4. CARBON & ITS COMPOUNDS

Carbon in nutshell

- Sixth most abundant element in the universe.
- Forms the largest number of compounds and is studied as a separate branch of chemistry known as organic chemistry.
- Atomic No = 6 ; Mass No. = 12
- Earth's crust has only 0.02% carbon in the form of minerals and atmosphere has 0.03% of carbon dioxide.

Bonding in carbon

- **The covalent bond**

We know that the reactivity of elements is explained as their tendency to attain a completely filled outer shell, that is, attain noble gas configuration. Elements forming ionic compounds achieve this by either gaining or losing electrons from the outermost shell. In the case of carbon,it has four electrons in its outermost shell and needs to gain or lose four electrons to attain noble gas configuration. If it were to gain or lose electrons –

- It could gain four electrons forming C^{4-} anion. But it would be difficult for the nucleus with six protons to hold on to ten electrons, that is, four extra electrons.
- It could lose four electrons forming C^{4+} cation. But it would require a large amount of energy to remove four electrons leaving behind a carbon cation with six protons in its nucleus holding on to just two electrons.

Carbon overcomes this problem by sharing its valence electrons with other atoms of carbon or with atoms of other elements. Not just carbon, but many other elements form molecules by sharing electrons in this manner. The shared electrons 'belong' to the outer shells of both the atoms and lead to both atoms attaining the noble gas configuration. This type of bonding is called covalent bonding.

- Thus the bonds which are formed by the sharing of an electron pair between two same or different atoms are known as covalent bonds.
- The no. of electrons shared show the covalency of that atom.

- **Examples of formation of covalent bonds**

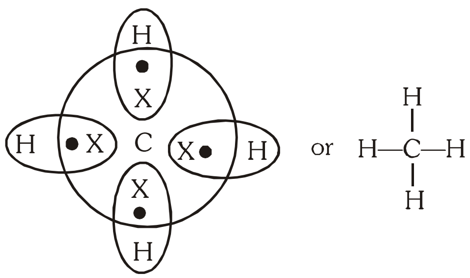


Fig. 1 Formation of methane molecule [It is also called marsh gas, used as a fuel & is a major compound of CNG]

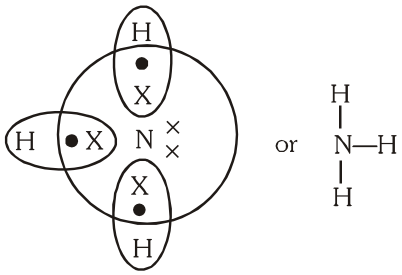
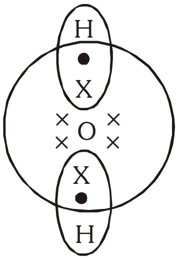


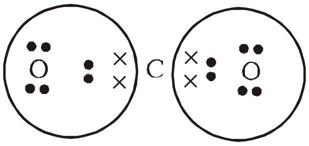
Fig. 2 Formation of ammonia (NH_3) molecule

Fig. 3 Formation of water molecule



or H—O—H

Fig. 4 Formation of sulphur molecule (S_8)



or O=C=O

Fig. 5 Formation of sulphur molecule

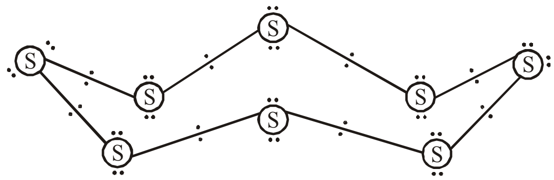


Fig. 6 Formation of cyclopentane (C_5C_{10})

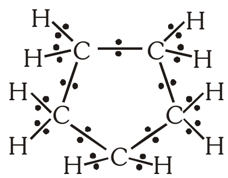


Fig. 7 Formation of chloromethane (CH_3Cl)

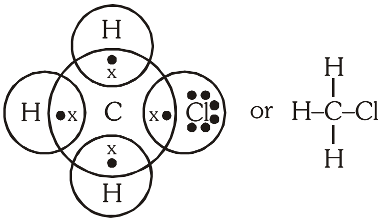


Fig. 8 Formation of Ethanoic acid (CH_3COOH)

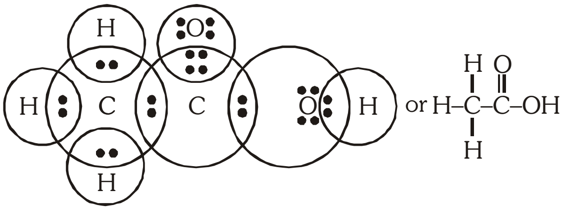
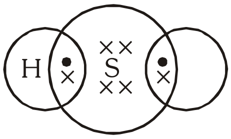


Fig. 9 Formation of Hydrogen sulphide (H_2S)



or H–S–H

Fig. 10 Formation of propanone (CH_3COCH_3)

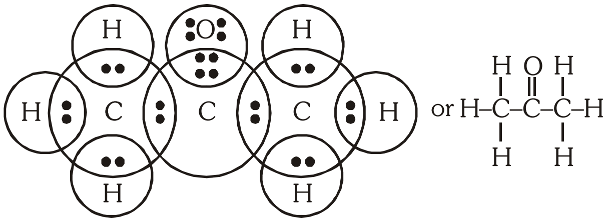
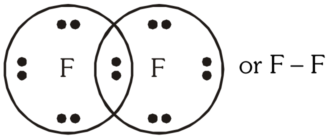


Fig. 11 Formation of Fluorine (F_2)



- **Properties of covalent compounds**
  - Covalently bonded molecules are seen to have strong bonds within the molecule, but intermolecular forces are small. This gives rise to the low melting and boiling points of these compounds. Exceptions : diamond & graphite.
  - Since the electrons are shared between atoms and no charged particles are formed, such covalent compounds are generally poor conductors of electricity.
  - These compounds are generally insoluble in water but some which are capable to form H-bond are soluble in water.

Allotropes of carbon

- **Diamond**
  - Each carbon in a diamond crystal is bonded to four other carbon atoms making a giant macromolecular array (lattice).
  - It is the hardest naturally occuring substance.
  - It is brittle (not malleable).
  - Diamond is an insulator (non-conductor of electricity) but good thermal conductor (heat).
  - It is insoluble in water due to its non polar nature.
  - It has very high melting point of about 3500 °C due to strong covalent bonds.
- **Uses of Diamond**
  - They are used in jewellery because of their ability to reflect and refract light.
  - Black diamonds called **carbonado** are used in cutting glass and drilling rocks.
  - Diamond has extraordinary sensitivity to heat rays and due to this reason, it is used for making high precision thermometers.
  - Diamond has the ability to cut out harmful radiations and due to this reason, it is used for making protective windows for space probes.
  - Diamond dies are used for drawing thin wires. Very thin tungsten wires of diameter of less than one sixth of the diameter of human hair have been drawn using diamond dies.

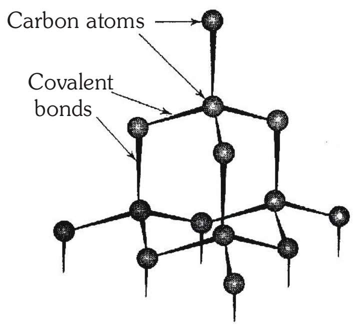


Fig.12 Part of the covalent giant structure of diamond

- **Graphite**

  - In graphite, each carbon atom is bonded to three other carbon atoms in the same plane giving a hexagonal array.
  - There are strong covalent bonds between carbon atoms in each layer. But, only weak forces exist between layers. This allows layers of carbon to slide over each other in graphite. That makes it slippery in nature.

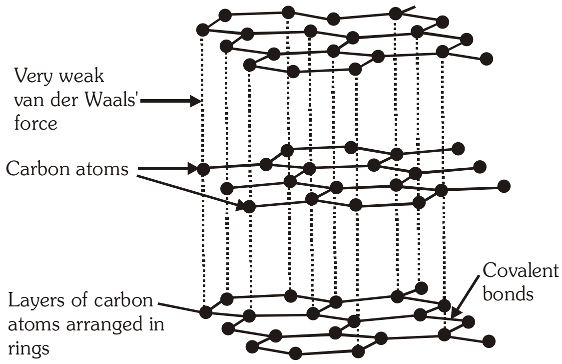


Fig.13 Part of the giant structure of graphite

  - It is a dark grey solid having a metallic lustre.
  - It has a soft greasy touch. It makes the paper grey.
  - It density ranges from 1.5 to 2.3 gm/cm^3.
  - It is good conductor of heat and electricity.
  - It is insoluble in ordinary solvents.
  - Graphite when heated in the absence of air, melts at about 3730℃
  - Graphite catches fire at 700℃ in the presence of oxygen and forms carbon dioxide gas.

$$\underset{\text{Graphite}}{C} + \underset{\text{Oxygen}}{O_2} \xrightarrow{700^\circ C} \underset{\text{Carbon dioxide}}{CO_2}$$

- **Uses of Graphite**

  - **As pencil lead :** Graphite is mixed with clay or finely powdered sand. It is then moulded to form thin rods, which are called pencil lead. The hardness of pencil lead depends upon the amount of clay in it, i.e, more the clay, the harder is the pencil lead.
  - **As electrodes :** Graphite is a good conductor of electricity. Moreover, it does not react with acids or alkalis. Thus, it is used for making electrodes for electrolytic cells, which are not affected by acids and alkalis.
  - **As a dry lubricant :** Graphite powder suspended in oil is used as a lubricant in those part of machinery, where oil cannot be applied easily.
  - **As heat resistant crucibles :** When graphite mixed with clay is moulded and baked, it forms heat resistant crucibles. The crucibles can with stand high temperatures on account of clay and are good conductors on account of graphite.
  - **In making light weight composite material :** The graphite fibres are very strong. These fibres are used to reinforce plastic. The reinforced plastic with carbon fibres form a composite material. It is used for making (i) tennis rackets, (ii) fishing rods, (iii) bicycle frame, (iv) aircraft frames (v) parts of the spacecraft, and (vi) dish antennas.
  - **In making artificial diamonds :** Graphite is heated to a temperature of 2000℃ in the presence of some noble gas at a pressure of 100,000 times the atmospheric pressure. The high pressure and temperature breaks the carbon atoms in graphite, which rearrange themselves into diamond structure. Roughly 90% of the diamonds required for making tools are made artificially from graphite.

- **Fullerenes**
  - These are small molecules of carbon in which the giant structure is closed over into spheres of atoms (**bucky balls**) or tubes (sometimes called **nano-tubes**).
  - The smallest fullerene has 60 carbon atoms arranged in pentagons and hexagons like a football. This is called **Buckminster fullerene**.
  - The name 'buckminster fullerene' comes from the inventor of the geodesic dome (Richard Buckminster Fuller) which has a similiar structure to a fullerene.

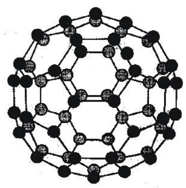


Fig.14 Structure of buckminsterfullerene. (The black and grey balls represent carbon atoms).

  - Fullerenes were first isolated from the soot of chimneys and extracted from solvents as red crystals.
  - Fullerenes are insoluble in water but soluble in methyl benzene. They are non- conductors as the individual molecules are only held to each other by weak Vander Waal's forces.
  - They are not very reactive due to the stability of the graphite-like bonds, and are also fairly insoluble in many solvents.
- **Uses of fullerenes**
  - Fullerenes and their compounds may prove to be of great use as semiconductors, superconductors, lubricants, catalysts, electric wires and as fibres to reinforce plastic (to make plastic strong).
  - Some of the compounds of fullerenes appear to be active against diseases like cancer and AIDS. This can lead to finding cure for cancer and AIDS.

Versatile nature of carbon

- **Catenation**

Carbon has the unique ability to form bonds with other atoms of carbon, giving rise to large molecules. This property is called catenation. These compounds may have long chains of carbon, branched chains of carbon or even carbon atoms arranged in rings.

- **Tetravalency**

Carbon atoms may be linked by single, double or triple bonds. Compounds of carbon, which are linked by only single bonds between the carbon atoms are called saturated compounds. Compounds of carbon having double or triple bonds between their carbon atoms are called unsaturated compounds.Since carbon has a valency of four, it is capable of bonding with four other atoms of carbon or atoms of some other mono-valent element.

- **Stability of C–C bonds**

No other element exhibits the property of catenation to the extent seen in carbon compounds. Silicon forms compounds with hydrogen which have chains of upto seven or eight atoms, but these compounds are very reactive. The carbon-carbon bond is very strong and hence stable. This gives us the large number of compounds with many carbon atoms linked to each other.

- **Small size of carbon**

The bonds that carbon forms with most other elements are very strong making these compounds exceptionally stable. One reason for the formation of strong bonds by carbon is its small size. This enables the nucleus to hold on to the shared pairs of electrons strongly. The bonds formed by elements having larger atoms are much weaker.

Important note

Remember that the strength of bond decreases with increase in the size of atoms.

Vital force theory

- **Organic compounds**

Because of versatile nature of carbon, it forms many compounds. In eighteenth century all known compounds were divided into two categories.

Compound

- **Organic compounds** — Like urea, sugar, oils, fats dyes etc. which were isolated directly or indirectly from living organisms such as animals and plants.
- **Inorganic compounds** — Like marble, common salt, alum, $CuSO_4$ etc which were isolated from non-living sources such as rocks and minerals.

- **Vital force theory**

This theory was given by **Berzelius** in 1815.

According to him, organic compounds are produced only under the influence of some mysterious force existing in the living organism. This mysterious force was called the **vital force**. So, it was believed that no organic compound can be prepared in the laboratory.

- **Wohler's synthesis**

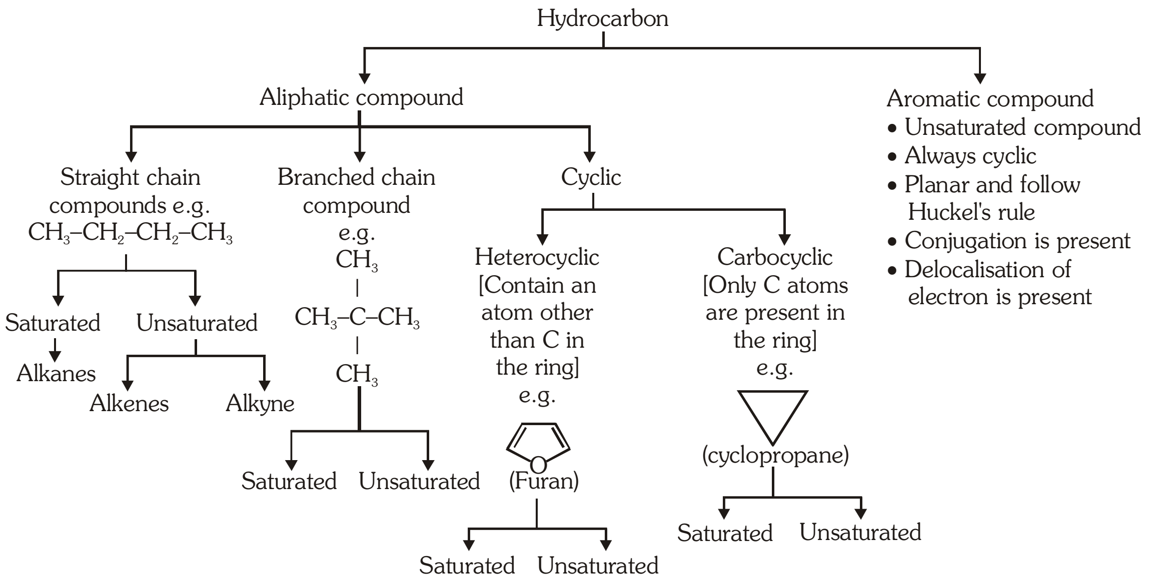
Berzilius's theory was disapproved by Friedrich Wohler in 1828 by preparing urea from ammonium cyanate (NH_4CNO) in laboratory.

Structure of urea $\longrightarrow H_2N{-}\overset{\overset{\displaystyle O}{\|}}{C}{-}NH_2$

- **Modern definition of organic compounds**

Compounds of carbon, containing usually hydrogen and one and more other element such as oxygen, nitrogen, sulphur, halogens, phosphorus etc. are called **organic compounds**.

Classification of organic compounds



- **Saturated and unsaturated hydrocarbon**

  On the basis of **bonding** carbon compounds can be classified in two categories.

  - Saturated hydrocarbons
  - Unsaturated hydrocarbons

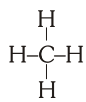
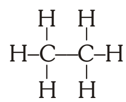
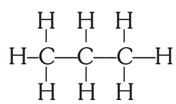
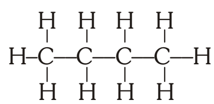
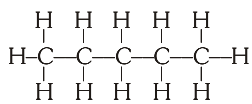
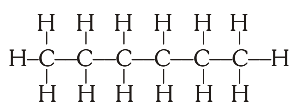
- **Saturated Hydrocarbon**

  The hydrocarbons which contain only single carbon-carbon covalent bonds are called **saturated hydrocarbons**.

  They are also called **alkanes**.

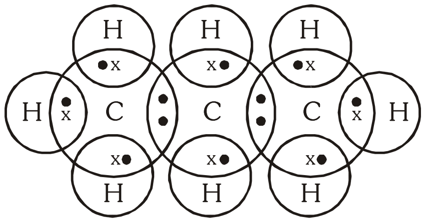
  General formula for alkanes is C_nH_{2n+2} where 'n' is the number of carbon atoms.

General formula of saturated hydrocarbon (C_nH_{2n+2})

No. of 'C' atoms	Name	Formula	Structure
1	Methane	CH_4	
2	Ethane	C_2H_6	
3	Propane	C_3H_8	
4	Butane	C_4H_{10}	
5	Pentane	C_5H_{12}	
6	Hexane	C_6H_{14}	

- **Structure of propane C_3H_8**

In a similar manner we can derive the structure of propane. $H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-H$



Lewis dot structure of propane

- **Unsaturated hydrocarbons**

  The hydrocarbons in which two carbon atoms are bonded to each other by a double (=) or a triple (≡) bond is called an **unsaturated hydrocarbon**.

  Unsaturated hydrocarbons are of two types viz. alkenes and alkynes.

- **Alkenes** ($-\overset{|}{C}=\overset{|}{C}-$)

  The hydrocarbons in which the two carbon atoms are bonded by a double bond are called **alkenes**.

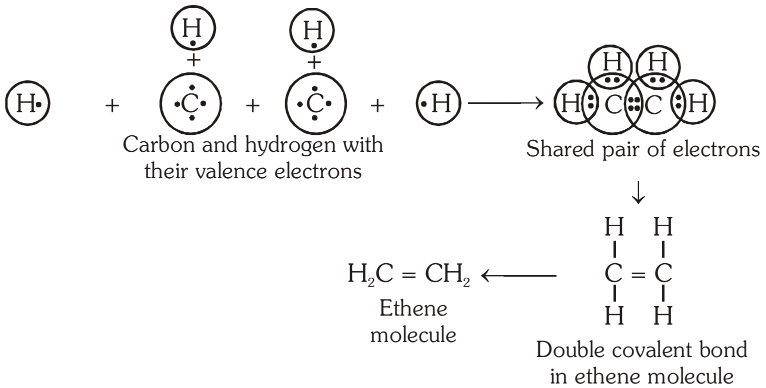
  Their general formula is C_nH_{2n} where "n" is the number of carbon atoms.

General formula of alkenes : C_nH_{2n}

No. of C atoms	Name	Formula	Structure
2	Ethene	C_2H_4	$H_2C=CH_2$ or $CH_2=CH_2$
3	Propene	C_3H_6	$H-\overset{H}{\underset{H}{C}}-\overset{H}{C}=\overset{H}{C}-H$ or $CH_3-CH=CH_2$
4.	Butene	C_4H_8	$H-\overset{H}{\underset{H}{C}}-\overset{H}{C}=\overset{H}{C}-\overset{H}{\underset{H}{C}}-H$ or $CH_3-CH=CH-CH_3$ $H-\overset{H}{C}=\overset{H}{C}-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-H$ or $CH_2=CH-CH_2-CH_3$

- **Formation of ethene molecule (C_2H_4)**

The electronic configuration of carbon atom is 2, 4. There are four valence electrons in one C atom. Each H atom contains one valence electron.



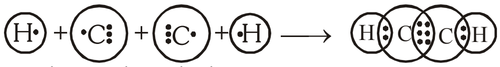
Alkyne (–C≡C–)

The hydrocarbons in which two carbon atoms are bonded by a triple bond are called **alkynes**. Their general formula is C_nH_{2n-2} where 'n' is the number of carbon atoms.

General formula of saturated alkynes (C_nH_{2n-2})

No. of 'C' atoms	Name	Formula	Structure
2	Ethyne	C_2H_2 or HC≡CH	H–C≡C–H
3	Propyne	C_3H_4 or H_3C–C≡C–H	H H—C—C≡C—H H
4	Butyne	C_4H_6 or H_3C–C≡C–CH_3	H H H—C—C≡C—C—H H H

Formation of ethyne molecule (C_2H_2)



⟶ H – C ≡ C – H

Two carbon and two hydrogen atoms with their valence electrons — Shared pairs of electrons — Triple covalent bond in ethyne molecule

Chains, branches and rings

On the basis of **structure** carbon compounds can be divided into 3 categories.

(a) Straight chain compounds

(b) Branched chain compounds

(c) Closed chain / cyclic / ringed compounds

Straight chain compounds

If a carbon compound has carbon-carbon link in chain fashion, we get a straight chain compound. In these, a carbon can form bond with a maximum of 2 carbon atoms e.g.

(i) Straight chain alkanes

CH_4	CH_3–CH_3	CH_3–CH_2–CH_3	CH_3–CH_2–CH_2–CH_3
Methane	Ethane	Propane	Butane

(ii) Straight chain alkenes

H_2C=CH_2	CH_3–CH=CH_2	CH_3–CH=CH–CH_3 or CH_2=CH–CH_2–CH_3
Ethene	Propene	Butene

(iii) Straight chain alkynes

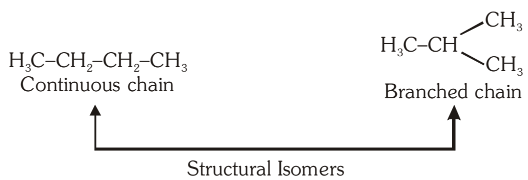
HC≡CH	H_3C–C≡CH	H_3C–C≡C–CH_3 or HC≡C–CH_2–CH_3
Ethyne	Propyne	Butyne

Branched structure

The alkanes containing three or less carbon atoms do not form branches.

CH_4	CH_3–CH_3	CH_3–CH_2–CH_3
Methane	Ethane	Propane

The alkane containing four carbon atoms (C_4H_{10}) has two types of arrangement of carbon atoms.



- Thus carbon compounds in which atleast one carbon of the chain is linked to three or four other carbon atoms are called **branched chain compounds**.
- Like saturated compounds, unsaturated compounds can also have branched chain structure e.g. C_2H_4, butene may have following structure.

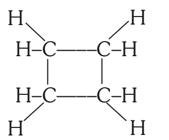
$CH_3–CH_2–CH=CH_2$ (1) $CH_3–CH=CH–CH_3$ (2) $CH_3–\underset{\displaystyle CH_3}{\underset{|}{C}}=CH_2$ (3)

Among these three, (1) and (2) are straight chains while (3) is a branched chain.

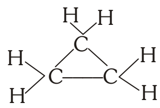
- **Closed chains or cyclic hydrocarbons or ring hydrocarbons**

  These hydrocarbons contains closed chain or ring of atoms in their molecules. These can be of further two types :

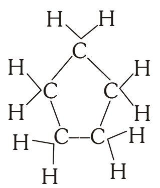
- **Alicyclic hydrocarbon or saturated cyclic carbon compounds or cycloalkanes**
  - These hydrocarbons contain a ring chain of three or more carbon atoms.
  - These cyclic compounds are named by prefixing '**cyclo**' before the name of corresponding straight chain hydrocarbon.



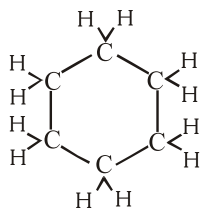
Cyclobutane (C_4H_8)



Cyclopropane (C_3H_6)

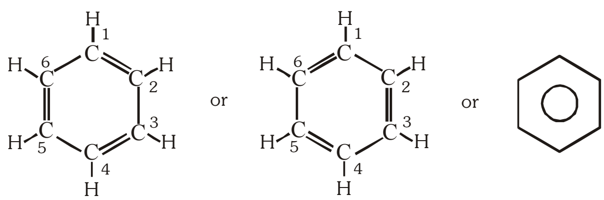


Cyclopentane (C_5H_{10})



Cyclohexane (C_6H_{12})

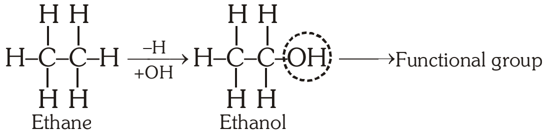
- **Aromatic hydrocarbon or Unsaturated cyclic carbon compound**
- These have at least one benzene ring in their molecules.
- It is a special type of ring of six carbon atoms with three double bonds in alternate positions.



Benzene

- **Functional group**
- Carbon forms most of the compounds with hydrogen. But carbon also forms bonds with other atoms such as halogen, oxygen, nitrogen and sulphur. Therefore, carbon is said to be a very friendly element.
- These compounds are obtained by replacing one or more hydrogen atoms by other atoms such that the valency of carbon remains satisfied. The atom or a group of atoms replacing the hydrogen atom are called **heteroatom** or **functional group** respectively.
- Different organic compounds having same functional group have almost same properties. These are called **families**.

- To understand the meaning of a functional group, let us consider ethane (C_2H_6) and ethanol (C_2H_5OH). Here, ethanol is obtained by replacing one hydrogen atom of ethane by the hydroxyl group as shown below :



Both ethane & ethanol have different physical and chemical properties. For example,

- Ethane is a gas while ethanol is a liquid at room temperature.
- Ethanol is an antiseptic and hypnotic (induces sleep) but ethane does not have these properties.
- Ethanol reacts with sodium to form sodium ethoxide with the evolution of hydrogen gas but ethane does not give this reaction.

Example of different compounds with same functional group

Properties of CH_3–OH and CH_3–CH_2OH are similar and it is due to the presence of –OH (hydroxyl) group. This group is known as **alcoholic group**.

Family of compounds having –OH group is called **alcohol**.

Some Functional Groups in Carbon compounds

Hetero atom	**Functional Group**	**Formula of Functional Group**
Halogen atom (F, Cl, Br, I)	Halo (Fluoro, Chloro, Bromo, Iodo)	–X (–F, –Cl, –Br, –I)
Oxygen (O)	1. Alcohol	–OH
	2. Aldehydes	–C(H)=O or –CHO
	3. Ketones	>C=O or –CO–
	4. Carboxylic acid	–C(=O)–OH or –COOH

- **Homologous Series**

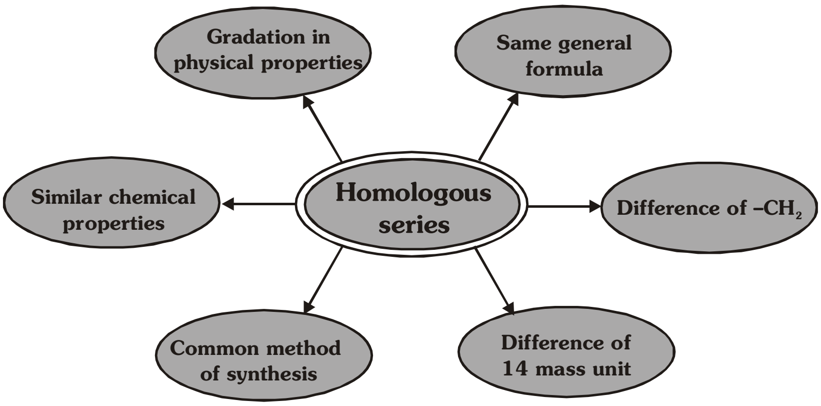
Definition : "A series of organic compounds having similar structures and similar chemical properties in which the successive members differ in their molecular formula by –CH_2 group".

The different members of the series are called as **homologues**.

Characteristics of homologous series

- All the members of a homologous series can be described by a common general formula.

  Example : All alkane can be described by the general formula $\mathbf{C_nH_{2n+2}}$.
- Each member of a homologous series differs from its higher and lower neighbouring member by a common difference of $–CH_2$ group.
- Molecular masses of the two adjacent homologues differ by 14 mass units, because molecular mass of $–CH_2$ group is 12 + 2 = 14.
- All the members of a homologous series show similar chemical properties. e.g. substitution reaction is shown by all alkanes.
- All the members of a homologous series show a gradation in physical properties as molecular mass increases. e.g. M.P. and B.P. increases with increase in molecular mass.
- All the members of the series can be prepared by similar methods known as the general method of preparation.



Alkane	**Alkene**	**Alkyne**
C_nH_{2n+2}	C_nH_{2n}	C_nH_{2n-2}
Homologous series	Homologous series	Homologous series

Some members of alkane, alkene and alkyne homologous series.

Name	Formula	Name	Formula	Name	Formula
Methane	CH_4	–	–	–	–
Ethane	C_2H_6	Ethene	C_2H_4	Ethyne	C_2H_2
Propane	C_3H_8	Propene	C_3H_6	Propyne	C_3H_4
Butane	C_4H_{10}	Butene	C_4H_8	Butyne	C_4H_6
Pentane	C_5H_{12}	Pentene	C_5H_{10}	Pentyne	C_5H_8
Hexane	C_6H_{14}	Hexene	C_2H_{12}	Hexyne	C_6H_{10}

- **Nomenclature of carbon compounds**

There are two ways to name carbon compounds :

1. Trivial system 2. IUPAC system

- **Trivial system :** In earlier days, organic compounds were named after the source from which they were obtained. For example, urea got its name because the substance was obtained from the urine of mammals. These names are without any systematic basis and are known as **common names** or **trivial names**.
- **IUPAC system :** It is the system for naming organic compound given by **International Union of Pure and Applied Chemistry**. This system is very useful in the study of organic compounds.

  In IUPAC system of nomenclature, the name of organic compounds consists of three parts.

  (i) Word root (ii) Suffix (iii) prefix
- **Word root :** The word root denotes the number of carbon atoms present in the chain. For chains containing upto four carbon atoms, special word roots (meth-C1, eth-C2, prop-C3, but-C4) have been used while those containing more than four carbon atoms, Greek numerals have been used to represent the word root. For example.

Chain length	Word root	Chain Length	Word Root
C-1	Meth	C-6	Hex
C-2	Eth	C-7	Hept
C-3	Prop	C-8	Oct
C-4	But	C-9	Non
C-5	Pent	C-10	Dec

- **Suffix**

The word root is linked to the suffix which may be primary or secondary or both.

- **Primary suffix :** It indicates the nature of linkage in the carbon atoms. For example if the carbon atom is linked by single covalent bond (C–C), the primary suffix - ane is used. Similarly for a double bond between two carbon atoms (C=C), –ene is used, the suffix –yne is used for a triple bond between two carbon atoms (C≡C).
- **Secondary suffix :** It indicates the presence of functional group in the organic compound. A few important secondary suffixes are listed below,

Functional group	Suffix
Alcohols (– OH)	–ol
Aldehydes (– CHO)	–al
Ketones (> C=O)	–one
Carboxylic acids (–COOH)	–oic acid

- **Prefix**

  There are few groups which are not regarded as functional groups in IUPAC name of a compound. These are regarded as substituent and are represented as prefixes and are put before the word root while naming a particular compound. A few important prefixes are given:

Substituent	Prefix
–F	Fluoro
–Cl	Chloro
–Br	Bromo
–I	Iodo
–R	Alkyl

Thus a complete IUPAC name of an organic compound may be represented as

Prefix + Word root + Primary suffix + Secondary suffix

- **Isomerism**

The existence of an organic compound with the same molecular formula and different structural formulae is called isomerism.

The isomerism can be of various types depending on the type of variation in the structures of the molecules.

(i) Chain isomerism: The phenomenon in which two or more organic compounds have the same molecular formula but differ in the arrangement of carbon atoms in the longest chain.

- All types of hydrocarbons (alkanes, alkenes and alkynes) with more than 3 carbon atoms exhibit this type of isomerism.
- The molecule in which all carbon atoms are arranged in a straight chain is called n-isomer. The molecule in which there is a branched chain arrangement in the molecule a prefix iso or neo is used depending on the type of branching.

Ex. 1. Pentane

$H_3C-CH_2-CH_2-CH_2-CH_3$ (n – Pentane)

$H_3C-CH_2-CH-CH_3$
$\quad\quad\quad\quad\quad\quad |$
$\quad\quad\quad\quad\quad CH_3$

(Isopentane)

$\quad\quad\; CH_3$
$\quad\quad\quad |$
$H_3C-C-CH_3$
$\quad\quad\quad |$
$\quad\quad\; CH_3$

(Neopentane)

2. Pentene

$H_2C=CH-CH_2-CH_2-CH_3$ (n – Pentene)

$\quad\quad\quad\quad\quad\quad\quad CH_3$
$\quad\quad\quad\quad\quad\quad\quad\; |$
$H_2C=CH-CH-CH_3$

(Isopentene)

3. Pentyne

$HC\equiv C-CH_2-CH_2-CH_3$ (n – Pentyne)

$HC\equiv C-CH-CH_3$
$\quad\quad\quad\quad\quad\; |$
$\quad\quad\quad\quad\; CH_3$

(Isopentyne)

(ii) Position isomerism: The phenomenon in which the hydrocarbon has the same chain but differs in the position of multiple bonds or constituents on the parent chain is called position isomerism.

This is exhibited by unsaturated hydrocarbons (alkenes and alkynes) with more than 3 carbon atoms (or) saturated hydrocarbons with substituents as side chain.

Ex. (i) Butene

Molecular formula - C_4H_8

$H_3C-CH_2-CH=CH_2$ (1 - Butene)

$H_3C-CH=CH-CH_3$ (2 - Butene)

(ii) Pentyne

Molecular formula - C_5H_8

$CH_3-CH_2-CH_2-C\equiv CH$ (1- Pentyne)

$H_3C-CH_2-C\equiv C-CH_3$ (2 - Pentyne)

(iii) 5-carbon chain with methyl substituent.

$\quad\; 1 \quad\;\; 2 \quad\quad\;\; 3 \quad\quad\; 4 \quad\quad\;\; 5$
$H_3C-CH_2-CH-CH_2-CH_3$ (3 - Methylpentane)
$\quad\quad\quad\quad\quad\quad\; |$
$\quad\quad\quad\quad\quad\; CH_3$

$\quad\; 1 \quad\;\; 2 \quad\quad\;\; 3 \quad\quad\; 4 \quad\quad\;\; 5$
$H_3C-CH-CH_2-CH_2-CH_3$ (2 - Methylpentane)
$\quad\quad\quad\;\; |$
$\quad\quad\; CH_3$

(iii) Functional isomerism: Compounds with the same molecular formula but different functional groups are called functional isomers and this phenomenon is called functional isomerism.

Ex. Two functional isomers are possible with the molecular formulae C_2H_6O.

One isomer with an alcoholic functional group (R—OH) and the other with an ether linkage or functional group (R—O—R)

(a) Molecular formulae: C_2H_6O

CH_3-CH_2-OH	CH_3-O-CH_3
Ethyl alcohol	Dimethyl ether
IUPAC : Ethanol	IUPAC : Methoxy methane

(b) Molecular formulae: C_3H_6O

$H_3C-CH_2-\overset{\overset{O}{\Vert}}{C}-H$	$H_3C-\overset{\overset{O}{\Vert}}{C}-CH_3$
Propanaldehyde	Acetone
IUPAC : Propanal	IUPAC : Propanone

Two functional isomers namely propionaldehyde and acetone are possible for the molecular formulae C_3H_6O, one with aldehydic functional group $(R-\overset{\overset{O}{\Vert}}{C}-H)$ and the other with ketone functional group $(R-\overset{\overset{O}{\Vert}}{C}-R)$.

(iv) Metamerism: The isomers in which there is unequal distribution of carbon chain or atoms on either side of the functional group are called metamers and this phenomenon is termed 'metamerism'. Thus metamers differ in the size of an alkyl group or chain on either side of the functional group.

- This is exhibited by compounds having divalent functional groups.
- Example

Molecular formula: $C_4H_{10}O$

$H_3C-CH_2-O-CH_2-CH_3$	$H_3C-O-CH_2-CH_2-CH_3$
Diethyl ether	Methyl propyl ether
IUPAC : Ethoxyethane	IUPAC : Methoxypropane

Chemical properties of carbon compounds

- Carbon, in all its allotropic forms, burns in oxygen to give carbon dioxide along with the release of heat and light. Most carbon compounds also release a large amount of heat and light on burning.

  (i) $C + O_2 \rightarrow CO_2$ + heat and light

  (ii) $CH_4 + O_2 \rightarrow CO_2 + H_2O$ + heat and light

  (iii) $CH_3CH_2OH + O_2 \rightarrow CO_2 + H_2O$ + heat and light

- Saturated hydrocarbons will generally give a clean flame while unsaturated carbon compounds will give a yellow flame with lots of black smoke. However, limiting the supply of air results in incomplete combustion of even saturated hydrocarbons giving a sooty flame. The gas/kerosene stove used at home has inlets for air so that a sufficiently oxygen-rich mixture is burnt to give a clean blue flame.

- If you observe the bottoms of cooking vessels getting blackened, it means that the air holes are blocked and fuel is getting wasted. Fuels such as coal and petroleum have some amount of nitrogen and sulphur in them. Their combustion results in the formation of oxides of sulphur and nitrogen which are major pollutants in the environment. This is because a flame is only produced when gaseous substances burn. When wood or charcoal is ignited, the volatile substances present vapourise and burn with a flame in the beginning. A luminous flame is seen when the atoms of the gaseous substance are heated and start to glow. The colour produced by each element is a characteristic property of that element.Carbon compounds can be easily oxidised on combustion. In addition to this complete oxidation, we have reactions in which alcohols are converted to carboxylic acids.

- In general, Alcohols $\xrightarrow{[O]}$ Aldehyde $\xrightarrow{[O]}$ Acid
- Remember that unsaturated compounds discharge the pink colour of alk. $KMnO_4$. This is known as test of unsaturation.
- Remember, saturated acids are harmful for health.

Oxidation

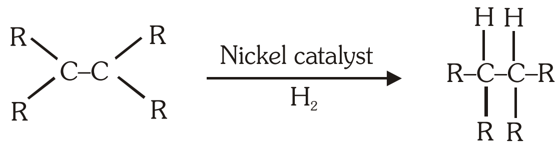
- Carbon compounds can be easily oxidised on combustion. In addition to this complete oxidation, we have reactions in which alcohols are converted to carboxylic acids.

$$CH_3{-}CH_2OH \xrightarrow[\text{Or acidified } K,Cr_2O_2 + \text{Heat}]{\text{Alkaline } KMnO_4 + \text{Heat}} CH_3COOH$$

- Which are capable of adding oxygen to others. These substances are known as oxidising agents. Alkaline potassium permanganate or acidified potassium dichromate are oxidising alcohols to acids, that is, adding oxygen to the starting material. Hence they are known as oxidising agents.

Addition Reaction

- Unsaturated hydrocarbons add hydrogen in the presence of catalysts such as palladium or nickel to give saturated hydrocarbons. Catalysts are substances that cause a reaction to occur or proceed at a different rate without the reaction itself being affected. This reaction is commonly used in the hydrogenation of vegetable oils using a nickel catalyst. Vegetable oils generally have long unsaturated carbon chains while animal fats have saturated carbon chains.



- You must have seen advertisements stating that some vegetable oils are 'healthy'. Animal fats generally contain saturated fatty acids which are said to be harmful for health. Oils containing unsaturated fatty acids should be chosen for cooking.

Substitution Reaction

- Saturated hydrocarbons are fairly unreactive and are inert in the presence of most reagents. However, in the presence of sunlight, chlorine is added to hydrocarbons in a very fast reaction. Chlorine can replace the hydrogen atoms one by one. It is called a substitution reaction because one type of atom or a group of atoms takes the place of another. A number of products are usually formed with the higher homologues of alkanes.

  $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ (in the presence of sunlight)

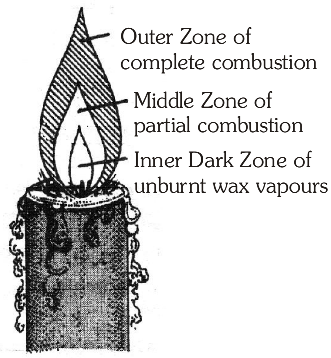
Fuels and flames

- Fuels are chemical substances which may be burnt in oxygen to generate heat.
- They mainly consist of carbon and hydrogen and sometimes a small amount of sulphur or minerals.
- A good fuel is one which is cheap, readily available, burns easily in air at a moderate rate. It produces a large amount of heat. It does not leave behind any undesirable substances.
- The amount of the heat produced on complete combustion of 1 kg of the fuel is called its **calorific value**. It is expressed in **kilo joule per kg**. A good fuel has a high calorific value.
- The increasing fuel combustion has harmful effects on the environment like carbon fuel (wood, coal, petroleum) release unburnt carbon particles which causes respiratory diseases. Incomplete combustion of these fuels gives carbon monoxide gas which is poisonous gas. Combustion of most fuels releases carbon dioxide. Increased concentration of carbon dioxide in the air causes global warming.
- Burning of coal and diesel releases sulphur dioxide. Moreover, petrol engines give oxides of nitrogen. Oxides of nitrogen and sulphur dissolve in water of rain to form acids. Such rain is called **acid rain** which is very harmful for crops, building and soil.

- **Types of fuels**
  - Solid fuels- wood, coal, coke, charcoal etc.
  - Liquid fuels-kerosene, petrol, diesel etc.
  - Gaseous fuels- LPG, CNG, coal gas, water gas etc.
- **Combustion**
  - A chemical process in which a substance reacts with oxygen to give heat is called **combustion**.
  - The substance that undergoes combustion is called to be a **combustible**. It is also called **fuel.** E.g. petrol, kerosene.
  - The fuel may be solid, liquid or gas. For combustion air is necessary.
  - The lowest temperature at which a substance catches fire is called **ignition temperature**.
  - A combustible substance cannot catch fire or burn as long as its temperature is lower than its ignition temperature.
  - The substances which have very low ignition temperature and can easily catch fire with a flame are **inflammable substances.** E.g. petrol, alcohol, LPG (Liquified petroleum gas) etc.
- **Types of combustion**
  - Combustion in which gas burns rapidly and produces light and heat is known as **rapid combustion**. E.g. burning of gas stove in kitchen.
  - The type of combustion in which a material suddenly bursts in the flame without application of any external source is called **spontaneous combustion**. E.g. spontaneous combustion of coal dust. Combustion in which a sudden reaction takes place with the evolution of heat, light and sound is known as **explosion** e.g. ignition of fire crackers.

Flame

- A **flame** (from Latin *flamma*) is the visible (light-emitting), gaseous part of a fire. It is caused by a highly exothermic reaction (for example, combustion, a self-sustaining oxidation reaction) taking place in a thin zone.If a fire is hot enough to ionize the gaseous components, it can become a **plasma**.
- Colour and temperature of a flame are dependent on the type of fuel involved in the combustion, as, for example, when a lighter is held to a candle. The applied heat causes the fuel molecules in the candle wax to vaporize.
- In this state they can then readily react with oxygen in the air, which gives off enough heat in the subsequent exothermic reaction to vaporize yet more fuel, thus sustaining a consistent flame.
- **Flame zones**
  - **Inner most zone :** It is cooler than outer zone and it is dark.
  - **Middle zone :** It is the largest zone of candle flame. This zone gives soot and smoke.
  - **Outermost zone :** This zone of the flame is thin and blue in colour. This is the hottest zone of the flame. The temperature of this zone is maximum around 1800°C.



Different zones of a candle flame

Some important carbon compounds

- **Ethanol**

Ethanol is a liquid at room temperature. It is commonly called alcohol and is the active ingredient of all alcoholic drinks. In addition, because it is a good solvent, it is also used in medicines such as tincture iodine, cough syrups, and many tonics. Ethanol is also soluble in water in all proportions. Consumption of small quantities of dilute ethanol causes drunkenness. Even though this practice is condemned, it is a socially widespread practice. However, intake of even a small quantity of pure ethanol (called absolute alcohol) can be lethal. Also, long-term consumption of alcohol leads to many health problems.

- **Reaction of Ethanol**

(i) Reaction with sodium - $2Na + 2CH_3CH_2OH \rightarrow 2CH_3CH_2O^-Na^+ + H_2$
(Sodium ethoxide)

Alcohols react with sodium leading to the evolution of hydrogen. With ethanol, the other product is sodium ethoxide.

(ii) Reaction to give unsaturated hydrocarbon: Heating ethanol at 443 K with excess concentrated sulphuric acid results in the dehydration of ethanol to give ethene. The concentrated sulphuric acid can be regarded as a dehydrating agent which removes water from ethanol.

(iii) $CH_3–CH_2OH \xrightarrow[H_2SO_4]{\text{Hotconc}} CH_2 = CH_2 + H_2O$

- **Effect of alcohol on living beings**

When large quantities of ethanol are consumed, it tends to slow metabolic processes and to depress the central nervous system. This results in lack of coordination, mental confusion, drowsiness, lowering of the normal inhibitions, and finally stupour.The individual may feel relaxed but does not realise that his sense of judgement, sense of timing, and muscular coordination have been seriously impaired. Unlike ethanol, intake of methanol in very small quantities can cause death. Methanol is oxidised to methanal in the liver. Methanal reacts rapidly with the components of cells. It causes the protoplasm to get coagulated, in much the same way an egg is coagulated by cooking. Methanol also affects the optic nerve, causing blindness.Ethanol is an important industrial solvent. To prevent the misuse of ethanol produced for industrial use, it is made unfit for drinking by adding poisonous substances like methanol to it. Dyes are also added to colour the alcohol blue so that it can be identified easily. This is called denatured alcohol.

- **Ethanoic acid**

Ethanoic acid is commonly called acetic acid and belongs to a group of acids called carboxylic acids. 5-8% solution of acetic acid in water is called vinegar and is used widely as a preservative in pickles. The melting point of pure ethanoic acid is 290 K and hence it often freezes during winter in cold climates. This gave rise to its name glacial acetic acid.

The group of organic compounds called carboxylic acids are obviously characterised by a special acidity. However, unlike mineral acids like HCl, which are completely ionised, carboxylic acids are weak acids.

- **Reactions of ethanoic acid**

  - Esterification reaction: Esters are most commonly formed by reaction of an acid and an alcohol.Ethanoic acid reacts with absolute ethanol in the presence of an acid catalyst to give an ester

$$\underset{\text{(Ethanoic acid)}}{CH_3–COOH} + \underset{\text{(Ethanol)}}{CH_3–CH_2OH} \xrightarrow{\text{Acid}} \underset{\text{(Ester)}}{CH_3–\overset{\overset{}{}}{\underset{\underset{O}{\|}}{C}}–O–CH_2–CH_3}$$

Esters are sweet-smelling substances. These are used in making perfumes and as flavouring agents. Esters react in the presence of an acid or a base to give back the alcohol and carboxylic acid. This reaction is known as saponification because it is used in the preparation of soap.

$$CH_3COOC_2H_5 \xrightarrow{\text{NaOH}} C_2H_5OH + CH_3COOH$$

- Reaction with a base: Like mineral acids, ethanoic acid reacts with a base such as sodium hydroxide to give a salt (sodium ethanoate or commonly called sodium acetate) and water:

  $NaOH + CH_3COOH \rightarrow CH_3COONa + H_2O$

- Reaction with carbonates and hydrogencarbonates: Ethanoic acid reacts with carbonates and hydrogencarbonates to give rise to a salt, carbon dioxide and water. The salt produced is commonly called sodium acetate.

  $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$

  $CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$

Soaps and detergents

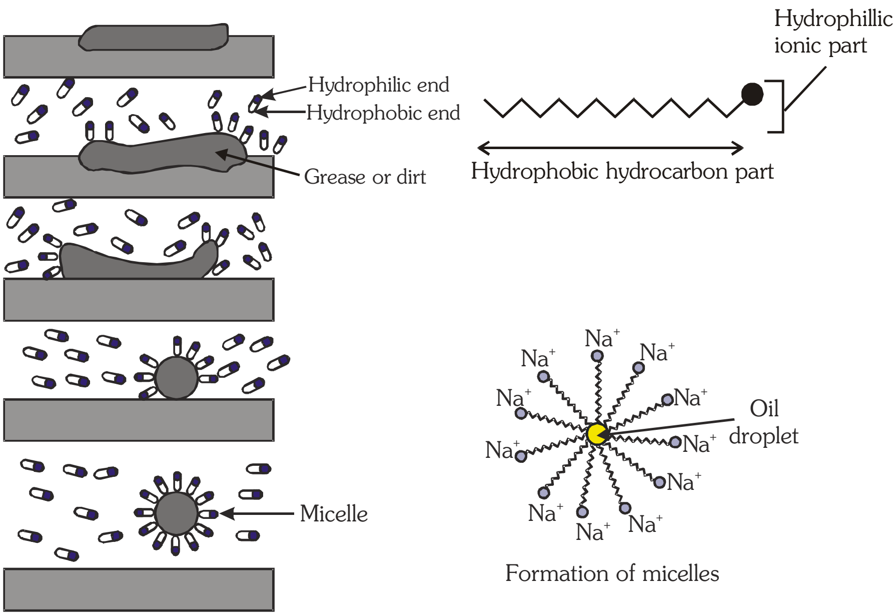
- Commercially used soaps are sodium salts of fatty acid, such as oleic acid ($C_{17}H_{33}COOH$), stearic acid and palmitic acid ($C_{15}H_{31}COOH$) which are plant or animal origin. Soap is made from oil or fat which are esters of fatty acids or glycerols as shown in the following equation.

$$\begin{array}{lcl} C_{15}H_{31}-COOCH_2 & & CH_2OH \\ \quad\quad\quad\quad | & & | \\ C_{15}H_{31}-COOCH + 3NaOH & \rightarrow & CHOH + 3C_{15}H_{31}COONa \\ \quad\quad\quad\quad | & & | \\ C_{15}H_{31}-COOCH_2 & & CH_2OH \\ & & \text{Glycerol} \quad \text{(Soap)} \end{array}$$

- The above reaction is known as **saponification**. The soap from the solution is separated by the addition of **common salt**.

The washing action of soap

- The washing action of soap has been explained on the basis of formation of micelles. (fig). The soap is made up of two components ; hydrocarbon part and –COONa group. The former is hydrophobic (water repelling) whereas the later is hydrophillic (water loving). Because of this, the arrangement of soap molecules is as shown in fig. The hydrocarbon part dissolves grease along with the dirt sticking to the cloth.



The formation of micelles

- Synthetic detergents have a structure similar to that of soap. The water attracting part in detergents is sulphonate ($-SO_3Na$) group. Synthetic detergents can **lather** well even with **hard water** as unlike soaps, they do not from insoluble calcium or magnesium salts with hard water.
- The essential constituents of washing powders are as follows.
  - Detergents - about 15-30% by mass.
  - Sodium sulphate and sodium silicate - to keep the washing powder dry.
  - Sodium tripolyphosphate or sodium carbonate - to maintain alkalnity which helps in removing dirt.
  - Carboxymethyl cellulose (CMC) to keep the dirt suspend in water.
  - Mild bleaching agent such as sodium perborate - to produce whiteness.
- Synthetic detergents containing branched hydrocarbons are not biodegradable, i.e. they are not decomposed by bacteria present in water. So these are pollutants for river water.

Important points to ponder

- Catalytic hydrogenation is not shown by saturated hydrocarbon.
- Vegetable oils generally have long unsaturated 'C' chains while animal fats have saturated 'C' chains.
- Hydrogenation reduces the number of unsaturated 'C' chains which produce rancidity in foods (due to the production of carboxylic acids & aldehydes) and hence slows down the development of rancidity.
- Unsaturated carbon compounds disappears orange colour of bromine water.
- Saturated hydrocarbons are less reactive than unsaturated hydrocarbons.

1. Which of the following have a triple bond?
(1) C_2H_4 (2) C_3H_4 (3) C_3H_8 (4) C_3H_9

2. How many unshared pairs of electrons are present in water molecule?
(1) One (2) Zero (3) Two (4) Three

3. Number of electrons shared between carbon carbon atoms in ethene is
(1) 2 (2) 4 (3) 6 (4) 8

4. Which of the following does not contain double bond?
(1) CO_2 (2) C_2H_4 (3) HCl (4) O_2

5. Nitrogen molecule involves formation of
(1) Single covalent bond
(2) Double covalent bond
(3) Triple covalent bond
(4) Ionic bond

6. Oxygen molecule involves formation of
(1) Single covalent bond
(2) Double covalent bond
(3) Triple covalent bond
(4) Ionic bond

7. A phenomenon by which an element occurs in different physical modification in same physical state is called
(1) Isomerism (2) Allotropy
(3) Amorphous (4) Crystalline

8. Which of the following is not an allotropic form of carbon?
(1) Fullerene (2) Fluorine
(3) Diamond (4) Graphite

9. Number of free electron(s) in each carbon atom in graphite is /are
(1) Two (2) Four
(3) One (4) Three

10. In fullerene carbon atoms are arranged in mixed
(1) tetragons and pentagons
(2) pentagons and hexagons
(3) pentagons and heptagons
(4) All are correct

11. Two adjacent layers in graphite are bonded by comparatively
(1) strong forces
(2) weak forces
(3) no forces
(4) few strong and few weak forces

12. Diamond is not a good conductor of electricity because
(1) it is very hard
(2) its structure is very compact
(3) it is not water soluble
(4) it has no free electrons

13. Which of the following is not a crystalline form of carbon?
(1) Diamond (2) Graphite
(3) Fullerene (4) Coke

14. In order to form branching, an organic compound must have a minimum number of
(1) four carbon atoms (2) three carbon atoms
(3) five carbon atoms (4) six carbon atoms

15. The number of isomers of pentane is
(1) 2 (2) 3
(3) 4 (4) 5

16. Which of the following represents the correct increasing order of unsaturation?
(1) Alkanes, alkenes, alkynes
(2) Alkanes, alkynes, alkenes
(3) Alkenes, alkynes, alkanes
(4) Alkynes, alkanes, alkenes

17. Among the following the one having longest chain is
(1) Neopentane
(2) Isopentane
(3) 2-Methylpentane
(4) 2,2-Dimethylbutane

18. In C_6H_{14} the number of possible isomers is
(1) 3 (2) 6
(3) 4 (4) 5

19. Which is not a property of graphite?
(1) It melts at 800°C
(2) It is a smooth, crystalline form of carbon
(3) It is a good conductor of electricity
(4) It forms a black sign on the paper

20. Which of the following is purest form of carbon?
(1) Diamond (2) Coal
(3) Wood (4) Paper

21. Which of the following is not a saturated hydrocarbon?
(1) Cyclohexane (2) Benzene
(3) Butane (4) Isobutane

22. Which of the following is a pair of saturated hydrocarbon ?

(1) Butane and isobutane

(2) Cyclohexane and hexene

(3) Propanal and propanone

(4) All of these

23. A double bond between two carbon atoms is formed by

(1) transfer of two electrons from one carbon to the other

(2) transfer of one electron from one carbon to the other

(3) sharing of two electrons

(4) sharing of two pairs of electrons

24. Which of the following is an isomeric pair?

(1) Ethane and propane

(2) Ethane and ethene

(3) Propane and butane

(4) Butane and 2-methyl propane

25. Pentane has the molecular formula C_5H_{12}. It has

(1) 5 covalent bonds

(2) 12 covalent bonds

(3) 16 covalent bonds

(4) 17 covalent bonds

26. Which of the following gases is called 'Marsh gas'?

(1) H_2 (2) CH_4

(3) C_2H_4 (4) C_2H_2

27. Organic compounds will always contain

(1) carbon (2) hydrogen

(3) nitrogen (4) sulphur

28. Which of the following statements is not correct ?

(1) A common functional group is present in different members of a homologous series.

(2) Two consecutive members of a homologous series differ by a $-CH_3$ group.

(3) The members of a homologous series can be represented by one general formula.

(4) Different members of a homologous series have similar chemical properties.

29. The difference in molecular weight of two consecutive members of a homologous series is

(1) 15 (2) 14

(3) 8 (4) 9

30. Which of the following belong to the same homologous series?

(1) Ethane, ethene, ethyne

(2) Propanol, propanone, propanal

(3) Methanol, ethanol, propanol

(4) Ethane, ethanol, ethanoic acid

31. Unsaturation in the organic compound can be tested by the help of

(1) Baeyer's test (2) Fehling's test

(3) Chlorination reaction (4) Dehydration reaction

32. The functional group present in butanone is

(1) Carboxy (2) Ketonic

(3) Aldehydic (4) Alcoholic

33. The IUPAC name of CH_3CHO is

(1) Acetaldehyde (2) Methanal

(3) Ethanal (4) Formaldehyde

34. The IUPAC name of $CH_3-CH_2-CH(CH_3)-C(CH_3)_2-CH_3$ is

(1) 2,2,3-Trimethylpentane

(2) 3,4,4-Trimethylpentane

(3) 2-Ethyl-3,3-dimethylbutane

(4) 2,3-Dimethlhexane

35. The IUPAC name of the compound $CH_2=C(CH_3)_2$ is

(1) 1,1-Dimethylprop-2-ene

(2) 2-Methylprop-1-ene

(3) 2-Ethyl-3,3-dimethylbutane

(4) 2,3-Dimethylhexane

36. The second member of homologous series of alkenes is

(1) Ethene (2) Propene

(3) Butene (4) Ethyne

37. Compound $CH_3CH_2CH(CH_3)CH_2-C(=O)-Cl$ has the IUPAC name

(1) 3-Methylpentanoyl chloride

(2) 1-Chloroformyl-2-methyl butane

(3) 3-Methylchloridebutane

(4) 3-Methylchloropentanone

38. Methane, ethane and propane are said to form a homologous series because all are

(1) hydrocarbons

(2) saturated hydrocarbons

(3) aliphatic hydrocarbons

(4) differ from each other by $-CH_2$ group

39. The reaction $CH_4 + Cl_2 \xrightarrow[\text{light}]{hv} CH_3Cl + HCl$ is an example of

(1) addition reaction (2) substitution reaction
(3) elimination reaction (4) oxidation reaction

40. The final product obtained when methane reacts with chlorine in presence of sunlight is

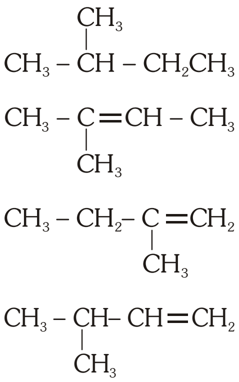
(1) C_2Cl_6 (2) CCl_4
(3) $CHCl_3$ (4) CH_2Cl_2

41. Which of the following hydrocarbons does not decolourise bromine water?

(1) $C_{10}H_{22}$ (2) C_6H_{12}
(3) $C_{10}H_{18}$ (4) $C_{10}H_{20}$

42. 2-Methylbut-2-ene will be represented as

(1) (2) (3) (4)



43. The substance that would not at all be formed during the reaction of methane and chlorine in presence of sunlight is

(1) CH_3Cl (2) $CHCl_3$
(3) $CH_3CH_2CH_3$ (4) CH_2Cl_2

44. The following reaction is an example of $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + heat + light

(1) addition reaction
(2) substitution reaction
(3) combustion reaction
(4) displacement reaction

45. When methane is burnt in an excess of air, the products of combustion are

(1) C and H_2O (2) CO and H_2O
(3) CO_2 and H_2 (4) CO_2 and H_2O

46. The number of oxygen molecules used in the combustion of 1 molecule of ethanol is

(1) 1 (2) 2
(3) 3 (4) 4

47. Saturated hydrocarbons on combustion gives

(1) Sooty flame (2) Non-sooty flame
(3) Oxygen (4) Carbon monoxide

48. An organic compound X with molecular formula $C_2H_4O_2$ turns blue litmus red and gives brisk effervescence with sodium bicarbonate.

Identify the compound.

(1) Methanoic acid (2) Ethanoic acid
(3) Propanoic acid (4) Butanoic acid

49. When ethanoic acid is heated with $NaHCO_3$ the gas evolved is

(1) H_2 (2) CO_2 (3) CH_4 (4) CO

50. Glacial acetic acid is

(1) frozen acetic acid
(2) 5–8% solution of acetic acid
(3) mixture of acetic acid and alcohol
(4) None of these

51. Ethene can be prepared by reaction of ethanol with

(1) Hot conc. H_2SO_4 (2) Alkaline $KMnO_4$
(3) Sodium metal (4) $NaHCO_3$

52. The reaction, $2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2$ suggests that ethanol is

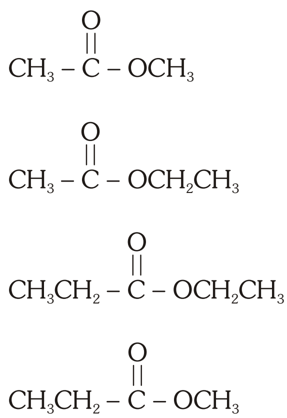
(1) acidic in nature
(2) basic in nature
(3) amphoteric in nature
(4) neutral in nature

53. Saponification means

(1) Acid hydrolysis (2) Alkaline hydrolysis
(3) Esterification (4) Dehydration

54. The structural formula of ethyl ethanoate is

(1) (2) (3) (4)



55. Conversion of ethanol to ethanoic acid is a/an

(1) substitution reaction

(2) oxidation reaction

(3) addition reaction

(4) rearrangement reaction

56. In the reaction $CH_3COONa + NaOH \rightarrow$ the gas obtained is

(1) C_2H_6 (2) C_2H_2

(3) CH_4 (4) C_2H_6

57. Ethanol on complete oxidation gives

(1) carbon dioxide and water

(2) acetaldehyde

(3) acetic acid

(4) acetone

58. The by-product of soap industry is

(1) glycerol (2) glycol

(3) isoprene (4) acid

59. C_2H_4 reacts with hydrogen in presence of Ni to give

(1) CH_4 (2) C_2H_6

(3) HCOOH (4) HCHO

60. Which of the following salts when dissolved in water produce hard water ?

(1) Calcium sulphate

(2) Magnesium bicarbonate

(3) Calcium bicarbonate

(4) All of these

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	3	2	3	3	2	2	2	3	2	2	4	4	1	2	1	3	4	1	1
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	1	4	4	3	2	1	2	2	3	1	2	3	1	2	2	1	4	2	2
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	2	3	3	4	3	2	2	2	2	1	1	2	2	2	3	3	1	2	4