**Experiment: 1** SALT ANALYSIS

**Anionic Analysis:** 

Dilute acid group: CO<sub>3</sub><sup>2</sup>, NO<sub>2</sub>, SO<sub>3</sub><sup>2</sup>, S<sup>2</sup>

Conc. acid group: Cl<sup>-</sup>, Br<sup>-</sup>, I<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, C<sub>2</sub>O<sub>4</sub><sup>2</sup>-, CH<sub>3</sub>COO<sup>-</sup> Special group: SO<sub>4</sub><sup>2</sup>-, PO<sub>4</sub><sup>3</sup>-

S. No.	Experiment	Observation	Inference
	Carbonate ion (CO <sub>3</sub> <sup>2</sup> -)		
1.	Salt + dilute H <sub>2</sub> SO <sub>4</sub>	Colorless, odorless gas released with effervescence	CO <sub>2</sub> may be
2.	Above gas passed through lime water solution	Lime water turns milky.	CO <sub>2</sub> may be
3.	Above gas passed through lime water solution in excess	Milky solution turns colourless	CO <sub>2</sub> may be
4.	Above gas passed through pink coloured KMnO <sub>4</sub> solution	The colour of the solution does not change.	CO <sub>2</sub> confirm.
5.	Aqueous solution of the salt + MgSO <sub>4</sub> solution	White ppt	CO <sub>3</sub> <sup>2</sup> - confirm.
	Sulphite ion (SO <sub>3</sub> <sup>2-</sup> )		
1.	Salt + dilute H <sub>2</sub> SO <sub>4</sub>	Colorless gas with the smell of burning sulphur released	SO <sub>2</sub> may be
2.	Above gas passed through lime water solution	Lime water turns milky.	SO <sub>2</sub> may be
3.	Above gas passed through lime water solution in excess	Milky solution turns colourless	SO <sub>2</sub> may be
4.	Above gas passed through pink coloured KMnO <sub>4</sub> solution	The colour of the solution changes from pink to colourless.	SO <sub>2</sub> confirm.
5.	Above gas passed through orange coloured K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> solution	The colour of the solution changes from orange to green.	SO <sub>2</sub> confirm.
6.	Aqueous solution of the salt + BaCl <sub>2</sub> solution	White ppt	SO <sub>3</sub> <sup>2-</sup> may be

7.	Above ppt + dilute HCl	White ppt dissolved	SO <sub>3</sub> <sup>2-</sup>
		to form a colourless solution.	confirm.
	Sulphide ion (S <sup>2-</sup> )		
1.	Salt + dilute H <sub>2</sub> SO <sub>4</sub>	Colourless gas with a smell of rotten eggs released	H <sub>2</sub> S may be
2.	Brought a paper dipped in lead acetate (CH <sub>3</sub> COO) <sub>2</sub> Pb solution near the mouth of the test tube	The paper turned silvery black due to the formation of PbS.	H <sub>2</sub> S confirm.
3.	Aqueous solution of the salt + few drops of sodium nitroprusside solution Na <sub>2</sub> [Fe(CN) <sub>5</sub> NO]	Purple colouration due to the formation of Na <sub>4</sub> [Fe(CN) <sub>5</sub> NOS]	S <sup>2-</sup> confirm.
	Nitrite ion (NO <sub>2</sub> -)		
1.	Salt + dilute H <sub>2</sub> SO <sub>4</sub>	Light brown coloured gas released which intensifies on heating	NO gas may be which on reaction with atmospheric oxygen turns NO <sub>2</sub>
2.	Brought a paper dipped in ferrous sulphate solution near the mouth of the test tube	The paper turns black/ brown	NO gas confirm.
3.	Salt solution + diphenylamine solution	A deep blue colour obtained.	NO <sub>2</sub> -confirm.
4.	Salt solution + 1 ml of acetic acid + half a pinch of solid KI + 2-4 drops of freshly prepared starch solution	Blue black ppt	NO <sub>2</sub> -confirm.
	Nitrate ion (NO <sub>3</sub> -)		
1.	Salt + conc. $H_2SO_4 \rightarrow heat$	Reddish brown gas released	NO <sub>2</sub> gas may be

	Bromide ion (Br <sup>-</sup> )		
	(CH3COO) <sub>2</sub> 1 b solution		
7.	Yellow solution + CH <sub>3</sub> COOH (CH <sub>3</sub> COO) <sub>2</sub> Pb solution	Yellow ppt	Cl <sup>-</sup> confirm.
	through NaOH solution	yellow.	CI- O'
6.	Above red vapours passed	NaOH solution turned	Cl <sup>-</sup> may be.
· .	solid $K_2Cr_2O_7 + conc. H_2SO_4 \rightarrow$ heat	red rapours obtained	Ci may oc.
5.	Chromyl Chloride test – Salt +	a colourless solution Red vapours obtained	Cl <sup>-</sup> may be.
4.	Above ppt + NH <sub>4</sub> OH in excess	Ppt dissolved to form	Cl <sup>-</sup> confirm.
3.	Salt solution + dilute HNO <sub>3</sub> + AgNO <sub>3</sub> solution	White ppt	Cl <sup>-</sup> may be.
2.	Brought a rod dipped in NH <sub>4</sub> OH near the mouth of the test tube	Dense white fumes obtained.	HCl gas confirm.
1.	Salt + conc. $H_2SO_4 \rightarrow heat$	Colourless gas with pungent smell	HCl gas may be.
	Chloride ion (Cl <sup>-</sup> )		
	ml conc. $H_2SO_4 \rightarrow heat$	•	confirm.
5.	Salt solution + 1 ml ethanol + 1	Fruity odour	CH <sub>3</sub> COO
4.	Above solution heated.	Reddish brown ppt	CH <sub>3</sub> COO <sup>-</sup> confirm.
	solution		confirm.
3.	drops of water → rub  Salt solution + neutral FeCl <sub>3</sub>	Red colouration	may be CH <sub>3</sub> COO
2.	Salt + a pinch of oxalic acid + 2-3	Vinegar like smell	CH <sub>3</sub> COO
1.	Salt + conc. H <sub>2</sub> SO <sub>4</sub>	Vinegar like smell	CH <sub>3</sub> COO <sup>-</sup> may be
	Acetate ion (CH <sub>3</sub> COO <sup>-</sup> )		
4.	<b>Brown Ring test</b> - Salt solution + freshly prepared ferrous sulphate solution + conc H <sub>2</sub> SO <sub>4</sub> by the sides of the test tube	Brown ring obtained at the junction of two liquids	confirm.
	solution	obtained.	confirm.
3.	pellets to the above mixture  Salt solution + diphenylamine	gas intensified A deep blue colour	confirm.
2.	Added copper turnings or paper	Brown colour of the	NO <sub>2</sub>

		T	1
1.	Salt + conc. $H_2SO_4 \rightarrow heat$	Reddish brown gas with pungent smell	Br <sup>-</sup> may be.
2.	Brought a paper dipped in starch solution near the mouth of the test tube	Orange red stains	Br⁻ may be.
2.	Salt solution + dilute HNO <sub>3</sub> + AgNO <sub>3</sub> solution	Light yellow ppt	Br may be.
3.	Above ppt + NH <sub>4</sub> OH in excess	Ppt is sparingly soluble.	Br⁻ confirm.
4.	Layer test/ Chlorine water test- Salt solution + 1 ml of CS <sub>2</sub> / CCl <sub>4</sub> + 1 ml of chlorine water → shake vigorously.	An orange colour obtained in the organic layer.	Br <sup>-</sup> confirm.
	Iodide ion (I <sup>-</sup> )		
1.	Salt + conc. $H_2SO_4 \rightarrow$ heat	Violet coloured gas with pungent smell released.	I⁻may be.
2.	Brought a paper dipped in starch solution near the mouth of the test tube	Blue black stains	I may be.
3.	Salt solution + dilute HNO <sub>3</sub> + AgNO <sub>3</sub> solution	yellow ppt	I⁻ may be.
4.	Above ppt + NH <sub>4</sub> OH in excess	Ppt is insoluble.	I⁻ confirm.
5.	Layer test/ Chlorine water test- Salt solution + 1 ml of CS <sub>2</sub> / CCl <sub>4</sub> + 1 ml of chlorine water → shake vigorously.	A violet colour obtained in the organic layer.	I <sup>-</sup> confirm.
	Oxalate ion (C <sub>2</sub> O <sub>4</sub> <sup>2-</sup> )		
1.	Salt + conc. $H_2SO_4 \rightarrow$ heat	Colourless gas released with effervescence	CO <sub>2</sub> may be
2.	Above gas passed through lime water solution	Lime water turns milky.	CO <sub>2</sub> may be
3.	Above gas passed through lime water solution in excess	Milky solution turns colourless	CO <sub>2</sub> may be

4.	Salt solution + CH <sub>3</sub> COOH →	White ppt	$C_2O_4^{2-}$ may
	boil off CO <sub>2</sub> + CaCl <sub>2</sub> solution +		be.
	dilute $HNO_3 \rightarrow boil$		
5.	Above solution + 3-4 drops of	Pink colour turns	$C_2O_4^{2-}$
	KMnO <sub>4</sub> solution	colourless.	confirm.
	Sulphate ion (SO <sub>4</sub> <sup>2-</sup> )		
1.	Salt solution + dilute HCl +	Whit ppt	SO <sub>4</sub> <sup>2</sup> - may be
	BaCl <sub>2</sub> solution		
2.	Above ppt + dilute HCl/ dilute	Ppt remains insoluble.	SO <sub>4</sub> <sup>2-</sup>
	HNO <sub>3</sub>		confirm.
3.	Salt solution+ CH <sub>3</sub> COOH +	White ppt	SO <sub>4</sub> <sup>2</sup> - may be
	(CH <sub>3</sub> COO) <sub>2</sub> Pb solution		
4.	Above ppt + hot CH <sub>3</sub> COONH <sub>4</sub> in	Ppt dissolves to form	SO <sub>4</sub> <sup>2-</sup>
	excess	a colourless solution	confirm.
	Phosphate ion (PO <sub>4</sub> <sup>3-</sup> )		
1.	Salt solution + conc. HNO <sub>3</sub> →	Canary yellow ppt	PO <sub>4</sub> <sup>3-</sup>
	boil + ammonium molybdate		confirm.
	solution (NH <sub>4</sub> ) <sub>2</sub> MoO <sub>4</sub> → boil		

#### **Equations involved:**

### Carbonate ion (CO<sub>3</sub><sup>2</sup>-)

$$CO_3^{2-} + 2H^+ \rightarrow CO_2 + H_2O$$

$$Ca(OH)_2 \quad + CO_2 \rightarrow CaCO_3 + H_2O$$

Lime water white ppt

$$CaCO_3 + H_2O + CO_2 \rightarrow Ca(HCO_3)_2$$

Colourless solution

$$CO_3^{2-} + Mg^{2+} \rightarrow MgCO_3$$
White ppt.

# Sulphite ion (SO<sub>3</sub><sup>2</sup>-)

$$Na_2SO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + SO_2$$

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

Chromium sulphate (green)

$$SO_2 + 2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5$$
 [O] pink colourless solution

$$Na_2SO_3 + BaCl_2 \longrightarrow 2NaCl + BaSO_3$$
  
White ppt

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BaSO_3 + 2HC1 \longrightarrow BaCl_2 + H_2O + SO_2
Nitrite ion (NO<sub>2</sub><sup>-</sup>)
2NaNO_2 + H_2SO_4 \longrightarrow Na_2SO_4 + 2HNO_2
3HNO_2 \longrightarrow HNO_3 + 2NO + H_2O
2NO + O_2 \longrightarrow 2NO_2
                   Brown gas
NO_2 - + CH_3COOH \longrightarrow HNO_2 + CH_3COO
2HNO_2 + 2KI + 2CH_3COOH \longrightarrow 2CH_3COOK + 2H_2O + 2NO + I_2
I_2 + Starch \longrightarrow Blue complex
Sulphide ion(S^{2-})
Na_2S + H_2SO_4 \longrightarrow Na_2SO_4 + H_2S
(CH_3COO)_2Pb + H_2S \longrightarrow PbS + 2 CH_3COOH
                              Black ppt
Na_2S + Na_2 [Fe(CN)_5NO] \longrightarrow Na_4 [Fe(CN)_5NOS]
         Sodium nitroprusside Complex of Purple colour
Nitrate ion (NO_3)
NaNO_3 + H_2SO_4 \longrightarrow NaHSO_4 + HNO_3
4HNO_3 \longrightarrow 4NO_2 + O_2 + 2H_2O
2NaNO_3 + 4H_2SO_4 + 3Cu \longrightarrow 3CuSO_4 + Na_2SO_4 + 4H_2O + 2NO
NaNO_3 + H_2SO_4 \longrightarrow NaHSO_4 + HNO_3
6 \text{ FeSO}_4 + 3 \text{H}_2 \text{SO}_4 + 2 \text{HNO}_3 \longrightarrow 3 \text{Fe}_2 (\text{SO}_4)_3 + 4 \text{H}_2 \text{O} + 2 \text{NO}_3
FeSO_4 + NO \longrightarrow [Fe(NO)]SO_4
                     Nitrosoferrous sulphate (brown ring)
Acetate ion (CH<sub>3</sub>COO<sup>-</sup>)
3 \text{ CH}_3\text{COO}^- + \text{Fe}^{3+} \longrightarrow (\text{CH}_3\text{COO})_3 \text{ Fe}
                            Red colouration
CH_3COONa + H_2SO_4 \longrightarrow Na_2SO_4 + 2 CH_3COOH
CH_3COOH + C_2H_5OH \longrightarrow CH_3COOC_2H_5 + H_2O
                                   Ethylacetate (Fruity odour)
Oxalate ion (C_2O_4^{2-})
(COONa)_2 + Conc. H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + CO_2 \uparrow + CO \uparrow
CaCl_2 + Na_2C_2O_4 \longrightarrow 2NaCl + CaC_2O_4
                                          Calcium oxalate (White precipitate)
CaC_2O_4 + H_2SO_4 \longrightarrow CaSO_4
                                         +
                                               H_2C_2O_4
                         Calcium sulphate Oxalic acid
2 \text{ KMnO}_4 + 3H_2SO_4 + 5H_2C_2O_4 \longrightarrow 2MnSO_4 + K_2SO_4 + 8H_2O + 10CO_2
Chloride ion (Cl<sup>-</sup>)
NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl
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#### Colourless gas

$$HCl + NH_3 \longrightarrow NH_4Cl$$
 Ammonium chloride (White fumes)

$$NaCl + AgNO_3 \longrightarrow NaNO_3 + AgCl$$

Silver chloride (White precipitate)

$$AgC1 + 2 NH_4OH \longrightarrow 2H_2O + [Ag(NH_3)_2]C1$$

Diammine silver (I) chloride

$$4NaCl + K_2Cr_2O_7 + 6 H_2SO_4 \longrightarrow 2KHSO_4 + 2CrO_2Cl_2 + 4 NaHSO_4 + 3H_2O_4 + 2CrO_2Cl_2 + 4 NaHSO_4 + 3H_2O_4 + 3$$

Chromyl chloride

$$CrO_2Cl_2 + 4 NaOH \longrightarrow Na_2CrO_4 + 2 NaCl + 2H_2O$$

$$(CH_3COO)_2Pb + Na_2CrO_4 \longrightarrow PbCrO_4 + 2 CH_3COONa$$

Yellow ppt

#### Bromide ion (Br<sup>-</sup>)

$$2NaBr + 2 H_2SO_4 \longrightarrow Br_2 + SO_2 + Na_2SO_4 + 2H_2O$$

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

Silver bromide (Pale yellow precipitate)

#### Iodide ion (I<sup>-</sup>)

$$2NaI + 2 H2SO4 \longrightarrow Na2SO4 + SO2 + 2H2O + I2$$

$$I_2 + Starch \longrightarrow Blue colour$$

$$NaI + AgNO_3 \longrightarrow NaNO_3 + AgI$$

### Sulphate ion (SO<sub>4</sub><sup>2</sup>-)

$$Na_2SO_4 + BaCl_2 \longrightarrow 2 NaCl + BaSO_4$$

Barium sulphate (White precipitate).

$$Na_2SO_4 + (CH_3COO)_2Pb \longrightarrow 2 CH_3COONa + PbSO_4$$

Lead sulphate (White precipitate)

# Phosphate ion (PO<sub>4</sub><sup>3-</sup>)

$$Na_2HPO_4 + 12 (NH_4)_2 MoO_4 + 23 HNO_3 \longrightarrow 2NaNO_3 + 21 NH_4NO_3 + 12H_2O + (NH_4)_3[P (Mo_3O_{10})_4]$$

Canary yellow ppt

# **Cationic Analysis:**

Group	<b>Group Reagent</b>	Cations	Chemical form of the ppt
0	-	NH <sub>4</sub> <sup>+</sup>	
Ι	Dilute HCl	Pb <sup>2+</sup>	PbCl <sub>2</sub> (white)
II	H <sub>2</sub> S gas in an acidic medium	Pb <sup>2+</sup>	PbS (black)
	or presence of dilute HCl	Cu <sup>2+</sup>	CuS (black)
		$As^{3+}$	As <sub>2</sub> S <sub>3</sub> (yellow)
III	NH <sub>4</sub> Cl solid + NH <sub>4</sub> OH	$Al^{3+}$	Al(OH) <sub>3</sub> (gel white)

		Fe <sup>3+</sup>	Fe(OH) <sub>3</sub> (brown)
IV	H <sub>2</sub> S gas in an alkaline	$Zn^{2+}$	ZnS (dirty white)
	medium or presence of	$Co^{2+}$	CoS (black)
	NH <sub>4</sub> Cl + NH <sub>4</sub> OH	Ni <sup>2+</sup>	NiS (black)
		Mn <sup>2+</sup>	MnS (flesh/buff)
V	(NH <sub>4</sub> ) <sub>2</sub> CO <sub>3</sub> in presence of	Ba <sup>2+</sup> ,	BaCO <sub>3</sub> (white)
	$NH_4Cl + NH_4OH$	Sr <sup>2+</sup>	SrCO <sub>3</sub> (white)
		Ca <sup>2+</sup>	CaCO <sub>3</sub> (white)
VI	Na <sub>2</sub> HPO <sub>4</sub> : Disodium hydrogen	$Mg^{2+}$	Mg(NH <sub>4</sub> )PO <sub>4</sub>
	phosphate		(white)

S.No.	Experiment	Observation	Inference
	Group 0		
1.	Salt + NaOH → warm	Pungent smelling	Group 0
		colourless gas	present.
		released.	
2.	Brought a rod dipped in conc.	Dense white fumes	NH <sub>4</sub> <sup>+</sup> may
	HCl near the mouth of the test	released.	be
	tube		
3.	OS + Nesseler's reagent (K <sub>2</sub> HgI <sub>4</sub> )	Brown ppt	$\mathrm{NH_4}^+$
			confirm.
	Group I		
1.	Salt + NaOH → warm	No pungent smelling	Group 0
		colourless gas	absent.
		released.	
2.	OS + dilute HCl	White ppt	Group I
			present
3.	Above ppt dissolved in hot water		
	and divided the solution into two		
	parts:		
	Part I + KI solution	Yellow ppt	Pb <sup>2+</sup>
			confirm
	Part II + <b>K</b> <sub>2</sub> <b>CrO</b> <sub>4</sub> solution	Yellow ppt which is	Pb <sup>2+</sup>
		soluble in NaOH	confirm
	Group II		

1.	Salt + NaOH → warm	No pungent smelling colourless gas released.	Group 0 absent.
2.	OS + dilute HCl	No white ppt	Group I absent
3.	Above solution + H <sub>2</sub> S gas	Ppt obtained  Black ppt Yellow ppt	Group II present Cu <sup>2+</sup> may be As <sup>3+</sup> may be
	Cu <sup>2+</sup>		
4.	Above ppt dissolved in dissolved in <b>conc.HNO</b> <sub>3</sub> and divide it into 3 parts:		
	Part $I + K_4[Fe(CN)_6]$	Chocolate brown	Cu <sup>2+</sup>
		ppt	confirm.
	Part II + NH <sub>4</sub> OH in excess	Deep blue colouration	Cu <sup>2+</sup> confirm
	Part III + KI solution	A white ppt obtained in brown solution	Cu <sup>2+</sup> confirm
4.	$As^{3+}$		
	Above ppt dissolved in dissolved in conc.HNO <sub>3</sub> and divide it into 2 parts:		
	Part I + ammonium molybdate solution (NH <sub>4</sub> ) <sub>2</sub> MoO <sub>4</sub> → boil	yellow ppt obtained	As <sup>3+</sup> confirm
	Part II + NH <sub>4</sub> OH + magnesia mixture	white ppt obtained	As <sup>3+</sup> confirm
	Group III		
1.	Salt + NaOH → warm	No pungent smelling colourless gas released.	Group 0 absent.
2.	OS + dilute HCl	No white ppt	Group I absent
3.	Above solution + H <sub>2</sub> S gas	No Ppt obtained	Group II absent
4.	Above solution + solid NH <sub>4</sub> Cl + NH <sub>4</sub> OH	Ppt obtained Gel white ppt	Group III present Al <sup>3+</sup> may be
		Brown ppt	Fe <sup>3+</sup> may be

	$Al^{3+}$		
5.	Gel white ppt dissolved in dilute HCl solution		
	Part I + NaOH and warm.	A white gelatinous precipitate soluble in excess of sodium hydroxide	Al <sup>3+</sup> confirm
	Lake test: Part II + blue litmus solution and then ammonium hydroxide solution drop by drop along the sides of the test tube.  Fe <sup>3+</sup>	A blue floating mass in the colourless solution is obtained.	Al <sup>3+</sup> confirm
5.	Brown ppt dissolved in dilute HCl and the solution is divided into two parts:		
	Part I + KCNS solution: potassium thiocyanate soln	Blood red colouration	Fe <sup>3+</sup> confirm
	Part II + K <sub>4</sub> [Fe (CN) <sub>6</sub> ] solution	Prussian blue colouration	Fe <sup>3+</sup> confirm
	Group IV		
1.	Salt + NaOH → warm	No pungent smelling colourless gas released.	Group 0 absent.
2.	OS + dilute HCl	No white ppt	Group I absent
3.	Above solution + H <sub>2</sub> S gas	No Ppt obtained	Group II absent
4.	Above solution + solid NH <sub>4</sub> Cl + NH <sub>4</sub> OH	No Ppt obtained	Group III absent
5.	Above solution + solid NH <sub>4</sub> Cl + NH <sub>4</sub> OH+ H <sub>2</sub> S gas	Ppt obtained  Gel white ppt Buff ppt  Black ppt	Group IV present Zn <sup>2+</sup> may be Mn <sup>2+</sup> may be Co <sup>2+</sup> or Ni <sup>2+</sup> may be
	Zn <sup>2+</sup>		

6.	Above ppt dissolved in dilute HCl, boil off H <sub>2</sub> S gas and divide the solution into two parts:	A white precipitate soluble in excess of sodium hydroxide	
	Part I + NaOH		Zn <sup>2+</sup> confirm
	Part II + K <sub>4</sub> [Fe (CN) <sub>6</sub> ] solution	Bluish white ppt	Zn <sup>2+</sup> confirm
	$\mathbf{M}\mathbf{n}^{2+}$		
6.	Above ppt dissolved in dilute HCl, boil off H <sub>2</sub> S gas and add NaOH	White ppt which turns Brown on standing	Mn <sup>2+</sup> confirm
6.	Co <sup>2+</sup> Dissolve the ppt in aqua regia (3 parts conc HCl + conc HNO <sub>3</sub> ) and add NH <sub>4</sub> OH + CH <sub>3</sub> COOH + KNO <sub>2</sub> → heat	Yellow ppt	Co <sup>2+</sup> confirm
	Ni <sup>2+</sup>		
6.	Dissolve the ppt in aqua regia (3 parts conc HCl + conc HNO <sub>3</sub> ) and add NH <sub>4</sub> OH + dimethyl glyoxime	Rose red ppt	Ni <sup>2+</sup> confirm
	Group V		
1.	Salt + NaOH → warm	No pungent smelling colourless gas released.	Group 0 absent.
2.	OS + dilute HCl	No white ppt	Group I absent
3.	Above solution + H <sub>2</sub> S gas	No Ppt obtained	Group II absent
4.	Above solution + solid NH <sub>4</sub> Cl + NH <sub>4</sub> OH	No Ppt obtained	Group III absent
5.	Above solution + solid NH <sub>4</sub> Cl + NH <sub>4</sub> OH+ H <sub>2</sub> S gas	No ppt obtained	Group IV absent
6.	Above solution heated to boil off + H <sub>2</sub> S gas and add solid NH <sub>4</sub> Cl + NH <sub>4</sub> OH+ (NH <sub>4</sub> ) <sub>2</sub> CO <sub>3</sub>	white ppt obtained	Group V present Ba <sup>2+</sup> or Sr <sup>2+</sup> or Ca <sup>2+</sup> may be

7.	Above ppt dissolved in hot CH <sub>3</sub> COOH and divide it into 3 parts:		
	Part I + K <sub>2</sub> CrO <sub>4</sub> solution	Yellow ppt	Ba <sup>2+</sup> confirm.
	Part II + (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> [ammonium sulphate solution]	White ppt	Sr <sup>2+</sup> confirm.
	Part III + NH <sub>4</sub> ) <sub>2</sub> C <sub>2</sub> O <sub>4</sub> [ammonium oxalate solution]  Group VI	White ppt	Ca <sup>2+</sup> confirm.
1.	Salt + NaOH → warm	No pungent smelling colourless gas released.	Group 0 absent.
2.	OS + dilute HCl	No white ppt	Group I absent
3.	Above solution + H <sub>2</sub> S gas	No Ppt obtained	Group II absent
4.	Above solution + solid NH <sub>4</sub> Cl + NH <sub>4</sub> OH	No Ppt obtained	Group III absent
5.	Above solution + solid NH <sub>4</sub> Cl + NH <sub>4</sub> OH+ H <sub>2</sub> S gas	No ppt obtained	Group IV absent
6.	Above solution heated to boil off + H <sub>2</sub> S gas and add solid NH <sub>4</sub> Cl + NH <sub>4</sub> OH+ (NH <sub>4</sub> ) <sub>2</sub> CO <sub>3</sub>	no ppt obtained	Group V absent
7.	Above solution + Na <sub>2</sub> HPO <sub>4</sub> solution→ scratch the sides of the test tube	white ppt	Group VI present Mg <sup>2+</sup>

# **Equations involved:**

 $NH_4^+$ 

 $(NH_4)_2 SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2NH_3 + 2H_2O$ 

 $NH_3 + HCl \rightarrow NH_4Cl$ 

 $2K_2HgI_4 + NH_3 + 3KOH \longrightarrow 7KI + 2H_2O + HgO.Hg(NH_2)I$ 

Basic mercury (II) amido-iodine (Brown precipitate)

**Pb**<sup>2+</sup>

 $Pb^{2+} + 2HCl \longrightarrow PbCl_2 + 2\ H^+$ 

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White ppt
PbCl_2 + 2KI \longrightarrow 2KCl + PbI_2
(Hot soln)
                                     Yellow precipitate
PbCl_2 + K_2CrO_4 \longrightarrow 2KCl + PbCrO_4
                                             Lead chromate (Yellow precipitate)
(Hot soln)
PbCrO_4 + 4NaOH \rightarrow Na_2CrO_4 + Na_2[Pb(OH)_4]
                                                  Sodium tetrahydroxoplumbate (II)
Cu<sup>2+</sup>
Cu^{2+} + H_2S \longrightarrow CuS + 2H^+
                      Black ppt
3 \text{ CuS} + 8 \text{ HNO} \longrightarrow 3 \text{ Cu(NO}_3)_2 + 2 \text{ NO} + 3 \text{ S} + 4 \text{ H}_2\text{O}
S + 2 HNO_3 \longrightarrow H_2SO_4 + 2NO
2 \text{ Cu}^{2+} + 2 \text{ H}_2 \text{SO}_4 + 2 \text{ NH}_3 + 2 \text{ H}_2 \text{O} \longrightarrow \text{Cu}(\text{OH})_2. CuSO<sub>4</sub> + 2 \text{ NH}_4^+
Cu(OH)_2.CuSO_4 + 8 NH_3 \longrightarrow 2 [Cu(NH_3)_4]SO_4 + 2 OH^2 + SO_4^{2-1}
                                          Tetraamminecopper (II) sulphate
                                                (Deep blue colour)
As^{3+}
As^{3+} + 3 H_2S \longrightarrow As_2S_3 + 6 H^+
                      Yellow ppt
                   3 (NH<sub>4</sub>)<sub>2</sub>S \longrightarrow 2 (NH<sub>4</sub>)<sub>3</sub>A<sub>5</sub>S<sub>4</sub> + S
As_2S_3 +
                                          Yellow ammonium sulphide
2 (NH_4)_3A_5S_4 + 6 HC1 \longrightarrow As_2S_5 + 3 H_2S + 6 NH_4C1
3 \text{ As}_2\text{S}_5 + 10 \text{ HNO}_3 + 4 \text{ H}_2\text{O} \longrightarrow 6 \text{ H}_3\text{AsO}_4 + 10 \text{ NO} + 15 \text{ S}_4
H_3AsO_4 + 12 (NH_4)_2 MoO_4 + 21 HNO_3 \longrightarrow 21 NH_4NO_3 + 12 H_2O_4
                                                                                    (NH_4)_3[As (Mo_3O_{10})_4]
                                                                           Ammonium arsinomolybdate
                                                                                       (yellow precipitate)
A1^{3+}
Al^{3+}+3NH_4OH \longrightarrow Al(OH)_3+2NH_4^+
                         Gel white ppt
AlCl_3 + 3 NaOH \longrightarrow Al(OH)_3 + 3 NaCl
Al(OH)_3 + NaOH \longrightarrow 2 H_2O + NaAlO_2
                                             White gelatinous ppt (Sodium meta aluminate)
Fe<sup>3+</sup>
Fe^{3+}+3NH_4OH \longrightarrow Fe(OH)_3+2NH_4^+
                             Brown ppt
Fe(OH)_3 + 3 HC1 \longrightarrow FeCl_3 + 3H_2O
4 \operatorname{FeCl}_3 + 3 \operatorname{K}_4[\operatorname{Fe}(\operatorname{CN})_6] \longrightarrow \operatorname{Fe}_4[\operatorname{Fe}(\operatorname{CN})_6]_3 + 12 \operatorname{KCl}
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Potassium ferrocyanide
                                       (Prussian blue colour)
Fe^{3+} + SCN^{-} \longrightarrow [Fe(SCN)]^{2+}
                            Blood red colour
Zn<sup>2+</sup>
Zn^{2+} + H_2S \longrightarrow ZnS + 2H^+
                    Dirty white ppt
ZnS + 2 HCl \longrightarrow ZnCl_2 + H_2S
ZnCl_2 + 2 NaOH \longrightarrow Zn(OH)_2 + 2NaCl
                              White ppt
Zn(OH)_2 + 2 NaOH \longrightarrow Na_2ZnO_2
                                                   +2 H<sub>2</sub>O
                                 Colourless soln
2 \operatorname{ZnCl}_2 + \operatorname{K}_4 [\operatorname{Fe}(\operatorname{CN})_6] \longrightarrow 4 \operatorname{KCl} + \operatorname{Zn}_2 [\operatorname{Fe}(\operatorname{CN})_6]
                                                      Zinc ferrocyanide (bluish white ppt)
Mn^{2+}
Mn^{2+} + H_2S \longrightarrow MnS + 2 H^+
                    Buff ppt
MnS + 2 HC1 \longrightarrow MnCl_2 + H2S
MnCl_2 + 2 NaOH \longrightarrow Mn(OH)_2
                                                      + 2NaCl
                             (White precipitate)
Mn (OH)_2 + [O] \rightarrow MnO(OH)_2
                               Hydrated manganese dioxide (Brown colour)
Co^{2+}
Co^{2+} + H_2S \longrightarrow CoS + 2 H^+
                 Black ppt
CoS + HNO_3 + 3HC1 \longrightarrow CoCl_2 + NOCl + S + 2 H_2O
CoCl_2 + 7KNO_2 + 2CH_3COOH \longrightarrow 2KCl + 2CH_3COOK + NO + H_2O+
                                                                                          K_3 [Co(NO_2)_6]
                                                                 Potassiumhexanitritocobaltate (III)
                                                                    (Yellow precipitate)
Ni^{2+}
Ni^{2+} + H_2S \longrightarrow NiS + 2H^+
                 Black ppt
3 \text{ NiS} + 2 \text{ HNO}_3 + 6 \text{ HCl} \longrightarrow 3 \text{ NiCl}_2 + 2 \text{ NO} + 3 \text{ S} + 4 \text{ H}_2\text{O}
Ba<sup>2+</sup>
Ba^{2+}+(NH_4)_2CO_3 \longrightarrow BaCO_3 + 2NH_4^+
                            White ppt
BaCO_3 + 2 CH_3COOH \longrightarrow (CH_3COO)_2 Ba + H_2O + CO_2
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$$(CH_3COO)_2Ba + K_2CrO_4 \longrightarrow BaCrO_4 + 2 CH_3COOK$$

$$Yellow ppt$$

$$Sr^{2+}$$

$$Sr^{2+} + (NH_4)_2CO_3 \longrightarrow SrCO_3 + 2 NH_4^+$$

$$White ppt$$

$$SrCO_3 + 2 CH_3COOH \longrightarrow (CH_3COO)_2 Sr + H_2O + CO_2$$

$$(CH_3COO)_2 Sr + (NH_4)_2SO_4 \longrightarrow SrSO_4 + 2 CH_3COONH_4$$

$$Strontium sulphate$$

$$(White precipitate)$$

$$Ca^{2+}$$

$$Ca^{2+} + (NH_4)_2CO_3 \longrightarrow CaCO_3 + 2 NH_4^+$$

$$White ppt$$

$$CaCO_3 + 2 CH_3COOH \longrightarrow (CH_3COO)_2Ca + H_2O + CO_2$$

$$(CH_3COO)_2Ca + (NH_4)_2C_2O_4 \longrightarrow (COO)_2Ca + 2 CH_3COONH_4$$

$$Ammonium \qquad Calcium oxalate$$

$$oxalate \qquad (White precipitate)$$

$$Mg^{2+}$$

$$Mg^{2+}$$

$$Mg^{2+} + Na_2HPO_4 \longrightarrow NH_4OH + 2Na^+ + H_2O + Mg(NH_4)PO_4$$

$$Magnesium ammonium phosphate$$

$$(white ppt)$$

# **Experiment 2**

Aim: To identify one cation and one anion in the given salt sample

S.No.	Experiment	Observation	Inference
1.	Noted the colour of the given salt.	white	Cu <sup>2+</sup> , Fe <sup>2+</sup> ,
			Ni <sup>2+</sup> ,Co <sup>2+</sup> ,
			Mn <sup>2+</sup> are
			absent.
2.	Noted the smell of the salt.	No specific smell	$S^{2-}$ , $SO_3^{2-}$ ,
			CH <sub>3</sub> COO <sup>-</sup>
			may be
			absent.
3.	Prepared a paste of the salt with	No distinct colour	Ca <sup>2+</sup> , Sr <sup>2+</sup> ,
	conc. HCl and performed the flame	of the flame seen.	$Ba^{2+},Cu^{2+}$
	test.		may be
			absent.

4.	Treated 0.1 g of salt with 1 mL dil.H <sub>2</sub> SO <sub>4</sub>	No effervescence or gas evolved.	CO <sub>3</sub> <sup>2-</sup> , SO <sub>3</sub> <sup>2-</sup> , S <sup>2-</sup> , NO <sub>2</sub> -
	G111125 0 7	or gas everyear	absent.
5.	Heated 0.1 g of salt with 1 mL conc.	No gas evolved	CH₃COO⁻,
	$H_2SO_4$ .		Cl <sup>-</sup> , Br <sup>-</sup> , I <sup>-</sup> ,
			$NO_3^-$ ,
			$C_2O_4^{2-}$ are
	A 110" 14 Y C	NY 11	absent.
6.	Acidified 1mL of aqueous salt	No yellow	PO <sub>4</sub> <sup>3–</sup> absent.
	solution with conc. HNO3. Warmed	precipitate	
	the contents and then added 4-5		
	drops of ammonium molybdate solution.		
7.	Salt solution + dilute HCl + BaCl <sub>2</sub>	Whit ppt	SO <sub>4</sub> <sup>2</sup> - may be
"	solution	, me ppe	
8.	Above ppt + dilute HCl/ dilute HNO <sub>3</sub>	Ppt remains	SO <sub>4</sub> <sup>2</sup> -
		insoluble.	confirm.
9.	Salt + NaOH → warm	No pungent	Group 0
		smelling	absent.
		colourless gas	
10	00 111 1101	released.	
10.	OS + dilute HCl	No white ppt	Group I
11.	Above solution   II C ass	No Det obtained	absent
11.	Above solution + H <sub>2</sub> S gas	No Ppt obtained	Group II absent
12.	Above solution + solid NH <sub>4</sub> Cl +	No Ppt obtained	Group III
12.	NH <sub>4</sub> OH	140 1 pt obtained	absent
13.	Above solution + solid NH <sub>4</sub> Cl +	No ppt obtained	Group IV
	NH <sub>4</sub> OH+ H <sub>2</sub> S gas		absent
14.	Above solution heated to boil off +	no ppt obtained	Group V
	H <sub>2</sub> S gas and add solid NH <sub>4</sub> Cl +		absent
	NH <sub>4</sub> OH+ (NH <sub>4</sub> ) <sub>2</sub> CO <sub>3</sub>		
15.	Above solution + Na <sub>2</sub> HPO <sub>4</sub>	white ppt	Group VI
	solution→ scratch the sides of the		present
	test tube		$Mg^{2+}$

**Result:** Cation - magnesium ion  $(Mg^{2+})$ Anion - sulphate ion  $(SO_4^{2-})$