

Class 9th Chemistry Chapter 11

Hydrocarbons

Descriptive Questions taleemzone.com

Q.1. (Ex. Q.4 (i)) Describe the importance of organic compounds in daily life.

Ans: Uses of Organic Compounds: No doubt, thousands of organic compounds are synthesized naturally by animals and plants. But millions of organic compounds are being prepared in the laboratories by chemists because these compounds are part of everything from the food we eat to the various items we use in daily life to fulfil our needs.

i. Uses as Food: The food we eat daily such as milk, eggs, meat, vegetables, etc., contain carbohydrates, proteins, fats, vitamins, etc., all of which are organic compounds.

ii. Uses as Clothing: All types of clothing (we wear, we use as bed sheets, etc.) are made up of natural fibers (cotton, silk, and wool, etc.) and synthetic fibers (nylon, Dacron, and acrylic, etc.); all these are organic compounds.

iii. Uses as Houses: Wood is cellulose (a naturally synthesized organic compound). It is used for making houses and furniture of all kinds.

iv. Uses as Fuel: The fuels we use for automobiles and domestic purposes are coal, petroleum, and natural gas. These are called fossil fuels. All of these are organic compounds.

v. Uses as Medicines: A large number of organic compounds (naturally synthesized by plants) are used as medicines by us. Most of the life-saving medicines and drugs such as antibiotics (which inhibit or kill microorganisms that cause infectious diseases) are synthesized in laboratories.

vi. Uses as Raw Material: Organic compounds are used to prepare a variety of materials, such as rubber, paper, ink, drugs, dyes, paints, varnishes, pesticides, etc.

Q.2. (Ex. Q.4 (ii)) Why is carbon so important as an element that the whole branch of chemistry is based on it? taleemzone.com

Ans. All the organic compounds are known to contain carbon as an essential element. This fact has led us to define organic chemistry as the chemistry of carbon compounds. Apart from carbon, most of the organic compounds contain hydrogen and oxygen as well. Organic compounds are famous for their large number and diverse behavior. Several million organic compounds are known to exist naturally or have been synthesized in the laboratory. Organic molecules are usually large and more complex in nature. They include life molecules like proteins, enzymes, carbohydrates, lipids, vitamins, and nucleic acids, pharmaceuticals and synthetic fibers, etc. The number of compounds formed by the element carbon is far more than the total number of compounds formed by all the rest of the elements put together. This is due to some unique properties of carbon. The element carbon is present at the center of the periodic table and it is energetically not possible for it to gain or lose electrons to form ionic bonds. Therefore, it forms four covalent bonds. Because of their small size, these covalent bonds are short and strong, enabling carbon to give strong and stable bonds with itself and with hydrogen, oxygen, and nitrogen. The self-linking property of carbon is called catenation, and due to this, it forms long, straight, and branched chains and rings. All these facts suggest that due to the diversity of carbon compounds, carbon as an element is very important and a separate branch of chemistry should be based upon it.

Q.3. (Ex. Q.4 (iii)) A carbon-carbon single bond (C-C) does not behave as a functional group but a carbon-carbon double bond (C=C) in alkenes does. Explain.

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

Example: -OH (Hydroxyl group) is the functional group of alcohols which gives characteristic properties to alcohols. **taleemzone.com**

Reasons:

i. Reactivity: A C-C single bond is relatively stable and non-reactive under normal conditions. It doesn't introduce significant chemical properties to a molecule. A C=C double bond is weaker and more reactive than a single bond. This reactivity makes the double bond a site for various chemical reactions, such as addition reactions (e.g., hydrogenation, halogenation).

ii. Influence on Molecular Properties: A C-C single bond doesn't significantly affect the physical or chemical properties of a molecule. A C=C double bond affects the molecule's shape and its electronic properties, which influence how the molecule interacts in chemical reactions.

iii. Role in Functional Group Definition: A functional group is defined as an atom or group of atoms within a molecule that determines its chemical reactivity. The double bond fits this criteria because it:

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1. Dictates how a molecule reacts.
2. Is a key site for chemical reactions.

In contrast, a single bond only connects atoms without imparting significant chemical properties.

iv. Functional Group Classification: The carbon-carbon double bond is the defining feature of alkenes, a class of organic compounds with distinct reactivity and properties. Single bonds, being relatively inert, do not define a specific class of compounds based on reactivity.

Q.4. (Ex. Q.4 (iv)) Explain the IUPAC system of nomenclature for alkanes.

Ans. As a result of the great complexity and large number of organic compounds, it is not possible to name each and every compound individually. The International Union of Pure and Applied Chemistry has devised a systematic way of naming organic compounds called **IUPAC nomenclature**.

According to the IUPAC system of nomenclature, the entire name of an organic compound has three parts:

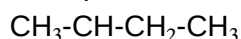
i. Root: It tells us the number of carbon atoms in the longest continuous chain present in the molecule. The roots up to ten carbon atoms are shown in the table.

Root	Meth	Eth	Prop	But	Pent	Hex	Hept	Oct	Non	Dec
	-	-	-	-	-	-	-	-	-	-
No. of Carbon atoms	1	2	3	4	5	6	7	8	9	10

ii. Suffix: It is added after the root and tells us about the class of organic compounds (e.g., -ane for alkanes, -ene for alkenes, -yne for alkynes).

iii. Prefix: It is indicated before the root and tells us about the group or groups attached to the longest chain (substituents).

To explain the above system, let us name the following compound:



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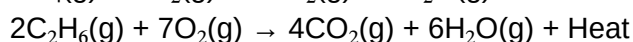
- a) Identify the longest continuous chain present in the compound (4 carbons).
- b) Identify the class of organic compounds (alkane).
- c) Identify the substituent(s) if present (methyl group at carbon 2).

This organic compound contains four carbon atoms in the longest continuous chain and it belongs to the family of organic compounds called Alkanes. The root is therefore But- and the suffix -ane is added to this. The organic compound will thus be given the name Butane. The name of the branch methyl will be added to this name as a prefix. To specify where the branch occurs, the longest continuous chain is numbered starting from the end closest to the branch. This number is then attached to this prefix. The name of the above compound will then be: **2-Methylbutane**.

If a compound has no branches, its name will contain only the root and suffix.

Q.5. (Ex. Q.4 (v)) How is the combustion reaction of alkanes useful for us?

Ans. Combustion: Alkanes burn in oxygen or air to form CO_2 and H_2O with the evolution of a large amount of heat.

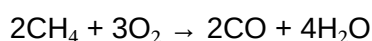


Types of Combustion

i. Complete Combustion: Occurs in the presence of sufficient oxygen, producing carbon dioxide and water as products. This releases a large amount of energy.



ii. Incomplete Combustion: Occurs when the oxygen supply is limited, leading to the formation of carbon monoxide (CO) and carbon black (soot) along with water. This releases less energy and can be harmful.



Importance of Combustion of Alkanes

The combustion of alkanes has several practical uses and benefits in our daily lives.

i. Energy Production: Alkanes, especially methane, propane, and butane, are used as fuels in homes and industries.

- Methane (natural gas) is used in cooking.
- Propane is used in gas cylinders for stoves.
- Large-scale combustion of alkanes in power plants generates electricity.

ii. Transportation: Gasoline and diesel, which are mixtures of alkanes, are used as fuels in cars, trucks, and airplanes. Their combustion provides the energy required to power engines.

iii. Industrial Applications: Alkanes are used as fuels in various industries, such as steel manufacturing and chemical production. For instance:

- Combustion of alkanes provides the heat needed for melting metals.
 - It drives machinery in factories.
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Investigative Questions

Q.1. (Ex. Q.5 (i)) When a natural gas valve is kept open in the kitchen, the gas spreads through the whole kitchen. This may cause an explosion. What is the reason for this explosion and how can you avoid it?

Ans. Natural gas is widely used in kitchens for cooking because it is a clean and efficient source of energy. However, if the gas valve is left open without being ignited, it can spread throughout the kitchen. This situation is highly dangerous and can lead to an explosion.

Why Does an Explosion Occur?

Natural gas, primarily composed of methane (CH_4), is highly flammable. This means it can easily catch fire when it comes into contact with a spark or flame. Methane reacts rapidly with oxygen in the air, releasing a large amount of energy in the form of heat and light. A small spark, flame, or even

heat from an electrical device (like a switch, bulb, or appliance) can ignite the gas-air mixture, causing a sudden and violent combustion – an explosion.

Consequences of a Gas Explosion:

- The force of the explosion can destroy walls, windows, and appliances in the kitchen.
- The explosion can start a fire, spreading further damage.
- The sudden explosion can cause severe injuries or even fatalities.

How Can You Avoid a Gas Explosion?

To prevent such accidents, follow these safety measures:

1. Always ensure the gas valve is turned off when not in use. Double-check the valve after cooking to confirm it is closed.
 2. Keep your kitchen well-ventilated. If you suspect a gas leak, open all doors and windows to allow the gas to disperse quickly. Leave the area and call a gas technician to address the issue.
 3. Inspect your gas appliances, pipes, and valves regularly for leaks or damage. Replace worn-out or damaged components immediately.
 4. Install a gas leak detector in your kitchen. These devices can sense the presence of gas and alert you before it becomes dangerous.
 5. Teach everyone in the household about gas safety, including how to identify a gas smell and what to do in an emergency.
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Q.2. (Ex. Q.5 (ii)) "Neem" is a common tree grown throughout our country. Comment on the medical benefits of this tree.

Ans: Medicinal Benefits of the Neem Tree

Neem is a well-known tree that is commonly grown throughout many parts of the world, including our country. It is often referred to as the "Village Pharmacy" because almost every part of this tree (e.g., leaves, bark, seeds, and oil) has medicinal properties. Neem is widely used in traditional medicine and plays an important role in promoting health and treating various health problems.

Medicinal Benefits of Neem:

1. Neem is highly effective in killing bacteria and viruses. Its extracts are used to treat skin infections, wounds, and acne. Neem oil is applied to cuts and scratches to prevent infection and promote healing.
2. Neem paste or neem water helps reduce pimples and other skin conditions. It is a common ingredient in soaps, creams, and face washes because of its cleansing and purifying effects.
3. Neem twigs are traditionally used as toothbrushes. Chewing on these twigs helps clean teeth, prevent cavities, and maintain oral hygiene. Neem also fights gum infections and strengthens teeth. **taleemzone.com**
4. Consuming neem leaves or neem-based medicines helps purify the blood. This improves overall health and reduces the risk of infections.
5. Neem has compounds that help lower blood sugar levels. Drinking neem tea or consuming neem extracts is beneficial for managing diabetes.
6. Regular use of neem strengthens the immune system, helping the body fight off diseases.
7. Neem oil is a natural insect repellent. It is used to protect crops from pests and keep mosquitoes and other insects away from humans.
8. Neem helps treat stomach problems like ulcers, constipation, and intestinal worms. It also promotes a healthy digestive system.
9. Neem reduces swelling and pain in conditions like joint problems.
10. Neem oil or neem shampoo helps control dandruff, lice, and other scalp infections. It promotes healthy hair growth and keeps the scalp nourished.

Q.3. (Ex. Q.5 (iii)) Name a few popular medicines which are, in fact, organic compounds.

Ans. Few Popular Medicines:

Several medicines we use are organic compounds, as they contain carbon-based structures essential for their biological activity.

i. Aspirin (Acetylsalicylic Acid): It is a pain reliever, anti-inflammatory, and fever reducer. Aspirin inhibits the enzyme which is involved in the production of chemicals that cause pain, inflammation, and fever.

ii. Paracetamol (Acetaminophen): It is an analgesic (pain reliever) and antipyretic (fever reducer). Paracetamol acts on the brain to regulate body temperature and reduce fever. It also blocks certain chemical pathways in the brain to reduce the sensation of pain.

iii. Penicillin: It is an antibiotic. It is effective against a range of bacterial infections, including pneumonia and throat infections.

iv. Morphine: It is an opioid painkiller. It is used to manage severe pain, such as in cancer patients or after surgery. However, it can be addictive and requires careful use.

v. Insulin: It is used for hormonal treatment for diabetes. Insulin helps regulate blood sugar levels by facilitating the uptake of glucose into cells for energy or storage.

SLO Based Additional Long Questions

Q.1. Describe the preparation of alkanes. **taleemzone.com**

Ans. Generally, any member of the alkane series can be prepared by the following methods.

(i) Cracking of Higher Hydrocarbons: Cracking is a process in which hydrocarbons with higher molecular masses are broken up into smaller hydrocarbons which are more useful. This is done by heating the hydrocarbons at high temperature in the presence of a catalyst. Fractional distillation of petroleum gives naphtha, which consists of a mixture of liquid hydrocarbons. It is then heated at around 500°C in the presence of a catalyst called zeolite to give hydrocarbons which have five to ten carbon atoms.

Naphtha $\xrightarrow{(500^{\circ}\text{C}, \text{Zeolite})}$ Alkanes and alkenes containing 5 to 10 carbon atoms

(ii) Reduction of Alkenes and Alkynes: Alkanes can be prepared by reducing alkenes and alkynes with hydrogen gas in the presence of nickel metal as a catalyst. Methane cannot be prepared by this method. The reaction is also called hydrogenation of alkenes and alkynes and is an example of an addition reaction. An addition reaction occurs when hydrogen (H_2) is added to an unsaturated compound.

$\text{CH}_2=\text{CH}_2 + \text{H}_2 \xrightarrow{(\text{Ni}, 200^{\circ}\text{C})} \text{CH}_3-\text{CH}_3$ (Ethene to Ethane)

$\text{CH}\equiv\text{CH} + 2\text{H}_2 \xrightarrow{(\text{Ni}, 200^{\circ}\text{C})} \text{CH}_3-\text{CH}_3$ (Ethyne to Ethane)

(iii) Reduction of Alkyl Halides: Alkyl halides (R-X) can be reduced to alkanes with hydrogen generated by the reaction of zinc metal with hydrochloric acid.

$\text{R-X} + 2[\text{H}] \rightarrow \text{R-H} + \text{H-X}$

$\text{CH}_3\text{-Cl} + 2[\text{H}] \rightarrow \text{CH}_4 + \text{HCl}$

Q.2. What are substitution reactions? Explain the halogenation of alkanes.

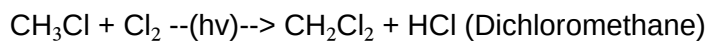
Ans. Substitution Reactions: Alkanes give substitution reactions. The reactions which involve the replacement of hydrogen of alkanes by an atom or a group of atoms like halogens are called substitution reactions.

Halogenation of Alkanes: Alkanes react with halogens, especially chlorine, to give alkyl halides. Since these substitution reactions are carried out in the presence of sunlight, they are called

photochemical substitution reactions.



The reaction may proceed ahead and all the hydrogen atoms attached to the carbon of methane are successively replaced by chlorine atoms.



Short Question Answers (Exercise)

Q.1 (Ex Q2 (i)) Differentiate between an organic and an inorganic compound.

Ans.

Organic Compound

These are the compounds which contain covalently bonded carbon as an essential component.

They are found in living things, i.e., plants and animals.

For example: carbohydrates and proteins.

Inorganic Compound

These compounds are made up of almost all elements of the periodic table except those compounds of carbon and hydrogen (hydrocarbons).

They are found in non-living things, i.e., rocks and minerals.

For example: NaCl and CaCO₃.

Q.2 (Ex Q2 (ii)) Why are organic compounds found in large numbers?

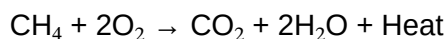
Ans. Organic compounds are found in large numbers due to the unique properties of carbon:

1. The self-linking property of carbon called catenation is responsible for the existence of a large number of organic compounds ranging from short to very long chains and large rings.
 2. Due to the small size of carbon, it can form strong bonds with small atoms like hydrogen, oxygen, and nitrogen, etc.
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Q.3 (Ex Q2 (iii)) Name the products which are obtained when natural gas is oxidized under controlled conditions.

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Ans. When natural gas is oxidized under controlled conditions, the products depend upon the degree of oxidation and reaction conditions such as temperature, pressure, and catalyst, etc. Excess supply of oxygen gives CO₂, H₂O, and heat.



Q.4 (Ex Q2 (iv)) How is the naphtha fraction decomposed to give lower hydrocarbons?

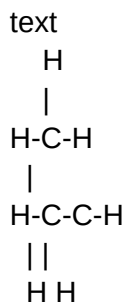
Ans. Fractional distillation of petroleum gives naphtha, which consists of a mixture of liquid hydrocarbons. It is then heated at around 500°C in the presence of a catalyst called **zeolite** to give hydrocarbons which have five to ten carbon atoms.



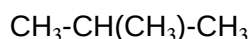
Q.5 (Ex Q2 (v)) Write down the molecular formula, structural formula, and the condensed structural formula for iso-butane.

Ans. The molecular formula of iso-butane is C₄H₁₀.

The structural formula of iso-butane is:



The condensed formula of iso-butane is:



Q.6 (Ex Q2 (vi)) How are organic compounds useful for us?

Ans. Organic compounds are useful for us in many ways such as:

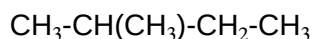
1. They are major constituents of our diet as carbohydrates, proteins, and fats, etc.
 2. The clothes we wear are made up of natural or synthetic fibers which are organic compounds.
 3. Fossil fuels used to run transport and industry contain hydrocarbons which are organic compounds.
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Q.7 (Ex Q2 (vii)) Write down the names of five such organic compounds which exist naturally.

Ans. Five naturally occurring organic compounds are:

1. Methane (CH_4)
 2. Glucose ($\text{C}_6\text{H}_{12}\text{O}_6$)
 3. Citric acid ($\text{C}_6\text{H}_8\text{O}_7$)
 4. Starch
 5. Nucleic acids (DNA & RNA)
-

Q.8 (Ex Q2 (viii)) Give the IUPAC name to the following compound.



Ans. The longest continuous chain contains four carbon atoms singly bonded to each other. So, its root name will be But- and the suffix will be -ane. A methyl group is attached at carbon 2. Therefore, the IUPAC name is **2-Methylbutane**.

Q.9 (Ex Q2 (ix)) How do the melting and boiling points of alkanes change when we move from lower members to higher members?

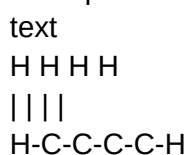
Ans. When we move from lower to higher members of alkanes, their melting and boiling points increase because of the increase in molecular size, which results in an increase in the attractive forces among molecules.

Practice Question Answers (Exercise)

Q.10 What do you understand by the term structural formula of an organic compound?

Ans. The structural formula of a compound represents the exact arrangement of the different atoms of various elements present in a molecule of a substance.

Example: Structural formula of butane is:



||||
H H H H
(n-butane)

Q.11 Name the following compounds according to the IUPAC system of nomenclature.

Ans.

(i) $(\text{CH}_3)_2\text{CH}-\text{CH}_2-\text{CH}_2-\text{CH}_3$

The longest continuous chain has five carbons singly bonded, and one methyl group is attached at carbon number two. So, the name will be: **2-Methylpentane**.

(ii) $(\text{CH}_3)_2\text{CH}-\text{CH}_2-\text{CH}_3$

The longest continuous chain has four carbons singly bonded, and one methyl group is attached at carbon number two. So, the name will be: **2-Methylbutane**.

Q.12 Draw the structural formula of the following saturated compounds.

$\text{C}_2\text{H}_5\text{Br}$, CH_3NH_2 , $\text{CH}_3\text{CH}_2\text{OH}$

Ans.

$\text{C}_2\text{H}_5\text{Br}$ (Bromoethane):

text
H H
||
H-C-C-Br

||
H H

CH_3NH_2 (Methylamine):

text
H
|
H-C-N-H

|
H

$\text{CH}_3\text{CH}_2\text{OH}$ (Ethanol):

text
H H
||
H-C-C-O-H

||
H H

Q.13 How many methyl and methylene groups are present in each of the above compounds?

Ans.

- Methane: 1 methyl group (CH_3), 0 methylene groups.
 - Ethane: 2 methyl groups (CH_3), 0 methylene groups.
 - Propane: 2 methyl groups (CH_3) and 1 methylene group (CH_2).
-

Q.14 In the reduction of alkyl halides with Zn / HCl , the alkyl halide is being reduced. Which species in this reaction is being oxidized?

Ans. During the reduction of alkyl halides using Zn/HCl , Zinc is being oxidized to Zn^{2+} .

Q.15 During the combustion reaction of ethane, which bonds are being broken and which are being formed?

Ans. $2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O} + \text{Heat}$

- Bonds broken: C-C, C-H, and O=O bonds.
 - Bonds formed: C=O and O-H bonds.
-

Q.16 What products other than CH_3Cl are formed when methane reacts with chlorine gas?

Ans. When methane reacts with chlorine gas, a series of reactions takes place. Along with CH_3Cl , the following products are formed:

CH_2Cl_2 (Dichloromethane), CHCl_3 (Chloroform), and CCl_4 (Carbon Tetrachloride).

SLO Based Additional Short Questions

Hydrocarbons

Q.17 What are hydrocarbons?

Ans. Hydrocarbons are organic compounds of carbon and hydrogen elements. They include alkanes, alkenes, alkynes, and aromatic compounds. Examples: CH_4 , C_2H_6 , etc.

Q.18 Why are hydrocarbons considered as parent organic compounds?

Ans. Hydrocarbons are those compounds which are made up of only carbon and hydrogen elements. Hydrocarbons are regarded as the parent organic compounds since other organic compounds are considered to be derived from them by replacing one or more hydrogen atoms by other atoms or groups of atoms.

Q.19 What does LPG and CNG stand for?

Ans. LPG stands for Liquefied Petroleum Gas, and CNG stands for Compressed Natural Gas.

Q.20 Write the categories of hydrocarbons.

Ans. Hydrocarbons are classified structurally as:

- Alkanes
 - Alkenes
 - Alkynes
 - Aromatics
-

Alkanes

Q.21 Define alkanes and give one example.

Ans. Alkanes are saturated hydrocarbons in which all the carbon atoms are connected by only single covalent bonds.

Examples: Methane (CH_4), Ethane (C_2H_6).

The general formula of alkanes is $\text{C}_n\text{H}_{2n+2}$.

Q.22 Which property of alkanes makes them distinct from other compounds?

Ans. The distinguishing feature of alkanes that makes them distinct from other compounds is their lack of reactivity towards usual chemical reagents.

Q.23 Which is the simplest alkane and give its uses?

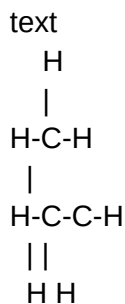
Ans. The simplest alkane is methane, having the formula CH_4 .

Uses: It is mainly used as a fuel, but it is also used to make hydrogen gas, carbon black, carbon disulphide, chloroform, hydrocyanic acid, etc.

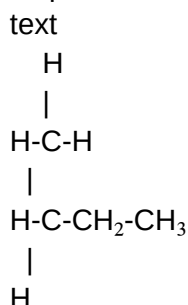
Q.24 Give the structural formula of Isopentane and Isobutane.

Ans.

Isobutane:



Isopentane:



Q.25 Why are alkanes called paraffins?

Ans. Alkanes are saturated hydrocarbons. In these compounds, all the bonds of carbon atoms are single, meaning the valencies of carbon atoms are fully satisfied (saturated). Therefore, they are least reactive. That is the reason alkanes are called paraffins (from Latin *parum affinis* = little affinity).

Q.26 What does IUPAC stand for?

Ans. IUPAC stands for the International Union of Pure and Applied Chemistry.

Q.27 Describe the three parts of the IUPAC name of an organic compound.

Ans. (i) Root: It tells us the number of carbon atoms in the longest continuous chain present in the molecule.

(ii) Suffix: It is added after the root and tells us about the class of organic compounds.

(iii) Prefix: It is indicated before the root and tells us about the group or groups attached to the longest chain.

Q.28 Write the dot and cross structure of methane, ethane, and propane.

Ans.

Methane: Carbon shares electrons with 4 Hydrogen atoms.

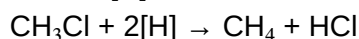
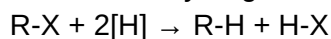
Ethane: Two carbons share electrons with each other and with Hydrogens.

Propane: Three carbons in a chain.

Preparation

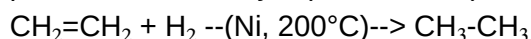
Q.29 How are alkyl halides reduced?

Ans. Reduction means the addition of nascent hydrogen. In fact, it is a replacement of a halogen atom with a hydrogen atom. This reaction takes place in the presence of Zn metal and HCl.



Q.30 What do you know about the hydrogenation of alkenes?

Ans. Hydrogenation means the addition of molecular hydrogen to an unsaturated hydrocarbon in the presence of a catalyst (Ni, Pt, or Pd) to form a saturated compound.

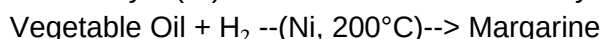


Q.31 What is the importance of cracking petroleum?

Ans. Cracking of petroleum helps balance the availability of petroleum fractions with the demand for them. Cracking transforms bigger hydrocarbons into smaller hydrocarbons. In this way, the fuel supply is increased, which helps to balance the demand and supply.

Q.32 How is margarine produced?

Ans. Margarine is produced by adding molecular hydrogen to vegetable oils at 200°C in the presence of a catalyst (Ni). The more the amount of hydrogen added, the more solid the margarine becomes.



Important Reactions

Q.33 Why does the burning of alkanes require a sufficient supply of oxygen?

Ans. Complete combustion takes place in excess of air or oxygen to produce CO₂, H₂O, and a large amount of heat. Insufficient oxygen leads to incomplete combustion, producing toxic CO and soot.

Q.34 Why are alkanes used as fuels? / How do hydrocarbons act as fuels? / How does combustion of methane take place? Describe the combustion process with an equation.

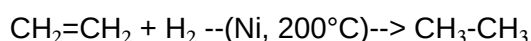
Ans. Alkanes burn in the presence of excess of air or oxygen to produce a lot of heat, carbon dioxide, and water. This reaction takes place in automobile combustion engines, domestic heaters, and cooking appliances. It is a highly exothermic reaction, and because of this, alkanes are used as fuels.



Q.35 What are addition reactions? Explain with an example.

Ans. Those reactions in which products are formed by the addition of a substance like H₂, Cl₂, etc., to an unsaturated hydrocarbon are called addition reactions.

Example: Addition of hydrogen to an unsaturated hydrocarbon in the presence of a catalyst (Ni, Pt) at 250-300°C.



Q.36 What is a substitution reaction?

Ans. A reaction which involves the replacement of hydrogen of alkanes by an atom or group of atoms like halogens is called a substitution reaction.



Q.37 Why do alkanes not give addition reactions?

Ans. It is because in alkanes, the valency of carbon is fully satisfied by forming single bonds. Alkanes are saturated compounds, which is why they do not give addition reactions.

Q.38 Give the roots of the first five carbon atoms.

Ans. Carbon 1 = Meth-

Carbon 2 = Eth-

Carbon 3 = Prop-

Carbon 4 = But-

Carbon 5 = Pent-

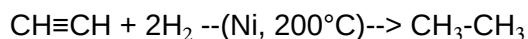
Q.39 How are alkanes prepared?

Ans. Alkanes are prepared by:

1. Cracking of higher hydrocarbons.
 2. Reduction of alkenes and alkynes.
 3. Reduction of alkyl halides.
-

Q.40 How are alkynes reduced?

Ans. Alkynes are reduced with hydrogen (or nascent hydrogen) in the presence of a catalyst Ni at a temperature of 200°C.



Q.41 Why are alkanes considered non-polar?

Ans. Alkanes contain carbon and hydrogen. The electronegativity values of carbon (2.5) and hydrogen (2.1) do not differ appreciably, and the bonding electrons between C-H and C-C are almost equally shared. This makes alkanes non-polar.

Constructed Response Questions

Q.1 (Ex. Q.3 (i)) Why do alkanes show little reactivity towards other reagents?

Ans. The unreactivity of alkanes may be explained on the basis of the strength of the C-C and C-H single bonds, which are difficult to break. A significant amount of energy is required to break these bonds for a reaction to occur.

Q.2 (Ex. Q.3 (ii)) Why does a mixture of natural gas and air explode?

Ans. Natural gas primarily contains methane, which is very flammable (gives a combustion reaction readily when ignited). That is why a mixture of natural gas and air explodes, and a large amount of heat is released along with CO₂ and water vapours.



Q.3 (Ex. Q.3 (iii)) How do you compare the melting and boiling points of inorganic and organic compounds?

Ans. Organic compounds are molecular in nature and have weak intermolecular forces, so generally organic compounds have low melting and boiling points. On the other hand, inorganic compounds mostly contain ionic bonds and have strong attractive forces. So inorganic compounds have comparatively high melting and boiling points.

Q.4 (Ex. Q.3 (iv)) Reactions of alkanes with chlorine take place in the presence of sunlight. / What is the role of sunlight in the reaction?

Ans. Reactions of alkanes with chlorine follow a free radical mechanism. Sunlight falls on the Cl₂ molecule and generates chlorine free radicals (Cl•), which attack the alkane molecule to form an alkyl halide. That is why sunlight is necessary for the reaction of chlorine with alkane molecules.

Q.5 (Ex. Q.3 (v)) How do you compare the boiling point of n-butane with that of iso-butane?

Ans. Straight-chain structured compounds have stronger intermolecular forces than branched-chain compounds and hence higher boiling points. n-butane has a straight chain of four carbon atoms, while iso-butane has a branched chain. So, n-butane has a higher boiling point than iso-butane.

Q.6 (Ex. Q.3 (vi)) Why are organic compounds not generally soluble in water?

Ans. Organic compounds are mostly non-polar in nature. According to the general principle of solubility "like dissolves like," non-polar compounds are soluble in non-polar solvents while polar compounds are soluble in polar solvents. As water is a polar solvent, generally organic compounds are not soluble in water.

Multiple Choice Questions (Exercise)

1. Which other atom is almost always present along with the carbon atom in all organic compounds?
(c) Hydrogen ✓
 2. Which other metal can be used to reduce alkyl halides?
(a) Al (*Note: Zn is commonly used, but Al can also be used*)
 3. If naphtha undergoes a combustion reaction, what products do you expect to form?
(c) CO₂ and H₂O ✓
 4. Why does a mixture of zinc and hydrochloric acid act as a reducing agent?
(b) Because atomic hydrogen is produced with Zn/HCl which acts as a reducing agent. ✓
 5. Which alkane will evolve the most amount of heat when it is burnt with oxygen?
(c) Butane (*Larger alkanes produce more heat per mole*)
 6. Indicate the most reactive hydrocarbon?
(b) CH₂=CH₂ (*Alkenes are more reactive than alkanes*)
 7. Which hydrocarbon is responsible for explosions in coal mines?
(c) Methane ✓
 8. Which product will be formed when ethyl bromide (C₂H₅Br) is treated with Zn/HCl?
(b) CH₃-CH₃ (*Ethane*) ✓
 9. Which of the following is not a process of halogenation of alkanes?
(a) Cracking ✓
 10. How many moles of oxygen will be required to completely burn propane?
(b) 5 moles (*C₃H₈ + 5O₂ → 3CO₂ + 4H₂O*) ✓
-

SLO Based Additional MCQs

Introduction

11. The ability of carbon atoms to form chains is called:
(b) Catenation ✓
12. The branch of chemistry which deals with the study of hydrocarbons and their derivatives is known as:
(a) Organic chemistry ✓
13. The most essential element for an organic compound is:
(a) Carbon ✓
14. Which carbon compounds are not considered organic compounds?
(d) All of these (*Carbonates, Cyanides, Carbides*) ✓

15. Carbon is present in the periodic table:
(c) Middle ✓
16. Examples of organic compounds are:
(d) All of these ✓
17. The valency of carbon is:
(d) 4 ✓
18. The formula which represents the actual number of atoms in one molecule of an organic compound is called:
(a) Molecular formula ✓

Hydrocarbons

19. The simplest family of organic compounds is:
(d) Hydrocarbons ✓
20. Which of the following is considered a parent organic compound?
(a) Alkanes ✓

Alkanes

21. Which one of these hydrocarbon molecules would have no effect on an aqueous solution of bromine?
(a) CH₄ ✓
22. If an organic compound has 4 carbon atoms, all singly bonded, it will have the following characteristics except one:
(d) It will be least reactive (Note: All alkanes are generally unreactive)
23. What is the molecular formula for the eighth alkane member, octane, which is found in petrol?
(c) C₈H₁₈ ✓
24. Which one of the following is a substitution reaction?
(c) Halogenation of alkanes ✓
25. Which is the simplest alkane?
(a) CH₄ ✓
26. The condensed formula of ethane is:
(b) C₂H₆ (or CH₃CH₃)
27. The molecular formula of butane is:
(a) C₄H₁₀ ✓
28. The formula of pentane is:
(d) C₅H₁₂ ✓
29. The general formula of saturated hydrocarbons is:
(d) C_nH_{2n+2} ✓
30. Saturated hydrocarbons are also called:
(b) Paraffins ✓
31. Alkane molecules are:
(b) non-polar ✓
32. Which one of these is a saturated hydrocarbon?
(d) C₅H₁₂ ✓
33. The longest continuous carbon chain in IUPAC nomenclature tells:
(a) Root ✓
34. The group/groups attached to the longest continuous carbon chain determine the:
(c) Prefix ✓
35. The root prop- corresponds to the number of carbon atoms:
(c) 3 ✓

Preparation

36. The reduction of alkyl halides takes place in the presence of:
(a) Zn/HCl ✓
37. Hydrogenation of alkenes and alkynes takes place at room temperature in the presence of:
(d) both a and b (Ni or Pt) ✓
38. Alkenes are produced in large amounts by cracking of:
(b) Petroleum ✓
39. Higher molecular mass hydrocarbons are broken up into smaller ones in a process called:
(b) Cracking ✓
40. During the process of cracking, naphtha is heated up to:
(c) 500°C ✓
41. The catalyst used for cracking of naphtha is:
(c) Zeolite ✓
42. The breakdown of naphtha produces:
(c) Both a and b (Alkanes and Alkenes) ✓
43. Alkenes are produced in large amounts by cracking of:
(b) Petroleum ✓
44. Which of the following will react with one mole of H_2 to form a saturated hydrocarbon?
(b) Alkene ✓

Important Reactions

45. Halogenation of methane produces the following valuable chemical compounds used as solvent except:
(c) Carbon black ✓
46. Substitution reaction is a characteristic of:
(a) alkanes ✓
47. Halogenation of alkanes in the presence of diffused sunlight takes:
(c) In a series of four steps ✓
48. Alkanes give reaction only:
(c) Substitution ✓
49. Alkanes do not react in:
(c) Dark ✓
50. The main component of natural gas is:
(a) Methane ✓
51. What percent of natural gas consists of methane (CH_4)?
(d) 85% (Approximately 85-95%) ✓
52. Alkanes are least reactive compounds because they are:
(a) Saturated hydrocarbons ✓
53. Which one is the formula of chloromethane?
(d) CH_3Cl ✓
54. The number of moles of oxygen required to completely burn ethane is:
(d) 7 ($2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$) ✓