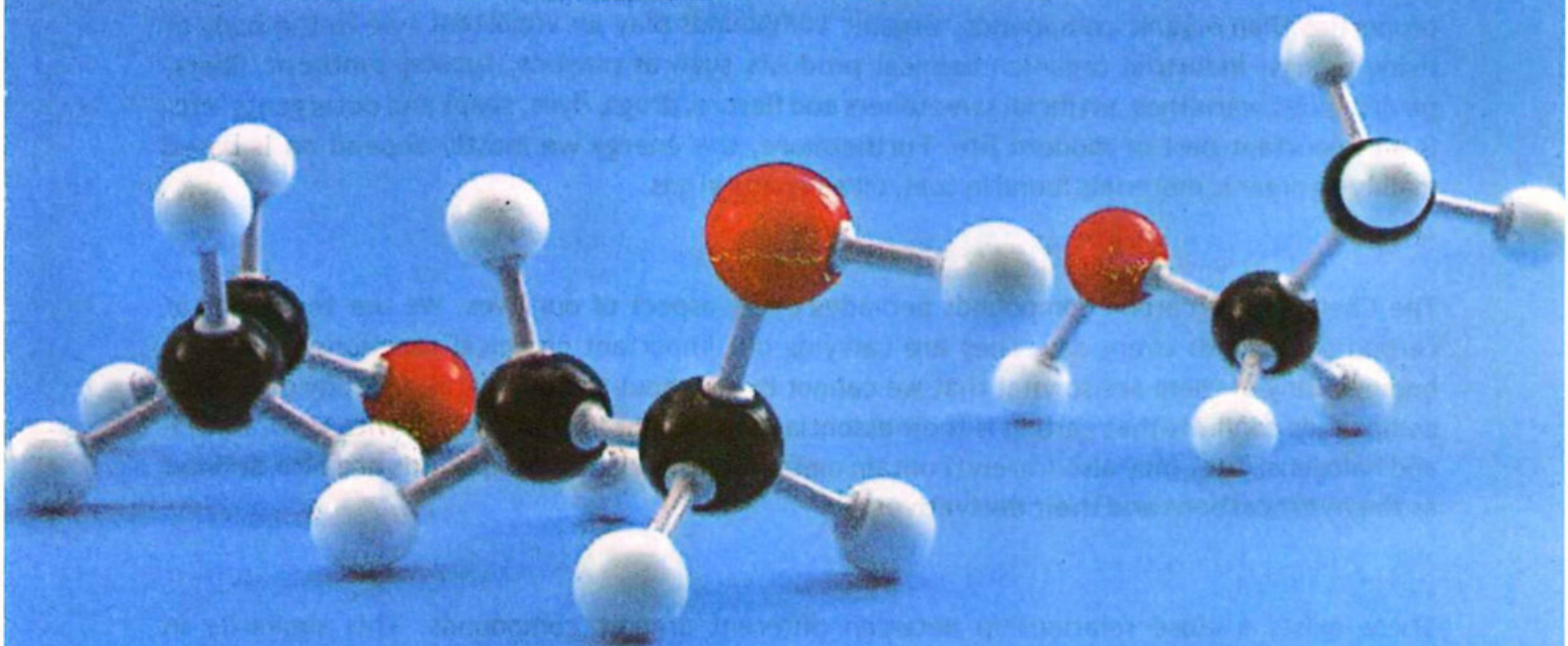


UNIT 13



ORGANIC CHEMISTRY

Student Learning Outcomes (SLOs)

After completing this lesson, the student will be able to:

- Describe organic molecules as either straight-chained, branched chained or cyclic.
- State that structural formula is an unambiguous description of the way the atoms in a molecule are arranged, including $\text{CH}_2=\text{CH}_2$, $\text{CH}_3\text{CH}_2\text{OH}$, $\text{CH}_3\text{COOCH}_3$.
- Identify and draw structural formulae for molecules.
- Interpret general formulae of compounds in the same homologous series including alkanes, alkenes, alkynes, alcohols and carboxylic acids.
- Define structural isomers as formula, but different structural formulae, including C_4H_{10} as $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ and $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_3$ and C_4H_6 as $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ and $\text{CH}_3\text{CH}=\text{CHCH}_3$.
- Identify a functional group as an atom or group of atoms that determines the chemical properties of a homologous series including that for alcohols, aldehydes, ketones, phenols, carboxylic acids, amines, esters and amide.
- Describe the general characteristics of a homologous series. These can include: (a) having the same functional group (b) having the same general formula (c) differing ifrom one member to the next by a $-\text{CH}_2-$ unit(d) displaying a trend in physical properties(e) sharing similar chemical properties.
- State that a saturated compound has molecules in which all carbon-carbon are single bonds.
- State that an unsaturated compound has molecules in which one or more carbon-carbon are not single bonds.

INTRODUCTION

The study of carbon-containing compounds and their properties is called organic chemistry. However, low carbon compounds such as carbon dioxide, carbon monoxide, carbonates and carbides are considered inorganic substances. This is because they have completely different properties than organic compounds. Organic compounds play an important role in the body of living beings. Industrial organic chemical products such as plastics, rubber, synthetic fibers, paints, glues, varnishes, artificial sweeteners and flavors, drugs, dyes, soaps and detergents, etc. is an important part of modern life. Furthermore, the energy we mostly depend on is based mainly on organic materials found in coal, oil and natural gas.

13.1 ORGANIC COMPOUNDS

The Chemistry of carbon compounds pervades every aspect of our lives. We use thousands of carbon compounds every day. They are carrying out important chemical reactions within our bodies. Many of them are so vital that we cannot live without them. A detailed study of organic compounds confirms that carbon is their essential constituent in combination with H, O, N, S, P and halogens. They may also (rarely) contain metal atoms. **Organic compounds are also defined as the hydrocarbons and their derivatives.**

13.2 Homologous Series

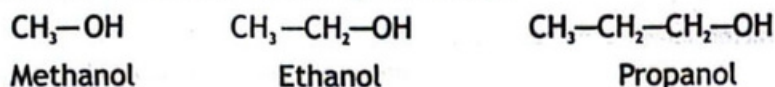
There exists a close relationship between different organic compounds. This similarity in behavior has made the study of millions of organic compounds easier. They can be classified into few families. A series of related compounds in which any two adjacent molecules differ by $\text{-CH}_2\text{-}$ group is called homologous series. For example, consider alkanes;



Note the difference between adjacent alkanes, they differ by the same unit.

$\text{-CH}_2\text{-}$ This means you can represent next member by simply adding $\text{-CH}_2\text{-}$ unit. A series of related compounds in which adjacent member differ by $\text{-CH}_2\text{-}$ is called a homologous series.

Similarly alcohols also form homologous series.



These compound also differ by the same unit $\text{-CH}_2\text{-}$. All the classes of prganic compounds including alkanes, alkenes, alkynes, alcohols, aldehydes, ketones, carboxylic acids etc. form homologous series.

13.2.1 General Characteristics of a Homologous Series

Each homologous series have some general characteristics.

- The family members of a homologous series have the same functional group.
- The family members have same general formula.
- The adjacent family members differ by a $\text{-CH}_2\text{-}$ unit.
- The family members display a trend in their physical properties.

- (v) The family members possess similar chemical properties.

Table 13.1 shows the general formulae of some homologous series

Homologous series	General formula
Alkanes	C_nH_{2n+2}
Akenes	C_nH_{2n}
Alkynes	C_nH_{2n-2}
Alcohols	$C_nH_{2n+1}OH$
Carboxylic acids	$C_nH_{2n+1}COOH$

From the general formula you can easily determine the molecular formula of any member of the series. For examples,

Alkanes have general formula C_nH_{2n+2} which can be used to determine the molecular formula for any member of alkane series by putting number of carbon atoms in the general formula.

Examples: Methane $n = 1$ $C_1H_{2 \times 1 + 2} = C_1H_4 = CH_4$

Ethane $n = 2$ $C_2H_{2 \times 2 + 2} = C_2H_6$

Propane $n = 3$ $C_3H_{2 \times 3 + 2} = C_3H_8$

Akenes have general formula C_nH_{2n}

Ethene $n = 2$ $C_2H_{2 \times 2} = C_2H_4$

Alcohols have general formula $C_nH_{2n+1}OH$

Methanol $n = 1$ $C_1H_{2 \times 1 + 1}OH = CH_3OH$

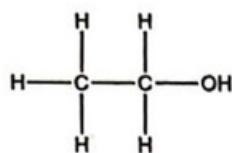
CONCEPT ASSESSMENT EXERCISE 13.1

Write the molecular formulae of the following compounds using general formulae

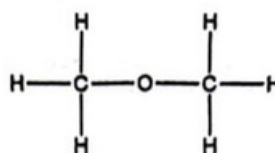
- Alkane containing (i) 4 carbon atoms (ii) 6 carbon atoms
- Alkene containing (i) 3 carbon atoms (ii) 4 carbon atoms
- Alkyne containing (i) 3 carbon atoms (ii) 4 carbon atoms
- Alcohol containing (i) 2 carbon atoms (ii) 3 carbon atoms

13.3 STRUCTURAL FORMULA

Frequently more than one organic compounds are represented by the same molecular formula. However, they have different properties. They have different structural formulas. For example, two organic compounds have the molecular formula C_2H_6O . They have different arrangements of atoms.

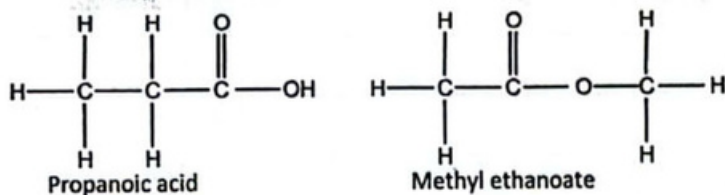


Ethanol



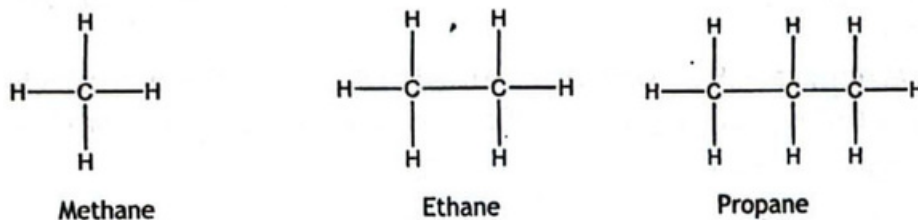
Dimethy ether

These formulas clearly show that the atoms are bonded to one another differently. In ethanol, the oxygen atom is bonded to only one carbon atom and a hydrogen atom. Whereas in dimethyl ether, the oxygen atom is bonded to two carbon atoms. Similarly, two organic compounds have the molecular formula $C_3H_6O_2$. They have different arrangement of atoms.

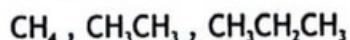


A formula that describes the arrangement of atoms in a molecule is called as structural formula.

The simple alkanes are straight-chain hydrocarbons. First three members of alkanes have following structural formulas.



The condensed structural formulas of these alkanes are



The corresponding molecular formulas are CH_4 , C_2H_6 , C_3H_8 respectively

A condensed formula is a structural formula that uses established abbreviation for various groups of chain. In condensed structural formula, we list the main chain carbon atoms and the hydrogen atoms attached to them in the sequence in which they appear in the naming system.

For instance,

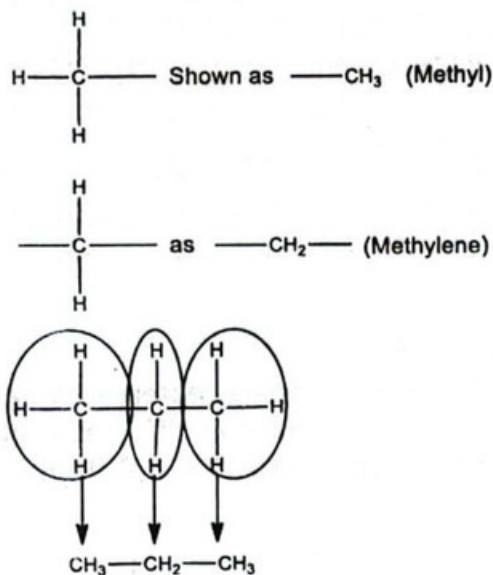


Table 13.2 shows the condensed structural formulas of some alkanes

Table 2.1: Properties of different states of matter

Name	Molecular Formula	Condensed Formula
Butane	C_4H_{10}	$CH_3CH_2CH_2CH_3$
Pentane	C_5H_{12}	$CH_3CH_2CH_2CH_2CH_3$
Hexane	C_6H_{14}	$CH_3CH_2CH_2CH_2CH_2CH_3$
Heptane	C_7H_{16}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_3$
Octane	C_8H_{18}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3$
Nonane	C_9H_{20}	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$
Decane	$C_{10}H_{22}$	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_3$

Example 13.1: Give the molecular formula, the structural formula and the condensed structural formula for pentane

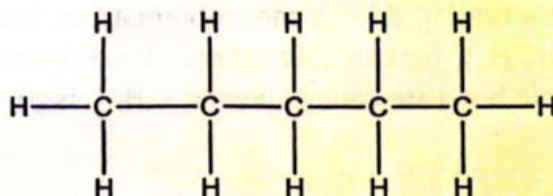
Problem Solving Strategy

1. The stem pent -means five carbon atoms.
2. The ending -ane indicates an alkane.
3. Write a string or chain of five carbon atoms.
4. Attach hydrogen atoms to the carbons to give each carbon atom four bonds. This requires three hydrogen atoms on each end carbon and two each on others.
5. For the condensed molecular formula, write each carbon atom's set of hydrogen atoms next to the carbon.
6. For molecular formula, simply count the carbon and hydrogen atoms or use the general formula C_nH_{2n+2} with $n=5$.

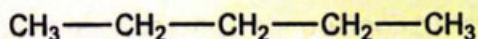
Solution:

C - C - C - C - C

Structural formula



Condensed Structural formula



Molecular formula

$$C_5H_{2 \times 5 + 2} = C_5H_{12}$$

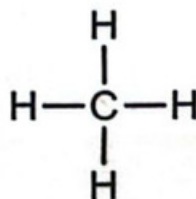
CONCEPT ASSESSMENT EXERCISE 13.2

Give the molecular, structural and condensed structural formulas for

- (a) Butane (b) Hexane (c) Octane

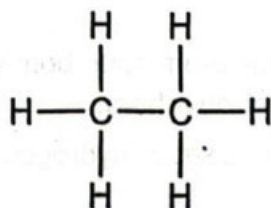
13.4 SATURATED AND UNSATURATED HYDROCARBONS

Hydrocarbons are compounds containing carbon and hydrogen only. Hydrocarbons whose carbon-carbon bonds are all single bonds are called saturated. Saturated hydrocarbons are also called alkanes. In alkanes each carbon atom is bonded to four other atoms. Methane is the simplest alkane. Other examples are ethane, propane, butane etc. The general formula of alkanes is C_nH_{2n+2} , where n is the number of carbon atoms.

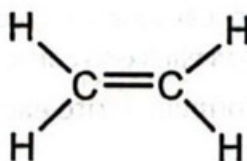


Methane

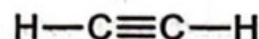
Hydrocarbons containing carbon-carbon multiple bonds are called unsaturated. Which of the following are unsaturated hydrocarbons



Ethane



Ethene



Ethyne

Unsaturated hydrocarbons are further divided into:

- (i) Alkenes.
(ii) Alkynes.

Unsaturated hydrocarbons containing at least one carbon-carbon double bond are called alkenes. They have general formula (C_nH_{2n}) , for example ethene. Unsaturated hydrocarbons that have at least one carbon-carbon triple bond are called alkynes. C_nH_{2n-2} is general formula for alkynes, for example ethyne.

CONCEPT ASSESSMENT EXERCISE 13.3

Choose saturated and unsaturated compounds from the following.

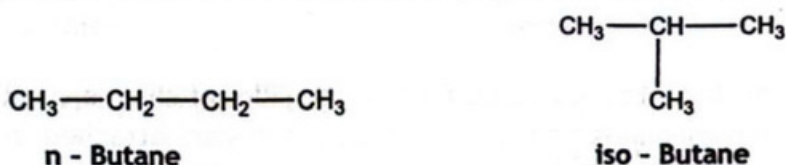
- (i) $\text{CH}_3-\text{CH}_2-\text{CH}_3$ (ii) $\text{CH}_3-\text{C}\equiv\text{CH}$
(iii) $\text{CH}_3-\text{CH}=\text{CH}_2$ (iv) $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$

13.5 CHEMICAL DIVERSITY OF ORGANIC COMPOUNDS

Carbon has four bonding electrons in its valence shell. Carbon, therefore forms four bonds with other atoms.

The Chemical diversity of organic compounds arises from carbon's ability to bond to each other to form long chains, branched chains and rings. This self-linking ability of carbon is called **catenation**. There appears to be almost no limit to the number of different structures that carbon can form. No other element can compete with carbon in this regard. Silicon and few other elements can form chains, but only short one. Carbon chains may contain thousands of carbon atoms.. Another reason for the large number of organic compounds is the phenomenon of **isomerism**.

The compounds that have same molecular formula but different arrangement of atoms in their molecules are called structural isomers. This phenomenon is called isomerism. For example two compounds have molecular formula C_4H_{10} but different structures.



Alkenes also show structural isomerism. For example two alkenes have same molecular formula C_4H_8 but different structures.



13.6 CLASSIFICATION OF ORGANIC COMPOUNDS

There are millions of organic compounds. It is not possible to study each compound separately. To facilitate learning, they are divided into different groups and sub-groups. It is useful to choose those compounds with a similar structure. So here you will learn the classification of organic compounds based on the carbon skeleton. They are broadly divided into two main groups.

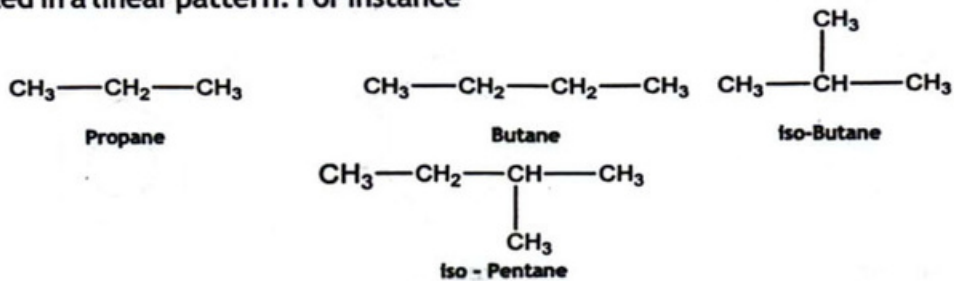
DO YOU KNOW?

Alkyl radical contains one less hydrogen than its parent alkane.

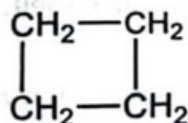
- (i) Open chain compounds or Acyclic compounds.
- (ii) Closed chain or Cyclic Compounds.

(i) Open chain compounds.

Open chain compounds contain an open chain of carbon atoms. In these compounds carbon atoms are linked in a linear pattern. For instance

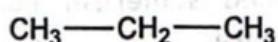


Is the compound having following structure an open chain compound?

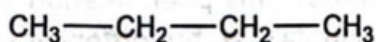


Open chain compounds may be either straight-chain or branched-chain. Those compounds which contain any number of carbon atoms joined one after the other in a chain or row are called **straight - chain compounds**. In these compounds carbon atoms are connected in one continuous chain.

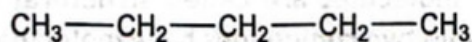
For example



Propane

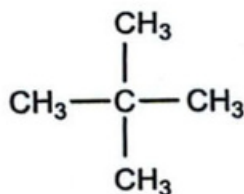


Butane



Pentane

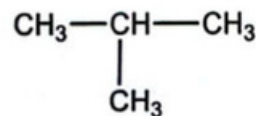
Those compounds which contain carbon atoms on the sides of chain are called branched chain compounds. In these compounds branches of carbon atoms are attached to a chain of carbon atoms. Which of the following is a branched chain compound?



neo-Pentane



Butane

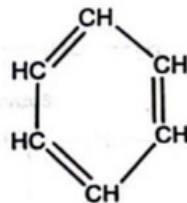
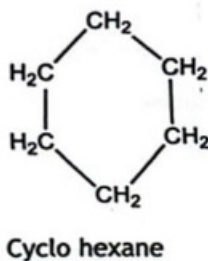
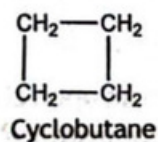
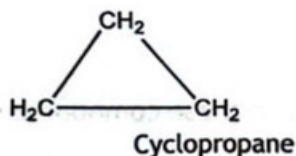


iso-Butane

Open chain compound are also called alicyclic compounds

(i) Closed Chain or Cyclic Compounds

Organic compounds which contain rings of atoms are called closed chain or cyclic compounds. For example

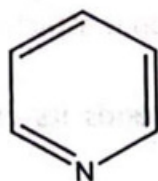


Benzene

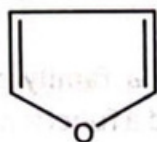
or



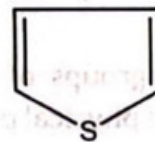
Cyclic compounds which contain rings of carbon atoms are called homocyclic or carbocyclic compounds. Which of the above cyclic compounds are carbocyclic? Cyclic compounds that contain one or more atoms other than carbon atoms in the ring are called heterocyclic compounds e.g.



Pyridine



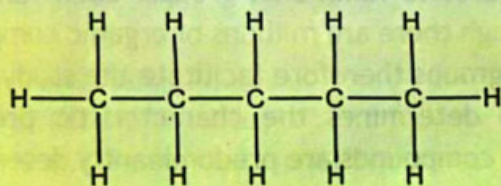
Furan



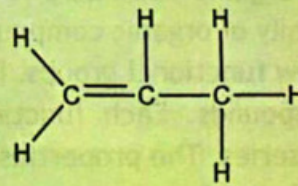
Thiophene

CONCEPT ASSESSMENT EXERCISE 13.4

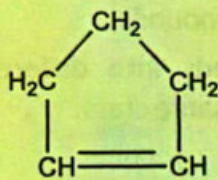
A to E are the structural formulas of some organic compounds.



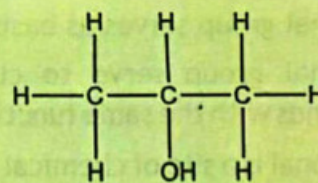
A



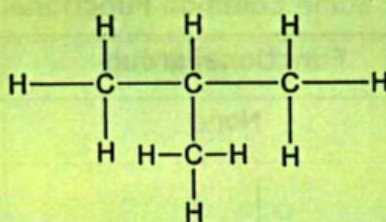
B



C



D



E

Give the letters which represents

1. A branched chain compound.
2. A cyclic compound.
3. Two straight chain compounds.

13.7 FUNCTIONAL GROUPS

Most organic compounds contain elements other than carbon and hydrogen. Most of these compounds are considered hydrocarbon derivatives. That is, they are essentially hydrocarbons, but instead of one or more hydrogen atoms, they have an additional atom or groups of atoms called functional groups. In many simple molecules, the functional group is attached to an alkyl group.

An atom or groups of atoms that give a family of organic compounds its characteristic chemical and physical properties is called a functional group.

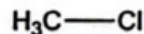
What is the difference in the following compounds?



Methane



Methyl alcohol



Methyl Chloride

Research in organic chemistry is organized around functional groups. Each functional group defines a family of organic compounds. Although there are millions of organic compounds, there are only a few functional groups. Functional groups therefore facilitate the study of millions of organic compounds. Each functional group determines the characteristic properties of a homologous series. The properties of organic compounds are predominantly determined by the properties of the functional group present in a compound. The concept of functional group is important in organic chemistry for three reasons.

1. Functional group serves as basis for naming organic compounds.
2. Functional group serve to classify organic compounds into different classes. All compounds with the same functional group belong to the same class.
3. A functional is a site of chemical reactivity in a molecule.

The common functional groups are listed in the table 13.3

Table 13.3: Some Common Functional groups

Name of class	Functional group	General formula
Alkane	None	$\text{R}-\text{H}$
Alkene	$\begin{array}{c} \quad \\ -\text{C}=\text{C}- \end{array}$	$\begin{array}{c} \text{R}' \quad \text{R}'' \\ \quad \\ \text{R}-\text{C}=\text{C}-\text{R}''' \end{array}$
Alkyne	$-\text{C}\equiv\text{C}-$	$\text{R}-\text{C}\equiv\text{C}-\text{R}'$
Alcohol	$\begin{array}{c} \\ -\text{C}-\text{O}-\text{H} \\ \end{array}$	$\text{R}-\text{O}-\text{H}$
Ether	$\begin{array}{c} \quad \\ -\text{C}-\text{O}-\text{C}- \\ \quad \end{array}$	$\text{R}-\text{O}-\text{R}'$

Aldehyde	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{H} \end{array}$
Ketone	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}- \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{R}' \end{array}$
Amine	$\begin{array}{c} \\ -\text{C}-\text{N}- \\ \quad \end{array}$	$\begin{array}{cc} \text{H} & \text{H} \\ & \\ \text{R}-\text{N}-\text{H} & \text{R}-\text{N}-\text{R}' \end{array}$
Carboxylic acid	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{O}-\text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{O}-\text{H} \end{array}$
Ester	$\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{O}-\text{C}- \\ \end{array}$	$\begin{array}{c} \text{O} \\ \parallel \\ \text{R}-\text{C}-\text{O}-\text{R}' \end{array}$

Each functional group exhibits characteristic properties

13.7.1 Functional groups containing Carbon, Hydrogen and Halogens: Haloalkanes

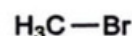
Haloalkanes are characterized by the presence of the halogen atom. The haloalkane is compound in which one hydrogen atom of an alkane is substituted by one halogen atom. Which of the following molecules are haloalkanes?



Methane



Chloromethane



Bromomethane



Iodoethane



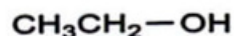
Chloroethane

13.7.2 Functional groups containing Carbon, Hydrogen and Oxygen: Alcohols

Alcohols are characterized by the presence of the hydroxyl group. (-OH) attached to a hydrocarbon chain.

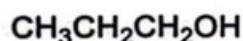


Methanol (Methyl alcohol)



Ethanol (Ethyl alcohol)

R-OH is the general formula for alcohols. Which of the following compounds is alcohol?



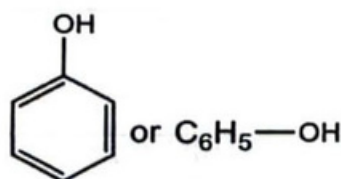
1-Propanol



1-Butanol

13.7.3 Phenols

When an -OH group is attached to a benzene ring, the compound is called a phenol.

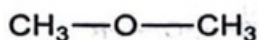


Phenol

Phenol was the first antiseptic used in an operation theatre.

13.7.4 Ethers

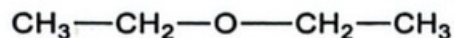
Organic compounds that have two alkyl groups attached to the same oxygen atom are called ethers. These compounds have C-O-C linkage in their molecules.



Dimethyl ether



Ethyl methyl ether

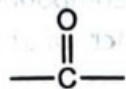


Diethyl ether

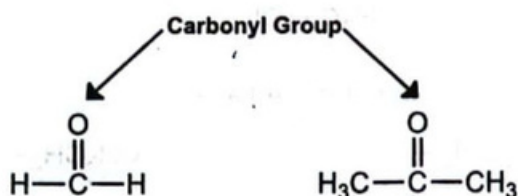
The general formula for ethers is R—O—R' . Where R and R' are alkyl groups which may be same or different.

13.7.5 Aldehydes and ketones

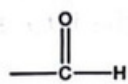
Aldehydes and ketones contain the carbonyl group



or



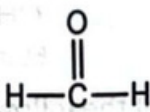
An aldehyde has at least one hydrogen atom attached to the carbonyl carbon atom. A ketone has two hydrocarbon groups (alkyl) bonded to the carbonyl carbon atom. Which of the above compound is an aldehyde? Which is a ketone?



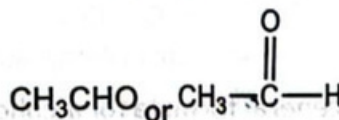
group in condensed form is written as -CHO. It is characteristic group of aldehydes



or

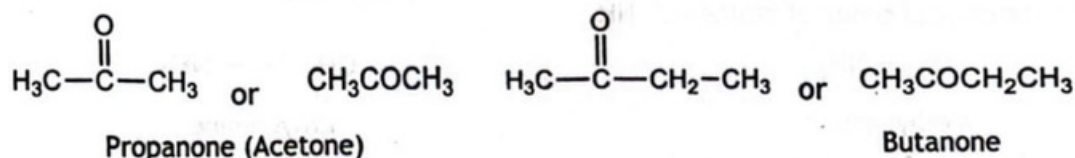


Methanal (Formaldehyde)



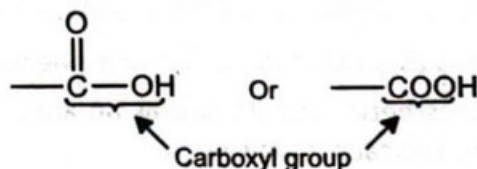
Ethanal (Acetaldehyde)

The general formula for ketone is $\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{R}'$ and in condensed form it is written as RCOR' . Where R and R' are alkyl groups which may be same or different. For example



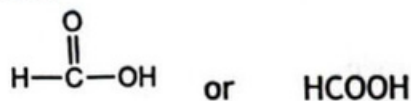
13.7.6 Carboxylic Acids:

The functional group of organic acid is called the carboxyl group.

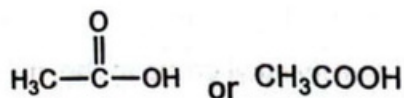


What is the difference between a carbonyl group and a carboxyl group?

Examples:



(Formic acid) Methanoic acid



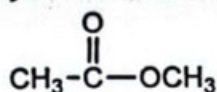
(Acetic acid) Ethanoic acid

The general formula for carboxylic acids is $\text{R}-\text{COOH}$

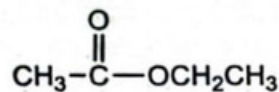
Where R = H or alkyl group

13.7.7 Esters:

Compounds having general formula $\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{OR}'$ are called esters. R and R' are alkyl groups which may be same or different.



(Methyl acetate) Methyl ethanoate

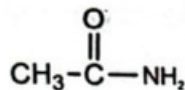


(Ethyl acetate) Ethyl ethanoate

$\text{—}\overset{\text{O}}{\parallel}{\text{C}}-\text{OR}'$ is the functional group for esters.

13.7.8 Amides:

Compounds having general formula $\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{NH}_2$ are called amides. R is an alkyl group.



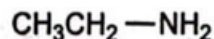
ethanamide

13.7.9 Functional groups containing Carbon, Hydrogen and Nitrogen: Amines

The functional group of amines is $-NH_2$



Methyl amine



Ethyl amine

The general formula for amines is $R-NH_2$

Example 13.2: Differentiating different organic compounds on the basis of their functional groups.

Classify the following compounds as an alcohol, ether or a phenol.

1. $CH_3CH_2OCH_2CH_3$ is an anesthetic, but its use as an anesthetic is now limited. This is because it is inflammable and causes nausea.
2. C_6H_5OH is a strong germicide. It is commonly used as disinfectant for floors, furniture and washrooms.
3. CH_3OH is poisonous and can cause blindness or death if taken internally.

Problem Solving Strategy:

1. Identify alkyl group in the molecule and functional group.
2. When $-OH$ group is attached to an alkyl group, the compound is an alcohol, but when $-OH$ is attached to benzene ring, the compound is a phenol.
3. When O -atom is attached to two alkyl groups, the compound is an ether.

Solution

- (a) Ether (b) Phenol (c) Alcohol

CONCEPT ASSESSMENT EXERCISE 13.5

Classify the following compound as alcohol, ether or phenol.

- (a) $CH_3CH_2OCH_2CH_3$ (b) $CH_3CH_2CH_2OH$
 (c) C_6H_5OH (d) C_2H_5OH

Example 13.3: Classify the following organic compounds on the basis of functional group.

Identify the following compounds as an aldehyde or a ketone or a carboxylic acid.

1. CH_3COCH_3 is a common solvent for organic materials such as fats, rubbers, plastic and varnishes.
2. CH_3CH_2CHO has a foul irritating odour.
3. CH_3COOH is present in vinegar and is used to flavor food and making a polymer called polyvinyl acetate.

Problem Solving Strategy

Remember that

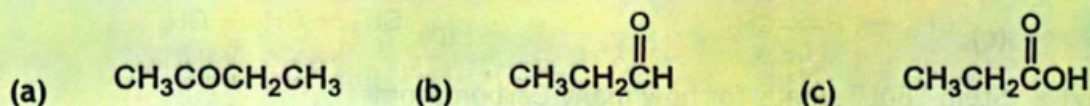
1. In an aldehyde a hydrogen atom is attached to the carbonyl carbon atom.
2. In a carboxylic acid -OH group is attached to the carbonyl carbon atom.
3. In a ketone, the carbonyl carbon is between two other carbon atoms.

Solution

- (a) A ketone (b) An aldehyde (c) An organic acid

CONCEPT ASSESSMENT EXERCISE 13.6

Identify the following compounds as an aldehyde, or a ketone or a carboxylic acid.



Almost all synthesis involves the inter conversion of at least one functional group to another. A functional group is the active portion of the molecule. It plays a key role in the synthesis of new compounds. The key to design most organic synthesis is the functional group in the target molecules.

KEY POINTS

- The study of carbon-containing compounds and their properties is called organic chemistry.
- Organic Compounds are also defined as the hydrocarbons and their derivatives.
- A series of related compounds in which any two adjacent molecules differ by $-\text{CH}_2-$ group is called homologous series.
- A formula that describes the arrangement of atoms in a molecule is called structure formula.
- Hydrocarbons whose carbon-carbon bonds are all single bonds are called saturated.
- Hydrocarbons containing carbon-carbon multiple bonds are called unsaturated.
- The compounds that have same molecular formula but different arrangement of atoms in their molecules are called structural isomers.
- Open chain compounds contain an open chain of carbon atoms.
- Organic compounds which contain rings of carbon atoms are called cyclic compound.
- An atom or groups of atoms that give a family of organic compounds its characteristic properties is called functional group.
- **References for additional information**
 - Chemistry for changing times, John W. Hill, Doris K. Kolb.
 - Longman chemistry for IGCSE, Jin Clark and Ray Oliver.

REVIEW QUESTIONS

1. Encircle the correct answer.

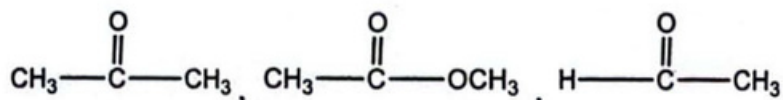
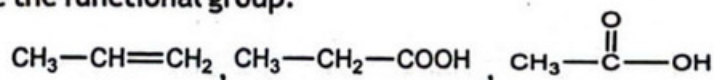
- (i) Condensed structural formula for butane is
 (a) $\text{CH}_3 - \text{CH}_2 - \text{CH}_3$ (b) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$
 (c) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$ (d) $\text{CH}_3 - \text{CH}_3$
- (ii) $\text{CH}_3 - \text{CH}_2 - \text{CH}_3$ is the chemical formula for
 (a) Ethane (b) Propane
 (c) Butane (d) Pentane
- (iii) Which compound is not a saturated hydrocarbon?
 (a) $\text{CH}_3 - \text{CH}_3$ (b) CH_4
 (c) $\text{CH}_3 - \text{CH} = \text{CH}_2$ (d) $\text{CH}_3 - \text{CH}_2 - \text{CH}_3$
- (iv) Stem "But" stands for how many Carbon atoms.
 (a) 2 (b) 3
 (c) 4 (d) 5
- (v) The functional group $\text{—}\overset{\text{O}}{\underset{\text{||}}{\text{C}}}\text{—}$ is found in
 (a) Alcohols (b) Ketones
 (c) Carboxylic acids (d) Esters
- (vi) In which of the following Compounds, oxygen is attached to two alkyl carbon atoms?
 (a) Alcohol (b) Phenol
 (c) Ether (d) Ester
- (vii) Which of the following is an alcohol?
 (a) $\text{CH}_3 - \text{CH}_2 - \text{O} - \text{CH}_2 - \text{CH}_3$ (b) $\text{CH}_3 - \text{CH}_2 - \text{COOH}$
 (c) $\text{C}_6\text{H}_5 - \text{OH}$ (d) $\text{CH}_3 - \text{CH}_2 - \text{OH}$
- (viii) The functional group of amines is
 (a) $-\text{OH}$ (b) $-\text{COOH}$
 (c) $-\text{NH}_2$ (d) $-\text{CHO}$
- (ix) Ethanoic acid contains functional group
 (a) $-\text{OH}$ (b) $-\text{CO}-$
 (c) $-\text{COOH}$ (d) $-\text{CHO}$

2. Give short answer.

What is catenation?

- (i) Define isomerism.

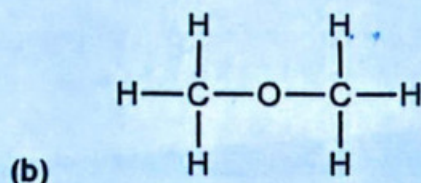
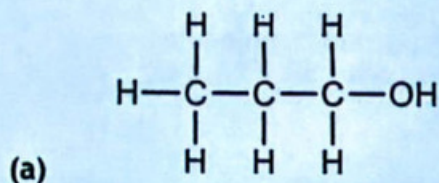
- (ii) Give three examples of unsaturated compound.
 (iii) Define a functional group.
 (iv) What is the difference between an alkene and an alkyne?
3. Identify the following compounds on the basis of functional groups they contain and encircle the functional group.



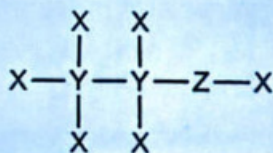
4. What is the name of alkane having four carbon atoms in the chain?
 5. Give the structural formula of two simple alkanes and one alkyne.
 6. What is meant by the term functional group?
 7. Identify the type of following compounds as an alcohol, aldehyde or ketone:
 (a) HCHO , which is used to manufacture polymers, such as urotropine which is used to treat urinary tract infection.
 (b) CH_3COCH_3 , which is used in nail polish remover.
 (c) $\text{CH}_3\text{CH}_2\text{OH}$, which is used in the preparation of many organic substances such as plastics, cosmetics, tinctures etc.

THINK TANK

8. Give molecular formula of a compound containing C, H and O and single bonds. List all the possible functional groups this compound can have?
 9. Give the condensed structural formulas of the following compounds and classify each on the basis of functional group.



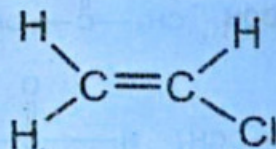
10. The diagram represents an organic compound that contains three different elements.



Select the possible compound from the following.

- a) Ethanoic acid b) Propene c) Ethanol d) Propane.

11. Polyvinyl chloride (PVC) is a polymer. It is used for making vinyl sheets, drainage pipes, wire insulation etc. It is obtained from vinyl chloride

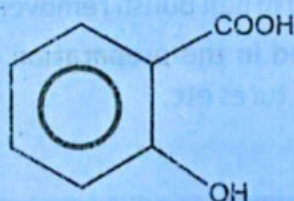


Classify Vinyl chloride as saturated or unsaturated compound.

12. For each of the following, sketch the structural formulas of a two-carbon compound containing the indicated functional group.

- (a) alcohol (b) aldehyde (c) carboxylic acid (d) alkene

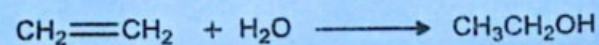
13. Aspirin is a mild pain killer and fever reducer. It is manufactured from salicylic acid.



Select functional groups present in it and encircle them. Justify your selection.

18. Construct the general formula for an alkane, an alkene, alkyne and an alcohol containing 4 carbon atoms.

19. Water adds to ethene according to the following reaction



Compare the functional groups in the reactant and product molecules.

PROJECT

Prepare a chart showing differences between organic and inorganic compounds.