

# 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 <sub>3</sub>

## 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 <sub>3</sub> <sup>-2</sup> ) may be present.

### CONFIRMATORY TEST FOR CO<sub>3</sub><sup>-2</sup>:

Salt + water. Boil and pass the gas through lime water.	Lime water does not turn milky.	CO <sub>3</sub> <sup>-2</sup> is confirmed.
$\text{CO}_3^{-2} + \text{HCl} \rightarrow \text{CO}_2 \uparrow + \text{H}_2\text{O} + \text{Cl}^-$ $\text{Ca(OH)}_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 \downarrow + \text{H}_2\text{O}$ <p style="text-align: center;">(milky)</p>		

### DETECTION OF GROUP II ACID RADICALS:

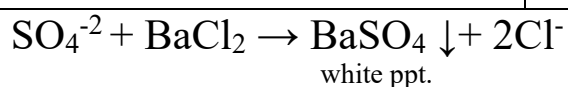
Salt + conc. H <sub>2</sub> SO <sub>4</sub> in a dry test tube.	a) Colourless gas is evolved. It gives dense white fumes with glass rod dipped in NH <sub>4</sub> OH.	Group II acid radical is present. Cl <sup>-</sup> may be present.
	b) Reddish brown fumes and the solution turns brown.	Bromide (Br <sup>-</sup> ) may be present.
	c) Colourless vapours with vinegar smell.	CH <sub>3</sub> COO <sup>-</sup> 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 ( $\text{NO}_3^-$ ) may be present.
<b><u>CONFIRMATORY TEST FOR CHLORIDE (<math>\text{Cl}^-</math>)</u></b>		
<b>1.Silver Nitrate test:</b> 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.
$\text{Cl}^- + \text{AgNO}_3 \rightarrow \text{NO}_3^- + \text{AgCl} \downarrow$ <p style="text-align: center;">white ppt.</p> $\text{AgCl} + 2\text{NH}_4\text{OH} \rightarrow [\text{Ag}(\text{NH}_3)_2]\text{Cl} + 2\text{H}_2\text{O}$ <p style="text-align: center;">soluble complex</p>		
<b>2.Chromyl Chloride test:</b> A pinch of salt + potassium dichromate crystals + few drops of conc. $\text{H}_2\text{SO}_4$ . Pass the above vapours into NaOH solution. To the yellow solution add acetic acid and lead acetate solution.	<p>Reddish brown vapours of Chromyl Chloride are evolved.</p> <p>Yellow solution.</p> <p>Yellow precipitate.</p>	Chloride is confirmed.
$2\text{Cl}^- + \text{K}_2\text{Cr}_2\text{O}_7 + 3\text{H}_2\text{SO}_4 \rightarrow \text{SO}_4^{2-} + \text{K}_2\text{SO}_4 + 2\text{CrO}_2\text{Cl}_2 + 3\text{H}_2\text{O}$ <p style="text-align: center;">chromyl chloride</p> $\text{CrO}_2\text{Cl}_2 + 4\text{NaOH} \rightarrow \text{Na}_2\text{CrO}_4 + 2\text{H}_2\text{O} + 2\text{NaCl}$ $\text{Na}_2\text{CrO}_4 + \text{Pb}(\text{CH}_3\text{COO})_2 \rightarrow \text{PbCrO}_4 \downarrow + 2\text{CH}_3\text{COONa}$ <p style="text-align: center;">Yellow ppt.</p>		
<b><u>CONFIRMATORY TEST FOR BROMIDE (<math>\text{Br}^-</math>)</u></b>		
<b>1.Silver Nitrate test:</b> 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.	$\text{Br}^-$ is confirmed.
$\text{Br}^- + \text{AgNO}_3 \rightarrow \text{NO}_3^- + \text{AgBr} \downarrow$ <p style="text-align: center;">pale yellow ppt.</p>		

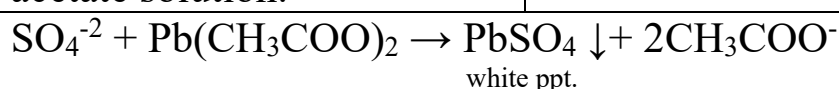
<b>2.Orange globule test:</b> Clear salt solution in water + few drops of carbon tetrachloride + Chlorine water, shaken well.	Orange brown globule separates out.	Bromide is confirmed.
$\text{Br}^- + \text{Cl}_2 \rightarrow \text{Cl}^- + \text{Br}_2$ Bromine being soluble in $\text{CCl}_4$ imparts orange colour to $\text{CCl}_4$ layer.		
<b><u>CONFIRMATORY TEST FOR ACETATE(<math>\text{CH}_3\text{COO}^-</math>):</u></b>		
<b>Oxalic acid test:</b> Salt on watch glass + solid oxalic acid. Make a paste with few drops of water. Rub the paste and smell.  <b>Ester test:</b> Salt + conc. $\text{H}_2\text{SO}_4$ . Heat. Add ethanol and shake. Pour the contents in a beaker full of water. Stir.	Smell of vinegar.         Pleasant fruity smell.	$\text{CH}_3\text{COO}^-$ is confirmed.
1. $(\text{COOH})_2 + 2 \text{CH}_3\text{COO}^- \rightarrow (\text{COONa})_2 + \text{CH}_3\text{COOH}$ <div style="text-align: right; margin-right: 100px;">vinegar smell</div> 2. $2 \text{CH}_3\text{COO}^- + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2 \text{CH}_3\text{COOH}$ $\text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH} \rightarrow \text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$ <div style="text-align: right; margin-right: 100px;">fruity smell</div>		
<b><u>CONFIRMATORY TEST FOR NITRATE(<math>\text{NO}_3^-</math>):</u></b>		
<b>Brown ring test:</b> Salt solution in dil. $\text{H}_2\text{SO}_4$ +freshly prepared saturated solution of Mohr's salt + conc. $\text{H}_2\text{SO}_4$ added carefully along the sides of the test tube.	A brown ring is formed at the junction of two liquids.	Nitrate ( $\text{NO}_3^-$ ) is confirmed.
$\text{NO}_3^- + \text{H}_2\text{SO}_4 \rightarrow \text{HSO}_4^- + \text{HNO}_3$ $2\text{HNO}_3 + 3\text{H}_2\text{SO}_4 + 6\text{FeSO}_4 \rightarrow 3\text{Fe}_2(\text{SO}_4)_3 + 2\text{NO} + 4\text{H}_2\text{O}$ $\text{FeSO}_4 + \text{NO} + 5\text{H}_2\text{O} \rightarrow [\text{Fe}(\text{H}_2\text{O})_5(\text{NO})]\text{SO}_4 + \text{H}_2\text{O}$ <div style="text-align: center; margin-top: 20px;">brown ring</div>		

**DETECTION OF GROUP III ACID RADICAL(SO<sub>4</sub><sup>2-</sup>):**

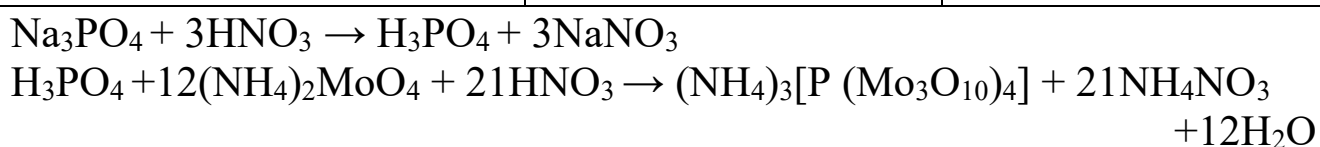
1. Clear solution of the salt in dil.HCl+ Barium chloride solution.	A white precipitate is formed. It is insoluble in excess of dil.HCl	III group acid radical SO <sub>4</sub> <sup>2-</sup> is present and confirmed
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<b>2. Lead acetate test:</b> Clear solution of the salt in water + acetic acid + lead acetate solution.	A white precipitate soluble in ammonium acetate solution	SO <sub>4</sub> <sup>2-</sup> is present and confirmed.
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**DETECTION OF GROUP III ACID RADICAL(PO<sub>4</sub><sup>3-</sup>):**

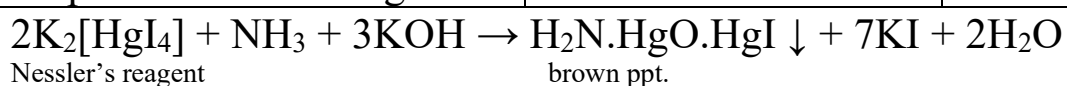
Salt solution in water + conc. HNO <sub>3</sub> + solution of ammonium molybdate. Heat to boil.	A canary yellow precipitate is formed.	III group acid radical phosphate is present and confirmed
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**C| ANALYSIS OF BASIC RADICALS (CATIONS):****TEST FOR AMMONIUM (NH<sub>4</sub><sup>+</sup>) 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 <sub>4</sub> <sup>+</sup> may be present.
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**CONFIRMATORY TEST FOR AMMONIUM (NH<sub>4</sub><sup>+</sup>) RADICAL:**

Salt solution in water + few drops of Nessler's reagent.	Brown precipitate is formed.	NH <sub>4</sub> <sup>+</sup> is confirmed.
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**PREPARATION OF ORIGINAL SOLUTION:**

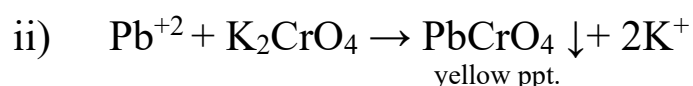
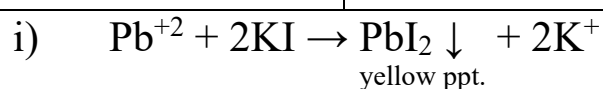
The given salt is taken in a test tube and it is dissolved in minimum amount of water or dil.HCl.

## DETECTION OF GROUP I BASIC RADICALS

Original solution + dil.HCl in a test tube.	White precipitate	I group basic radical present. Pb <sup>+2</sup> may be present.
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### CONFIRMATORY TEST FOR $\text{Pb}^{+2}$ RADICAL:

Dissolve the precipitate in hot water and divide the solution into two parts.		
i) Part 1 + KI solution	Yellow precipitate is formed.	$\text{Pb}^{+2}$ is confirmed.
ii) Part 2 + potassium chromate solution.	Yellow precipitate is formed.	

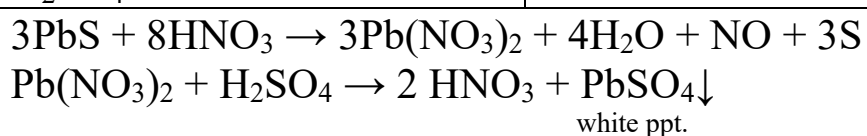


## DETECTION OF GROUP II BASIC RADICALS

Original solution + dil.HCl + H <sub>2</sub> S solution is added.	Black precipitate.	II group basic radical present. Pb <sup>+2</sup> or Cu <sup>+2</sup> may be present.
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**CONFIRMATORY TEST FOR Pb<sup>+2</sup> RADICAL:**

Black precipitate + dil. HNO <sub>3</sub> . Boil, cool + few drops of alcohol + dil. H <sub>2</sub> SO <sub>4</sub> .	White precipitate is formed.	Pb <sup>+2</sup> is confirmed.
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### CONFIRMATORY TEST FOR $\text{Cu}^{+2}$ RADICAL:

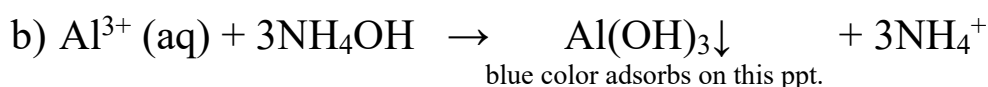
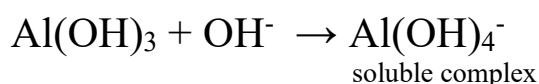
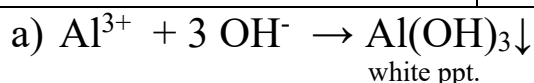
Original solution + excess $\text{NH}_4\text{OH}$ . Acidify with acetic acid. Add potassium ferrocyanide solution.	Blue solution.  Chocolate brown precipitate.	$\text{Cu}^{+2}$ is confirmed.
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### DETECTION OF GROUP III BASIC RADICALS

Original Solution + NH <sub>4</sub> Cl solid + NH <sub>4</sub> OH solution in excess.	A gelatinous white precipitate.	III group basic radical present. Al <sup>3+</sup> may be present.
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### CONFIRMATORY TEST FOR ALUMINIUM(Al<sup>3+</sup>)

a) Original solution + NaOH solution dropwise. Above solution is treated with NH <sub>4</sub> Cl solid.	Gelatinous white precipitate soluble in excess of NaOH. White gelatinous precipitate reappears.	Al <sup>3+</sup> is confirmed.
b) <b>Lake test:</b> Original solution + blue litmus solution + NH <sub>4</sub> OH solution in excess.	Bluish white precipitate, floating like lake is formed.	

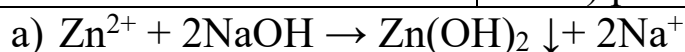


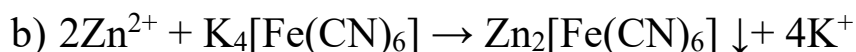
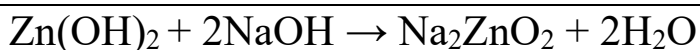
### DETECTION OF GROUP IV BASIC RADICALS

Original solution + NH <sub>4</sub> Cl solid + NH <sub>4</sub> OH solution in excess + H <sub>2</sub> S	i) White precipitate.  ii) Buff precipitate.	IV group basic radical present. Zn <sup>+2</sup> may be present. Mn <sup>+2</sup> may be present.
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### CONFIRMATORY TEST FOR ZINC (Zn<sup>2+</sup>)

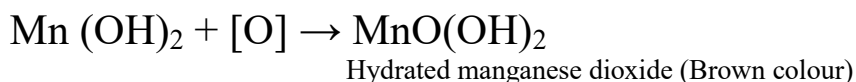
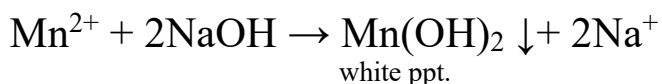
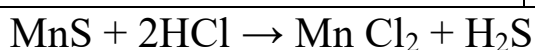
i) Original solution + NaOH solution dropwise. To the above solution acidify with Dil. HCl and add H <sub>2</sub> S	White precipitate is soluble in excess of NaOH. White precipitate reappears.	Zn <sup>+2</sup> confirmed.
ii) Original solution + NH <sub>4</sub> OH solution + potassium ferrocyanide solution.	White (or bluish white) precipitate.	





### **CONFIRMATORY TEST FOR MANGANOUS ( $\text{Mn}^{2+}$ )**

Original solution + $\text{NH}_4\text{Cl}$ solid + $\text{NH}_4\text{OH}$ solution in excess + $\text{H}_2\text{S}$	Buff / flesh coloured precipitate.	$\text{Mn}^{2+}$ is confirmed.
Add dil. $\text{HCl}$ and boil.	Precipitate dissolves.	
Add sodium hydroxide solution in excess	White precipitate formed and turns brown on exposure to air.	

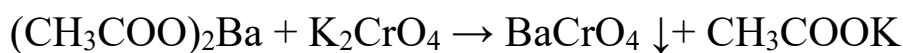
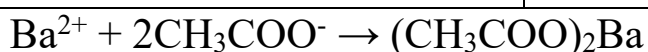


### **DETECTION OF GROUP V BASIC RADICALS**

Original solution + $\text{NH}_4\text{Cl}$ solid + $\text{NH}_4\text{OH}$ solution in excess + $(\text{NH}_4)_2\text{CO}_3$ solution.	A white precipitate.	IV group basic radical present. $\text{Ba}^{2+}$ , $\text{Sr}^{2+}$ , or $\text{Ca}^{2+}$ may be present.
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### **CONFIRMATORY TEST FOR BARIUM ( $\text{Ba}^{2+}$ )**

Original solution + acetic acid + potassium chromate solution.	Yellow precipitate.	$\text{Ba}^{2+}$ is confirmed.
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<b>Flame test:</b> A pinch of salt + few drops conc. $\text{HCl}$ 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.	$\text{Ba}^{2+}$ is confirmed.
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<b><u>CONFIRMATORY TEST FOR STRONTIUM (Sr<sup>2+</sup>)</u></b>		
Original solution + ammonium sulphate solution, warm.	White precipitate.	Sr <sup>2+</sup> is confirmed.
$\text{Sr}^{2+} + (\text{NH}_4)_2\text{SO}_4 \rightarrow \text{SrSO}_4 \downarrow + 2\text{NH}_4^+$		
<b>Flame test:</b> 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 <sup>2+</sup> is confirmed.
<b><u>CONFIRMATORY TEST FOR CALCIUM (Ca<sup>2+</sup>)</u></b>		
Original solution + NH <sub>4</sub> OH solution + Ammonium oxalate solution.	White precipitate	Ca <sup>2+</sup> is confirmed
$\text{Ca}^{2+} + (\text{NH}_4)_2\text{C}_2\text{O}_4 \rightarrow \text{CaC}_2\text{O}_4 \downarrow + 2\text{NH}_4^+$		
<b>Flame test:</b> 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 <sup>2+</sup> is confirmed
<b><u>DETECTION OF GROUP VI BASIC RADICALS</u></b>		
i) Original solution + NH <sub>4</sub> Cl solid + NH <sub>4</sub> OH solution + ammonium phosphate solution. ii) Original solution + NaOH solution.	White crystalline precipitate  White precipitate insoluble in NaOH solution	Mg <sup>2+</sup> is confirmed.  Mg <sup>2+</sup> is confirmed.
$\text{Mg}^{2+} + \text{NH}_4\text{OH} + (\text{NH}_4)_2\text{HPO}_4 \rightarrow \text{Mg}(\text{NH}_4)\text{PO}_4 \downarrow + 2\text{NH}_4^+ + \text{H}_2\text{O}$ $\text{Mg}^{2+} + 2\text{NaOH} \rightarrow \text{Mg}(\text{OH})_2 \downarrow + 2\text{Na}^+$		

### **RESULT:**

The given salt contains \_\_\_\_\_ as acid radical and \_\_\_\_\_ as basic radical.

Hence the given salt is \_\_\_\_\_.