QUALITATIVE INORGANIC ANALYSIS OF SIMPLE SALTS (SCHEME)

	Experiment	Observation	Inference
Part A: Preliminary Examination			
1.	Colour and appearance of the given salt are noted.	a) Blue or bluish green b) Light pink c) No characteristic colour	Cu^{2+} may be present Mn^{2+} may be present Cu^{2+} and Mn^{2+} may be absent
2. Write Only	A little of the salt is heated strongly in a dry test tube.	a) A colourless gas is produced which turns lime water milky b) Reddish brown fumes of NO_2 c) No characteristic reaction	Carbonate (CO_3^{2-}) may be present. Nitrate (NO_3^-) of Heavy metal may be present. CO_3^{2-} and NO_3^- may be absent
Part B: Systematic tests for Anion			
1.	Dil. HCl is added to a little of the salt.	a) Brisk effervescence with evolution of a colourless, odorless gas.	Presence of Carbonate (CO_3^{2-})
$MCO_3 + 2HCl \longrightarrow MCl_2 + H_2O + CO_2$			
		b) No characteristic reaction. (Proceed to test 2)	Absence of Carbonate
2.	A little of the salt is rubbed with few drops of dil. H_2SO_4.	a) Vinegar Smell	Presence of Acetate (Confirm by other tests)
$H_2SO_4 + CH_3COOM \longrightarrow CH_3COOH + MHSO_4$			
		b) No characteristic reaction. (Proceed to test 3)	Absence of Acetate
3.	Few drops of con. H_2SO_4 are added to a little of the salt taken in a dry test tube.	a) A colourless fuming gas giving dense white fumes when a glass rod dipped in NH_4OH is shown at the mouth of the test tube	Presence of Chloride (Confirm by other tests)
$MCl + H_2SO_4 \longrightarrow MHSO_4 + HCl$ $HCl + NH_3 \longrightarrow NH_4Cl$			
		b) No characteristic reaction (Proceed to test 4)	Absence of Chloride
4.	Few drops of con. H_2SO_4 are added to a little of the salt taken in a dry test tube, heated and a paper ball is added.	a) Reddish brown fumes of NO_2	Presence of Nitrate (NO_3^-) (Confirm by other tests)
$MNO_3 + H_2SO_4 \longrightarrow MHSO_4 + HNO_3$ $4HNO_3 + C \longrightarrow 2H_2O + CO_2 + 4NO_2$			
		b) No reddish brown gas (proceed to test 5)	Absence of Nitrate
	Note: If there is no characteristic reaction in test (3), the test tube containing salt and con. H_2SO_4 may heated and paper ball added for testing for nitrate)		
5.	$BaCl_2$ solution is added to a little of the salt solution in water taken in a test tube.	a) A white precipitate insoluble in dil. HCl	Presence of Sulphate (SO_4^{2-}) (Confirm by other tests)
$M_2SO_4 + BaCl_2 \longrightarrow BaSO_4 + 2MCl$			
		b) No white precipitate	Absence of Sulphate

CONFIRMATORY TESTS FOR ANIONS

	Experiment	Observation	Inference
I	**CARBONATE**		
	The colourless gas produced on reaction with dil. HCl is passed through lime water taken in a test tube and shaken well.	The lime water turned milky.	Presence of Carbonate (CO_3^{2-}) is confirmed.
	$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$		
II	**ACETATE**		
	Few drops of neutral $FeCl_3$ are added to a little of the salt solution.	Reddish brown colour is obtained.	Presence of Acetate is confirmed.
	$Fe^{3+} + 3CH_3COOH \longrightarrow (CH_3COO)_3Fe$		
III	**CHLORIDE**		
1.	A little of salt is warmed with little MnO_2 and few drops of con. H_2SO_4.	Greenish Yellow gas with pungent smell	Presence of Chloride is confirmed.
	$2MCl + MnO_2 + 3H_2SO_4 \longrightarrow 2MHSO_4 + 2H_2O + Cl_2 + MnSO_4$		
2.	Silver Nitrate solution is added to a little of the salt solution.	A white curdy precipitate soluble in NH_4OH	Presence of Chloride is confirmed.
	$MCl + AgNO_3 \longrightarrow MNO_3 + AgCl$ $AgCl + 2NH_4OH \longrightarrow [Ag(NH_3)_2]Cl + 2H_2O$		
IV	**NITRATE**		
	Brown Ring Test: A little of the salt solution is mixed with freshly prepared $FeSO_4$ solution and con. H_2SO_4 is added carefully along the sides of the test tube without shaking (Keeping the test tube in slanting position).	A brown ring is formed at the junction of the two liquids.	Presence of Nitrate is confirmed.
	$NO_3^- + 3Fe^{2+} + 4H^+ \longrightarrow 3Fe^{3+} + NO + 2H_2O$ $[Fe(H_2O)_6]^{2+} + NO \longrightarrow [Fe(H_2O)_5NO]^{2+} + H_2O$		
V	**SULPHATE**		
	A little of the salt solution is acidified with Acetic acid and Lead Acetate solution is added.	White precipitate	Presence of Sulphate is confirmed.
	$M_2SO_4 + (CH_3COO)_2Pb \longrightarrow PbSO_4 + 2CH_3COOM$		
		b) No white precipitate	Absence of Sulphate

The given salt contains the anion .....

	Experiment	Observation	Inference
Part C: Systematic tests for Cation			
1.	Solubility of the given salt in water is tested.	a) Soluble in water b) Insoluble in water (Na_2CO_3 test may not be conducted)	a) Presence of Ammonium or soluble salt of any class II cation b) Absence of Ammonium (Presence of class II cation)
2.	Na_2CO_3 solution is added to a little of salt solution in water.	a) No precipitate b) Formation of a precipitate	a) Presence of Ammonium b) Presence of class II cation (Absence of Ammonium)
	Note: i. Analyze for AMMONIUM if the presence of Ammonium is indicated by the above tests. ii. Analyze for class II cations (Pb to Mg) if the presence of class II cations is indicated by the above tests.		
Confirmatory tests for Ammonium			
1.	A little of the salt is boiled with NaOH solution.	colourless gas with pungent smell And gives dense white fumes when a glass rod dipped in con. HCl is shown a the mouth of the test tube.	Presence of Ammonium
	$NH_4^+ + NaOH \longrightarrow Na^+ + H_2O + NH_3$ $NH_3 + HCl \longrightarrow NH_4Cl$		
		No characteristic smell	Absence of Ammonium
2.	To a little of the salt solution Nessler's reagent is added.	A brown precipitate	Presence of Ammonium is confirmed.
	$2K_2HgI_4 + NH_3 + KOH \longrightarrow H_2NHgO.HgI + 7KI + 2H_2O$		

Preparation of stock solution

A stock solution of the salt in water, dil. HCl or dil. H_2SO_4 is prepared. These solvents should be tried in the order given below.

Dil. HCl is used only if the salt is insoluble in water.

Dil. HNO_3 is used only if the salt is insoluble in water and in Dil. HCl. (Use minimum acid)

The solubility of the salt is tested by using a little of the salt. Then the stock solution is prepared in the suitable solvent using the bulk of the salt. Small portion of the stock solution are used for various tests given below.

SYSTEMATIC TESTS FOR CLASS II CATIONS

	Experiment	Observation	Inference
1.	Dil. HCl is added to a little of the salt solution.	a) A heavy white precipitate soluble in hot water	Presence of Lead ion (Confirm by other tests)
	$Pb^{2+} + 2HCl \longrightarrow PbCl_2 + 2H^+$		
		b) No precipitate (Proceed to test 2 if the given salt is bluish in colour, else to test 3)	Absence of Lead ion
2. Write Only	H_2S is passed through the above solution	a) A black precipitate	Presence of Copper ion (Confirm by other tests)
	$Cu^{2+} + S^{2-} \longrightarrow CuS$		
		b) No precipitate (Proceed to test 3)	Absence of Copper ion
3.	Solid NH_4Cl is added to a little of the salt solution, dissolve the NH_4Cl and then NH_4OH is added.	a) White gelatinous precipitate	Presence of Al^{3+} (Confirm by other tests)
	$Al^{3+} + 3OH^- \longrightarrow Al(OH)_3$		
		No precipitate (Proceed to test 4)	Absence of Al^{3+}
4.	NH_4Cl, NH_4OH are added to the salt solution and then H_2S is passed (i.e. H_2S is passes through the above solution in test 3)	a) A white precipitate	Presence of Zinc ion (Confirm by other tests)
	$Zn^{2+} + S^{2-} \longrightarrow ZnS$		
		b) A flesh coloured precipitate	Presence of Manganese ion (Confirm by other tests)
	$Mn^{2+} + S^{2-} \longrightarrow MnS$		
		c) No precipitate (Proceed to test 5)	Absence of Zn^{2+} and Mn^{2+}
5.	NH_4Cl, NH_4OH and $(NH_4)_2CO_3$ are added to the salt solution.	a) A white precipitate	Presence of group V cation (Ba^{2+} and Ca^{2+}) (Distinguish and confirm)
	$M^{2+} + CO_3^{2-} \longrightarrow MCO_3$		
		b) No precipitate (Proceed to test 6)	Absence of group V cation
6.	NH_4Cl, NH_4OH and Na_2HPO_4 are added to a little of the salt solution (scratch the side of the test tube with a glass rod if necessary)	a) A white crystalline precipitate	Presence of Mg^{2+} (Confirm by other tests)
	$Mg^{2+} + NH_3 + Na_2HPO_4 \longrightarrow Mg(NH_4)PO_4 + 2Na^+$		
		b) No precipitate	Absence of Mg^{2+}

CONFIRMATORY TESTS FOR CATIONS

	Experiment	Observation	Inference
I	**LEAD (Pb^{2+})**		
1.	K_2CrO_4 solution is added to a little of the salt solution.	Yellow precipitate	Presence of Lead ion is confirmed.
	$Pb^{2+} + K_2CrO_4 \longrightarrow PbCrO_4 + 2K^+$		
2.	KI solution is added to a little of the salt solution.	A bright yellow precipitate soluble in boiling water and reappearing in golden spangles on cooling.	Presence of Lead ion is confirmed.
	$Pb^{2+} + 2KI \longrightarrow PbI_2 + 2K^+$		
II	**COPPER (Cu^{2+})**		
1.	NH_4OH is added drop by drop to a little of the salt solution.	A pale blue precipitate dissolving in excess NH_4OH to form a deep blue solution.	Presence of Cu^{2+} is confirmed.
	$Cu^{2+} + 2NH_4OH \longrightarrow Cu(OH)_2 + 2NH_4^+$ $Cu(OH)_2 + 4NH_4OH \longrightarrow [Cu(NH_3)_4](OH)_2 + 4H_2O$		
2.	Few drops of Potassium ferrocyanide solution are added to a little of the salt solution.	Reddish brown precipitate	Presence of Cu^{2+} is confirmed.
	$2Cu^{2+} + K_4[Fe(OH)_3] \longrightarrow Cu_2[Fe(CN)_6] + 4K^+$		
III	**ALUMINIUM (Al^{3+})**		
1.	NaOH solution is added to about 1 ml of the salt solution.	A white precipitate soluble in excess NaOH	Presence of Al^{3+} is confirmed.
	$Al^{3+} + 3NaOH \longrightarrow Al(OH)_3 + 3Na^+$ $NaOH + Al(OH)_3 \longrightarrow NaAlO_2 + 2H_2O$		
2.	A little of the salt is boiled with 1 ml of con. HNO_3 and few drops of Cobalt Nitrate solution. A filter paper strip is dipped in the solution and burnt.	A blue tinted ash	Presence of Al^{3+} is confirmed.
	$2Al_2O_3 + 2Co(NO_3)_2 \longrightarrow 2CoO.Al_2O_3 + 4NO_2 + O_2$		
IV	**ZINC (Zn^{2+})**		
	NaOH solution is added to about 1 ml of the salt solution.	A white precipitate soluble in excess NaOH	Presence of Zinc ion is confirmed.
	$Zn^{2+} + 2NaOH \longrightarrow Zn(OH)_2 + 2Na^+$ $2NaOH + Zn(OH)_2 \longrightarrow Na_2ZnO_2 + 2H_2O$		
2.	A little of the salt is boiled with 1 ml of con. HNO_3 and few drops of Cobalt Nitrate solution. A filter paper strip is dipped in the solution and burnt.	A green tinted ash	Presence of Zinc ion is confirmed.
	$2ZnO + 2Co(NO_3)_2 \longrightarrow 2CoO.ZnO + 4NO_2 + O_2$		

	Experiment	Observation	Inference
V	**MANGANESE (Mn^{2+})**		
1.	NaOH is added drop by drop to a little of the salt solution.	White precipitate turning brown and insoluble in excess NaOH	Presence of Mn^{2+} is confirmed.
	$Mn^{2+} + 2NaOH \longrightarrow Mn(OH)_2 + 2Na^+$ $Mn(OH)_2 + (O) \longrightarrow MnO_2.H_2O$		
2.	Two drops of salt solution are mixed with little PbO_2 and 2 ml of con. HNO_3. The mixture is boiled, well diluted and allowed to stand.	The supernatant solution is coloured pink.	Presence of Mn^{2+} is confirmed.
	$2Mn(NO_3)_2 + 5PbO_2 + 6HNO_3 \longrightarrow 5Pb(NO_3)_2 + HMnO_4 + 2H_2O$		

Distinction between Ba^{2+} and Ca^{2+}			
	Acetic Acid and K_2CrO_4 solution are added to a little of the salt solution.	a) Yellow Precipitate	Presence of Ba^{2+} (Confirm by other tests)
	$Ba^{2+} + CrO_4^- \longrightarrow BaCrO_4$		
		b) No precipitate	Presence of Ca^{2+} (Confirm by other tests)
VI	**BARIUM (Ba^{2+})**		
	Flame Test: A little of the salt is made into a paste with few drops of con. HCl and a little of the paste is brought to the base of a non-luminous flame at the end of a glass rod.	Pale green flame	Presence of Ba^{2+} is confirmed.
VII	**CALCIUM (Ca^{2+})**		
1.	NH_4Cl, NH_4OH and Ammonium Oxalate solution are added to the salt solution.	White precipitate	Presence of Ca^{2+}
	$Ca^{2+} + (NH_4)_2C_2O_4 \longrightarrow CaC_2O_4 + 2NH_4^+$		
2.	**Flame Test:** A little of the salt is made into a paste with few drops of con. HCl and a little of the paste is brought to the base of a non-luminous flame at the end of a glass rod.	Brick red flame	Presence of Ca^{2+} is confirmed.

	Experiment	Observation	Inference
VIII	**MAGNESIUM (Mg^{2+})**		
1.	A little of the salt is boiled with 1 ml of con. HNO_3 and few drops of Cobalt Nitrate solution. A filter paper strip is dipped in the solution and burnt.	A pink tinted ash	Presence of Mg^{2+} is confirmed.
	$2MgO + 2Co(NO_3)_2 \longrightarrow 2CoO.MgO + 4NO_2 + O_2$		
2.	To a little of the salt solution, few drops of Magneson reagent and NaOH solution are added.	Blue precipitate	Presence of Mg^{2+} is confirmed.

The given salt contains the cation .....

Result:

The given salt contains the anion ..... and the cation .....
So, the given salt is ....

Class I Cation (Group O)		Ammonium (NH_4^+)
Class II Cations:-		
Group	**Cations**	**Group Reagent**
I	Pb^{2+}	Dil. HCl
II	Cu^{2+}	Dil. HCl, H_2S
III	Al^{3+}	NH_4Cl, NH_4OH
IV	Zn^{2+}, Mn^{2+}	NH_4Cl, NH_4OH, H_2S
V	Ba^{2+}, Ca^{2+}	NH_4Cl, NH_4OH, $(NH_4)_2CO_3$
VI	Mg^{2+}	NH_4Cl, NH_4OH, Na_2HPO_4