

(2) Federal Boards (Exercise Short/Section-B)

2. Give short answers.

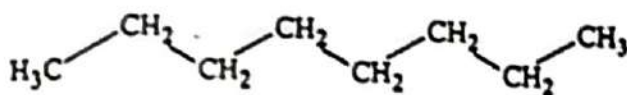
(i) What is catenation?

Ans: **Catenation:**

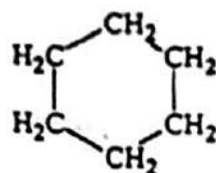
The ability of carbon atoms to link with other carbon atoms to form long chains and large rings is called catenation.

Example:

Silicon and carbon have similar electronic configuration but carbon shows catenation whereas silicon does not. It is mainly due to the reason that C-C bonds are much stronger (355 kJ mol^{-1}) than Si-Si (200 kJ mol^{-1}) bonds. Such as



Octane



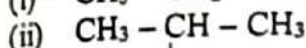
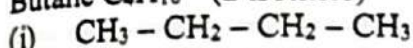
(ii) Define isomerism

Ans: **Isomerism:**

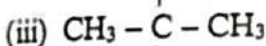
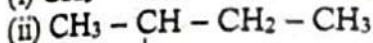
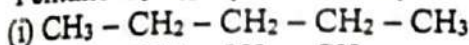
Compound having same molecular formula but different structural formula is called isomers and this phenomenon and the process is called isomerism.

Example:

Butane C_4H_{10} - (2 isomers)



Pentane C_5H_{12} (3 - isomers)



(iii) Give three examples of alkyl groups

Ans: (a) Methyl $\text{CH}_3 -$

(b) Ethyl $\text{CH}_3\text{CH}_2 -$

(c) Propyl $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 -$

(iv) Define a functional group.

Ans: **Functional Group:**

An atom or group of atoms or presence of double or triple bond which determines the characteristic properties of an organic compound is known as the functional group.

OR

An atom or group of atoms that provide characteristics properties to an organic compound is called functional group.

Example:

Alcoholic functional group: $-\text{OH}$

CH₃OH Methyl Alcohol
 Carboxylic functional group: -COOH
 CH₃COOH Acetic acid

(v) What is the difference between an alkane and an alkyl radical?

Ans:

Characteristic	Alkane	Alkyl Radical
Molecular Structure	Consists of only carbon-carbon single bonds	Derived from an alkane by removing one hydrogen atom
General Formula	C _n H _{2n+2}	C _n H _{2n+1}
Example	Methane (CH ₄), Ethane (C ₂ H ₆), Propane (C ₃ H ₈)	Methyl (CH ₃ [•]), Ethyl (C ₂ H ₅ [•]), Propyl (C ₃ H ₇ [•])
Saturated or Unsaturated	Saturated	Unsaturated (contains a single bond)
Chemical Reactivity	Generally unreactive due to stable single bonds	More reactive due to the presence of a lone pair on the carbon atom
Role	Often used as fuels and hydrocarbons	Serve as building blocks in organic chemistry, often used as substituents
Examples	Alkanes are common in petroleum products	Alkyl radicals are common in organic synthesis and functional group substitution

3. What do you mean by the term destructive distillation?

Ans: **Destructive distillation:**

Destructive distillation is a process where organic material is heated in the absence of air, causing it to break down into volatile products. This process typically yields a variety of useful substances such as tar, gas, and charcoal, while leaving behind a residue of solid material.

4. List some general properties of organic compounds.

Ans: **Characteristics of organic compounds:**

- **Carbon-Based:** Contain carbon atoms bonded to other atoms such as hydrogen, oxygen, nitrogen, and halogens.
- **Covalent Bonding:** Formed by covalent bonds between carbon and other atoms, resulting in stable molecular structures.
- **Varied Solubility:** Range from highly soluble in nonpolar solvents (like hydrocarbons) to moderately soluble in polar solvents (like water).
- **Combustibility:** Many organic compounds are combustible, burning in the presence of oxygen to produce carbon dioxide and water.
- **Isomerism:** Exhibit isomerism due to the ability of carbon atoms to form different structural arrangements.
- **Functional Groups:** Can contain various functional groups (e.g., hydroxyl, carbonyl, amino), which determine their chemical properties and reactivity.

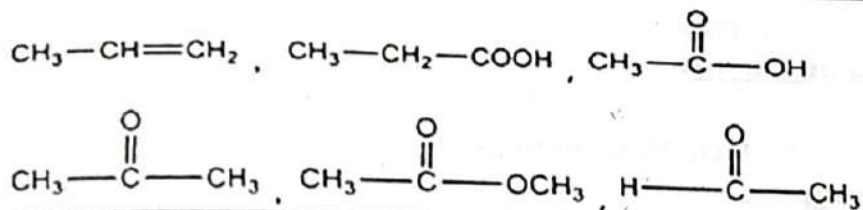
5. List major commercial sources of alkanes.

Ans: **Commercial Sources of Alkanes:**

- **Petroleum:** Crude oil is the primary source of alkanes, which are separated through fractional distillation.

- **Natural Gas:** Methane, the simplest alkane, is the main component of natural gas extracted from underground reservoirs.
- **Refinery Processes:** Alkanes are also obtained through refinery processes such as cracking, reforming, and hydrocracking of petroleum fractions.
- **Biological Sources:** Certain microorganisms produce methane as a byproduct of metabolism, which can be captured and used as a source of alkanes.

6. Identify the following compounds on the basis of functional groups they contain and encircle the functional group.



Formula	Name	Functional group	Organic family
$\text{CH}_3-\text{CH}=\text{CH}_2$	Propene	$\text{C}=\text{C}$	Alkene
$\text{CH}_3-\text{CH}_2-\text{COOH}$	Propanoic acid	$-\text{COOH}$	Carboxylic acid
$\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{OH}$	Acetic acid	$-\text{COOH}$	Carboxylic acid
$\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$	Acetone	$\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{R}'$	Ketone
$\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{OCH}_3$	Methyl acetate	$\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}-\text{R}'$	Ester
$\text{H}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$	Acetaldehyde	$\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$	Aldehyde

7. What is the name of alkane having seven carbon atoms in the chain?

Ans: The alkane with seven carbon atoms in its chain is named heptane.
(Hept = Seven, ane = Alkane).

8. What is the name of the alkyl group obtained by removing an end hydrogen atom from (i) propane (ii) ethane?

Ans: Alkyl groups from Ethane and Propane:

Alkyl groups are formed by removing a hydrogen atom from an alkane (hydrocarbon with only single bonds). Their names are derived from the corresponding alkane by replacing the -ane suffix with -yl.

(i) Propane:

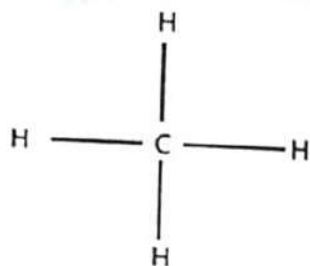
- ❖ Removing a hydrogen atom from an end carbon of propane gives the n-propyl group ($\text{CH}_3\text{CH}_2\text{CH}_2-$). The n-prefix indicates a normal (straight-chain) structure.
- ❖ Removing a hydrogen atom from the middle carbon is also possible, but it results in a different alkyl group called the isopropyl group. Here iso- signifies a branched structure with a methyl group attached to the second carbon.

(ii) Ethane:

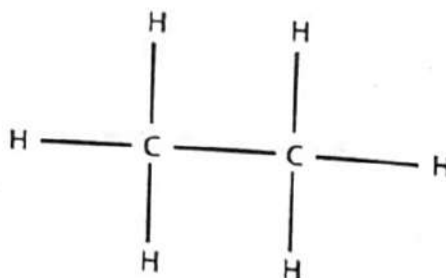
- ❖ Since Ethane only has two carbon atoms, removing a hydrogen atom can only happen from an end carbon. This leads to the formation of the ethyl group (CH_3CH_2-). As there are no branches, the "n-" prefix is not necessary.

9. Give the structural formula of two simple alkanes and one alkyne.

Ans: Structural formula of Alkanes:

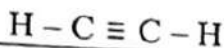


Methane



Ethane

Structural formula of Alkyne:



10. What is meant by the term functional group?

Ans: Functional Group:

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

11. 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) CH₃COCH₃ which is used in nail polish remover.
 (c) CH₃CH₂OH which is used in the preparation of many organic substances such as plastics, cosmetics, tinctures etc.

Ans: (a) HCHO: Aldehyde because CHO - group is attached.

(b) CH₃COCH₃: Ketone because CO - group is attached

(c) CH₃CH₂OH: Alcohol because OH group is attached to an alkyl group.

THINK-TANK

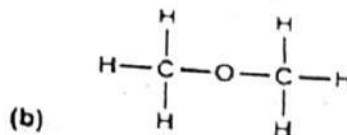
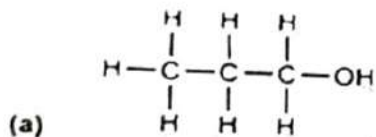
12. Give molecular formula of a compound containing C, H and O and single bonds. List all the possible functional groups this compound can have?

Ans: Molecular formula: C₂H₆O

Functional group isomers:

- (i) CH₃ - CH₂ - OH (containing -OH group)
Ethanol
 (ii) CH₃ - O - CH₃ (containing C - O - C group)
Dimethyl ether

13. Give the condensed structural formulas of the following compounds and classify each on the basis of functional group.

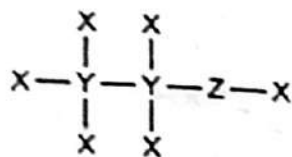


Ans:

	Structural formula	Condensed formula	Organic family	Name
(a)	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H} - \text{C} - \text{C} - \text{C} - \text{OH} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$	CH ₃ CH ₂ CH ₂ OH	Alcohol	1-Propanol

(b)	$\begin{array}{c} \text{H} & & \text{H} \\ & & \\ \text{H}-\text{C}-\text{O}-\text{C}-\text{H} \\ & & \\ \text{H} & & \text{H} \end{array}$	CH_3OCH_3	Ether	Dimethyl ether
-----	---	---------------------------	-------	----------------

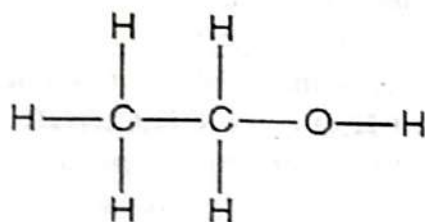
13. The diagram represents an organic compound that contains three different elements.



Select the possible compound from the following

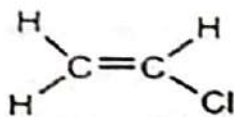
- a) Ethanoic acid
- b) Propene
- c) Ethanol
- d) Propane

Ans:



Option (c) is correct (Ethanol).

14. 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.

Ans: Vinyl chloride is an unsaturated compound. It contains a double bond between two carbon atoms, which makes it unsaturated.

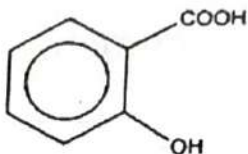
15. For each of the following, sketch the structural formulas of a two-carbon compound containing the indicated functional group.

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

Ans:

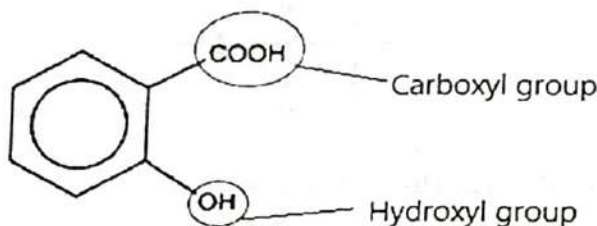
	Organic family	Example
(a)	Alcohol	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
(b)	Aldehyde	CH_3OCH_3
(c)	Carboxylic acid	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3 - \text{C} - \text{OH} \end{array}$
(d)	Alkene	$\begin{array}{c} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C} = \text{C} & \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array}$

16. 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.

Ans:

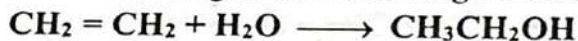


Salicylic acid contains carboxyl group (-COOH) and hydroxyl group (-OH).

17. General formula for alkane is C_nH_{2n+2} . Construct the general formula for alkyl radical?

Ans: The general formula for an alkyl radical can be derived by removing one hydrogen atom from an alkane molecule. Since the general formula for an alkane is C_nH_{2n+2} , removing one hydrogen atom yields C_nH_{2n+1} . Therefore, the general formula for an alkyl radical is C_nH_{2n+1} .

18. Water adds to ethane according to the following reaction.



Compare the functional groups in the reactant and product molecules.

Ans: In the reactant molecule, ethene ($CH_2=CH_2$), we have a carbon-carbon double bond, which is characteristic of an alkene functional group ($C=C$).

In the product molecule, ethanol (CH_3CH_2OH), we have an alkyl group (CH_3) attached to a carbon atom, indicating an alkane functional group ($C-C$), and also a hydroxyl group (OH), indicating an alcohol functional group (OH).

Therefore, in the reactant molecule, we have an alkene functional group, while in the product molecule, we have both alkane and alcohol functional groups.

19. Bonding of carbon atom to heteroatoms increases the number of organic compounds. Justify it.

Ans: The bonding of carbon atoms to heteroatoms, such as oxygen, nitrogen, and sulfur, increases the diversity of organic compounds by introducing various functional groups. These functional groups exhibit unique chemical reactivity, leading to a wide array of molecules with distinct properties and applications. Incorporating heteroatoms enhances chemical versatility, modifies physical properties, and contributes to the biological significance of organic molecules. Overall, this diversity facilitates the development of new materials, drugs, and technologies across scientific and industrial sectors.