to the flame.	Ba^{2+} is confirmed.

CONFIRMATORY TEST FOR STRONTIUM (Sr^{2+})		
Original solution + ammonium sulphate solution, warm.	White precipitate.	Sr^{2+} is confirmed.
$Sr^{2+} + (NH_4)_2SO_4 \rightarrow SrSO_4 \downarrow + 2NH_4^+$		
Flame test: A pinch of salt +few drops conc.HCl and made into a paste. The paste is held to the flame with the help of a platinum wire.	Crimson red colour is imparted to the flame.	Sr^{2+} is confirmed.
CONFIRMATORY TEST FOR CALCIUM (Ca^{2+})		
Original solution + NH_4OH solution + Ammonium oxalate solution.	White precipitate	Ca^{2+} is confirmed
$Ca^{2+} + (NH_4)_2C_2O_4 \rightarrow CaC_2O_4 \downarrow + 2NH_4^+$		
Flame test: A pinch of salt +few drops conc.HCl and made into a paste. The paste is held to the flame with the help of a platinum wire.	Brick red colour is imparted to the flame	Ca^{2+} is confirmed
DETECTION OF GROUP VI BASIC RADICALS		
i) Original solution + NH_4Cl solid + NH_4OH solution + ammonium phosphate solution. ii) Original solution + NaOH solution.	White crystalline precipitate White precipitate insoluble in NaOH solution	Mg^{2+} is confirmed. Mg^{2+} is confirmed.
$Mg^{2+} + NH_4OH + (NH_4)_2HPO_4 \rightarrow Mg(NH_4)PO_4\downarrow + 2NH_4^+ + H_2O$ $Mg^{2+} + 2NaOH \rightarrow Mg(OH)_2\downarrow + 2Na^+$		

RESULT:

The given salt contains _____ as acid radical and _____ as basic radical.

Hence the given salt is_____.