

Ch: 15

By Nimrah Irshad

Organic Compound

Old definition: Compound which is animal or plant origin is **organic chemistry**

eg: bamboo, hardwoods, trees, glucose, methane, proteins

The compounds which is of mineral origin eg: Salt, Marble, CO_2 , H_2O etc. are included in **inorganic chemistry**

MODERN DEFINITIONS

ORGANIC: The branch of chemistry that deals with the study of Hydrocarbons & its derivatives.

eg C_6H_6 $\text{C}_6\text{H}_{12}\text{O}_6$ CH_3-OH

benzene

Glucose

Methanol

INORGANIC: The branch of chemistry that deals with elements and Compounds except organic compounds

eg CO_2 , Salt, H_2O , HCO_3^- , CO_3^{2-}

Carbon dioxide

NaCl

Water

bi-carbonates

Carbonate

→ Sources of Organic Compounds

The main sources of organic compounds is fossil fuels.

The dead remains of living organisms are called fossil remains.

Coal, petroleum & Natural gas are called fossil fuels becz they are formed from fossil fuels.

① Coal:

↳ Major Source of O.C

↳ Yields Coke & Coal-Tar on pyrolysis / destructive distillation.

↳ More than 200 O.C → directly isolated from coal-Tar which are used as starting materials for O.C.

② PETROLEUM:

↳ Complex mixture of Hydro-Carbons

↳ Black sticky liquid seeps out of the ground is called petroleum or crude oil. $< 25^{\circ}\text{C}$

Fractions of Petroleum: • LPG (Liquid Petroleum Gas)

- Gasoline or Petrol $25^{\circ} - 60^{\circ}\text{C}$
- Naphtha $60^{\circ} - 180^{\circ}\text{C}$
- kerosene / Paraffin $180^{\circ} - 220^{\circ}\text{C}$
- Diesel $220^{\circ} - 250^{\circ}\text{C}$
- Lubricating oils $300^{\circ} - 370^{\circ}\text{C}$
- Fuel oil $370^{\circ} - 600^{\circ}\text{C}$
- Bitumen $> 350^{\circ}\text{C}$

Products prepared from petroleum:

Methan CH_4

Ethylene $\text{CH}_2=\text{CH}_2$

Benzene C_6H_6



Toulene $\text{C}_6\text{H}_5\text{CH}_3$

Acytylene $\text{CH}\equiv\text{CH}$

Propene $\text{CH}_3\text{CH}=\text{CH}_2$

Xylene $\text{C}_6\text{H}_4(\text{CH}_3)_2$

③ NATURAL GAS:

- It is mixture of low boiling Hydrocarbons.
- Major portion $\rightarrow$ methane CH_4 85%
- Other gases $\rightarrow$ ethane, propane & butane.
- Formed by decomposition of organic matter.
- Reserves of gas $\rightarrow$ Sui in Balochistan, Sindh & Punjab

④ PLANTS:

Many O.C are obtained from Plants & Animals sources by suitable methods of isolation.

eg. Carbohydrates (cellulose, sugar, starches)

Proteins (Silk, wool, casein, protein foods)

Alkaloids (quinine, morphine, strychnine)

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Partial Synthesis | Total Synthesis

Definition

Obtaining a desired compound from an intermediate product of a reaction.

Starting material is converted through many steps into target product.

Starting Materials

Natural compounds or Intermediates derived from them.

Small, inexpensive molecules as starting materials.

Time

Generally less-Time consuming

Requires Significant time

Process

Involves fewer steps & often uses existing functional groups.

Requires multiple steps & may involve creating new functional groups.

Examples

Carboxylic acid obtained from oxidizing aldehyde

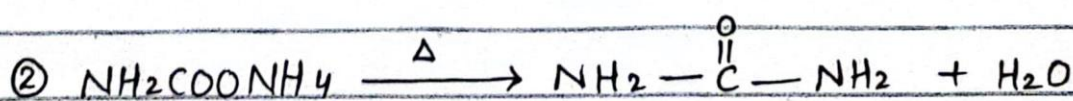
Aspirin synthesis from Salicylic acid.

Total Synthesis:

If you make biryani, you follow different steps to make it. This process is called total Synthesis.

eg. Formation of urea

Formation of Ammonium Carbamate from benzene

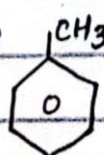
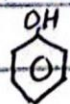


Ammonium Carbamate

Urea

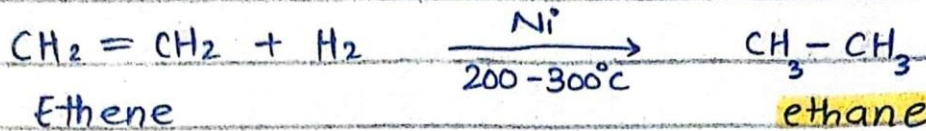
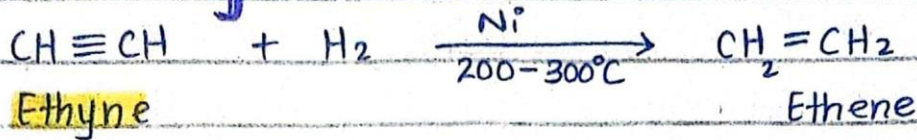


benzene



Ammonium Carbamate

Partial Synthesis:



Intermediate is a short-lived specie → Unstable

Fermentation:-

Production of chemicals by the action of micro-organisms.

eg: Sugar produces alcohol, vinegar & many other products.

→ also called Pyrolysis

Destructive Distillation of Coal:-

Coal is produced by decaying/decomposition of trees buried under earth crust under the influence of ↑ Temp & ↑ Pressure.

Breakdown / Distillation / Purification / Separation

Fractional distillation
Separation of liquids on the basis of their B.P.

Destructive distillation
Carried out in absence of air

Process:

When coal is heated in the absence of air (Temp 500 - 1000°C) is converted into:

1- Coke → Solid Carbon allotrope is called Coke.

→ Pure Carbon

→ Solid state

→ It produces two gases

Uses: form graphite, carbides CS₂

(Mixture of H₂ + CO)

H₂O Water gas

(Mixture of CO + N₂)

NH₃ producer gas

2- Coal Tar $\rightarrow$ Black -Thick liquid mixture of 215 O.C



Fractional distillation

$\rightarrow$ Benzen $\rightarrow$ Naphthalene $\rightarrow$ Xylene $\rightarrow$ Phenol
 $\rightarrow$ Toulene

Use: used to manufacture paints, photographic materials

3. Coal Gas $\rightarrow$ Mixture of H_2 , CO , CH_4

Use: $\rightarrow$ Used as fuel in industry
 $\rightarrow$ Also called Carbon gas

4. Ammonical liq,uor $\rightarrow$ Mixture of NH_3/NH_4OH
+ water + NH_4Cl

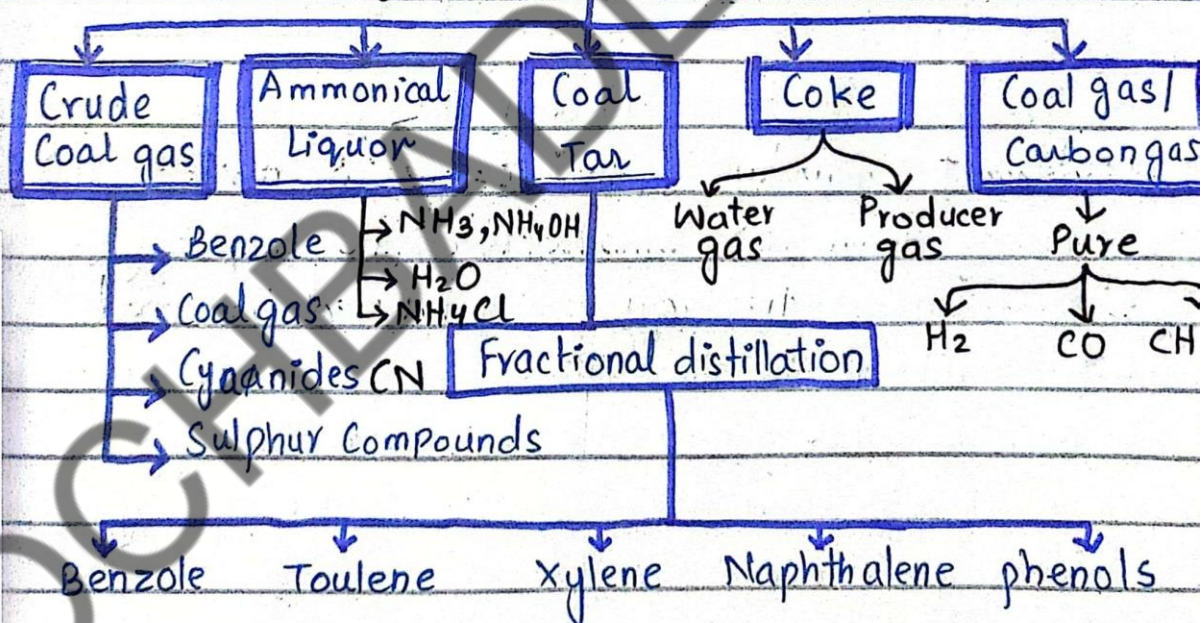
Use: Fertilizers, Medicines

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Coal Destructive distillation



SLO Based QUESTIONS

Q1. What is water gas?

$\rightarrow$ Water gas is a type of synthetic natural gas (SNG) that is produced from water.

$\rightarrow$ It is created through a process called gasification

where water is converted into a mixture of CO_2 , H_2 & CH_4 through a reaction that takes place about 800°C .

→ Resulting water gas is a colourless, odourless, tasteless & non-toxic gas.

→ It can be used as fuel or as a chemical intermediate in various industrial processes.

Q2. What is coal gas? How it is obtained?

Coal gas, also known as town gas is a flammable gaseous fuel made from coal. It is obtained through a process called gasification, which involves heating coal in the absence of O_2 to produce a mixture of gases.

Process:

1- **Gasification:** Coal is heated in a controlled environment (usually with steam & limited O_2) to break down its complex $\text{H}\cdot\text{C}$ into simpler gases.

2- **Gas cleaning:** The raw gas produced from coal gasification contains impurities such as sulphur comp, ammonia & tar. These are removed through various purification processes to make the gas suitable for use.

3- **Composition:** The composition of coal gas typically includes H_2 , CO , methane CH_4 & small amounts of other gases like CO_2 & N_2 .

Q4. Name the products produced by pyrolysis of coal?

Coal gas, Coal tar, coke, Ammonia

Q3. Differentiate b/w fractional & Destructive distillation.

Fractional Distillation

Destructive Distillation

Purpose

Separates components of a liq. mixture based on B.P.

Breaks down organic materials into simpler subs.

Process

Heating a mixture to separate components by their B.P.

Heating organic materials in the absence of O_2 to decompose.

Conditions

Controlled heating under specific temperatures & Conditions

High Heat in the absence of O_2 .

Examples / Applications

Refining crude oil into different petroleum products

Producing coal gas from coal.

Products

Purified components with distinct B.P.

Gases (eg. H_2 , CO), tar and other by-products.

Mixture of gases, liq. & solids from decomposition.

Outcome

Separate components suitable for various uses.

Breakdown into simpler subs. for further processing.

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Allotropes:

Definition: different structural forms of same element in same physical state.

Reason: • Due to diff arrangement of atom physical forms of element exist.

• They have diff physical properties (M.P & Physical prop)

Physical Properties: M.P, BP, density, taste, smell, evaporation, colour, shape, Thermal Conductivity, electrical Conductivity, volume, refractive index.

Allotropes of Carbon:-

1- Diamond $\rightarrow 1C = 4C$

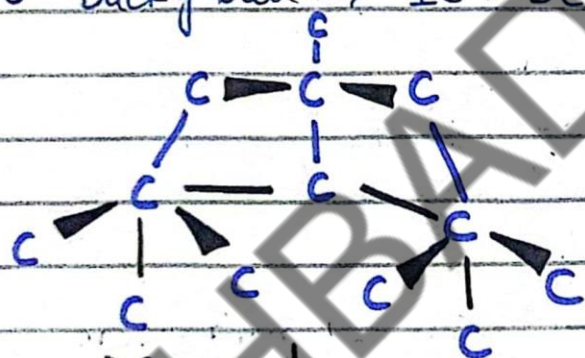
Tetrahedral structure

2- Graphite $\rightarrow 1C = 3C$

hexagonal sheets

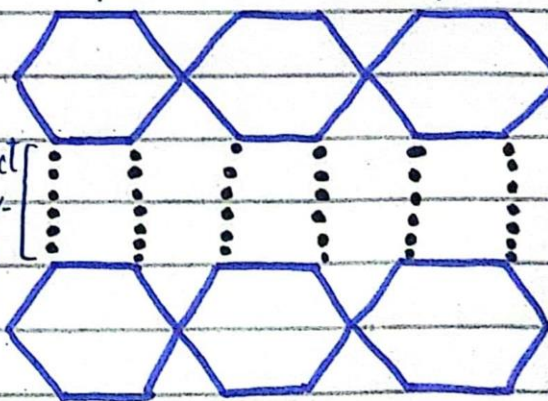
3- Bucky ball $\rightarrow 1C = 3C$

do not conduct electricity



• Diamond

Conduct electricity



• Graphite

Bucky ball as new allotrope:- of Carbon / fullerenes

Discovery: Discovered in 1985 by buckminster Fullerenes.

No. of Carbon atoms: Contains C-atom from $C_{40} - C_{100}$.

Simplest buckyball has carbon atom = C_{60}

Structure: Hollow cage like structure containing pentagon & Hexagons.

Bonding: Each Carbon atom is connected to 3 - carbon atoms.

Diagram:

Pentagons = 12

Hexagons = 20



Uses:

- Lubricant
- Semi-conductor
- Serve as drug delivery carriers
- Improve performance in solar cells & transistors.

Functional Group:

A functional group is an atom or group of atoms in a molecule that gives characteristic properties to the molecule.

eg CH_4

Methane

CH_3-OH

Methanol (IUPAC) systematic

Methyl Alcohol (common name) Nick

Importance of functional group:

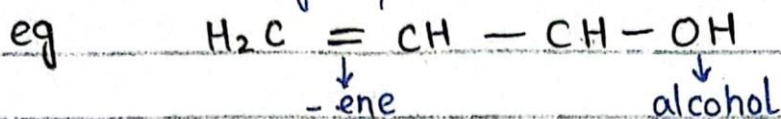
→ Basis of nomenclature (naming) of organic compounds.

→ Basis to classify O.C into classes.

→ A F.G is a site of chemical reactivity in a molecule. Compounds in the same class have similar chemical properties.

Polyfunctional Group :

A molecule that contain more than one functional group.

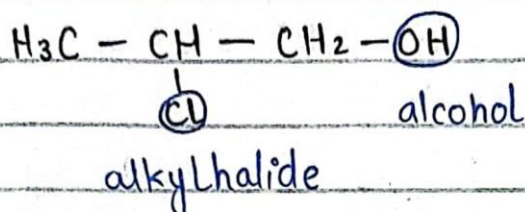


-ane C-C

-ene C=C

-yne C≡C

* M.P & B.P $\propto$ C-atom



Same members

Homologous Series:

A series of organic compound in which each successive members differ by $-\text{CH}_2$ unit or by molar mass of 14 amu eg: family of alkanes

→ Base of Organic Compounds

n - straight chain

C-C → saturated

iso - branch

C=C } → unsaturated

neo - C all branch

C≡C

General Formula:

Alkane $\text{C}_n\text{H}_{2n+2}$

Molecular formula: C_2H_6

Alkene C_nH_{2n}

Condensed : $\text{H}_3\text{C} - \text{CH}_3$

Alkyne $\text{C}_n\text{H}_{2n-2}$

Structural : $\text{H} - \underset{\text{H}}{\overset{\text{H}}{\text{C}}} - \underset{\text{H}}{\overset{\text{H}}{\text{C}}} - \text{H}$

Alkyl Radical $\text{C}_n\text{H}_{2n+1}$

Structural Formula: This shows the arrangement of different atoms in a molecule or compound.

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Detection of elements in Organic Compounds:

- * Carbon is an essential constituent of all organic compounds
- * Hydrogen is also present.
- * Some other elements such as N, S, O, P are also present.

Detection of Carbon & Hydrogen:

Small amount of O.C in test tube + Small amount of CuO $\xrightarrow{\text{Heat}}$ CO₂ + H₂O

① H₂O detection:

CuSO₄ (anhydrous white color solid)



bcz of H₂O, it turns into blue CuSO₄

Blue vitrol

CuSO₄ · 5 H₂O ⇒ Hydrogen is confirmed in O.C.

② CO₂ detection:

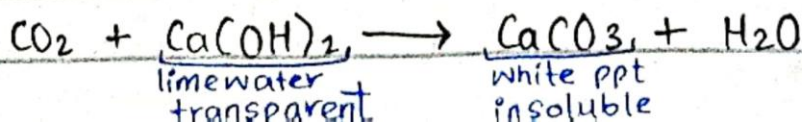
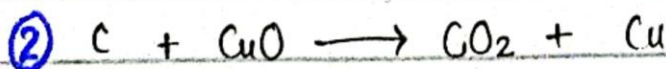
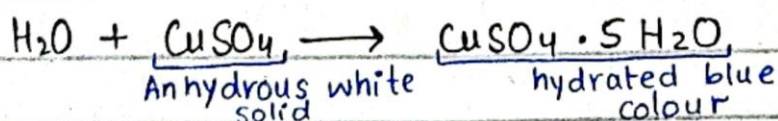
limewater Ca(OH)₂ (transparent soln)



CaCO₃ (insoluble in H₂O milky ppt)



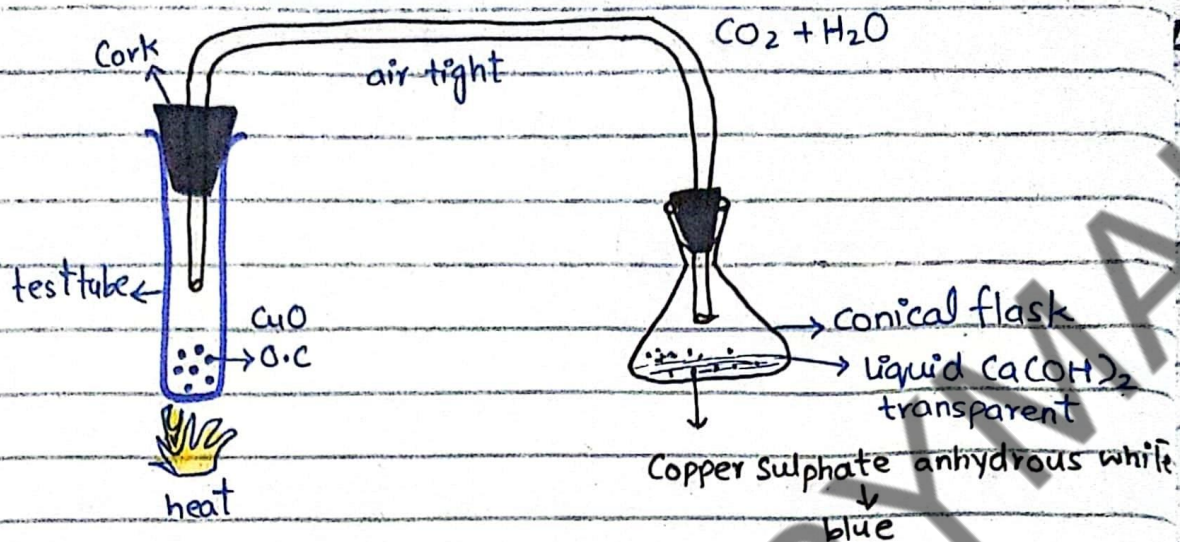
Carbon is confirmed in O.C.



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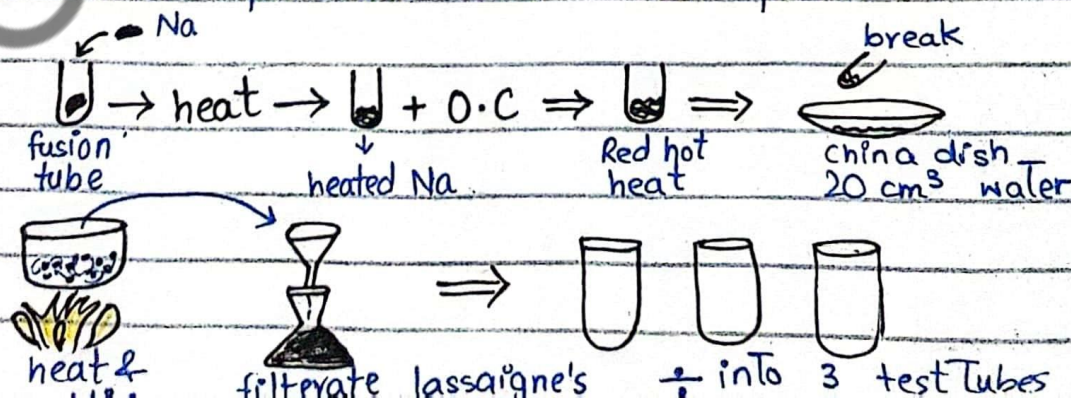
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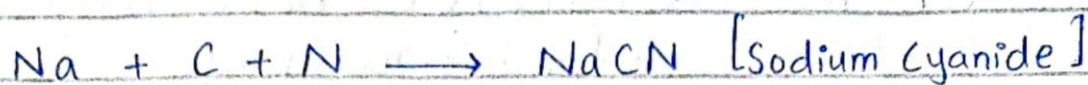
Detection of N, S & X

Preparation of Lassaigne's Solution: OR Sodium extract

- ① Cut small piece of Na metal with the help of knife.
- ② Put piece of Na metal in a fusion Tube.
- ③ Heat the fusion Tube To melt the Na metal.
- ④ Add small of O.C in a fusion Tube.
- ⑤ Reheat the fusion Tube until its bottom become red hot.
- ⑥ Break fusion Tube in a china dish 20 cm^3 of distilled water.
- ⑦ Mix, boil & filter the Sdn.
- ⑧ Filtrate obtained is called Lassaigne's Soln.
- ⑨ Divide filtrate into three portions.



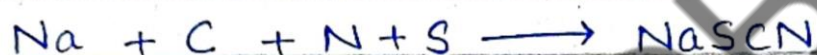
↳ Lassaigne soln containing Nitrogen:



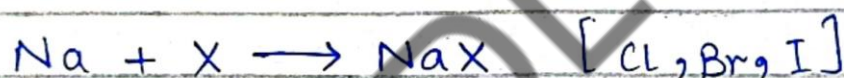
Lassaigne soln containing Sulphur:



Lassaigne soln containing S, N, C:



Lassaigne soln containing Halogen X:



Detection of Nitrogen:

Lassaigne soln + few drops of + Freshly Prepared
in a test tube NaOH FeSO_4



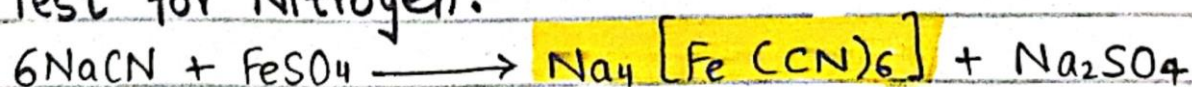
boil + Few drops of FeCl_3
+ Conc. HCl drops

(green-blue)

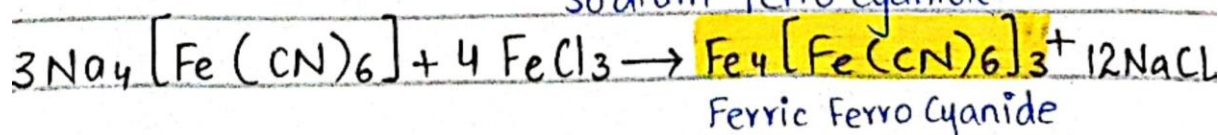
Prussian blue ppt
(Nitrogen)

Blood red colour
(N, S)

Test for Nitrogen:



Sodium Ferro Cyanide

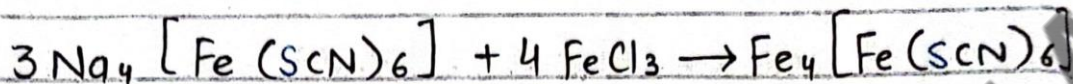
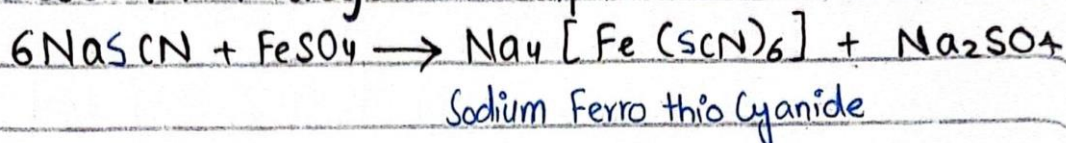


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Test for Nitrogen & Sulphur:



Ferric Ferro thio Cyanide
+ 12 NaCl
→ Blood red

Test : 1

Detection of Sulphur:

① Lassaigne soln + Acetic Acid + boil
(to expel H_2S gas) → rotten egg smell

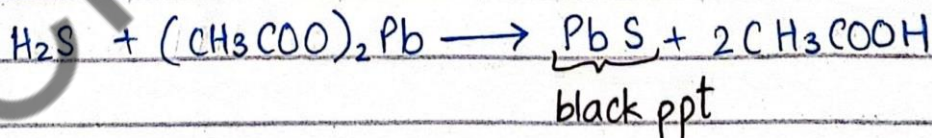
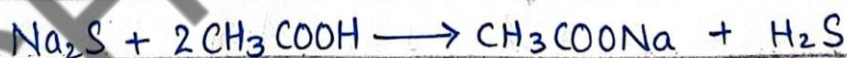
② Take lead acetate soln or lead acetate paper.

③ By dipping paper or adding soln we get results.

Result:

Black spots on paper & Pure black colour in H_2S soln.

Equation:



Q: Which reagent is used for the detection for the presence of Sulphur? Lead Sulphate

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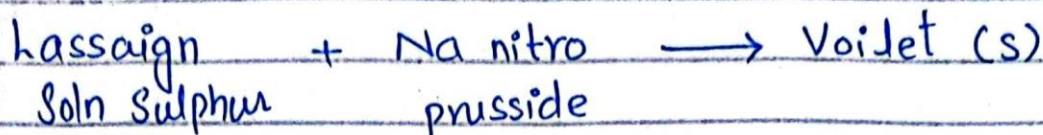
CamScanner



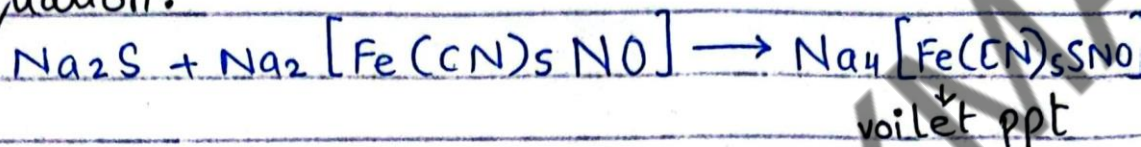
Test : 2

MD Cat SLO

Sodium Nitroprusside test for Sulphur



Equation:



Detection of Halogen:



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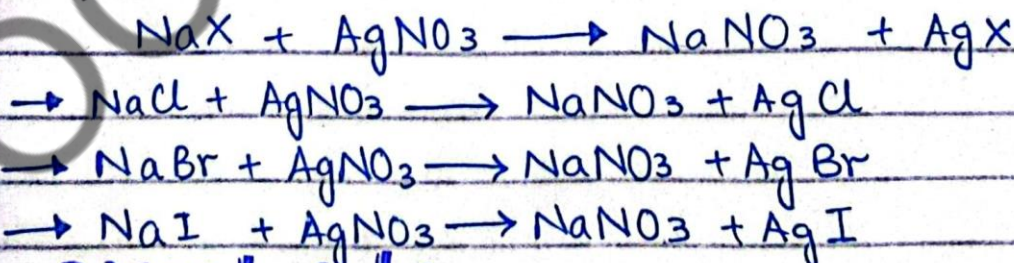
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Results :

Deep Yellow (I)	White ppt (Cl)	Pale yellow (Br)
$\rightarrow \text{AgI}$	$\rightarrow \text{AgCl}$	$\rightarrow \text{AgBr}$
$\rightarrow \text{NH}_4\text{OH}$ insoluble ppt	$\rightarrow \text{NH}_4\text{OH}$ Soluble ppt	$\rightarrow \text{NH}_4\text{OH}$ partial Soluble

Equation:



Alkaloid :-

Any class of Nitrogenous O.C of plant origin which have pronounced physiological action on human.
e.g Quinine, Morphine, nicotine