

Systematic Qualitative Analysis (Salt Analysis)

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October 28, 2026

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1 Preliminary Tests

Experiment	Observation	Inference
State and nature: Observe and note the state and nature of the salt	Amorphous	CO_3^{2-} may be present
	Crystalline	CO_3^{2-} may be absent
Colour: Observe and note the colour of the salt	Blue	Cu^{2+} may be present
	Brown	Fe^{3+} may be present
	Bright green	Ni^{2+} may be present
	Pink	Co^{2+} may be present
	Pale pink	Mn^{2+} may be present
	Colourless	Cu^{2+} , Fe^{3+} , Ni^{2+} , Co^{2+} , Mn^{2+} may be absent
Odour: Observe and note the odour of the salt	Pungent smell	NH_4^+ may be present
	Vinegar smell	CH_3COO^- may be present
	Odourless	NH_4^+ , CH_3COO^- may be absent
Flame test: Prepare a paste of a pinch of salt using 1-2 drops of dil. HCl. Introduce the paste to a flame using a glass rod. Observe and note the flame colour.	Grassy green	Ba^{2+} may be present
	Crimson red	Sr^{2+} may be present
	Brick red	Ca^{2+} may be present
	Colourless	Ba^{2+} , Sr^{2+} , Ca^{2+} may be absent

2 Solubility Tests

	Water	dil. HCl	conc. HCl	dil. HNO ₃	conc. HNO ₃	Aqua regia (conc. HNO ₃ : conc. HCl = 1 : 3)
Cold						
Hot						

3 Detection of Anions

Group	Group reagent	Experiment	Observation	Inference
I	dil. HCl	Treat a pinch of the salt with dil. HCl	Brisk effervescence of a <i>colourless, odourless</i> gas, which turns lime water <i>milky</i> . $\text{Na}_2\text{CO}_3 + \text{dil. HCl} \longrightarrow \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2 \uparrow$ $\text{CO}_2 + \text{Ca(OH)}_2 \longrightarrow \text{CaCO}_3 \downarrow + \text{H}_2\text{O}$ (milky white ppt.)	CO ₃ ²⁻ may be present
			<i>Colourless</i> gas with <i>smell of rotten eggs</i> which turns lead acetate paper <i>black</i> . $\text{Na}_2\text{S} + \text{dil. HCl} \longrightarrow \text{NaCl} + \text{H}_2\text{S} \uparrow$ $(\text{CH}_3\text{COO})_2\text{Pb} + \text{H}_2\text{S} \longrightarrow \text{PbS} \downarrow + \text{CH}_3\text{COOH}$ (black ppt.)	S ²⁻ may be present

Group	Group reagent	Experiment	Observation	Inference
			<i>Colourless</i> gas with a <i>suffocating smell of burning sulphur</i> which turns acidified potassium dichromate paper <i>green</i>. $\text{Na}_2\text{SO}_3 + \text{dil. HCl} \longrightarrow \text{NaCl} + \text{H}_2\text{O} + \text{SO}_2 \uparrow$ $\text{K}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4 + \text{SO}_2 \longrightarrow \text{K}_2\text{SO}_4 + \text{Cr}_2(\text{SO}_4)_3 + \text{H}_2\text{O}$ (green)	SO_3^{2-} may be present
			<i>Reddish brown</i> gas evolves and salt solution turns acidified potassium iodide solution containing starch solution gives <i>blue</i> colour. $\text{NaNO}_2 + \text{dil. HCl} \longrightarrow \text{NaCl} + \text{HNO}_2$ $\text{HNO}_2 \longrightarrow \text{HNO}_3 + \text{NO} + \text{H}_2\text{O}$ $\text{NO} + \text{O}_2 \longrightarrow \text{NO}_2$ (reddish-brown gas) $\text{NO}_2^- + \text{CH}_3\text{COOH} \longrightarrow \text{HNO}_2 + \text{CH}_3\text{COO}^-$ $\text{HNO}_2 + \text{KI} + \text{CH}_3\text{COOH} \longrightarrow \text{CH}_3\text{COOK} + \text{H}_2\text{O} + \text{NO} + \text{I}_2$ $\text{I}_2 + \text{Starch} \longrightarrow \text{Blue complex}$	NO_2^- may be present
			No characteristic observation	I group anions absent
II	conc. H_2SO_4	Treat a pinch of salt with conc. H_2SO_4	<i>Colourless</i> gas with <i>pungent smell</i>, which gives <i>dense white fumes</i> when exposed to a glass rod dipped in ammonium hydroxide. $\text{NaCl} + \text{conc. H}_2\text{SO}_4 \longrightarrow \text{NaHSO}_4 + \text{HCl} \uparrow$ $\text{HCl} + \text{NH}_4\text{OH} \longrightarrow \text{NH}_4\text{Cl} + \text{H}_2\text{O}$ (dense white fumes)	Cl^- may be present

Group	Group reagent	Experiment	Observation	Inference
			<i>Reddish brown fumes and solution turns brown.</i> $\text{NaBr} + \text{conc. H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{SO}_2 \uparrow + \underset{\substack{\text{(reddish brown} \\ \text{fumes)}}}{\text{Br}_2 \uparrow}} + \text{H}_2\text{O}$	Br^- may be present
			<i>Light brown fumes on heating and solution does not turn brown.</i> $\text{NaNO}_3 + \text{conc. H}_2\text{SO}_4 \longrightarrow \text{NaHSO}_4 + \text{HNO}_3$ $\text{HNO}_3 \xrightarrow{\Delta} \underset{\substack{\text{(light brown fumes)}}}{\text{NO}_2 \uparrow} + \text{O}_2 + \text{H}_2\text{O}$	NO_3^- may be present
			<i>Colourless, odourless gases which turn lime water milky and burns which a blue flame.</i> $(\text{COONa})_2 + \text{conc. H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2 \uparrow + \text{CO} \uparrow$ $\text{CO}_2 + \text{Ca(OH)}_2 \longrightarrow \text{CaCO}_3 \downarrow + \text{H}_2\text{O}$ $\text{CO} + \text{O}_2 \longrightarrow \text{CO}_2 + \text{Blue light}$	$\text{C}_2\text{O}_4^{2-}$ may be present
			<i>Colourless vinegar smell vapours that turn blue litmus red.</i> $\text{CH}_3\text{COONa} + \text{conc. H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{CH}_3\text{COOH}$	CH_3COO^- may be present
			No characteristic observation	II group anions absent

Group	Group reagent	Experiment	Observation	Inference
III	No group reagent	Test for sulphate:		
		Barium chloride test: Acidify salt solution with dil. HCl and treat with barium chloride solution.	<i>White</i> precipitate insoluble in dil. HCl. $\text{Na}_2\text{SO}_4 + \text{BaCl}_2 \xrightarrow{\text{dil. HCl}} \text{BaSO}_4 \downarrow + \text{NaCl}$ (white ppt.)	SO_4^{2-} is present
		Lead acetate test: Acidify salt solution with acetic acid and treat with lead acetate solution.	<i>White</i> precipitate soluble in ammonium acetate solution. $\text{Na}_2\text{SO}_4 + (\text{CH}_3\text{COO})_2\text{Pb} \xrightarrow{\text{dil. CH}_3\text{COOH}} \text{PbSO}_4 \downarrow + (\text{CH}_3\text{COO})\text{Na}$ (white ppt.) $\text{PbSO}_4 + \text{CH}_3\text{COONH}_4 \longrightarrow (\text{CH}_3\text{COO})_2\text{Pb} + (\text{NH}_4)_2\text{SO}_4$	SO_4^{2-} is confirmed
		Test for phosphate:		
		Ammonium molybdate test: Add conc. HNO_3 and ammonium molybdate to the salt solution and boil.	<i>Canary yellow</i> precipitate. $\text{Na}_2\text{HPO}_4 + (\text{NH}_4)_2\text{MoO}_4 + \text{HNO}_3 \xrightarrow{\Delta} (\text{NH}_4)_3[\text{P}(\text{Mo}_3\text{O}_{10})_4] \downarrow$ (canary yellow ppt.) Ammonium phosphomolybdate $+ \text{NaNO}_3 + \text{NH}_4\text{NO}_3 + \text{H}_2\text{O}$	PO_4^{3-} is present

Group	Group reagent	Experiment	Observation	Inference
		Magnesia mixture test: Add dil. HCl to salt solution and boil. After cooling, treat with magnesia mixture .	<i>White</i> precipitate. $\text{Na}_2\text{HPO}_4 + \text{MgCl}_2 + \text{NH}_4\text{OH} + \text{NH}_4\text{Cl} \longrightarrow \text{Mg}(\text{NH}_4)\text{PO}_4 \downarrow + \text{NaCl} + \text{H}_2\text{O}$ Magnesia mixture (white ppt.)	PO_4^{3-} is confirmed

4 Confirmatory Tests for Anions

Radical	Experiment	Observation	Inference
CO_3^{2-}	Lime water test: Treat a pinch of salt with dil. HCl and pass the gas into lime water. $\text{Na}_2\text{CO}_3 + \text{dil. HCl} \longrightarrow \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2 \uparrow$ $\text{CO}_2 + \text{Ca}(\text{OH})_2 \longrightarrow \text{CaCO}_3 \downarrow + \text{H}_2\text{O}$ (milky white ppt.)	Lime water turns <i>milky</i>	CO_3^{2-} is present
	Continue passing the gas through lime water for longer time. $\text{CaCO}_3 + \text{CO}_2 + \text{H}_2\text{O} \longrightarrow \text{Ca}(\text{HCO}_3)_2$ (clear solution)	<i>Milkiness</i> disappears	CO_3^{2-} is confirmed

Radical	Experiment	Observation	Inference
NO_2^-	Ferrous sulphate test: Treat salt solution with dilute acetic acid and ferrous sulphate solution. $\text{NaNO}_2 + \text{CH}_3\text{COOH} \longrightarrow \text{CH}_3\text{COONa} + \text{HNO}_2$ $\text{HNO}_2 + \text{FeSO}_4 \longrightarrow \text{Fe}_2(\text{SO}_4)_3 + \text{NO} + \text{H}_2\text{O}$ $\text{Fe}^{2+} + 6 \text{H}_2\text{O} \rightleftharpoons [\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ Hexaaquairon(II) ion $[\text{Fe}(\text{H}_2\text{O})_6]^{2+} + \text{NO} \longrightarrow [\text{Fe}(\text{H}_2\text{O})_5(\text{NO})]^{2+} + \text{H}_2\text{O}$ (dark brown complex) Pentaaquanitrosyliron(II) ion	<i>Dark brown or black colour</i>	NO_2^- is confirmed
Cl^-	Chromyl chloride test:		
	Add solid potassium dichromate to a pinch of salt in a dry test tube. Treat with conc. H_2SO_4. $\text{NaCl} + \text{K}_2\text{Cr}_2\text{O}_7 + \text{conc. H}_2\text{SO}_4 \longrightarrow \text{KHSO}_4 + \text{NaHSO}_4$ $+ \text{CrO}_2\text{Cl}_2 \uparrow + \text{H}_2\text{O}$ (reddish brown vapours)	<i>Reddish brown vapours evolved</i>	Cl^- is present
	Dissolve the vapours evolved in sodium hydroxide solution. $\text{CrO}_2\text{Cl}_2 + \text{NaOH} \longrightarrow \text{Na}_2\text{CrO}_4 + \text{NaCl} + \text{H}_2\text{O}$ (yellow solution)	<i>Yellow solution</i>	
	Treat the yellow solution with dilute acetic acid and lead acetate solution. $\text{Na}_2\text{CrO}_4 + (\text{CH}_3\text{COO})_2\text{Pb} \xrightarrow{\text{dil. CH}_3\text{COOH}} \text{PbCrO}_4 \downarrow + \text{CH}_3\text{COONa}$ (yellow ppt.)	<i>Yellow precipitate</i>	Cl^- is confirmed

Radical	Experiment	Observation	Inference
	Silver nitrate test:		
	Treat salt solution with dil. HNO_3 and silver nitrate solution. $\text{NaCl} + \text{AgNO}_3 \xrightarrow{\text{dil. HNO}_3} \text{NaNO}_3 + \text{AgCl} \downarrow$ (curdy white ppt.) $\text{AgCl} + \text{NH}_4\text{OH} \longrightarrow [\text{Ag}(\text{NH}_3)_2]\text{Cl} + \text{H}_2\text{O}$	<i>Curdy white</i> precipitate soluble in ammonium hydroxide	Cl^- is confirmed
Br^-	Globule test: Add carbon tetrachloride (or carbon disulphide/chloroform/dichloromethane) to salt solution. Treat with chlorine water and shake well. $\text{NaBr} + \text{Cl}_2 \xrightarrow{\text{Organic layer}} \text{NaCl} + \text{Br}_2 \uparrow$ (in organic layer)	<i>Orange red globules</i> separate out	Br^- is confirmed
	Silver nitrate test: Treat salt solution with dil. HNO_3 and silver nitrate solution. $\text{NaBr} + \text{AgNO}_3 \xrightarrow{\text{dil. HNO}_3} \text{NaNO}_3 + \text{AgBr} \downarrow$ (pale yellow ppt.) $\text{AgBr} + \text{NH}_4\text{OH} \longrightarrow [\text{Ag}(\text{NH}_3)_2]\text{Br} + \text{H}_2\text{O}$	<i>Pale yellow</i> precipitate sparingly soluble in ammonium hydroxide	Br^- is confirmed
NO_3^-	Copper turnings test: Add copper turnings to salt solution with conc. H_2SO_4 and heat. $\text{NaNO}_3 + \text{H}_2\text{SO}_4 + \text{Cu} \xrightarrow{\Delta} \text{Cu}(\text{NO}_3)_2 + \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{NO} \uparrow$ (blue-green) $\text{NO} + \text{O}_2 \longrightarrow \text{NO}_2$ (brown gas)	<i>Brown</i> gas is evolved and the solution becomes <i>blue-green</i>	NO_3^- is confirmed

Radical	Experiment	Observation	Inference
CH_3COO^-	Esterification test: Treat a pinch of salt with 1-2 drops of conc. H_2SO_4 and ethyl alcohol. Heat and pour the mixture into sodium carbonate solution. $\text{CH}_3\text{COONa} + \text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{CH}_3\text{COOH}$ $\text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH} \xrightarrow[\text{(fruity odour)}]{\text{conc. H}_2\text{SO}_4} \text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}_2\text{O}$ Addition of sodium carbonate neutralises excess sulphuric acid acetic acid: $\text{H}_2\text{SO}_4 + \text{Na}_2\text{CO}_3 \longrightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2 \uparrow$ $\text{CH}_3\text{COOH} + \text{Na}_2\text{CO}_3 \longrightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O} + \text{CO}_2 \uparrow$	<i>Fruity</i> odour	CH_3COO^- is confirmed
	Neutral ferric chloride test: Treat salt solution with neutral ferric chloride solution. After formation of red colour, add dil. HCl. $\text{CH}_3\text{COONa} + \text{FeCl}_3 \longrightarrow (\text{CH}_3\text{COO})_3\text{Fe} + \text{NaCl}$ (red complex) $(\text{CH}_3\text{COO})_3\text{Fe} + \text{dil. HCl} \longrightarrow \text{FeCl}_3 + \text{CH}_3\text{COOH}$ (yellowish-brown)	<i>Red</i> colour disappears	CH_3COO^- is confirmed

5 Preparation of Original Solution

A solution of the salt is prepared by dissolving a small amount of the salt in a suitable solvent. This solution is used to detect the presence of the cations.

6 Detection of Cations

Group	Group reagent	Experiment	Observation	Inference
0	No group reagent	Sodium hydroxide test: Treat a pinch of salt with sodium hydroxide solution and heat. $(\text{NH}_4)_2\text{SO}_4 + \text{NaOH} \xrightarrow{\Delta} \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{NH}_3 \uparrow$	<i>Pungent</i> smell of ammonia	NH_4^+ is present
		Expose a glass rod dipped in conc. HCl to the mouth of the test tube. $\text{NH}_3 + \text{HCl} \longrightarrow \text{NH}_4\text{Cl}$ (dense white fumes)	<i>Dense white</i> fumes	NH_4^+ is present
		Nessler's reagent test: Treat original solution with Nessler's reagent. $(\text{NH}_4)_2\text{SO}_4 + \underset{\substack{\text{(pale yellow/colourless)} \\ \text{Nessler's reagent}}}{\text{K}_2\text{HgI}_4 + \text{KOH}} \longrightarrow \underset{\substack{\text{(brown ppt.)} \\ \text{Iodide of Millon's base}}}{\text{HgO} \cdot \text{Hg}(\text{NH}_2)\text{I}} \downarrow + \text{KI} + \text{K}_2\text{O} + \text{K}_2\text{SO}_4$	<i>Brown</i> ppt	NH_4^+ is confirmed
I	dil. HCl	Treat original solution with dil. HCl.	<i>White</i> ppt (PbCl_2)	Pb^{2+} is present

Group	Group reagent	Experiment	Observation	Inference
II	dil. HCl +H ₂ S	Treat original solution with dil. HCl and H ₂ S gas in excess.	Black ppt (CuS/PbS)	Cu ²⁺ / Pb ²⁺ is present
			Yellow ppt (As ₂ S ₃)	As ³⁺ is present
III	NH ₄ Cl +NH ₄ OH	Treat original solution with NH ₄ Cl and NH ₄ OH in excess.	Brown ppt (Fe(OH) ₃)	Fe ³⁺ is present
			White ppt (Al(OH) ₃)	Al ³⁺ is present
IV	NH ₄ Cl +NH ₄ OH +H ₂ S	Treat original solution with NH ₄ Cl, NH ₄ OH and H ₂ S in excess.	Black ppt (CoS/NiS)	Co ²⁺ / Ni ²⁺ is present
			Flesh coloured ppt (MnS)	Mn ²⁺ is present
			White ppt (ZnS)	Zn ²⁺ is present
V	NH ₄ Cl +NH ₄ OH +(NH ₄) ₂ CO ₃	Treat original solution with NH ₄ Cl, NH ₄ OH and (NH ₄) ₂ CO ₃ .	White ppt (BaCO ₃ /SrCO ₃ /CaCO ₃)	Ba ²⁺ / Sr ²⁺ /Ca ²⁺ is present
VI	No group reagent	Ammonium phosphate test: Treat original solution with NH₄Cl, NH₄OH and ammonium phosphate solution. Scratch the side of the test tube with a glass rod. $\text{Mg}^{2+} + \text{NH}_4^+ + \text{PO}_4^{3-} + \text{H}_2\text{O} \longrightarrow \text{Mg}(\text{NH}_4)\text{PO}_4 \cdot 6\text{H}_2\text{O} \downarrow$ (white ppt.)	White ppt	Mg ²⁺ is present

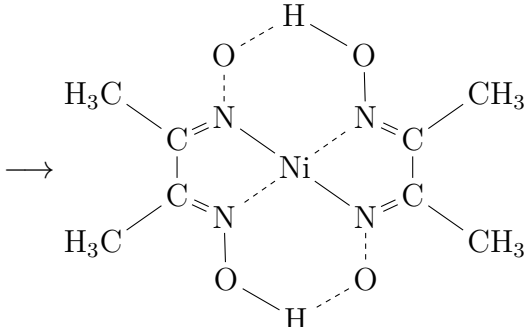
Group	Group reagent	Experiment	Observation	Inference
		Sodium hydroxide test: Treat original solution with NaOH solution. $\text{MgCl}_2 + \text{NaOH} \longrightarrow \text{Mg}(\text{OH})_2 \downarrow + \text{NaCl}$ (white ppt.)	White ppt insoluble in NaOH solution	Mg ²⁺ is confirmed

7 Confirmatory Tests for Cations

Radical	Experiment	Observation	Inference
Pb ²⁺	Potassium chromate test: Treat original solution with potassium chromate solution. $\text{PbCl}_2 + \text{K}_2\text{CrO}_4 \longrightarrow \text{PbCrO}_4 \downarrow + \text{KCl}$ (yellow ppt.)	Yellow precipitate	Pb ²⁺ is confirmed
	Potassium iodide test: Treat original solution with potassium iodide solution. $\text{PbCl}_2 + \text{KI} \longrightarrow \text{PbI}_2 \downarrow + \text{KCl}$ (yellow ppt.)	Yellow precipitate	Pb ²⁺ is confirmed
Cu ²⁺	Ammonium hydroxide test: Treat original solution with ammonium hydroxide solution. $\text{CuSO}_4 + \text{NH}_4\text{OH} \longrightarrow [\text{Cu}(\text{NH}_3)_4]\text{SO}_4 + \text{H}_2\text{O}$ (blue complex)	Blue precipitate soluble in excess ammonium hydroxide	Cu ²⁺ is confirmed

Radical	Experiment	Observation	Inference
	Potassium ferrocyanide test: Treat original solution with potassium ferrocyanide solution. $\text{CuSO}_4 + \text{K}_4[\text{Fe}(\text{CN})_6] \longrightarrow \underset{\text{(chocolate brown ppt.)}}{\text{Cu}_2[\text{Fe}(\text{CN})_6] \downarrow} + \text{K}_2\text{SO}_4$	<i>Chocolate brown precipitate</i>	Cu^{2+} is confirmed
As^{3+}	Ammonium molybdate test: Treat the original solution obtained with conc. HNO_3 and ammonium molybdate solution. $\text{H}_3\text{AsO}_4 + (\text{NH}_4)_2\text{MoO}_4 + \text{HNO}_3 \longrightarrow \underset{\substack{\text{(canary yellow ppt.)} \\ \text{Ammonium arsenomolybdate}}}{(\text{NH}_4)_3[\text{As}(\text{Mo}_3\text{O}_{10})_4] \downarrow} + \text{NH}_4\text{NO}_3 + \text{H}_2\text{O}$	<i>Canary yellow precipitate</i>	As^{3+} is confirmed
	Magnesia mixture test: Treat the original solution with magnesia mixture. $\text{H}_3\text{AsO}_4 + \text{MgCl}_2 + \text{NH}_4\text{OH} + \text{NH}_4\text{Cl} \longrightarrow \underset{\text{(white ppt.)}}{\text{Mg}(\text{NH}_4)\text{AsO}_4 \cdot 6\text{H}_2\text{O} \downarrow} + \text{NH}_4\text{Cl}$	<i>White precipitate</i>	As^{3+} is confirmed
Fe^{3+}	Potassium ferrocyanide test: Treat original solution with potassium ferrocyanide. $\text{FeCl}_3 + \text{K}_4[\text{Fe}(\text{CN})_6] \longrightarrow \underset{\text{(prussian blue complex)}}{\text{Fe}_4[\text{Fe}(\text{CN})_6]_3} + \text{KCl}$	<i>Prussian blue colour</i>	Fe^{3+} is confirmed
	Potassium thiocyanate (sulphocyanide) test: Treat original solution with potassium thiocyanate. $\text{Fe}^{3+} + \text{SCN}^- \longrightarrow \underset{\substack{\text{(blood red complex)} \\ \text{Thiocyanatoiron(III)}}}{[\text{Fe}(\text{SCN})]^{2+}}$	<i>Blood red colour</i>	Fe^{3+} is confirmed

Radical	Experiment	Observation	Inference
Al ³⁺	Sodium hydroxide test:		
	Treat original solution with 2-3 drops of NaOH solution. $\text{AlCl}_3 + \text{NaOH} \longrightarrow \text{Al}(\text{OH})_3 \downarrow + \text{NaCl}$ (white ppt.) $\text{Al}(\text{OH})_3 + \text{NaOH} \longrightarrow \text{NaAlO}_2 + \text{H}_2\text{O}$	White precipitate soluble in excess NaOH	Al ³⁺ is present
	To the clear solution, add solid NH ₄ Cl and warm. $\text{NaAlO}_2 + \text{NH}_4\text{Cl} + \text{H}_2\text{O} \xrightarrow{\Delta} \text{Al}(\text{OH})_3 \downarrow + \text{NH}_3 \uparrow$	Precipitate reappears	Al ³⁺ is confirmed
	Lake test:		
	Treat original solution with blue litmus solution and drop-wise NH ₄ OH along the side. $\text{AlCl}_3 + \text{NH}_4\text{OH} \xrightarrow{\text{Blue litmus}} \text{Al}(\text{OH})_3 \downarrow + \text{NH}_4\text{Cl}$ (absorbs blue colour)	Blue precipitate floating on the colourless solution	Al ³⁺ is confirmed
Co ²⁺	Potassium nitrite test: Treat original solution with NH ₄ OH, dil. CH ₃ COOH and potassium nitrite solution. $\text{CoCl}_2 + \text{KNO}_2 + \text{dil. CH}_3\text{COOH} \xrightarrow{\text{NH}_4\text{OH}} \text{K}_3[\text{Co}(\text{NO}_2)_6] \downarrow$ (yellow ppt.) Potassium cobaltinitrite + KCl + CH ₃ COOK + NO + H ₂ O	Yellow precipitate	Co ²⁺ is confirmed

Radical	Experiment	Observation	Inference
	Ammonium thiocyanate-ether test: Treat original solution with ether, ammonium thiocyanate and shake well. $\text{CoCl}_2 + \text{NH}_4\text{SCN} \xrightarrow{\text{Ether}} (\text{NH}_4)_2[\text{Co}(\text{SCN})_4]$ (blue complex in ether layer) Ammonium tetrathiocyanatocobaltate(II)	<i>Blue</i> ether layer	Co^{2+} is confirmed
Ni^{2+}	Dimethyl glyoxime test: Treat original solution with NH_4OH and dimethyl glyoxime. $\text{NiCl}_2 + \text{NH}_4\text{OH} + \begin{array}{c} \text{H}_3\text{C}-\text{C}=\text{N}-\text{OH} \\ \\ \text{H}_3\text{C}-\text{C}=\text{N}-\text{OH} \end{array} \rightarrow$  (bright red complex) Bis(dimethylglyoximate)nickel(II) + $\text{NH}_4\text{Cl} + \text{H}_2\text{O}$	<i>Bright red</i> precipitate	Ni^{2+} is confirmed
Zn^{2+}	Sodium hydroxide test: Treat original solution with sodium hydroxide solution. $\text{ZnCl}_2 + \text{NaOH} \longrightarrow \text{Zn}(\text{OH})_2 \downarrow + \text{NaCl}$ (white ppt.) $\text{Zn}(\text{OH})_2 + \text{NaOH} \longrightarrow \text{Na}_2\text{ZnO}_2 + \text{H}_2\text{O}$	<i>White</i> precipitate soluble in excess of NaOH solution	Zn^{2+} is confirmed

Radical	Experiment	Observation	Inference
	Potassium ferrocyanide test: Treat original solution with potassium ferrocyanide solution. $\text{ZnCl}_2 + \text{K}_4[\text{Fe}(\text{CN})_6] \longrightarrow \text{Zn}[\text{Fe}(\text{CN})_6] \downarrow + \text{KCl}$ (bluish white ppt.)	White or bluish white precipitate	Zn^{2+} is confirmed
Mn^{2+}	Sodium hydroxide test: Treat original solution with sodium hydroxide solution. $\text{MnSO}_4 + \text{NaOH} \longrightarrow \text{Mn}(\text{OH})_2 \downarrow + \text{Na}_2\text{SO}_4$ (white ppt.) $\text{Mn}(\text{OH})_2 + \text{O}_2 \longrightarrow \text{MnO}_2 \cdot x \text{H}_2\text{O} \downarrow$ (brown ppt.)	White precipitate which turns brown on exposure to air	Mn^{2+} is confirmed
	Permanganic acid test/Lead oxide test: Treat a pinch of salt with conc. HNO_3 and lead oxide; boil and then cool and dilute with water. $\text{MnSO}_4 + \text{PbO}_2 + \text{HNO}_3 \longrightarrow \underset{\substack{\text{(pink solution)} \\ \text{Permanganic acid}}}{\text{HMnO}_4} + \text{Pb}(\text{NO}_3)_2 + \text{PbSO}_4 \downarrow + \text{H}_2\text{O}$	Pink colour solution	Mn^{2+} is confirmed
Ba^{2+}	Potassium chromate test: Treat original solution with dilute acetic acid and potassium chromate solution. $\text{BaCO}_3 + \text{CH}_3\text{COOH} \longrightarrow (\text{CH}_3\text{COO})_2\text{Ba} + \text{H}_2\text{O} + \text{CO}_2$ $(\text{CH}_3\text{COO})_2\text{Ba} + \text{K}_2\text{CrO}_4 \longrightarrow \text{BaCrO}_4 \downarrow + \text{CH}_3\text{COOK}$ (yellow ppt.)	Yellow precipitate	Ba^{2+} is confirmed

Radical	Experiment	Observation	Inference
Sr^{2+}	Ammonium sulphate test: Treat original solution with dilute acetic acid and ammonium sulphate solution and warm. $\text{SrCO}_3 + \text{CH}_3\text{COOH} \longrightarrow (\text{CH}_3\text{COO})_2\text{Sr} + \text{H}_2\text{O} + \text{CO}_2$ $(\text{CH}_3\text{COO})_2\text{Sr} + (\text{NH}_4)_2\text{SO}_4 \xrightarrow{\Delta} \text{SrSO}_4 \downarrow + \text{CH}_3\text{COOK}$ (white ppt.)	White precipitate	Sr^{2+} is confirmed
Ca^{2+}	Ammonium oxalate test: Treat original solution with dilute acetic acid and ammonium oxalate solution. $\text{CaCO}_3 + \text{CH}_3\text{COOH} \longrightarrow (\text{CH}_3\text{COO})_2\text{Ca} + \text{H}_2\text{O} + \text{CO}_2$ $(\text{CH}_3\text{COO})_2\text{Ca} + (\text{NH}_4)_2\text{C}_2\text{O}_4 \longrightarrow (\text{COO})_2\text{Ca} \downarrow + \text{CH}_3\text{COONH}_4$ (white ppt.)	White precipitate	Ca^{2+} is confirmed