Al-Mustaqbal University

College of Science

Qualitative Analytical Chemistry

First Year Students / 1st Lecture

Qualitative Inorganic Analysis

2025-2026

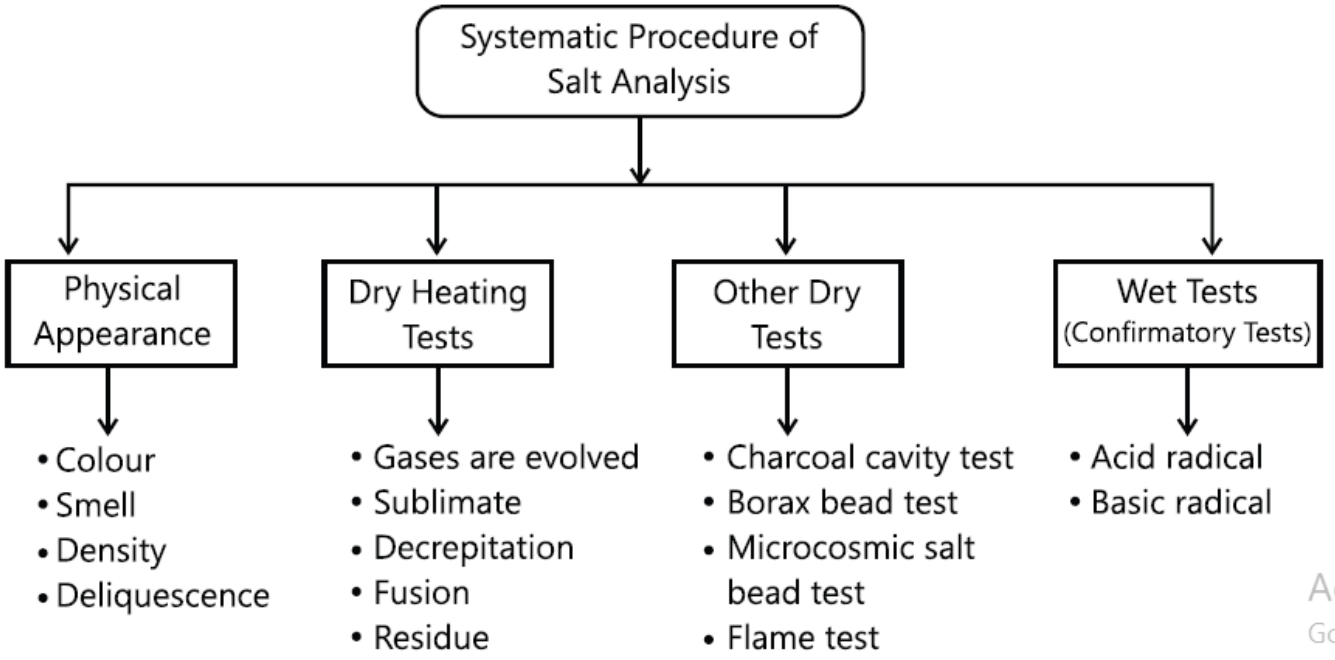
By

Prof. Dr. Naser Abdulhasan Naser

Qualitative Inorganic Analysis

$$\text{Salt} \longrightarrow \underbrace{\text{Cation } (C^+)}_{\text{from base (basic radical)}} + \underbrace{\text{Anion } (A^-)}_{\text{from acid (acidic radical)}}$$

Determination of quality of any salt mixture is called **Qualitative analysis** or **Salt analysis**.



Flowchart 30.1: Procedure of salt analysis

Qualitative Analysis Steps

Observation physical properties of salts

Action of heat on salt

Make aqueous solution of the salt to test for anions and cations present

Carry out confirmatory tests

How to identify cation and anion in salt???

1. Colour and solubility of the salt
2. Gas test
3. Effect of heat on salt
4. Confirmatory test for anions
5. Confirmatory test for cations

Colour and solubility of the salt

SALT	COLOUR	
	SOLID	AQUEOUS SOLUTION
Ca^{2+} , Mg^{2+} , Al^{3+} , Pb^{2+} , $NH4^{+}$	white	colourless
$CuSO_4$, $Cu(NO_3)_2$	Blue	Blue
$CuCl_2$	Green	Blue
$FeSO_4$, $Fe(NO_3)_2$, $FeCl_2$	Green	Green
$Fe(SO_4)_3$, $Fe(NO_3)_3$, $FeCl_3$	Brown	Yellow/Brownish
$CuCO_3$	Green	(Insoluble)
PbO	Brown when Hot & Yellow when cooled	Insoluble
CuO	black	Insoluble
ZnO	Yellow when Hot & White when cooled	Insoluble
PbCl2	white	Insoluble in cold water but soluble in hot water
PbI_2	Yellow	Insoluble in cold water but soluble in hot water

ACTIVITY TO INVESTIGATE THE COLOUR AND SOLUBILITY OF SALT IN WATER

Gas Test

Gas	Colour	Smell	Confimatory Test
O_2	colourless	Odourless	Light up a glowing wooden splinter
H_2	colourless	Odourless	Produces a 'pop'sound with lighted wooden
CO_2	colourless	Odourless	Turn lime water cloudy
NH_3	colourless	Pungent smell	Turn moist red litmus paper blue
Cl_2	Grenish Yellow	Pungent smell	Bleaches moist red litmus paper Turn moist blue LP to red and bleaches it.
HCl	colourless	Pungent smell	Form dense white fumes with ammonia gas
NO_2	Brown	Pungent smell	Turn moist blue litmus paper to red
SO_2	colourless	Pungent smell	Turn moist blue litmus paper to red


Methods Used
For Identifying
Gases

Action Of Heat On Salts

When Salt are Heated

- A colour change
- Release a certain gas
- Release of water vapour

Heating CO_3 salt

- **All carbonates** are decomposed by heat to release CO_2 **except K_2CO_3 and $NaCO_3$.**
- **$MCO_3 \rightarrow MO + CO_2$**
- CO_2 will turn lime water,$Ca(OH)_2$ milky ($CaCO_3 + H_2O$)

Heating NO_3 salt

- Most **metal nitrate** decompose to produce a **metal oxide, nitrogen oxide and oxygen.**
- **KNO_3 & $NaNO_3$** produced **Oxygen gas** and **nitrites** when heated
- **NO_2** (brown gas: acidic) , turn moist blue litmus paper red.
- **O_2** relight glowing wooden splinter.

Heating SO_4 salt

- **All suphate salt are not decomposed** by heat.
- Some (Fe, Zn, Cu) will decomposed during **strong heating** producing **sulphur trioxide gas.**
- Ex: $ZnSO_4 \rightarrow ZnO + SO_3$

Heating Chloride salt

- **All chloride salts** are **not decomposed** by heat **except ammonium chloride.**
- **NH4Cl produced white fumes.**
- Ex: $NH_4 \rightarrow NH_3 + HCl$

Deduction Of Types Of Ion Present From Gas Produced

Gas produced	Types of ion
CO_2	CO_3^{2-} (except Na_2CO_3, K_2CO_3)
O_2	NO_3^-
NO_2 and O_2	NO_3^- (excepts $NaNO_3$, KNO_3)
SO_2	SO_4^{2-}
NH_3	NH_4^+

Test for Anion

Anion	Confirmatory Test
CO_3^{2-}	• Bubbles with dilute acid and the gas produced will cause limewater milky
SO_4^{2-}	• Mixed with dilute sulphuric acid and barium chloride and a white precipitate is formed.
Cl^-	• Mixed with dilute nitric acid followed by silver nitrate solution and a white precipitate is formed
NO_3^-	• Brown ring test and a brown ring will be formed.

Test for Cation

Cation	NaOH Solution	NH_3 Solution
Ca^{2+}	• White precipitate formed. • Not soluble in excess	• No reaction
Mg^{2+}	• White precipitate formed. • Not soluble in excess	• White precipitate formed. • Not soluble in excess
Al^{3+}	• White precipitate formed. • Soluble in excess	• White precipitate formed. • Not soluble in excess
Zn^{2+}	• White precipitate formed. • Soluble in excess	• White precipitate formed. • Soluble in excess

Cation	NaOH Solution	NH_3 Solution
Pb^{2+}	• White precipitate formed. • Soluble in excess	• White precipitate formed. • Not soluble in excess
Fe^{2+}	• Green precipitate formed. • Not soluble in excess	• Green precipitate formed. • Not soluble in excess
Fe^{3+}	• Brown precipitate formed. • Not Soluble in excess	• Brown precipitate formed. • Not soluble in excess
Cu^{2+}	• Blue precipitate formed. • Not soluble in excess	• Blue precipitate formed. • Not Soluble in excess and a dark blue solution is produced
NH_4^+	• White precipitate formed. • Soluble in excess	• No reaction

Confirmatory Tests for Fe^{2+} , Fe^{3+} ,Pb^{2+}, NH_4^+

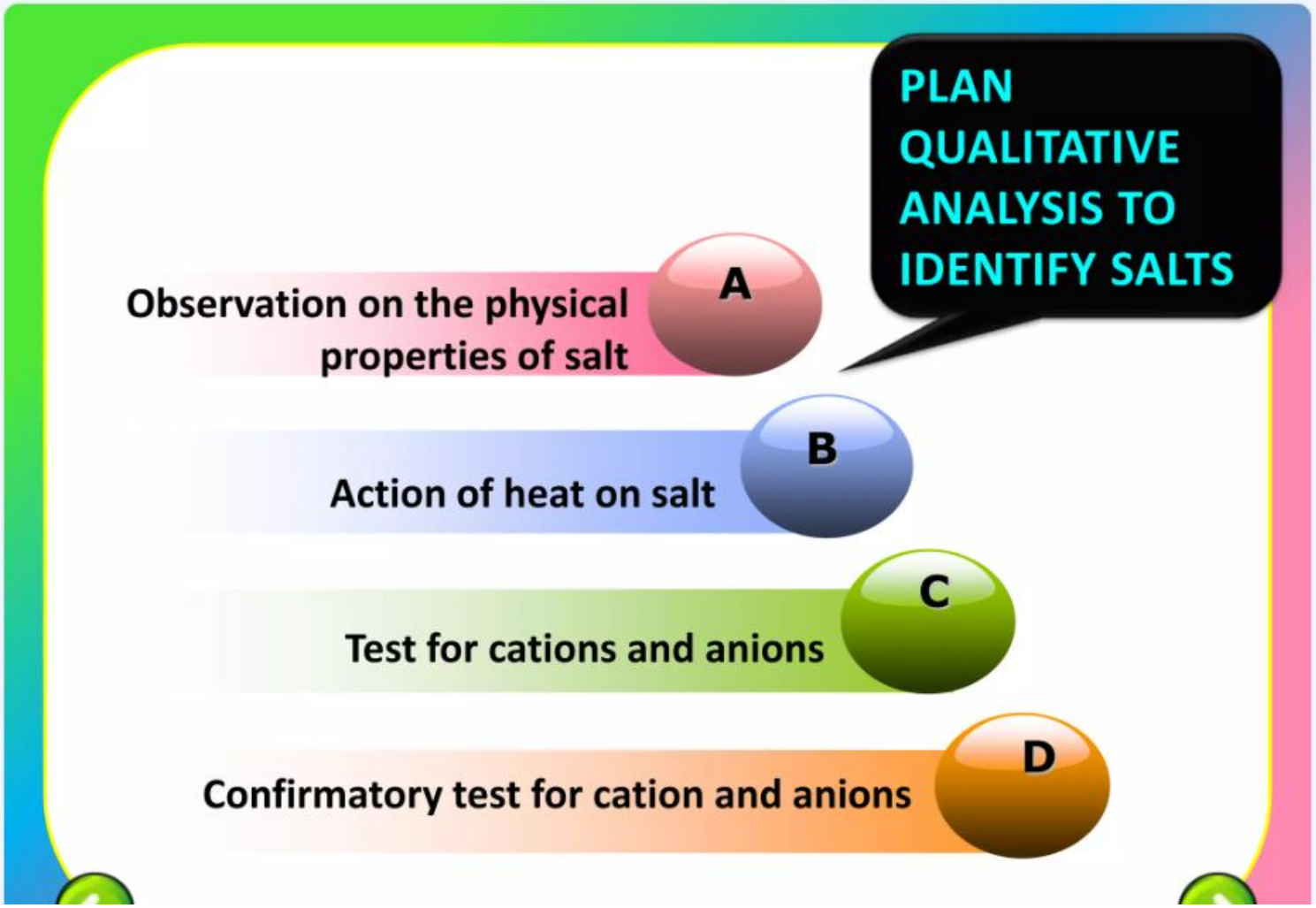
Cation	Specific reagent	Observation
Pb^{2+}	• KI, NaI	• Yellow precipitate, soluble in hot water and recrystallises when cooled
	• KCl, NaCl,HCl	• White precipitate, soluble in hot waterand recrystallises when cooled
	• K_2SO_4, Na_2SO_4, H_2SO_4	• White precipitate, insoluble in hot water

Confirmatory Tests for Fe^{2+} , Fe^{3+} ,Pb^{2+}, NH_4^+

Cation	Specific reagent	Observation
Fe^{2+}	• Potassium hexacyanoferreta (II) K4Fe(CN)6	• Light blue precipitate
	• Potassium hexacyanoferreta (III) $K_3Fe(CN)_6$	• Dark blue precipitate
	• Acidified $KMnO_4$	• Purple colour decolourises

Confirmatory Tests for Fe^{2+} , Fe^{3+} ,Pb^{2+}, NH_4^+

Cation	Specific reagent	Observation
Fe^{3+}	• Potassium thiocyanate, KSCN	• Brown precipitate formed. • Not soluble in excess
	• Potassium hexacyanoferrate (II) , K4Fe(CN)6	• Dark blue precipitate
	• Potassium hexacyanoferrate (II) , K4Fe(CN)6	• Greenish-brown solution
NH_4^+	• Nessler reagent	• Brown precipitate


PLAN QUALITATIVE ANALYSIS TO IDENTIFY SALTS
A
Observation on the physical properties of salt
B
Action of heat on salt
C
Test for cations and anions
D
Confirmatory test for cation and anions