9 ORGANIC CHEMISTRY

Topic-1

Organic Compounds

Concepts covered: • *Unique nature of carbon atoms,* • *Characteristics of organic compounds,* • *Cycloalkanes,* • *Hydrocarbons*

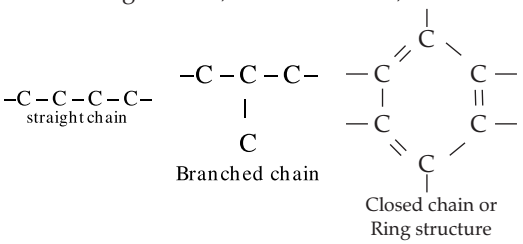
Revision Notes

- The word "organic" means pertaining to life. Earlier, it was regarded that organic compounds can only be produced by nature under the influence of living force called **vital force**.
- The vital force theory was soon discarded when a German scientist, Friedrich Wohler, synthesize an organic compound urea in the laboratory, by heating ammonium cyanate.

$$\underset{\text{Ammonium cyanate}}{NH_4CNO} \xrightarrow{\text{Heat}} \underset{\text{Urea}}{CO(NH_2)_2}$$

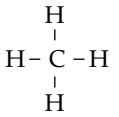
Later on, Kolbe prepared acetic acid (CH_3COOH) and Berthelot synthesised methane (CH_4) gas in the laboratory.

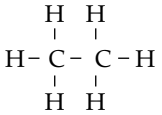
- All organic compounds essentially contain carbon atom. Carbon has 4 valence electrons. Therefore, to satisfy its valency carbon shares its electrons with other carbon atoms or with the atoms of other elements. As a result of sharing, it leads to the formation of straight chain, branched chain, closed chain or the ring structure.



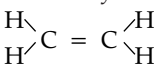
- **Unique nature of carbon atoms :**
  - **(i)** Carbon has four valence electrons. It can neither lose nor gain electrons to attain octet. It forms covalent bonds by sharing its four electrons with other atoms. It is known as **tetra valency** of the carbon atoms.
  - **(ii)** Carbon atom possesses a unique property to link with one another by means of covalent bonds to form long chains (or rings) of carbon atoms. This property of forming bonds with atoms of the same elements is called as **catenation**.
- **Characteristics of organic compounds are :**
  - **(i)** All organic compounds are covalent in nature.
  - **(ii)** Almost all the organic compounds are insoluble in water but soluble in organic solvents like benzene, ether, carbon tetrachloride.
  - **(iii)** All have relatively low melting point and boiling point.
  - **(iv)** All organic compounds are combustible in nature.
- Older chemists basically classified hydrocarbons as either aliphatic or aromatic. The classification was done on the basis of their source and their properties.
- **Cycloalkanes :** These hydrocarbons possess one or multiple carbon rings. The hydrogen atom is attached to the carbon ring.
- **Aromatic Hydrocarbons :** These are also called as arenes. Arenes are compounds which consist of at least one aromatic ring.
- **Hydrocarbons :** A compound made up of hydrogen and carbon only is called **hydrocarbon**. For example, CH_4, C_2H_2, C_2H_6, etc. The most important natural source of hydrocarbon is petroleum or crude oil. Hydrocarbons are further divided into two main groups:
  - **(i)** Aliphatic (open) and **(ii)** Cyclic (closed) chain compounds.

  The aliphatic compounds are further divided into saturated and unsaturated hydrocarbons.
- **Saturated hydrocarbons :** A hydrocarbon in which the carbon atoms are connected by only single bonds is called **saturated hydrocarbon**. It is represented by the general formula C_nH_{2n+2} where n is the number of carbon atoms.

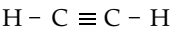
Methane CH_4 

Ethane C_2H_6 

- **Unsaturated hydrocarbons :** A hydrocarbon in which two carbon atoms are connected by a double bond or a triple bond is called as an **unsaturated hydrocarbon**. Alkenes are the hydrocarbons with double bond between two carbon atoms. Alkynes are the hydrocarbons with triple bond between two carbon atoms.



Ethene

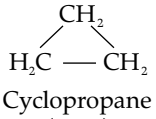


Ethyne

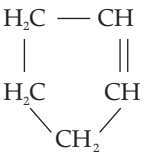
- **Difference between Saturated and Unsaturated Organic Compounds :**

Saturated Organic Compounds	Unsaturated Organic compounds
i. All the four valencies of each carbon atom are satisfied by forming single covalent bonds with carbon and with hydrogen atoms.	**1.** The valencies of at least two carbon atoms are not fully satisfied by the hydrogen atoms.
ii. Carbon atoms are joined only by a single covalent bond.	**2.** Carbon atoms are joined by double covalent bonds, or by triple covalent bonds.
3. They are less reactive due to the non-availability of electrons in the single covalent bond, and therefore they undergo substitution reaction.	**3.** They are non–reactive due to the presence of electrons in the double or the triple bond, and therefore, undergo reaction.

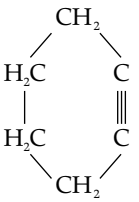
- **Carbocyclic compounds :** Cyclic or closed chain hydrocarbons contain three or more carbon atoms in their molecule. Cyclic compounds containing single, double and triple bonds are called cycloalkanes, cycloalkenes and cycloalkynes respectively.



Cyclopropane
(C_3H_6)

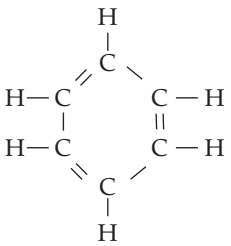


Cyclopentene
C_5H_8



Cyclohexyne
(C_6H_8)

Some hydrocarbon contains at least one benzene ring in their molecules. It is a ring of six carbon atom having C — C single and C = C double bond in alternate positions.



Benzene

- **Alkyl Group :** Alkyl group is represented by 'R'. The general formula of alkyl group is C_nH_{2n+1} (where n = number of carbon atoms). The group formed by the removal of one hydrogen atom from alkane molecules is called an alkyl group. An alkyl group is named by replacing the suffix 'ane' of the alkane with the suffix – yl.

$$\underset{\text{Methane}}{CH_4} \xrightarrow{-H} \underset{\text{Methyl}}{-CH_3}$$

$$\underset{\text{Ethane}}{C_2H_6} \xrightarrow{-H} \underset{\text{Ethyl}}{-C_2H_5}$$

- **Homologous Series :** When the organic compounds having similar structural formula, same functional group are arranged in order of increasing molecular weights, they form a homologous series.
- **Characteristics of a Homologous Series**
  - **(i)** They have similar general and structural formula and same chemical properties.
  - **(ii)** The two adjacent members of homologous series differ by CH_2 unit.

(iii) The molecular mass of two adjacent homologous differ by 14 amu.
(iv) The members of a homologous series can be prepared by similar methods of preparation.

- **Homologous Series of Alkanes :** (General formula C_nH_{2n+2})

Alkane	Formula
1. Methane	CH_4
2. Ethane	C_2H_6
3. Propane	C_3H_8
4. Butane	C_4H_{10}
5. Pentane	C_5H_{12}

- **Importance of Homologous Series :**
  (i) It helps in systematic study of organic compounds.
  (ii) By knowing the properties of any member of a homologous series, we can predict the properties of other members of the series.
- **Isomerism :** Two or more compounds having the same molecular formula but different physical and chemical properties are called isomers and this phenomenon is known as isomerism.

Example - **(i)** $\overset{5}{C}H_3 - \overset{4}{C}H_2 - \overset{3}{C}H_2\ \overset{2}{C}H_2 - \overset{1}{C}H_3$

Pentane (n – pentane)

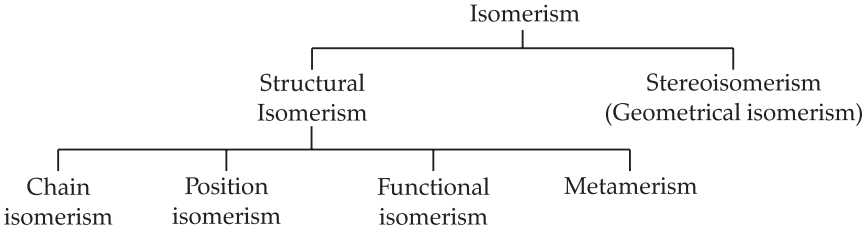
(ii) $\overset{4}{C}H_3 - \overset{3}{C}H_3 - \overset{2}{C}H_3 - \overset{1}{C}H_3$ with CH_3 branch on C-3

2-methyl butane (*iso* -pentane)

(iii) $\overset{1}{C}H_3 - \overset{2}{C}(CH_3)_2 - \overset{3}{C}H_3$

2,2 dimethyl propane
(*neo* -pentane)

- **There are two types of isomerism :**
  (1) Structural isomerism : Chain isomerism, position isomerism, functional isomerism, metamerism and tautomerism
  (2) Stereo isomerism : Optical and geometrical isomerism



- **Chain Isomerism :** When the same molecular formula represents two or more compounds which differ in the length of carbon chain without altering the position of double or triple bond then the isomerism is said to be chain isomerism. For example : C_5H_{10}

$\overset{5}{H_3}C - \overset{4}{H_2}C - \overset{3}{H_2}C - \overset{2}{C}H = \overset{1}{C}H_2$

Pent – 1 – ene

$\overset{4}{H_3}C - \overset{3}{C}H(CH_3) - \overset{2}{H}C = \overset{1}{C}H_2$

3-Methyl but - 1- ene

- **Position Isomerism :** The isomerism in this case differ with respect to the position of the double bond and triple bond. For example : Butyne C_4H_6.

$\overset{4}{H_3}C - \overset{3}{C}H_2 - \overset{2}{C} \equiv \overset{1}{C}H$ (But - 1 - yne)

$\overset{4}{H_3}C - \overset{3}{C} \equiv \overset{2}{C} - \overset{1}{C}H_3$ (But - 2 - yne)

- **Functional group** : A **functional group** is an atom or a group of atoms which imparts characteristics properties to the organic compound.

Series	Functional Group	General Formula	Example
Alkane	Hydrocarbon chain	C_nH_{2n+2}	Methane, CH_4 Ethane, C_2H_6
Alkene	Double bond $>C = C<$	C_nH_{2n}	Ethene, C_2H_4 Propene, C_3H_6

Alkyne	Triple bond $-C \equiv C-$	C_nH_{2n-2}	Ethyne, C_2H_2 Propyne, C_3H_4
Alcohol	– OH group	$C_nH_{2n+1}OH$	Methanol, CH_3OH Ethanol, C_2H_5OH
Aldehyde	– CHO group	$C_nH_{2n+1}CHO$	Ethanal, CH_3CHO Propanal, C_2H_5CHO
Carboxylic acid	– COOH group	$C_nH_{2n+1}COOH$	Ethanoic acid, CH_3COOH Propanoic acid, C_2H_5COOH
Halides -			
Chloride	– Cl	$C_nH_{2n+1}Cl$	Chloromethane CH_3Cl Chloroethane C_2H_5Cl
Bromide	– Br	$C_nH_{2n+1}Br$	Bromomethane CH_3Br Bromoethane C_2H_5Br
Iodide	– I	$C_nH_{2n+1}I$	Iodomethane CH_3I Iodoethane C_2H_5I

➢ **Nomenclature of Organic Compounds :** Nomenclature is the system of assignment of names to organic compounds. Organic compounds have two names, common name or trivial system and IUPAC name.

Trivial System : The basic of naming organic compounds by the trivial system is its **(a)** Source **(b)** Properties **(c)** Latin or Greek origin.

IUPAC System : (International Union of Pure and Applied Chemistry)

IUPAC name takes up only one molecular structure of the compound and assign only one name to the compound.

According to this system, the name of an organic compound consists of three parts :

(i) Word Root **(ii)** Suffix **(iii)** Prefix

(i) Word Root : The Word root indicates the total number of carbon atoms present in the longest carbon chain belonging to the compound. For example, 'Meth' refers to a chain with 1 carbon atom and 'Hept' refers to a chain with 7 carbon atoms.

Number of carbon atoms	Word Root
C_1	Meth
C_2	Eth
C_3	Prop
C_4	But
C_5	Pent
C_6	Hex
C_7	Hept
C_8	Oct
C_9	Non
C_{10}	Dec

(ii) Suffix : The part of the name which appears after the word root.

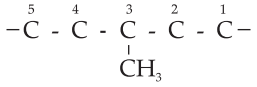
- **Primary Suffix :** It tells us about the nature of carbon chain i.e., whether saturated or unsaturated.

Name	Group	Suffix
Alkane	$\rangle C - C \langle$	ane
Alkene	$\rangle C = C \langle$	ene
Alkyne	$-C \equiv C-$	yne

- **Secondary Suffix** : It is written after the primary suffix for functional group present in the compound.

Name	Group	Suffix
Alcohol	– OH	ol
Aldehyde	– CHO	al
Carboxylic acid	– COOH	oic acid

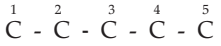
(iii) Prefix : There are many groups which are not regarded as functional groups in the IUPAC system. These are regarded as side chains and represent as prefix. A prefix is placed before the word root while naming a particular compound.



3-methyl

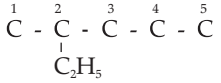
➢ **Rules for naming an Organic Compound :**

(i) Selection of carbon chain : The longest chain of carbon atoms in the structure of the compound is found first. The compound is then named as a derivative of the alkane hydrocarbon.



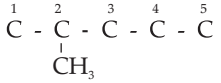
Longest chain of 5 carbon atoms, so word root is 'pent'.

(ii) The alkyl group present as side chains (branches) are considered as substituent's and named separately as methyl (– CH_3) or ethyl (– C_2H_5) group.



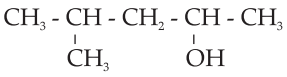
2-ethyl

(iii) The carbon atoms of the longest carbon chain are numbered in such a way that the alkyl groups (substitutes) get the lowest possible number.



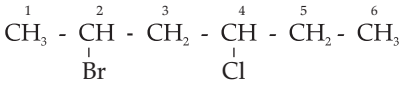
2-methyl

(iv) If the functional group is also present in the chain, then the carbon atoms are numbered in such a way that the functional group gets the smallest possible number.

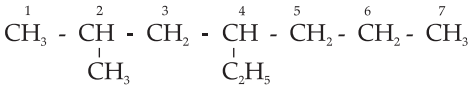


4-methyl pentan - 2- ol

(v) If different types of substituents are attached in the chain, they are named alphabetically.

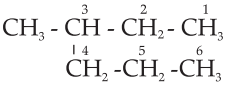


2-bromo-4-chlorohexane



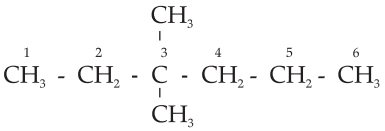
4-ethyl 2-methylheptane

(vi) The IUPAC name of the compound is obtained by writing the position and name of alkyl group just before the name of parent 'hydrocarbon'.



3-methylhexane

(vii) Multiple alkyl groups are named as di, tri or tetra for two, three or four respectively.



3,3-dimethyl hexane

Mnemonics

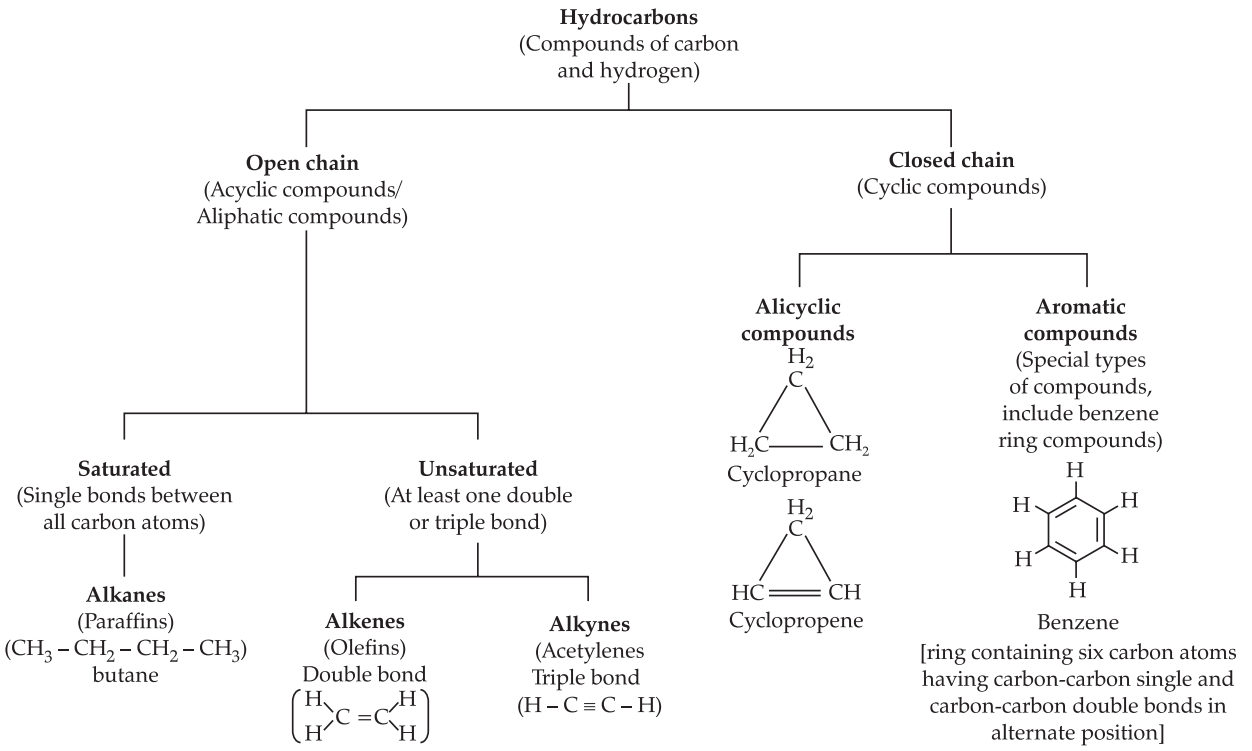
Concept : Homologous series of alkanes.
Mnemonics : Many **e**lephants **p**refer **b**lue **p**ineapples
Interpretation :
M – methane
E – ethane
P – propane
B – butane
P – pentane

Key Words

- **Organic Chemistry :** It is the study of hydrocarbons and their derivatives.
- **Catenation :** It is the property by virtue of which atoms of the same element get linked together through covalent bonds so as to form long straight, branched or closed chain or rings.
- **Tetracovalency :** Carbon atom shows tetracovalency because it has four electrons in its valence shell.
- **Functional Group :** An atom or group of atoms or some other characteristics structural feature which gives special properties to a compound.
- **Homologous Series :** It is a series of compound having similar structural formulae, same functional group and hence similar chemical properties.
- **Structural Formula :** It gives up the relative arrangements of bonded atoms in a molecule.

Key Terms

- Carbon is a necessary element in every organic compound.
- The characteristic of the carbon atom by virtue of which it forms four covalent bonds, is known as tetravalency of carbon.
- The unique nature of carbon a atom, i.e., catenation and tetravalency gives rise to the formation of a large number of compounds.
- **Classification of Hydrocarbons**



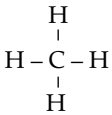
Topic-2

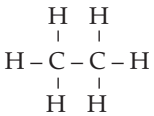
Hydrocarbons-Alkanes, Alkenes and Alkynes

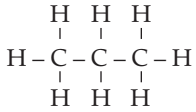
Concepts covered: *Alkanes: • Structural formula, • Laboratory preparation of methane and ethane, • Properties of methane and ethane, • Alkenes, • Preparation of ethene, • Properties of alkenes, • Alkynes, • Laboratory preparation of ethyne, • Properties of alkynes.*

Revision Notes

- Alkanes are the saturated hydrocarbons which contain only single covalent bonds between two carbon atoms. They posses the general formula C_nH_{2n+2}, Where n = is the number of the series is methane CH_4 and second member (n=2) is ethane, C_2H_6.
- **Structural formula of Alkanes** :

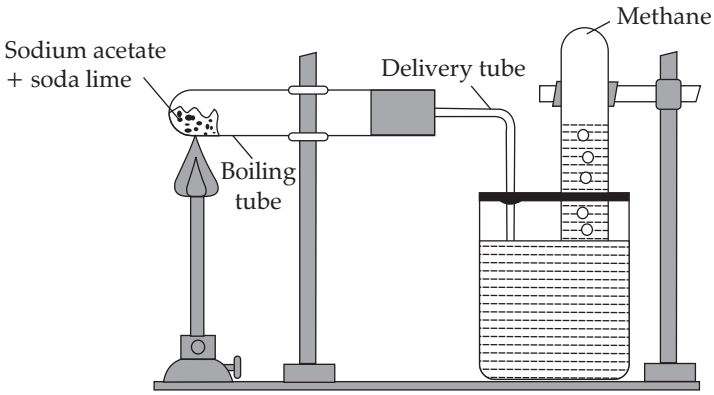

Methane


Ethane


Propane

- **Laboratory preparation of methane and ethane :** Methane is prepared by anhydrous sodium acetate (sodium ethanoate) with sodalime, NaOH + CaO.

$$\underset{\text{Sodium acetate}}{CH_3COONa(s)} + NaOH(s) \xrightarrow[\Delta]{CaO} Na_2CO_3(s) + \underset{\text{Methane}}{CH_4(g)}\uparrow$$



Preparation of methane (CH_4)

Ethane is prepared by heating anhydrous sodium propionate with sodalime.

$$\underset{\text{Sodium propionate}}{C_2H_5COONa(s)} + NaOH(s) \xrightarrow[\Delta]{CaO} Na_2CO_3(s) + \underset{\text{Ethane}}{C_2H_6(g)}\uparrow$$

- **Other methods of preparations of Methane :**

(i) Methane can also be prepared by the action of water on aluminium carbide.

$$\underset{\text{Aluminium carbide}}{Al_4C_3(s)} + 12H_2O(l) \rightarrow 4Al(OH)_3(s) + \underset{\text{Methane}}{3CH_4(g)}$$

(ii) Methane can also be prepared by the reduction of methyl iodide (iodo methane) with Zn-Cu couple Zn/HCl.

$$\underset{\text{Iodomethane}}{CH_3I} + 2[H] \xrightarrow{Zn-Cu\ Couple} \underset{\text{Methane}}{CH_4} + HI$$

- **Other methods of Preparation of Ethane :**

(i) Ethane can also be prepared by the reduction of bromoethane with Zn-Cu couple or Zn/HCl.

$$\underset{\text{Bromoethane}}{C_2H_5Br} + 2[H] \xrightarrow{Zn-Cu\ Couple} \underset{\text{Ethane}}{C_2H_6} + HBr$$

(ii) Ethane from alkyl halides - Methyl iodide or methyl bromide reacts with sodium metal in the presence of dry ether, than ethane gas is produced.

$$2CH_3I + 2Na \xrightarrow{dry\ ether} \underset{\text{Ethane}}{H_3C - CH_3} + 2NaI$$

➢ **Physical Properties :**

1. Methane is colourless and odourless gas. Its melting point is - 183°C and boiling point is -162°C. It is insoluble in water but soluble in organic solvents.
2. Ethane is colourless and odourless gas. Its boiling point is - 89°C and melting point is - 172°C. It is insoluble in water but soluble in organic solvents.

➢ **Chemical Properties :**

(i) Combustion of Alkanes : Methane and ethane burn in air to form carbon dioxide and water with the evolution of large amount of heat.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{Energy}$$

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O + \text{Energy}$$

(ii) Substitution Reactions :

Methane reacts with chlorine in the presence of diffused sunlight to form mono-chloromethane, CH_3Cl.

$$CH_4(g) + Cl_2 \rightarrow \underset{\text{Monochloromethane}}{CH_3Cl(g)} + HCl(g)$$

With excess of chlorine, the remaining three H atoms are successively replaced by Cl atoms to form dichloromethane, trichloromethane and tetrachloromethane.

$$CH_3Cl + Cl_2 \rightarrow \underset{\text{Dichloromethane}}{CH_2Cl_2} + HCl$$

$$CH_2Cl_2 + Cl_2 \rightarrow \underset{\text{Trichloromethane}}{CHCl_3} + HCl$$

$$CHCl_3 + Cl_2 \rightarrow \underset{\text{Tetrachlormethane}}{CCl_4} + HCl$$

These reactions are called **substitution rections** because chlorine atom successively replaces hydrogen atoms in the methane molecule.

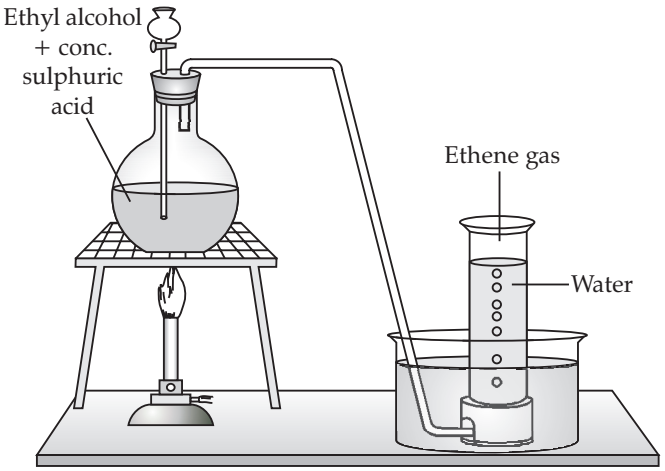
Similarly it will happen with C_2H_6

➢ **Alkenes :** Alkenes are also called olefins because the lower member of alkenes form oily products when they were treated with chlorine or bromine. Alkenes form a homologous series having the general formula C_nH_{2n}. Ethene is the first member of the alkene series.

Preparation of Ethene

i. Dehydration of ethyl alcohol.

Reactants : Ethanol and conc. sulphuric acid.



Laboratory Preparation of ethene

➢ **Reaction :**

$$\underset{\text{Ethyl alcohol}}{CH_3CH_2OH} + H_2SO_4 \xrightarrow{100°C} \underset{\text{Ethyl hydrogen sulphate}}{CH_3CH_2HSO_4} + H_2O$$

$$CH_3CH_2HSO_4 \xrightarrow[170°C]{\text{excess } H_2SO_4} \underset{\text{Ethene}}{CH_2=CH_2} + H_2O$$

➢ **Collection :** The gas is collected by downward displacement of water because :

(i) It is an inflammable gas.

(ii) It is insoluble in water.

(ii) By dehydration : Industrial preparation:

By passing ethanol vapours through a tube containing alumina (Al_2O_3) at 300°C.

$$C_2H_5OH \xrightarrow[300^\circ C]{Al_2O_3} C_2H_4 + H_2O$$

(iii) Dehydrogenations :

When an alkyl halide is heated gently in an alcoholic medium, it forms corresponding alkene.

$$\underset{\text{Ethyl chloride}}{C_2H_5Cl} + \underset{\text{(alc.hot and conc.)}}{KOH} \rightarrow C_2H_4 + KCl + H_2O$$

$$\underset{\text{Ethyl bromade}}{C_2H_5Br} + \underset{\text{(alc.hot and conc)}}{KOH} \rightarrow C_2H_4 + KBr + H_2O$$

➢ **Physical properties of alkenes**

Ethene is a colourless and inflammable gas with a peculiar odour. Its boiling is - 102°C and melting point is –169°C. It is sparingly soluble in water but highly soluble in organic solvents.

➢ **Chemical properties**

(i) Addition of hydrogen (hydrogenation) in the presence of catalyst such as platinum or palladium at ordinary temperature or nickel at 200°C.

$$\underset{\text{Ethene}}{C_2H_4} + H_2 \xrightarrow[200^\circ C]{Ni} \underset{\text{Ethane}}{C_2H_6}$$

(ii) Addition of halogens (halogenation) : Ethene reacts with halogens in presence of carbon tetrachloride as a solvent. The order of the reaction with halogens is $F_2 > Cl_2 > Br_2 > I_2$

$$\underset{\text{Ethene}}{CH_2=CH_2} + Cl_2 \xrightarrow{CCl_4} \underset{\text{(1, 2-dichloroethane)}}{\begin{matrix} CH_2 & - & CH_2 \\ | & & | \\ Cl & & Cl \end{matrix}}$$

$$\underset{\text{Ethene}}{CH_2=CH_2} + Br_2 \xrightarrow{CCl_4} \underset{\text{(1, 2-dibromoethane)}}{\begin{matrix} CH_2 & - & CH_2 \\ | & & | \\ Br & & Br \end{matrix}}$$

(iii) Addition of water (hydration)

$$CH_2=CH_2 + H_2O \xrightarrow{H^+} \underset{\text{Ethyl alcohol}}{C_2H_5OH}$$

(iv) Addition of HCl : Ethene reacts with HCl at room temperature. The order of reaction of hydrogen halides with alkanes is HI > HBr > HCl > HF.

$$\underset{\text{Ethene}}{CH_2=CH_2} + HCl_{(aq)} \longrightarrow \underset{\begin{pmatrix}\text{Ethyl chloride}\\ \text{Chloroethane}\end{pmatrix}}{CH_3CH_2Cl}$$

(v) Polymerization : Ethene polymerises to produce polyethene.

$$\underset{\text{Ethane}}{nH_2C=CH_2} \xrightarrow{\text{Polymerization}} \underset{\text{Polyethene}}{\{H_2C-CH_2\}_n}$$

(vi) Combustion of ethene : Ethene burns in air with a sooty flame producing a large amount of heat.

$$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O + \text{Heat}$$

➢ **Uses of Ethene :**

(i) It is used for ripening of fruits.

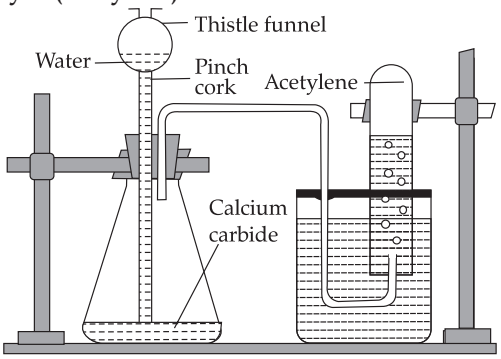
(ii) It is used in making polythene.

(iii) It is used in making epoxy ethane.

➢ **Alkynes**

- The aliphatic hydrocarbons, containing a triple bond (-C ≡ C-) between two carbon atoms are called alkynes. General formula for Alkynes is C_nH_{2n-2}. Ethyne is the first member of alkyne series.
- Molecular formula of Ethyne is C_2H_2.

➢ **Laboratory Preparation of Ethyne (Acetylene)**



Laboratory preparation of ethyne

➢ **Reactants :** Water and Calcium carbide

$$\underset{\text{Calcium Carbide}}{CaC_2} + 2H_2O \rightarrow \underset{\text{Calcium hydroxide}}{Ca(OH)_2} + \underset{\text{Ethyne}}{C_2H_2}\uparrow$$

➢ **Collection :** The gas collected by downward displacement of water, since it is insoluble in water.

➢ **Preparation from 1,2-dibromoethane** :

$$\underset{\substack{| \\ CH_2Br - CH_2Br}}{C_2H_4} + 2\underset{\text{alcoholic}}{KOH} \xrightarrow[\text{boiling}]{200^oC} \underset{\text{Ethyne}}{CH \equiv CH} + 2KBr + 2H_2O$$

➢ **Physical Properties**

It is a colourless gas with an ether like odour. Its boiling point is - 75°C. It liquefies at - 84°C. It is negligibly soluble in water but highly soluble in organic solvents.

➢ **Chemical Properties**

(i) Oxidation of Ethyne: Ethyne burns in excess air with a brilliant white flame to produce carbon dioxide, water vapours and a large amount of heat.

$$\underset{\text{Ethene}}{2CH = CH} + 5O_2 \rightarrow 4CO_2\uparrow + 2H_2O + \text{heat}$$

(ii) Addition of hydrogen (catalytic hydrogenation) : In the presence of nickel, platinum or palladium.

$$\underset{\text{Ethyne}}{C_2H_2} + H_2 \xrightarrow{Ni} \underset{\text{Ethylene}}{C_2H_4}$$

$$\underset{\text{Ethylene}}{C_2H_4} + H_2 \xrightarrow{Ni} \underset{\text{Ethane}}{C_2H_6}$$

(iii) Reaction with chlorine : Acetylene in an inert solvent reacts with chlorine to give first dichloroethene and then tetrachloroethane.

$$\underset{\text{Acetylene}}{HC \equiv CH} + Cl_2 \xrightarrow{Ni} \underset{\substack{\text{Acetylenedichloride} \\ \text{(1,2-dichloroethene)}}}{\begin{matrix} CHCl \\ \| \\ CHCl \end{matrix}} + Cl_2 \rightarrow \underset{\substack{\text{Acetylenetetrachloride} \\ \text{(1,1,2,2-tetrachloroethane)}}}{\begin{matrix} CHCl_2 \\ | \\ CHCl_2 \end{matrix}}$$

Acetylene reacts vigorously with chlorine gas in the presence of sunlight to give out flames.

$$C_2H_2 + Cl_2 \rightarrow 2C + 2HCl$$

(iv) Reaction with Bromine : Ethyne reacts with bromine in carbon tetrachloride to first form dibromoethene and then tetrabromoethane. During addition, the red - brown colour of bromine gets decolourized.

$$\underset{\text{Acetylene}}{C_2H_2} \xrightarrow{+Br_2} \underset{\text{Acetylene dibromide}}{C_2H_2Br_2} \xrightarrow{+Br_2} \underset{\text{Acetylene tetrabromide}}{C_2H_2Br_4}$$

(v) Reaction with HCl :

$$\underset{\text{Ethyne}}{\begin{matrix} CH \\ \| \\ CH \end{matrix}} + HCl \rightarrow \underset{\text{Chloroethene}}{\begin{matrix} CH_2 \\ \| \\ CHCl \end{matrix}} + HCl \rightarrow \underset{\text{1,1-dichloroethane}}{\begin{matrix} CH_3 \\ | \\ CHCl_2 \end{matrix}}$$

➢ **Uses**

(i) As an illuminant in oxy-acetylene lamp.

(ii) For artificial ripening and preservation of fruits.

(iii) For oxy-acetylene welding at very high temperature.

Mnemonics

Concept : Preparation of methane.
Mnemonics : SAW SaiL GuM
Interpretation :
S – sodium
A – acetate
W – with
S – soda
L – lime
G – gives
M – methane

Key Words

- **Alkanes :** These are the hydrocarbons in which all the linkages between the carbon atom are single covalent bonds.
- **Fire-damp :** It is called 90% methane found in cavities in coal.
- **Pyrolysis :** The decomposition of a compound by heat in the absence of air is known as Pyrolysis.
- **Cracking :** It is defined as a process in which pyrolysis occurs in alkanes.

Key Terms

- Alkanes are relatively unreactive under ordinary conditions so, they are called paraffins.
- Alkanes with more than three carbon atoms form isomers.
- Methane is considered as a green house gas. It is 20 times more effective in trapping heat in comparison to CO_2.
- Methane can not be prepared by Wurtz reaction as this reaction is not suitable for the preparation of alkanes with odd number of carbon atoms.
- Soot is used in the manufacture of printing inks and tyres.
- All alkanes react with chlorine, bromine and iodine in a similar manner, producing the corresponding substituted products.
- Alkenes are also known as olefins (oil-forming) because the lower members of alkenes form oily products on reacting with chlorine or bromine.
- Ethyne is used for oxy-acetylene welding at very high temperature. It is also used for artificial ripening and preservation of fruits.

❑❑