big DREAMS Tuition Centre

PLUS ONE CHEMISTRY

Prepared by

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PGT CHEMISTRY

ORGANIC CHEMISTRY

BIG DREAMS UNIQUE SPECIALITY

UNIT – 11

Fundamentals of Organic Chemistry

(Pg. No: 110 – 137)

SELECTED 2 MARK QUESTIONS

1. **Why carbon cannot form ionic bond?**
   - ❖ It is not possible to form either C^{4+} or C^{4-} ions to attain noble gas configuration, as it requires large amount of energy.

2. **Give the Geometry of sp^3, sp^2 and sp hybridised carbon.**

hybridisation	Geometry
sp^3	Tetrahedral
sp^2	Trigonal Planar
sp	Linear

3. **Define Catenation.**
   The tendency of an atom to form a chain of bonds with the atoms of same element is called catenation. The high strength of C-C bond is responsible for its catenation property.

4. **Define Homologous series:**
   A series of organic compounds each containing a characteristic functional group and the successive members differ from each other by $–CH_2$ group is called homologous series.
   Eg:

Alcohols	IUPAC name
CH_3OH	Methanol
CH_3CH_2OH	Ethanol
$CH_3CH_2CH_2OH$	Propanol

5. **Write the general molecular formula for alkanes, alkenes and alkynes**

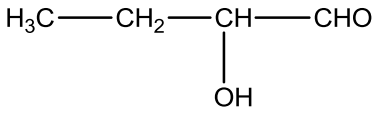
Alkanes	C_nH_{2n+2}
Alkenes	C_nH_{2n}
Alkynes	C_nH_{2n-2}

6. **Define functional group. Identify the functional group in the following compounds.**
   a) Acetaldehyde b) Oxalic acid c) dimethyl ether d) methylamine

   A functional group is an atom or group of atoms in a molecule, which gives its characteristic chemical properties.

Name	Functional group
Acetaldehyde	-CHO
Oxalic acid	-COOH
Dimethyl ether	-O-
Methyl amine	$-NH_2$

7. **Give the IUPAC name for the following**

a) 

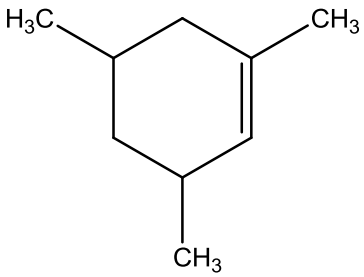
b) CH_3-O-CH_3

Answer: a) 2-hydroxy butanal b) methoxy methane

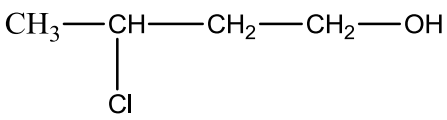
8. **Give the structure for the following compound.**
   a) 1,3,5-trimethyl cyclohex-1-ene
   b) **3 – chlorobutanol**

Answer:

a) 1,3,5-trimethyl cyclohex-1-ene



b) 3 - chlorobutanol



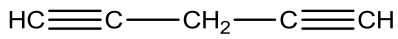
9. **Write the molecular formula of the first six members of homologous series of nitro alkanes.**

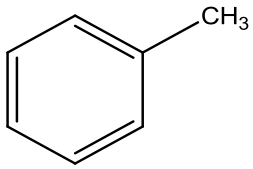
Molecular formula	IUPAC name
CH_3NO_2	Nitro methane
$C_2H_5NO_2$	Nitro ethane
$C_3H_7NO_2$	Nitro propane
$C_4H_9NO_2$	Nitro butane
$C_5H_{11}NO_2$	Nitro pentane
$C_6H_{13}NO_2$	Nitro Hexane

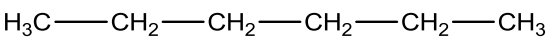
10. **Write the molecular formula and possible structural formula of the first four members of homologous series of carboxylic acids.**

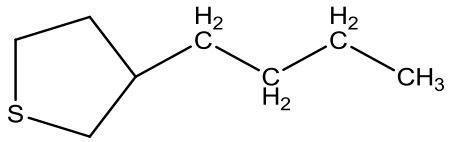
Molecular formula	Structural formula	IUPAC name
CH_2O_2	H-COOH	Formic acid
$C_2H_4O_2$	CH_3-COOH	Acetic acid
$C_3H_6O_2$	CH_3-CH_2-COOH	Propanoic acid
$C_4H_8O_2$	CH_3-CH_2-CH_2-COOH	Butanoic acid

11. **Classify the compounds based on their structure:**

a) 

b) 

c) 

d) 

Answer:

a) Unsaturated open chain compound
b) Aromatic benzenoid compound
c) Saturated open chain compound
d) Alicyclic compound

12. **When more than one functional group is present in same structure, we have to follow the priority order of functional groups. Write the priority order of functional groups.**

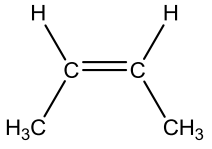
-COOH > -SO_3H > -COOR > -COX > -$CONH_2$ > -CN > -CHO >-CO >-OH >

-SH > -NH_2 > -C=C- > -C ≡ C- > -C-C- > -O- > -X > -NO_2

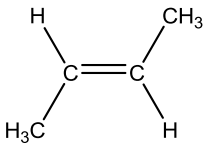
13. **What is cis-trans isomerism (Geometrical isomerism) ? Give one example.**

Cis: Similar groups lie on the same side of the double bond is called cis isomerism.

Trans: Similar groups lie on the opposite direction is called trans isomerism.



cis-2-butene



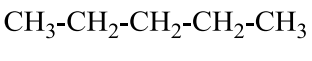
trans -2-butene

14. **What is isomerism? Give one example for chain isomerism.**

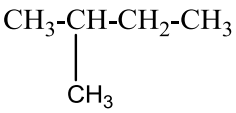
Same molecular formula but different structure and properties are called isomers.

Isomers differ only in the carbon chain (Straight or branched) is called chain isomerism.

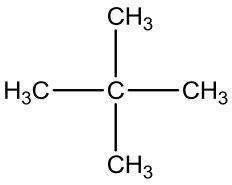
Molecular formula: C_5H_{12}



n-pentane



2 methyl butane



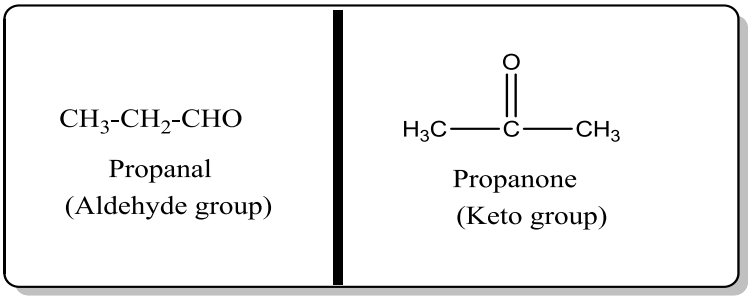
neopentane

15. **Define functional isomerism. Give one example**

Different compounds having same molecular formula but different functional groups are called functional isomerism.

Example:

(i) Molecular formula : C_3H_6O



Propanal
(Aldehyde group)

Propanone
(Keto group)

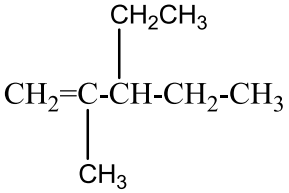
SELECTED 3 MARK QUESTIONS

1. **Give the general characteristics of organic compounds.**

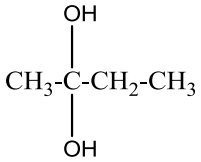
- ✯ Organic compounds are covalent in nature.
- ✯ Organic compounds are insoluble in water and readily soluble in organic solvents such as benzene, toluene etc.
- ✯ Organic compounds are inflammable (except CCl_4)
- ✯ They possess low boiling and melting points due to their covalent nature.
- ✯ Organic compounds are characterised by functional groups. They exhibit isomerism.
- ✯ Homologous series: A series of organic compounds each containing a characteristic functional group and successive members differ from each other by CH_2 group in molecular formula.

2. **Give the structure for the following compounds:**

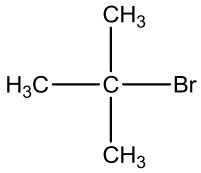
(i) 3-ethyl 2-methyl -1-pentene.



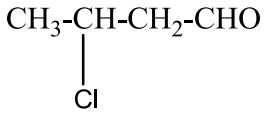
(ii) Butan-2,2-diol



(iii) Tertiary butyl bromide



(iv) 3-chloro butanal



(v) 3-chloro butanol

(vi) **Acetaldehyde** : CH_3CHO

3. **Describe optical isomerism with example.**

Compounds having same physical property but differ only in the rotation of plane of the polarised light are known as optical isomers.

Examples: Lactic acid, Glucose

The optical isomer, which rotates the plane polarised light to the right or clockwise direction is said to be dextro rotatory (+), whereas the compound rotates to the left or anticlockwise is said to be leavo rotatory (-)

4. **What are enantiomers?**

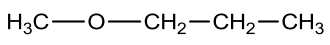
An optically active substance may exist in two or more isomeric forms which have same physical and chemical properties but differ in terms of direction of rotation of plane polarised light is called enantiomers.

Isomers which are non-super impossible mirror images of each other are called enantiomers.

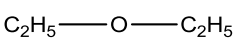
5. **What is metamerism? Give one example**

Different alkyl groups attached to either side of the same functional group and having same molecular formula is called metamerism.

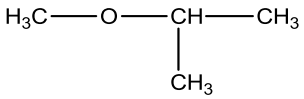
Molecular formula : $C_4H_{10}O$



methyl propyl ether

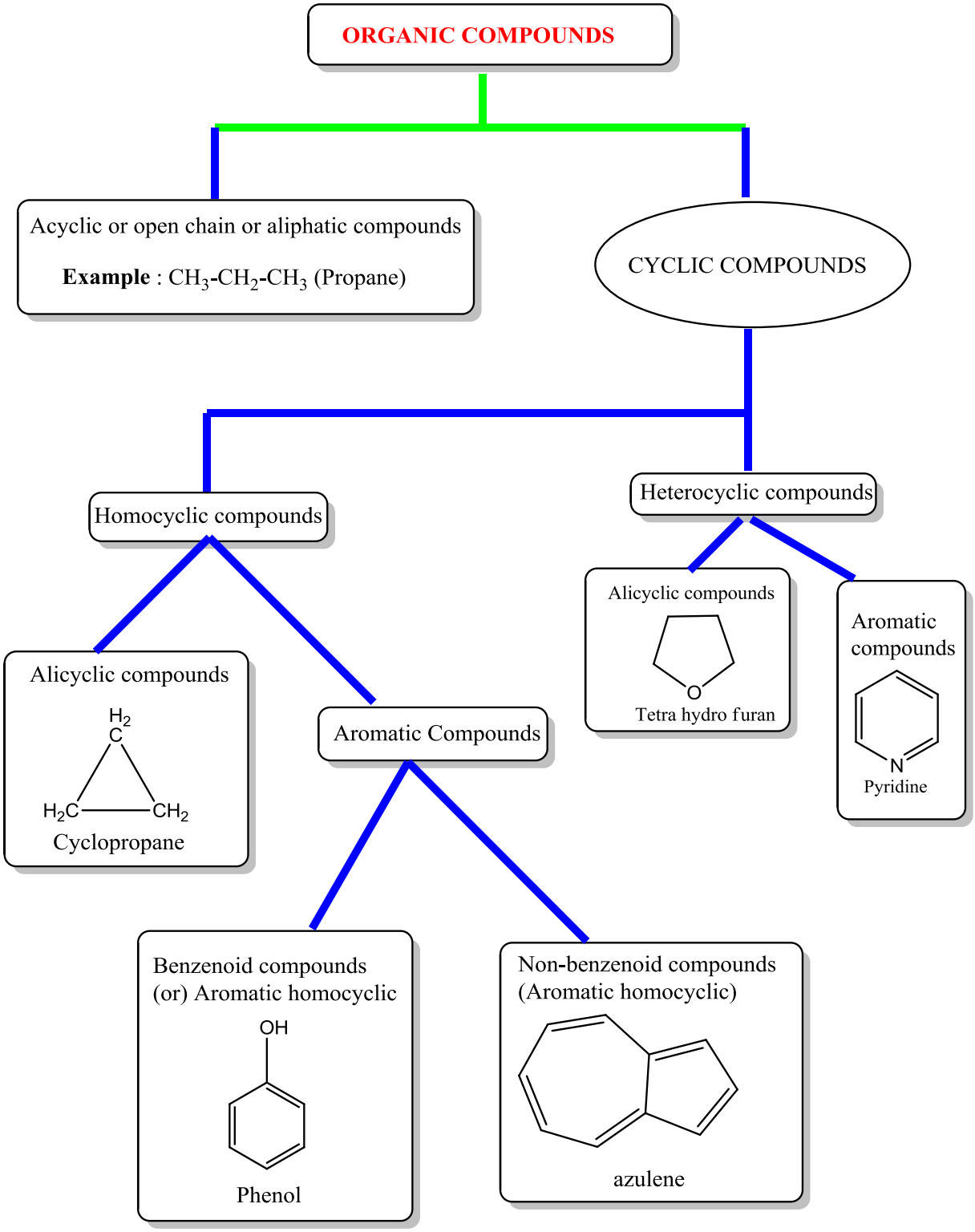


diethyl ether



Methyl isopropyl ether

6. **Describe the classification of organic compounds based on their structure.**



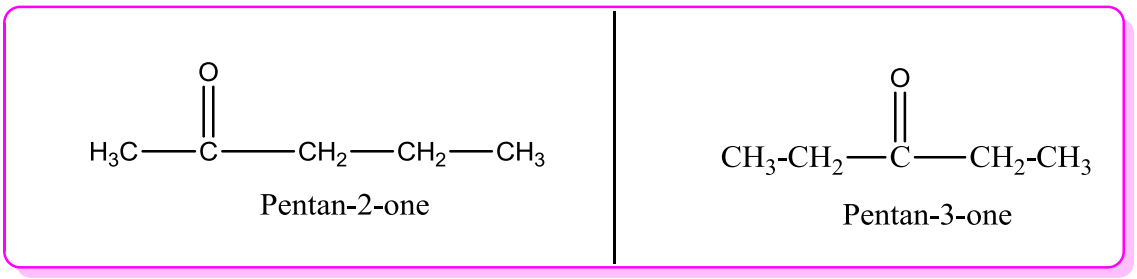
7. **Give the general formula for the following classes of organic compounds:**
   a) **Aliphatic monohydric alcohols**
   b) **Aliphatic ketones**
   c) **Aliphatic amines**

Functional groups	Molecular formula	Examples
Aliphatic monohydric alcohols	$C_nH_{2n+2}O$	CH_3OH, CH_3CH_2OH
Aliphatic ketones	$C_nH_{2n}O$	CH_3COCH_3
Aliphatic amines	$C_nH_{2n+3}N$	CH_3NH_2, $CH_3CH_2NH_2$

8. **Explain Position isomerism with an example.**

Same molecular formula and same carbon skeleton but differ in the position of substituent or functional group or an unsaturated linkage are called position isomerism.

Example:



9. **Explain Tautomerism with an example.**

A single compound exists in two readily inter-convertible structures that differ markedly in the relative position of atleast one atomic nucleus, generally hydrogen. The two different structures are known as tautomers.

DYAD system:

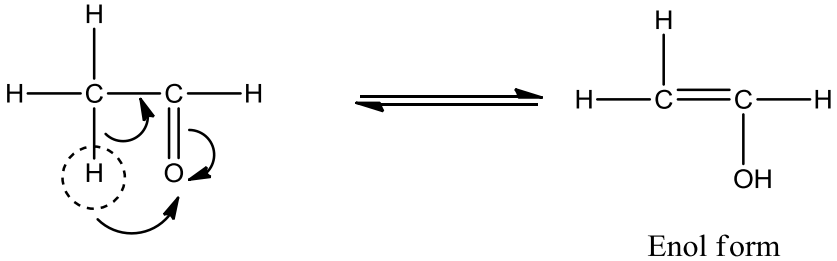
Hydrogen cyanide — hydrogen isocyanide

In this example, hydrogen atom oscillates between carbon and nitrogen atoms

TRIAD system:

It involves 1,3 migration of hydrogen atom from one polyvalent atom to other within the molecule.

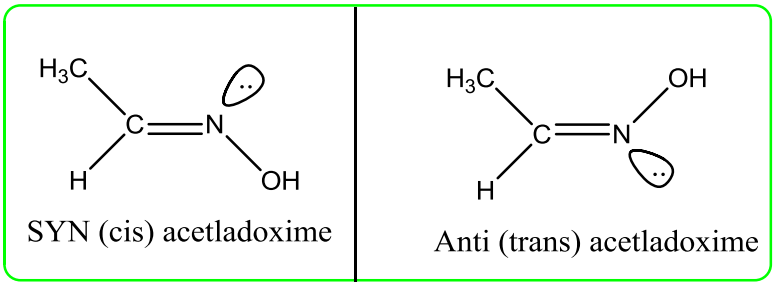
Example : Keto-enol tautomerism.



Acetaldehyde (Keto form) — Enol form (trace amount)

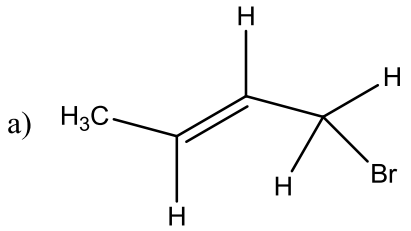
10. **Explain the geometrical isomerism in oximes**

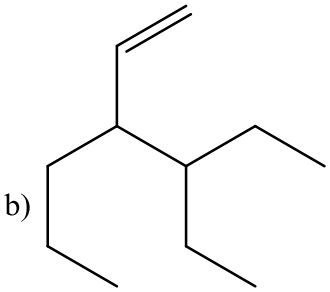
- In oximes, syn and anti are used instead of cis and trans respectively.
- In syn, H-atom of doubly bonded Carbon and –OH group of doubly bonded nitrogen lie on the same direction.
- In anti isomer, H-atom of doubly bonded Carbon and –OH group of doubly bonded nitrogen lie on the opposite direction.

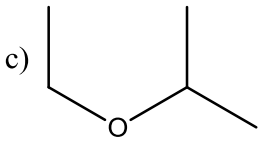


SELECTED 5 MARK QUESTIONS

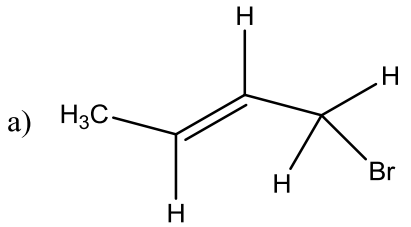
1. A) Give the IUPAC name for the following compounds







Answer:



Just to understand only

Step 1

First convert bond line structure into dash line or condensed strucutre

CH_3-CH=CH-CH_2-Br

Step : 2

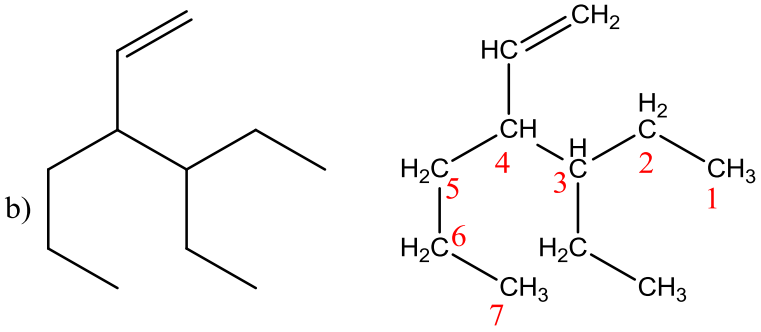
Give the number to carbon atoms and find the root word

Step : 3

Predict the prefix and suffix and follow the basic IUPAC rules for nomenclature

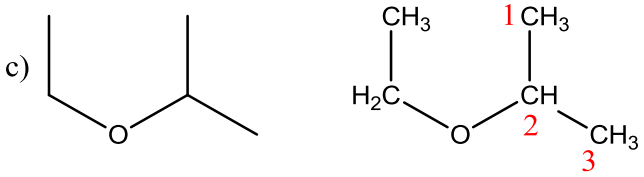
IUPAC name: **1-bromo but-2-ene**

b)



IUPAC name : **3-ethyl – 4 ethenyl heptanes**

c)



IUPAC name : **2- ethoxy propane**

B) **What is Ring Chain isomerism? Give one example.**

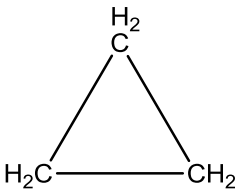
Same molecular formula but differs in bonding of carbon atom to form open chain and cyclic structures.

Example:

Molecular formula : C_3H_6

CH_3-CH=CH_2 and

Propene



cyclopropane

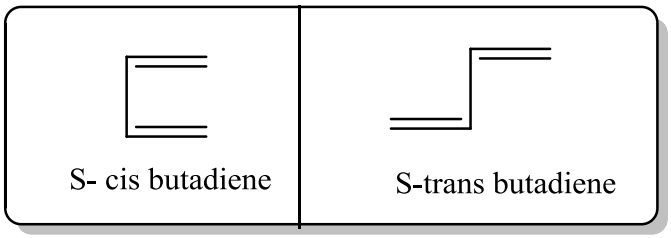
2. **A) Which carbon is said to be chiral carbon?**
   B) Write the cis – trans isomerism in 1,3 butadiene.

Answer:

A) Which carbon is said to be chiral carbon?

A carbon which is attached to four different groups or atoms are called asymmetric carbon or chiral carbon. A molecule which possesses asymmetric carbon atom and non-super imposable mirror image is called chiral molecule and this phenomenon is known as chirality.

B) Write the cis – trans isomerism in 1,3 butadiene.



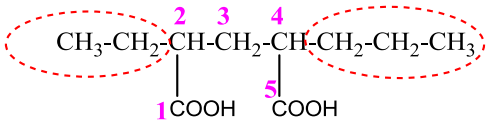
3. **A) Which isomer is more stable? Cis or Trans.**
   B) Give the structure for 2-ethyl-4-propylpentane dioic acid and 2-methyl butanal.

Answer:

A) Which isomer is more stable? Cis or Trans.

Generally, trans isomer is more stable than cis isomer. This is because, in cis isomer, the bulky groups are on the same side of the double bond. The steric repulsion of the groups make the cis isomers less stable than trans isomers where the bulky groups are in opposite direction.

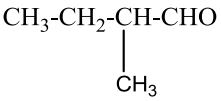
B) Give the structure for 2-ethyl-4-propylpentane dioic acid and 2-methyl butanal



2-ethyl - 4- propylpentane dioic acid

Here main funcitonal group is -COOH

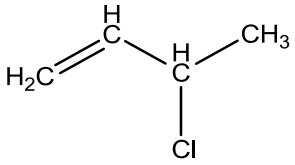
If the same funcitonal group is present more than once, choose the very longest carbon chain in such a way that it contains maximum number of functional group.



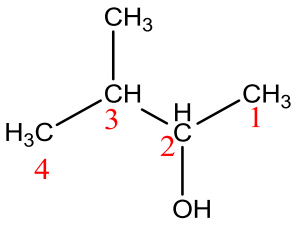
2-methyl butanal

4. **Give the structure for the following compound:**
   a) 3-methyl but-1-ene
   b) 3-chlor-but-1-ene
   c) 3-methylbutan-2-ol
   d) Octane – 1,3-diene
   e) 1,5-Dimethylcylclohexane

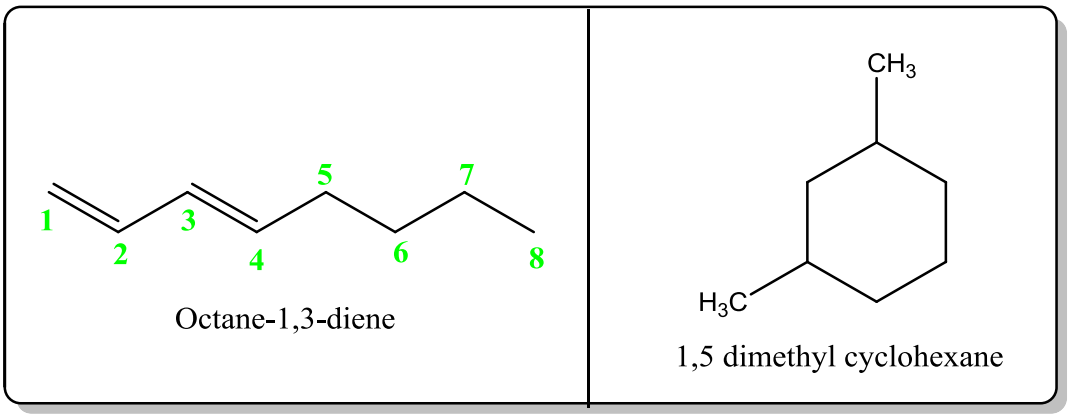
3-methyl but-1-ene



3-chloro but-1-ene



3-methyl butan-2-ol



5. **A) How will you convert cis-trans isomer?**
   B) Write short note on Newman Projection formula and Fischer projection formula

Answer:

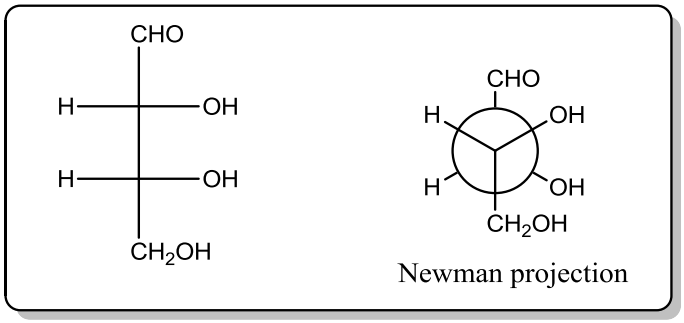
A) How will you convert cis-trans isomer?

- ❖ The cis isomer can be converted into trans isomer or vice versa if heated or absorbs light.
- ❖ The heat energy break the π bond so that rotation of sigma bond becomes possible.
- ❖ Upon cooling, the reformation of the π bond can take place in two ways giving a mixture both cis and trans forms.

B) Write short note on Newman Projection formula and Fischer projection formula

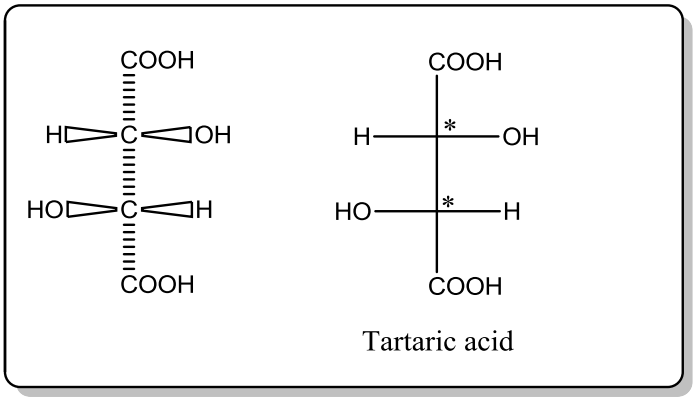
Newman Projection formula:

- ❖ Molecules are viewed from the front along Carbon-carbon bond axis.
- ❖ The two carbon atom forming the σ bond is represented by two circles, one behind the other so that only the front carbon is seen.
- ❖ The C-H bonds of the front carbon are depicted from the circle while C-H bonds of the back carbon are drawn from the circumference of the circle.



Fischer projection formula:

- This is a method of representing three dimensional structures in two dimensions.
- In this method, the chiral atom lies in the plane of the paper.
- The horizontal substituents are pointed towards the observer and the vertical substituents are away from the observer.



Tartaric acid

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UNIT – 11

Fundamentals of Organic Chemistry

(Pg. No: 137 – 152)

SELECTED 2 MARK QUESTIONS

1. **What is Sodium fusion extract?**
   - ❖ A small piece of Na dried by pressing between the folds of a filter paper is taken in a fusion tube and it is gently heated.
   - ❖ When it melts to a shining globule, put a pinch of the organic compound on it. Heat the tube till reaction ceases and become red hot. Plunge it in about 50ml of distilled water taken in a china dish and break the bottom of the tube by striking against the dish.
   - ❖ Boil the contents of the dish for about 10 minutes and filter. This filtrate is known Lassaignes extract or sodium fusion extract.

2. **Describe the reactions involved in the detection of nitrogen in an organic compound by Lassaigne method.**

   If nitrogen present, it gets converted to sodium cyanide. It reacts with freshly prepared ferrous sulphate and ferric ion followed by conc.HCl and gives a Prussian blue colour or green colour precipitate.

   $$Na + C + N \rightarrow NaCN$$

   $$FeSO_4 + 2NaOH \rightarrow Fe(OH)_2 + Na_2SO_4$$

   $$6NaCN + Fe(OH)_2 \rightarrow Na_4[Fe(CN)_6] + 2\text{NaOH}$$

   sod. ferrocyanide

   $$3Na_4[Fe(CN)_6] + 4\text{FeCl}_3 \rightarrow Fe_4[Fe(CN)_6]_3 + 12\text{NaCl}$$

   Ferric Ferrocyanide (prussian blue)

3. **Define Sublimation.**
   Few substances like benzoic acid, naphthalene and camphor when heated pass directly from solid to vapour without melting. On cooling the vapours will give back solids. Such phenomenon is called sublimation.

4. **What are the steps involved in crystallization?**
   a) Selection of solvent
   b) Preparation of solution
   c) Filtration of hot solution.
   d) Crystallization and e) Isolation and drying of crystals.

5. **Define Chromatography.**
   Chromatography is defined as a technique for the separation of a mixture. This is done by differential movement of the individual compound through porous medium under the influence of moving solvent.

6. **Define retention factor (R_f).**
   $$R_f = \frac{\text{Distance moved by the substance from base line}}{\text{Distance moved by the solvent from base line}}$$

7. **Name the stationary phase and mobile phase in Column chromatography.**

   Stationary phase : adsorbent (Silica gel or alumina or Starch)
   Mobile phase : Solvent (Eluent)

8. **What are the conditions involved in steam distillation?**
   - ✯ Substance should not decompose at steam temperature.
   - ✯ Substance should have a fairly high vapour pressure at 373K.
   - ✯ Substance should be insoluble in water
   - ✯ Impurities present should be non-volatile.

9. **Explain briefly (shortly) about distillation.**
   The process of distillation involves the impure liquid when boiled gives out vapour. The vapour is collected and condensed to give back the pure liquid in the receiver. This method is called simple distillation.

   Examples: (i) Mixture of nitrobenzene and benzene
   (ii) Mixture of diethyl ether and ethyl alcohol

10. **Write the test for phosphorus.**
    - ❖ A solid compound is strongly heated with a mxture of Na_2CO_3 and KNO_3.
    - ❖ Phosphorous present in the compound is oxidised to sodium phosphate.
    - ❖ The residue is extracted with water and boiled with conc. HNO_3. A solution of ammonium molybdate is added to the above solution.
    - ❖ A canary yellow colouration or precipitate shows the presence of phosphorous.

11. **How will you detect halogen?**
    To a portion of Lassaigne's extract, add dil. HNO_3 and warm gently and $AgNO_3$ is added.

Observation	**Solubility in Ammonia**	**Inference**
Curdy white precipitate	Soluble in ammonia	Presence of chlorine
Pale yellow precipiatate	Sparingly soluble in ammonia	Presence of bromine
Yellow precipitate	Insoluble in ammonia	Presence of iodine.

12. **How will you detect sulphur in an organic compound?**
Lassaigne's extract + freshly prepared sodium nitroprusside solution. Deep violet colour or purple colour indicates the presence of sulphur.

$$Na_2S + Na_2[Fe(CN)_5NO] \longrightarrow Na_4[Fe(CN)_5NOS]$$
sodium nitroprusside

13. **Which method is used in the analysis of foods and fertilizers in the estimation of nitrogen content?**

Answer : Kjeldahls method.

14. **Explain paper chromatography.**
- ✯ Paper chromatography is based on the principle partition chromatography.
- ✯ Stationary phase: chromatography paper
- ✯ Mobile phase: Solvent
- ✯ Adsorbent : strip of paper
- ✯ A strip of paper spotted at the base with the solution of the mixture is suspended in a suitable solvent.
- ✯ The solvent rises and flows over the spot.
- ✯ The paper selectively retains different components according to their different partition in the two phases where a chromatogram is developed.

15. **What is differential extraction?**
- ❖ The process of removing a substance from its aqueous solution by shaking with a suitable organic solvent is termed as extraction.

Process:
The aqueous solution is taken in separating funnel with little ether or Chloroform. The organic solvent (ether) immiscible with water will form a separate layer and the contents are shaken well. The solute which is more soluble in organic solvent and it is transferred to it. The solvent layer is separated and the substance is recovered.

SELECTED 3 MARK QUESTIONS

1. **Give the principle involved in the estimation of halogen in an organic compound by carius method.**

Principle:
- ➢ A known mass of the organic compound is heated with HNO3 and $AgNO_3$.
- ➢ Carbon, hydrogen and sulphur gets oxidised to CO_2, H_2O and SO_2 and halogen combines with $AgNO_3$ to form silver halide precipitate.

$$X \xrightarrow{\text{fuming } HNO_3/AgNO_3} AgX\downarrow$$

- The ppt of AgX is filtered washed, dried and weighed.
- From the mass of AgX and the mass of the organic compound taken, percentage of halogen is calculated.
- Temperature : **530K to 540K**

Calculation:

Weight of the organic compound = wg

Weight of AgCl precipitate = 'a' g

Molecular mass of AgCl = 143.5

$$\% \text{ of Cl in wg organic compound} = \left(\frac{35.5}{143.5} \times \frac{a}{w} \times 100\right)\%$$

Weight of the organic compound = w g

Weight of AgBr precipitate = 'b' g

Molecular mass of AgBr = 188

$$\% \text{ of Br in w g organic compound} = \left(\frac{80}{188} \times \frac{b}{w} \times 100\right)\%$$

Weight of the organic compound = w g

Weight of AgI precipitate = ' c ' g

Molecular mass of AgI = 235

$$\% \text{ of I in w g organic compound} = \left(\frac{127}{235} \times \frac{c}{w} \times 100\right)\%$$

****

2. **0.284g of an organic substance gave 0.287 g AgCl in a carius method for the estimation of halogen. Find the percentage of Cl in the compound.**

Given:

Weight of the organic compound = 0.284 g

Weight of AgCl precipitate = 0.287 g

Molecular mass of AgCl = 143.5

Formula used:

% of Cl in wg organic compound = $\left(\frac{35.5}{143.5}\times\frac{a}{w}\times 100\right)\%$

% of Cl in 0.284g organic compound = $\left(\frac{35.5}{143.5}\times\frac{0.287}{0.284}\times 100\right)\%$

% of chlorine = 24.98 % or 25%

****

3. **0.40 g of an iodo-substituted organic compound gave 0.235g of AgI by carius method. Calculate the percentage of iodine in the compound.**

Given:

Weight of the organic compound = 0.40 g

Weight of AgI precipitate = ' 0.235 ' g

Molecular mass of AgI = 235

Formula used

% of I in w g organic compound = $\left(\frac{127}{235}\times\frac{c}{w}\times 100\right)\%$

% of I in 0.40 g organic compound = $\left(\frac{127}{235}\times\frac{0.235}{0.40}\times 100\right)\%$

% of Iodine = 31.75%

****

4. **Give the principle involved in the estimation of sulphur in an organic compound by carius method.**

Principle:

- A known mass of the organic compound is heated with fuming HNO_3.
- Carbon, hydrogen gets oxidised to CO_2, H_2O while sulphur is oxidised to sulphuric acid.

(*i*) $C \xrightarrow{fum.\ HNO_3} CO_2$ (ii) $2H \xrightarrow{fum.\ HNO_3} H_2O$

(*iii*) $S \xrightarrow{fum.\ HNO_3} SO_2 \xrightarrow{O+H_2O} H_2SO_4$

- The resulting solution is treated with excess of $BaCl_2$ solution.
- H_2SO_4 present is converted into $BaSO_4$.
- From the mass of $BaSO_4$, percentage of sulphur is calculated.

Calculation:

Weight of the organic compound = w g

Weight of $BaSO_4$ precipitate = ' x ' g

Molecular mass of $BaSO_4$ = 233

% of S in w g of organic compound = $\left(\frac{32}{233}\times\frac{x}{w}\times 100\right)\%$

5. **0.16g of an organic compound was heated in a carius tube and H_2SO_4 acid formed was precipitated with $BaCl_2$. The mass of $BaSO_4$ was 0.35g. Find the percentage of sulphur**.

Given:

Weight of the organic compound = 0.16 g

Weight of $BaSO_4$ precipitate = ' 0.35 ' g

Molecular mass of $BaSO_4$ = 233

Formula used:

% of S in w g of organic compound = $\left(\frac{32}{233}\times\frac{x}{w}\times 100\right)\%$

% of S in 0.16 g of organic compound = $\left(\frac{32}{233}\times\frac{0.35}{0.16}\times 100\right)\%$

% of S = 30.04%

****

6. **How will you estimate phosphorous using carius method?**
   - ❖ A known mass of the organic compound (w) containing phosphorus is heated with fuming HNO_3 in sealed tube.
   - ❖ Carbon is converted into CO_2 and H to H_2O.
   - ❖ Phophorous present is oxidised to phosphoric acid. By adding ammonium molybdate and con.HNO_3 we get **ammonium phosphomolybdate precipitate.**

$$H_3PO_4 + 12(NH_4)_2MoO_4 + 21\ HNO_3 \xrightarrow{\text{Heat}} (NH_4)_3PO_4.12MoO_3 + 21NH_4NO_3 + 12HNO_3$$

- ❖ In the alternative method, the phosphoric acid is precipitated as **magnesium – ammonium phosphate** by adding magnesia mixture (mixture of $MgCl_2$, NH_4Cl)

- This precipitate is washed, dried and ignited to get **magnesium pyrophosphate** which is washed, dried and weighed.

Weight of the organic compound = w g

Weight of ammonium phospho molybdate ppt = 'x' g

Molecular mass of ammonium phospho molybdate = 1877

$$\% \text{ of P in w g of organic compound} = \left(\frac{31}{1877}\times\frac{x}{w}\times 100\right)\%$$

[OR]

Weight of magnesium pyrophosphate ($Mg_2P_2O_7$) ppt = 'y' g

Molecular mass of magnesium pyrophosphate ($Mg_2P_2O_7$) = 222

$$\% \text{ of P in w g of organic compound} = \left(\frac{62}{222}\times\frac{y}{w}\times 100\right)\%$$

****

7. **0.33 g of an organic compound containing phosphorous gave 0.397g of $Mg_2P_2O_7$ by the analysis. Calculate the percentage of P in the compound.**

Weight of the organic compound = 0.33 g

Weight of magnesium pyrophosphate ($Mg_2P_2O_7$) ppt = 0.397g

Molecular mass of magnesium pyrophosphate ($Mg_2P_2O_7$) = 222

$$\% \text{ of P in w g of organic compound} = \left(\frac{62}{222}\times\frac{y}{w}\times 100\right)\%$$

$$\% \text{ of P in 0.33 g of organic compound} = \left(\frac{62}{222}\times\frac{0.397}{0.33}\times 100\right)\%$$

% of P = 33.59%

****

8. **Explain Azeotropic distillation.**
   - **Azeotropes**: a mixture of two liquids which has a constant boiling point and composition throughout distillation.
   - These are the mixture of liquids that cannot be separated by fractional distillation.
   - Azeotropes are constant boiling mixtures, which distil as a single component at a fixed temperature.
     For example, ethanol and water are in the ratio of 95.87 : 4.13

- Substance like benzene, CCl_4, glycerol, glycol (third component)which act as a dehydrating agent depress the partial pressure of one component of Azeotropic mixture and raises the boiling point of that component. The other component will now distil over.

9. **Explain Thin Layer Chromatography.**
   - Principle : Adsorption
   - Adsorbent: Cellulose, silica gel
   - A sheet of glass is coated with a thin layer of adsorbent.
   - This sheet of glass is called chromoplate. After drying the plate, a drop of mixture is placed just above one edge and the plate is then placed in a closed jar containing solvent.
   - The eluent is drawn up and the adsorbent layer by capillary action.
   - The components of the mixture move up along with the eluent to different distances depending upon their degree of adsorption of each component of the mixture. It is expressed in terms of Retention factor.

$$R_f = \frac{\text{Distance moved by the substance from base line}}{\text{Distance moved by the solvent from base line}}$$

   - The colourless compounds are viewed under UV light or in another method using iodine crystals or by using appropriate reagent.

10. **How will you eliminate, if Nitrogen and sulphur present in the detection of halogen?**

If nitrogen or Sulphur present in the compound along with halogen, we get NaCN and Na_2S in the solution.

Interference and Confusion in detecting Halogen

$$NaCN + AgNO_3 \xrightarrow{\Delta} NaNO_3 + AgCN$$

White ppt confusing with AgCl

$$Na_2S + AgNO_3 \longrightarrow Ag_2S\downarrow + NaNO_3$$

black ppt

In order to avoid confusion, we boil the Lassaignes extract with HNO_3 which decomposes NaCN and Na_2S.

$$NaCN + HNO_3 \xrightarrow{\Delta} NaNO_3 + HCN\uparrow$$

$$Na_2S + 2HNO_3 \xrightarrow{\Delta} 2\,NaNO_3 + H_2S\uparrow$$

****

SELECTED 5 MARK QUESTIONS

1. **How will you estimate Carbon and hydrogen present in an organic compound?**

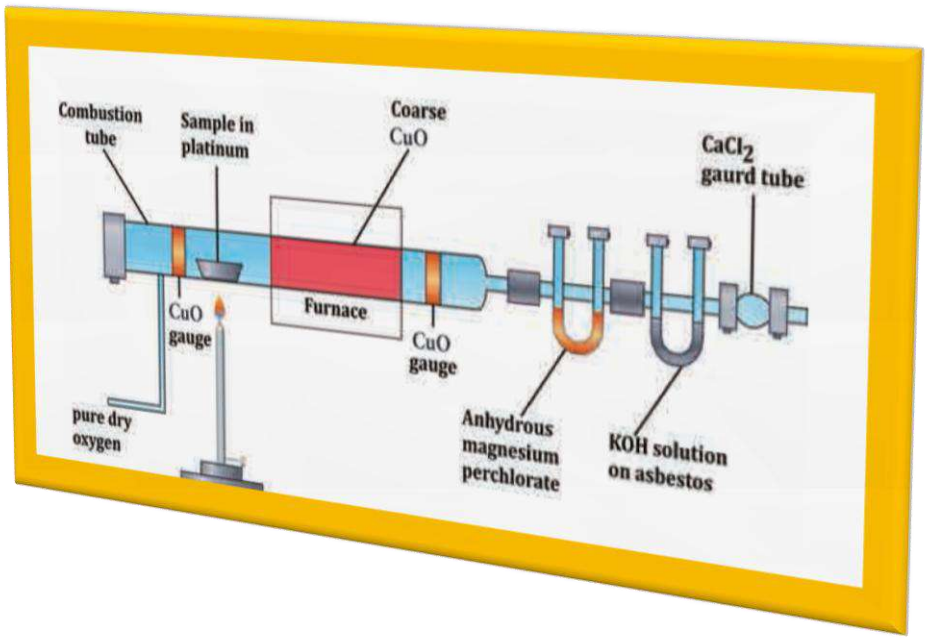
   - A known mass of the organic substance is burnt in excess of oxygen and the carbon and hydrogen present in it are oxidized to carbon dioxide and water, respectively.

$$C_xH_y + O_2 \quad \rightarrow \quad xCO_2 + \frac{y}{2}H_2O$$

   - The weight of carbon dioxide and water thus formed are determined and the amount of carbon and hydrogen in the organic substance is calculated.

Apparatus required:

(i) Oxygen supply (ii) combustion tube (iii) absorption apparatus



Procedure:

- The combustion tube is heated strongly to dry its content.
- One end of the combustion tube is connected to absorption apparatus and other end is opened for a while and weighed organic substance is introduced.
- The tube is heated for 2 hours and finally a strong current of oxygen is passed through the combustion tube to sweep away any traces of CO_2 or moisture which may be left in it.
- The carbon and hydrogen is converted into CO_2 and H_2O and it is absorbed by absorption apparatus. U-tube packed with pumice soaked in con.H_2SO_4 is used to absorb water. Strong solution of KOH is used to absorb CO_2.
- Finally the increase in weight of U-tube and potash bulbs is determined.

Calculation:

Weight of the organic compound = w g

Increase in weight of H_2O = ' x ' g

Increase in weight of CO_2 = ' y ' g

% of Hydrogen in w g of organic compound = $\left(\frac{2}{18}\times\frac{x}{w}\times 100\right)\%$

% of Carbon in w g of organic compound = $\left(\frac{12}{44}\times\frac{y}{w}\times 100\right)\%$

****

2. Give a brief description of the principles of a) Fractional distillation b) column chromatography

a) Fractional distillation:

- This is one method to purify and separate liquids present in the mixture having their boiling point close to each other.
- In this method, a fractionating column is fitted with distillation flask and a condenser.
- A thermometer is fitted in the fractionating column near the mouth of the condenser.
- The process of separation of components in a liquid mixture at their respective boiling points in the form of vapours and subsequent condensation of those vapours is called fractional distillation.
- This method used in distillation of petroleum, coal-tar and crude oil.

b) Column Chromatography

- This method involves separation of a mixture over a column of adsorbent (Stationary phase) packed in a column.
- Adsorbents are activated aluminium oxides (Alumina), MgO, Starch.
- The mixture to be separated is placed on the top of the adsorbent column, Eluent (solvent) is allowed to flow down the column slowly.
- Different components, based on adsorbing power, complete separation takes place.
- The most readily adsorbed substances are retained near the top and others come down to various distances in the column.

****

3. Explain Crystallization in the purification of solid organic compound.

Selection of solvent:

- Most of the organic substances being covalent do not dissolve in polar solvents like water; Hence selection of solvent becomes necessary.

- If the organic substance dissolves on heating and throws out maximum crystals on cooling, then the solvent is suitable.
- This process is repeated with other solvents like benzene, acetone, ether and alcohol to select the suitable solvent.

Preparation of solution:

- The organic substance is dissolved in a minimum quantity of suitable solvent.
- Small amount of animal charcoal can be added to decolourize an coloured substance.
- The heating is done over a wire gauze or water bath.

Filtration of hot solution:

- The hot solution is filtered through a fluted filter paper place in a funnel.

Crystallization:

- The hot filtrate is then allowed to cool.
- Most of the impurities are removed on the filter paper, the pure solid substance separate as crystal.
- If the crystallization rate is slow, it is induced either by scratching the walls of the beaker with a glass rod or by adding a few crystals of the pure compounds to the solution.

Isolation and drying of crystals:

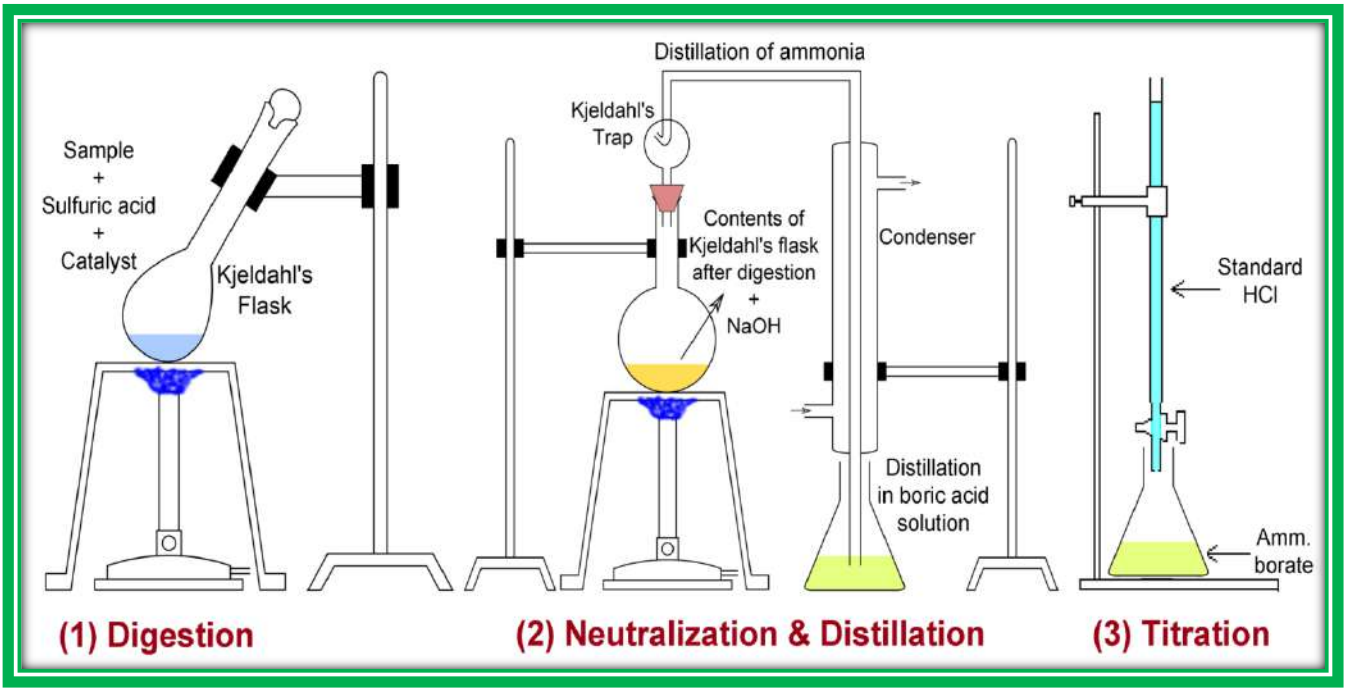
- The crystals are separated from the mother liquor by filtration using Bucher funnel under reduced pressure.
- Finally the crystals are washed with small quantities of the pure cold solvent and then dried.

****

4. Explain Kjeldahls method in the estimation of Nitrogen.

- This method is largely used in the analysis of foods and fertilizers.
- When an organic compound containing nitrogen is heated with conc.H_2SO_4, then nitrogen in it is quantitatively converted to ammonium sulphate.
- The resultant liquid is then treated with excess of alkali and then liberated ammonia gas is absorbed in excess of standard acid.
- The amount of ammonia is determined by finding the amount of acid neutralized by back titration with std. alkali.

Diagram : (Refer Text book also)



Procedure:

- A weighed quantity of substance is placed in a special long necked Kjeldahl flask made of pyrex glass.
- About 25ml H_2SO_4 and little K_2SO_4 and $CuSO_4$ (catalyst) are added to the flask and heated gently in an inclined position.
- The heating is continued till the brown colour of the liquid first produced, disappears leaving the contents clear as before.
- At this point, all the nitrogen is converted into **ammonium sulphate**.
- The contents present in Kjeldhals flask is transferred to 1 litre round bottom flask and excess of NaOH solution is poured down the side of the flask.
- The lower end of the condenser dips in a measured volume of excess N/20 H_2SO_4 solution. Upper end of the condenser is connected to Kjeldahl trap which serves to retain any alkali splashed up on vigorous boiling.
- The liquid in the round bottom flask is heated and the liberated ammonia is distilled into sulphuric acid.
- Finally, the excess of acid is then determined by titration with alkali using phenolphthalein as the indicator.

Calculation:

- Weight of the organic compound = w g
- Volume of H_2SO_4 required for the complete neutralization of NH_3 = V ml
- Strength of H_2SO_4 = N

- Percentage of Nitrogen present in an organic compound

$$= \left(\frac{14 \times V \times N}{1000 \times w} \right) \times 100\%$$

5. Explain DUMAS method in the estimation of Nitrogen.

This method is based on the fact that nitrogenous compound when heated with cupric oxide in an atmosphere of CO_2 yields free nitrogen.

$$C_xH_yN_z + \left(2x + \frac{y}{2}\right)CuO \rightarrow xCO_2 + \frac{y}{2}H_2O + \frac{z}{2}N_2 + \left(2x + \frac{y}{2}\right)Cu$$

CO_2 generator:

- CO_2 is prepared by heating $NaHCO_3$ by the action of dil.HCl on marble in a kipps apparatus.
- The CO_2 gas is passed through the combustion tube after being dried by bubbling through conc. H_2SO_4

Combustion tube:

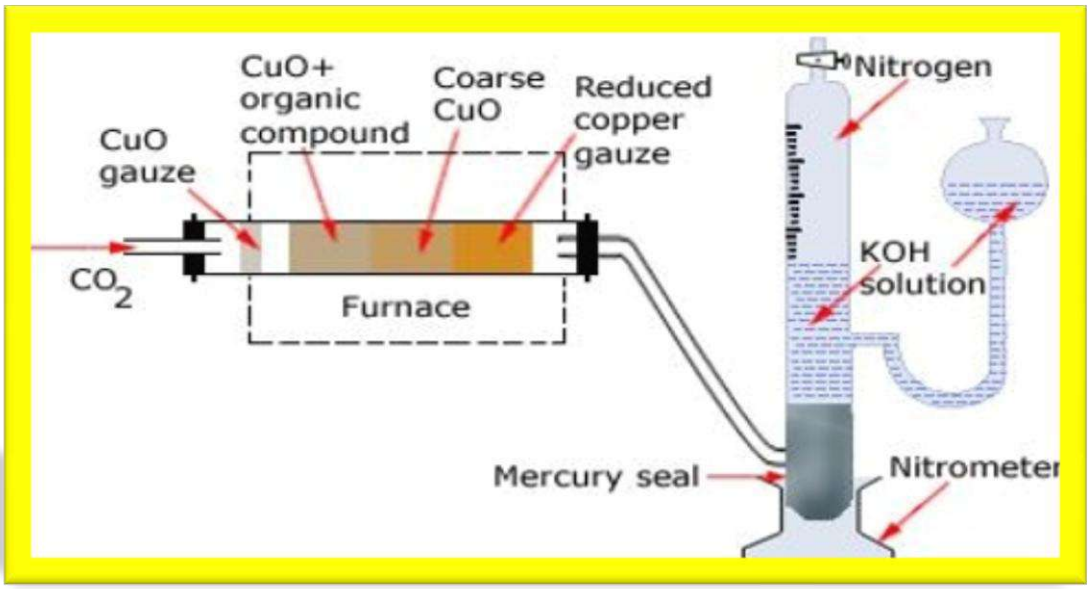
Combustion tube consists of

a) A roll of oxidized copper gauze to prevent the back diffusion of the products of combustion.
b) A weighed amount of the organic substance mixed with excess of CuO
c) A layer of coarse CuO packed in about 2/3 of the entire length of the tube
d) A reduced copper spiral which reduces any oxides of nitrogen formed during combustion to nitrogen.

Schiff's nitro meter:

- The nitrogen gas obtained by the decomposition of the substance is mixed with considerable excess of CO_2
- It is estimated by passing nitrometer when CO_2 is absorbed by KOH
- Nitrogen gets collected in the upper part of the graduated tube.

Diagram:



Calculations:

- Weight of the organic compound = w g
- Volume of Nitrogen = V_1L
- Room temperature = T_1K
- Pressure of dry nitrogen = (Atm pressure (P) – Aqueous tension P′)
  = (P - P′) = P_1 mm of Hg
- P_0, V_0 and T_0 be the pressure, volume and temperature respectively of dry nitrogen at STP

$$\text{Then, } \frac{P_0V_0}{T_0} = \frac{P_1V_1}{T_1} \quad \Rightarrow V_0 = \frac{P_1V_1}{T_1} \times \frac{T_0}{P_0}$$

$$\Rightarrow V_0 = \left(\frac{P_1V_1}{T_1} \times \frac{273K}{760mm\ Hg} \right)$$

$$Percentage \text{ of nitrogen} = \left(\frac{28}{22.4} \times \frac{V_0}{w} \right) \times 100\%$$

****

SELECTED PROBLEMS:

1. **0.6 g of an organic compound was Kjeldalised and NH_3 evolved was absorbed into 50 ml of semi-normal solution of H_2SO_4. The residual acid solution was diluted with distilled water and the volume made up to 150ml. 20 ml of this diluted solution required 35ml of N/20 NaOH solution for complete neutralization. Calculate the % of nitrogen in the compound.**

Given:

- Weight of the organic compound = 0.6 g
- Volume of H_2SO_4 taken = 50 ml
- The residual acid solution was diluted with distilled water and the volume made up to 150ml. *20 ml of this diluted solution required 35ml of N/20 NaOH solution for complete neutralization*

Now we have to find the strength of diluted acid.

Strength of diluted sulphuric acid $= \frac{35 \times 0.05}{20} = 0.0875N$

- Normality of H_2SO_4 taken = 0.5 N
- Volume of dilute H_2SO_4 = 150ml
- Strength of dilute H_2SO_4 = 0.0875N

Volume of H_2SO_4 $= \frac{150 \times 0.0875}{0.5} = 26.25ml$

Volume of H_2SO_4 consumed by ammonia (V) = 50ml – 26.25 ml
= 23.75ml

❖ Percentage of Nitrogen present in an organic compound $= \left(\frac{14 \times V \times N}{1000 \times w}\right) \times 100\%$

$$= \left(\frac{14 \times 23.75 \times 0.5}{1000 \times 0.6}\right) \times 100\%$$
$$= 27.66\%$$

****

2. 0.30 g of a substance gives 0.88g of carbon dioxide and 0.54g of water. Calculate the percentage of carbon and hydrogen in it.

Weight of the organic compound = 0.30 g

Weight of H_2O = 0.54 g

Weight of CO_2 = 0.88 g

% of Hydrogen in w g of organic compound $= \left(\frac{2}{18} \times \frac{x}{w} \times 100\right)\%$

$$= \left(\frac{2}{18} \times \frac{0.54}{0.30} \times 100\right)\% = 20\%$$

% of Carbon in w g of organic compound $= \left(\frac{12}{44} \times \frac{y}{w} \times 100\right)\%$

$$= \left(\frac{12}{44} \times \frac{0.88}{0.30} \times 100\right)\% = 80\%$$

****

3. The ammonia evolved from 0.20g of an organic compound by Kjeldahl method neutralized 15ml of N/20 sulphuric acid solution. Calculate the percentage of nitrogen.

Weight of the organic compound = 0.20 g
Volume of H_2SO_4 required to neutralize NH_3 = 15ml
Strength of H_2SO_4 = 0.05N

Percentage of Nitrogen present in an organic compound $= \left(\frac{14 \times V \times N}{1000 \times w}\right) \times 100\%$

$$= \left(\frac{14 \times 15 \times 0.05}{1000 \times 0.20}\right) \times 100\%$$
$$= 5.25\%$$

****

4. 0.32 g of an organic compound, after heating with fuming nitric acid and barium nitrate crystals in a sealed tube gave 0.466g of barium sulphate. Determine the % of sulphur in the compound

Given:

Weight of the organic compound = 0.32 g

Weight of $BaSO_4$ precipitate = ' 0.466 ' g

Molecular mass of $BaSO_4$ = 233

Formula used:

% of S in w g of organic compound = $\left(\frac{32}{233}\times\frac{x}{w}\times 100\right)\%$

% of S in 0.16 g of organic compound = $\left(\frac{32}{233}\times\frac{0.466}{0.32}\times 100\right)\%$

% of S = 20%

****

5. In the estimation of nitrogen present in an organic compound by Dumas method 0.35g yielded 20.7ml of nitrogen at 150°C and 760mm pressure. Calculate the percentage of nitrogen in the compound.

- Weight of the organic compound = 0.35 g
- Volume of Nitrogen (V_1) = 20.7 x 10^{-3} L
- Room temperature (T_1) = 423 K
- Pressure (P_1) = 760mm

Let P_0, V_0 and T_0 be the pressure, volume and temperature respectively of dry nitrogen at STP

$$\text{Then, } \frac{P_0V_0}{T_0}=\frac{P_1V_1}{T_1} \quad \Rightarrow V_0 = \frac{P_1V_1}{T_1}\times\frac{T_0}{P_0}$$

$$\Rightarrow V_0 = \left(\frac{P_1V_1}{T_1}\times\frac{273K}{760mm\ Hg}\right)$$

$$\Rightarrow V_0 = \left(\frac{760\times 20.7\times 10^{-3}}{423}\times\frac{273K}{760mm\ Hg}\right)L$$

$$V_0 = 13.36\times 10^{-3}L$$

$$Percentage \text{ of nitrogen} = \left(\frac{28}{22.4}\times\frac{V_0}{w}\right)\times 100\%$$

$$Percentage \text{ of nitrogen} = \left(\frac{28}{22.4}\times\frac{13.36\times 10^{-3}}{0.35}\right)\times 100\% = 4.77\%$$

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