CHAPTER FOUR

QUALITATIVE ANALYSIS

4.0 Qualitative analysis is a chemical analysis used to determine the presence or constituents (cations and anions) of an unknown substance or compound. In general expression, Qualitative analysis refers to analysis in which substances are identified or classified on the basis of their chemical or physical properties, such as chemical reactivity, solubility, molecular weight and melting point.

4.1 **CATIONS:** These are positively charged ions. They are Ca^{2+}, Cu^{2+}, Pb^{2+}, Zn^{2+}, Al^{3+}, Fe^{3+}, Fe^{2+} and NH_4^+

4.1.1 PRELIMINARY TEST FOR CATIONS (FLAME TEST)

This is a test used to identify few metals by the characteristics colours they impact on the flame. Examples are

S/No	Observation	Inference
1	Brilliant or golden yellow	Sodium metal/ion
2	Brick-red	Calcium metal/ion
3	Light yellowish green	Barium metal/ion
4	Lilac (light purple)	Potassium metal/ion
5	Light or pale blue	Lead (II) ions/metal

4.1.2 TEST FOR CATIONS

Sodium hydroxide and aqueous ammonia are the most common reagents used for identifying most cations. ***Below is a summary of the actions of sodium hydroxide solution and aqueous ammonia on the cations.***

Cations	**Sodium hydroxide solution**		**Aqueous Ammonia**	
	Drops	*Excess*	*Drops*	*Excess*
Ca^{2+}	White precipitate	Insoluble	No precipitate	No ppt.
Zn^{2+}	White gel. ppt.	Soluble	White gel. ppt.	Soluble
Pb^{2+}	White gel. ppt.	Soluble	White gel. ppt.	Insoluble
Al^{3+}	White gel. ppt.	Soluble	White gel. ppt.	Insoluble
Cu^{2+}	A blue gel. ppt.	Insoluble	Blue gel. ppt.	Soluble
Fe^{2+}	Dirty green gel. Ppt.	Insoluble	Dirty green gel. ppt.	Insoluble
Fe^{3+}	Rusty-brown gel. ppt.	Insoluble	Rusty-brown gel. ppt.	Insoluble

ppt =Precipitate, gel =gelatinous

Confirmatory Test for NH_4^+, Pb^{2+} and Al^{3+}

i. Ammonium ion NH_4^+

Test:- To the sample in a test tube + few drops of dilute sodium hydroxide and warm.

Observation:- There will be evolution of a colourless gas with pungent smell like that of urine, turns red litmus paper blue and produces white dense fumes with concentrated HCl.

Inference: The gas is ammonia, NH_3 from NH_4^+

ii. **Zn^{2+}, Pb^{2+} and Al^{3+}** ions react in similar way with dilute sodium hydroxide solution but with ammonia solution, only Zn^{2+} gives soluble solution. Hence **Pb^{2+} and Al^{3+}** can be distinguished as:

Test: To the solution + potassium iodide solution

Observation: A yellow precipitate soluble in hot water and insoluble in cold water confirms Pb^{2+} ions **Or**

Test: To the solution, add a few drops of dilute HCl

Observation: A white precipitate soluble in hot water and insoluble in cold water confirms Pb^{2+} ions.

NOTE

If there is no visible reaction with the two tests (potassium iodide and dilute HCl solutions) above, it means that Al^{3+} is present.

4.2 ANIONS (Acid radicals). These are negatively charged ions. They include Cl^-, S^{2-}, NO_3^- $HCO3^-$, CO_3^{2-}, SO_3^{2-}, and SO_4^{2-}

4.2.1 PRELIMINARY TESTS FOR ANIONS

(a) Solubility in Water

<u>The following substances are soluble in water</u>

i All trioxonitrate (V) salts, NO_3^-

ii All hydrogen trioxocarbonate (IV) salts, HCO_3^-

iii All common salts of sodium, potassium and ammonium

iv All tetraoxosulphate (VI) salts, SO_4^{2-} except those of Ba^{2+}, Pb^{2+} and Ag^+. Calcium tetraoxosulphate (VI) is slightly soluble in water.

v All chlorides except those of Ag^+, Hg and Pb^{2+}.

The following substances are insoluble in water:

i All trioxocarbonate (IV) salts, CO_3^{2-} except those of Na^+, K^+, and NH_4^+ that are soluble.

ii All hydroxides, OH^- except those of K^+, Na^+ and NH_4^+ that are soluble.

iii All oxides, O^{2-} except those of K^+ and Na^+, CaO is partially soluble.

iv All trioxosulphates (IV) except those of K^+, Na^+ and NH_4^+ that are soluble.

v All sulphides salts except those of K^+, Na^+, NH_4^+, Mg^{2+}, Ca^{2+} and Ba^{2+} that are soluble.

(b) STABILITY OF SALTS ON HEATING

1 Ammonium salts

(i) Ammonium chloride sublimes on heating on heating to give ammonia and hydrogen chloride gas. $NH_4Cl_{(s)} \xrightarrow{Heat} NH_{3(g)} + HCl_{(g)}$

(ii) Ammonium trioxocarbonate (IV) decomposes on heating to give water, ammonia and carbon (IV) oxide. $(NH_4)_2CO_{3(s)} \xrightarrow{Heat} H_2O_{(l)} + 2NH_{3(g)} + CO_{2(g)}$

(iii) Ammonium tetraoxosulphate (VI) decomposes on heating to give ammonia and tetraoxosulphate (VI) acid. $(NH_4)_2SO_{4(s)} \xrightarrow{Heat} 2NH_{3(g)} + H_2SO_{4(aq)}$

(iv) Ammonium dioxonitrate (III) decomposes on heating to give nitrogen and water $NH_4NO_{2(s)} \xrightarrow{Heat} N_{2(g)} + 2H_2O_{(g)}$

(v) Ammonium trioxonitrate (V) decomposes on heating to give nitrogen (I) oxide and water $NH_4NO_{3(s)} \xrightarrow{Heat} N_2O_{(g)} + 2H_2O_{(g)}$

2 Trioxonitrate (V) salts

Metals	Decomposition on heating
K **Na**	Their trioxonitrate (V) decompose on heating to give the corresponding metal dioxonitrate (III) and oxygen. $2NaNO_{3(s)} \rightarrow 2NaNO_{2(s)} + O_{2(g)}$
Ca **Mg** **Zn** **Pb** **Cu**	Their trioxonitrate (V) decompose on heating to give the corresponding metallic oxide, brown nitrogen (IV) oxide and oxygen. $2Zn(NO_3)_{2(s)} \rightarrow 2ZnO_{(s)} + 4NO_{2(g)} + O_{2(g)}$
Hg **Ag** **Au**	Their trioxonitrate (V) decompose on heating to give the corresponding metals, brown nitrogen (IV) oxide and oxygen. $2AgNO_{3(s)} \rightarrow 2Ag_{(s)} + 2NO_{2(g)} + O_{2(g)}$

3 Tetraoxosulphate (VI) salts

Metals	Decomposition on heating
K Na	Their tetraoxosulphate (VI) do not decompose on heating because they are stable to heat.
Ca Mg Zn Pb Cu	They decompose on heating to give corresponding metal oxide and sulphur (VI) oxide. $ZnSO_{4(s)} \rightarrow ZnO_{(s)} + SO_{3(g)}$
Hg Ag Au	They decompose on heating to give corresponding free metal, sulphur (VI) oxide and oxygen. $2Ag_2SO_{4(s)} \rightarrow 4Ag + 2SO_{3(g)} + O_{2(g)}$

4 Trioxocarbonate (IV) salts

Metals	Decomposition on heating
K Na	Their trioxocarbonate (IV) do not decompose on heating because they are stable to heat.
Ca Mg Zn Pb Cu	They decompose on heating to give corresponding metal oxide and cabon (IV) oxide. $ZnCO_{3(s)} \rightarrow ZnO_{(s)} + CO_{2(g)}$
Hg Ag Au	They decompose on heating to give corresponding free metal, carbon (IV) oxide and oxygen. $2Ag_2CO_{3(s)} \rightarrow 4Ag + 2CO_{2(g)} + O_{2(g)}$

NOTE:

All metallic hydrogen trioxocarbonate (IV) decompose on heating to produce their corresponding trioxocarbonate (IV), water and carbon (IV) oxide.

Example

$2NaHCO_{3(s)} \rightarrow Na_2CO_{3(s)} + H_2O_{(g)} + CO_{2(g)}$

(c) Action of heat/ addition of dilute HCl or H_2SO_4 solution.

When the solid substance is heated or dilute mineral acid is added, usually there is evolution of a gas. ***It should be noted that any gas given off, provides useful information about the anion present in the compound.*** Below is a table showing properties of some gases and the possible anions that can produce them.

S/NO	Observation	Inference
i.	If a colourless and odourless gas that turns blue litmus paper red and lime-water milky is evolved.	The gas is acidic. CO_2 gas from CO_3^{2-} or HCO_3^-
ii.	If the gas is colourless with irritating smell, acidic to litmus paper, decolourizes $KMnO_4$ or turns yellow $K_2Cr_2O_7$ solution to green on strip of filter paper	Gas is SO_2 from SO_3^{2-} or $S_2O_3^{2-}$
iii.	If a reddish brown acidic gas with irritating smell and turns starch-iodide paper blue-black is evolved.	Gas is NO_2 from NO_2^- or NO_3^- (except those of alkali metals).
iv	Colourless, sweetish gas, no action on litmus paper and rekindle glowing splint.	Gas is N_2O (laughing gas). It is obtained by decomposition of NH_4NO_3.
iv.	If a colourless gas with pungent smell like that of urine, turns red litmus paper blue and give white dense fumes on conc. HCl.	The gas is NH_3 from ammonium ion, NH_4^+
v.	If water vapour condenses on the upper and cooler part of the test-tube	Salt is hydrated or contains HCO_3^-
vi.	If a colourless, odourless gas, neutral to litmus paper and rekindles a glowing splint is observed.	Gas is Oxygen, O_2 from NO_3^- of alkali metals
vii.	If the gas evolved is acidic to litmus paper, smells like rotten egg and turns lead (II) ethanoate or $Pb(NO_3)_2$ solution black on strip of filter paper.	The gas is H_2S from S^{2-}
viii.	If the gas evolved is colourless acidic to litmus paper, and produces white dense fumes with NH_3 solution	The gas is HCl from Cl

4.2.2 TEST FOR ANIONS + CONFIRMATORY TESTS

S/ No	TEST	OBSERVATION	INFERENCE
1	**TEST FOR CHLORIDE ION (Cl^-)** (a) Measure about $1cm^3$ of the Solution of unknown sample into a test tube, add $1cm^3$ of dilute $HNO_{3(aq)}$ followed by aqueous $AgNO_3$ in drops until excess.	A white precipitate is formed.	Chloride ion (Cl^-) present.
	(b) Add excess $NH_4OH_{(aq)}$ to the solution in (a) above and expose the solution to sunlight.	White precipitate dissolves turns grey on exposure to sunlight	Chloride ion (Cl^-) confirmed.
2	**TEST FOR TRIOXOCARBONATE IV (CO_3^{2-}) AND HYDROGEN TRIOXOCARBONATE IV (HCO_3^-) IONS.** (a) Measure about $1cm^3$ of the Solution of unknown sample into a test, add about $1cm^3$ of dilute HCl or dilute H_2SO_4 and warm the mixture.	If a colourless and odourless gas which is acidic to litmus paper and turns lime water milky is evolved.	The gas is CO_2 from CO_3^{2-} or HCO_3^-
	(b) Measure about $1cm^3$ of the Solution of unknown sample into a test, add about $1cm^3$ each of dilute HCl and $BaCl_{2(aq)}$ or $MgSO_{4(aq)}$	If a white precipitate soluble in dilute HCl is formed. If there is no visible reaction but on warming gives white precipitate.	CO_3^{2-} present HCO_3^- present
	(c) Measure about $1cm^3$ of the Solution of unknown sample into a test and add about $1cm^3$ phenolphthalein solution.	If the solution turns pink or purple. If there is no colour change but on warming gives pink solution.	CO_3^{2-} confirmed HCO_3^- confirmed
3	**Test for SO_4^{2-} and SO_3^{2-} ions** (a) Measure about $1cm^3$ of the	If white precipitate insoluble in	SO_4^{2-} is present

	Solution of unknown sample in a test, add about 1cm^3 of $BaCl_{2(aq)}$ and few drops of dil. $HCl_{(aq)}$.	dil. $HCl_{(aq)}$ is formed. If white precipitate soluble in dilute $HCl_{(aq)}$ is formed.	SO_3^{2-} is presen
	(b) Measure about 1cm^3 of the Solution of unknown sample into a test and add few drops of acidified $KMnO_4$ or $K_2Cr_2O_{7(aq)}$	If purple colour $KMnO_4$ decolourizes or yellow colour $K_2Cr_2O_7$ changes to green	SO_3^{2-} confirmed
4	**TEST FOR NITRATE (NO_3^-)ION** (a) Put a small quantity of unknown solid sample into a test tube and add conc. H_2SO_4	If a reddish brown fume gas is evolved.	The gas is NO_2. NO_3^- present
	(b) Measure about 1cm^3 of the Solution of unknown sample into a test, add about 1cm^3 of freshly prepared solution of $FeSO_4$ and add 1cm^3 of conc. H_2SO_4 slowly down the side of the test tube held in a slanting position.	There will formation of a brown ring at the junction of the two layers. The brown ring is due to the formation of $FeSO_4.NO$	NO_3^- confirmed
5	**TEST FOR SULPHIDE (S^{2-}) ION** (a) Put a small quantity of solid unknown sample in a test tube and add conc. HCl.	If a colourless gas of rotten egg smell which is acidic to litmus paper decolourizes $KMnO_4$ or turns yellow $K_2Cr_2O_7$ solution to green on strip of filter paper is formed.	The gas is H_2S from S^{2-}
	(b) Put about 1cm^3 of the Solution of unknown sample in a test and add about 1cm^3 lead (II) ethanoate or $Pb(NO_3)_2$ solution	If a black precipitate is formed.	S^{2-} confirmed

NOTE: $Ba(NO_3)_{2(aq)}$ and $HNO_{3(aq)}$ can also be used in place of $BaCl_{2(aq)}$ and $HCl_{(aq)}$

4.3 ORGANIC ANALYSIS

Organic analysis implies chemical analysis used in the identification and quantification of an unknown organic compound. Just like inorganic analysis, Organic analysis is classified into two: Qualitative organic and quantitative organic analysis.

4.3.1 QUALITATIVE ORGANIC ANALYSIS

This is a technique used to identify the various functional groups and elements present in organic compounds.

4.3.1.1 *TEST FOR HYDROCARBONS AND* FUNCTIONAL GROUPS:-

Hydrocarbons are organic compounds containing only hydrogen and carbon as constituent elements. **Saturated hydrocarbons** are those hydrocarbons that the carbon atoms in the compound are joined by single bonds only. **Unsaturated hydrocarbons** are those hydrocarbons that possess at least a double or triple bonds in-between carbon atoms.

FUNCTIONAL GROUPS: This is a bond, atom or group of atoms that determines the properties and reactivity of a compound.

Below is a summary of action of some reagents on saturated and unsaturated hydrocarbons.

	SATURATED HYDROCARBON	**UNSATURATED HYDROCARBON**	
REAGENTS	**Alkanes e.g. CH_3-CH_3**	**Alkenes e.g. CH_2=CH_2**	**Alkynes e.g. CH≡CH**
Bromine water (Reddish brown)	No visible reaction	Turns to colourless	Turns to colourless
Acidified $KMnO_4$ Solution (purple)	No visible reaction	Turns to colourless	Turns to colourless
Acidified $K_2Cr_2O_{7(aq)}$ (orange or yellow)	No visible reaction	Turns to green	Turns to green
Ammoniacal copper (I) chloride	No visible reaction	No visible reaction	Gives red precipitate
Ammoniacal silver trioxonitrate (V) Solution	No visible reaction	No visible reaction	Gives white precipitate

NOTE:
Alkynes without terminal hydrogen cannot give positive test with ammoniacal copper (I) chloride and ammoniacal silver nitrate solution. Terminal hydrogen is hydrogen attached to the carbon atom(s) bearing the triple bonds. Examples are 2-butyne i.e. $CH_3C{\equiv}CCH_3$, 3-hexyne i.e. $CH_3CH_2C{\equiv}CCH_2CH_3$ etc.

(a) ***Test for alkanols:***

i. Unknown sample + ethanoic acid + few drops of conc. H_2SO_4 in a test-tube boil with care for a while.

Observation: An ester is formed with the characteristic of pleasant fruit smell.

Inference: Alkanol is present

ii. *Sodium Test*: Unknown anhydrous liquid in a test-tube + small amount of sodium with care.

Observation: There is vigorous effervescence, with evolution of colourless, odourless gas which has no effect on litmus paper and gives pop sound on glowing splint.

Inference The gas is hydrogen gas. Alkanol present.

iii. Iodoform Test: This test is suitable for primary and secondary alkanol. It is also used for alkanals and alkanones.

Test: To the solution of the substance in water or methanol, add NaOH solution and slowly add about $2cm^3$ of iodine solution in potassium iodide solution.

Observation: A yellow precipitate of or triiodomethane CHI_3 (iodoform) separates as a solid or as an oil with its characteristic smell.

Inference: Primary akanols, secondary alkanols, alkanals or alkanones present.

iv. Use of oxidizing agents. Such as $KMnO_4$ or $K_2Cr_2O_7$ solution.

Primary and secondary alkanols decolourize the purple colour of $KMnO_4$ solution and change the orange colour of $K_2Cr_2O_7$ solution to green.

Examples:

Primary alkanols $\longrightarrow$ Alkanals $\longrightarrow$ Alkanoic acid

CH_3CH_2-OH $\longrightarrow$ CH_3CHO $\longrightarrow$ CH_3COOH

Secondary alkanols $\longrightarrow$ Alkanones

$R_2CHOH \longrightarrow R_2CO$

Tertiary alkanols hardly oxidized.

b. **Test for Alkanoic acid**

i. **Test:** Unknown substance in a test tube + saturated solution of $NaHCO_3$ or any salt of carbonates

Observation: There is effervescence with evolution of colourless, odourless gas, acidic to litmus paper and turns lime-water milky.

Inference: The gas is CO_2, hence the substance is carboxylic acid

ii. Reaction with ethanol: (check alkanol)

c. Test for Alkanals and Alkanones

i. Iodoform Test: (check alkanols)

REACTIONS TO DISTINGUISH ALKANALS FROM ALKANONES

i. **Fehling's Test**: Alkanals reduce Fehling's solution to a red precipitate of copper (i) oxide.

ii. **Tollen's reagent (silver mirror test):** Alkanals give black colouration with tollen's reagent and formation of silver mirror on the inner walls of the test tube.

iii. **Reaction with acidified $KMnO_4$ or $K_2Cr_2O_7$ solution**. Alkanals decolourize the purple colour $KMnO_4$ solution and turn Orange colour $K_2Cr_2O_7$ solution to green

NOTE: Alkanones in contrast have no effect on the reagents mentioned above.

4.3.1.2 FOOD TEST

TEST	OBSERVATION	INFERENCE
(I) *Test for Reducing Sugar* **E.g Test for glucose.** **a) *Benedict's Test*** Add $2cm^3$ of a solution of reducing sugar e.g. glucose in a test tube. Add same volume of Benedict's solution, shake and boil.	The initial blue colour of the mixture turns yellow and finally form a brick-red precipitate.	This shows the presence of a reducing sugar.
b) *Fehling's Test* Add $2cm^3$ of a solution of the reducing sugar to a test tube. Add $1cm^3$ of Fehling's solution A and $1cm^3$ of Fehling's solution B. Shake and boil.	The initial blue colour turns to yellow and finally to brick-red	Reducing sugar is present

c) Tollen's Test (silver mirror test): Add about $2cm^3$ of the reducing sugar solution into a test tube and add about same quantity of tollen's reagent.	There will be formation of black colouration of silver mirror-like on the inner walls of the test tube.	Reducing sugar is present
TEST FOR SUCROSE Add $2cm^3$ of sucrose solution into a test tube. Add $1cm^3$ of dilute hydrochloric acid. Boil for one minute. Add $2cm^3$ of Benedict's solution.	The blue colour turns to yellow and finally forms brick-red precipitate.	Reducing sugar is present.
Test for non-reducing sugar e.g. starch ***Iodine test*** Add $2cm^3$ of 1% starch solution to a test tube. Add few drops of iodine solution.	A blue-black colouration is observed.	Starch is present
Test for both reducing and non-reducing sugar (Carbohydrates). Put little amount of the solid substance in a test-tube, add few drops conc. H_2SO_4 and warm gently for a while.	The solid substance darkens (charred) leaving behind black residue (carbon).	Carbohydrate is present
TEST FOR PROTEINS/AMINO ACIDS **a) *Millon's Test*** Add $2cm^3$ of egg albumen (egg white to a test tube. Add $1cm^3$ of Millon's reagent, shake and boil.	A white precipitate forms which turns brick-red on heating.	Protein is present.
b) ***Biuret Test*** Add $2cm^3$ of egg albumen into a test tube. Add sodium hydroxide of same volume to it. Add few drops of copper (II) sulphate solution.	There will be formation of violet colouration.	Protein is present
c) **Xanthoproteic Test** *Trioxonitrate (V)acid Test* Place equal quantities of milk or egg white in a test tube and add conc. trioxonitrate (V) acid.	There will be formation of dense yellow precipitate.	Protein is present

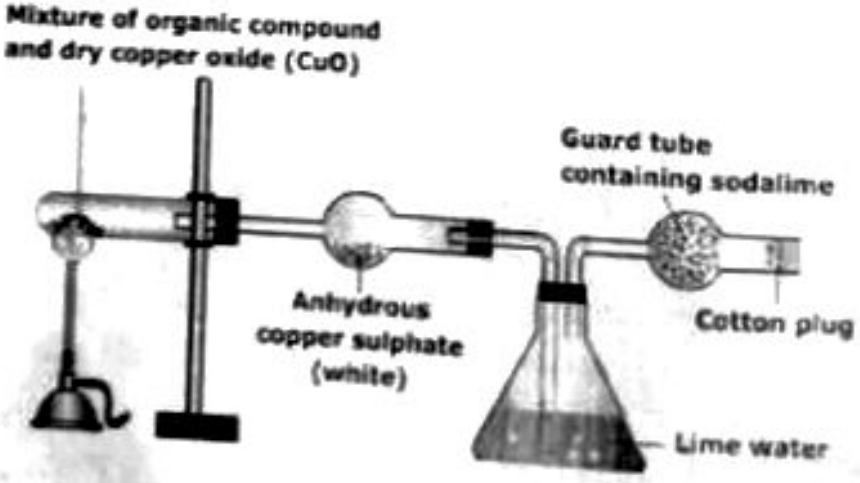
TEST FOR LIPIDS (FATS AND OIL) a) ***Sudan III Test*** Add $2cm^3$ of oil to $2cm^3$ of water in a test tube. Add a few drops of Sudan III and shake	A red-stained layer separate on the surface of the water, which remains uncoloured	Lipid (oil) is present.
b) ***Emulsion Test*** Add $2cm^3$ of fat or oil to a test tube containing $2cm^3$ of absolute ethanol. Dissolve the lipid by shaking vigorously	A cloudy white suspension is formed	Lipid is present.
c) ***Grease spot Test*** Rub a drop of lipid sample on a surface of piece of paper.	A permanent translucent spot on the paper	Lipid is present.

4.3.1.3 ANALYSIS OF THE ELEMENTS IN ORGANIC COMPOUNDS

(a) Qualitative analysis of Carbon and Hydrogen

Principle

Mix the organic compound with dry copper oxide (CuO) and heat the mixture in a hard glass tube. Pass the products of the reaction over (white) anhydrous copper (II) sulphate and then bubbled through lime water. If copper (II) sulphate turns blue due to the formation of $CuSO_4.5H_2O$ (by water vapor) then the compound contains hydrogen. If lime water is turned milky by CO_2, then the compound contains carbon.



$C + 2CuO \longrightarrow CO_{2(g)} + 2Cu$. ***Carbon is oxidized.***

$2H + CuO \longrightarrow H_2O + Cu$. ***Hydrogen is oxidized***

$CO_{2(g)} + Ca(OH)_2 \longrightarrow CaCO_3 + H_2O$
Milky

$5H_2O + CuSO_4 \longrightarrow CuSO_4.5H_2O$
White anhydrous → blue hydrated

(b) Qualitative analysis of Nitrogen, Sulphur, Halogens and Phosphorus

This is done by carrying out sodium fusion test (Lassaigne's test).

Preparation of Lassaigne's extract.

Place a small piece of sodium metal in an ignition tube and heat till the sodium melts. Add about 50 to 60 mg of the organic compound to the melted sodium and heat strongly for 2-3 minutes to fuse the material inside it. Cool and carefully break the tube in a china dish containing about 20 to 30 ml of distilled water, crush the mixture with a glass rod and boil for a few minutes. The sodium salts formed in the above reactions (i.e. NaCN, Na_2S, NaX or NaSCN) dissolve. Excess of sodium reacts with water to give sodium hydroxide. This alkaline solution is called Lassaigne's extract or sodium extract. Filter the solution to remove the insoluble materials and use the filtrate to test for nitrogen, sulphur and halogens. The table below shows the test, expected observation and inference.

OBSERVATION TABLE:

S/NO	TEST	OBSERVATION	INFERENCE
I	**Test for cyanid ion from nitrogen in the organic compound** To the Lassaigne's or sodium extract (1-2 ml), add ferrous sulphate or Iron (II) sulphide solution.	Prussian blue colour	Nitrogen present
II	**Test for sulphide ion from sulphur in the organic compound.** To the Lassaigne's or sodium extract (1-2 ml), add lead acetate reagent or	Black precipitate	Sulphur present

	lead (II) sulphide solution		
III	**Test for halides ion from sulphur in the organic compound.** To the Lassaigne's or sodium extract (1-2 ml), add silver nitrate solution followed by aqueous ammonia.	White precipitate soluble in aqueous ammonia Pale yellow precipitate soluble in aqueous ammonia Bright yellow precipitate insoluble in aqueous ammonia	Chlorine present SBromine present Iodine present
IV	**Test for phosphate ion from phosphorus in the organic compound.** To the Lassaigne's or sodium extract (1-2 ml), add ammonium molybdate	Yellow precipitate	Phosphorus present

EQUATION FOR THE REACTIONS

$$\left(\begin{matrix}\text{Organic compound}\\ \text{Containing N,S,X,P}\end{matrix}\right) \xrightarrow[\text{Heat}]{\text{Na}} NaCN + Na_2S + Na_3PO_4 + NaX$$

(where X may be Cl, Br or I)

I **DETECTION OF NITROGEN**

$NaCN \rightarrow Na^+ + CN^-$

$CN^- + FeSO_4 \rightarrow Fe_4[Fe(CN)_6]_3$

Prussian blue

II **DETECTION OF SULPHUR**

$Na_2S + Pb(CH_3COOH)_2 \rightarrow PbS + 2CH_3COONa$

Black ppt

III **DETECTION OF HALOGENS**

$NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

White ppt