



9TH CLASS • CHEMISTRY • CHAPTER 11

HYDROCARBONS

Complete Exercise Solutions

MCQs with Explanations • Short, Constructed,
Descriptive & Investigative Questions

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1 | Tick (✓) the correct answer.

(i) Which other atom is almost always present along with carbon atom in all organic compounds?

(a) Oxygen

(b) Nitrogen

(c) Hydrogen



(d) Halogen

Explanation: Organic compounds are fundamentally built on carbon backbones. Carbon has a valency of 4 and forms strong covalent bonds. Almost all organic compounds are hydrocarbons or their derivatives, meaning they universally contain hydrogen atoms bonded to carbon. While oxygen, nitrogen, and halogens can be present as functional groups, hydrogen is the ubiquitous partner to carbon.

(ii) Which other metal can be used to reduce alkyl halides?

(a) Al

(b) Mg



(c) Ni

(d) Co

Explanation: Alkyl halides can be reduced to alkanes using a zinc-copper couple or Zn/HCl. However, another highly effective method involves reacting alkyl halides with magnesium in dry ether to form Grignard reagents (alkyl magnesium halides), which can then be hydrolyzed to yield alkanes. Therefore, Magnesium (Mg) is the correct metal among the choices.

(iii) If naphtha undergoes a combustion reaction what products do you expect it to form?

(a) Alkanes

(b) Alkenes

(c) CO_2 and H_2O



(d) Both alkanes and alkenes

Explanation: Naphtha is a mixture of liquid hydrocarbons. The complete combustion of any hydrocarbon (in the presence of sufficient oxygen) always yields carbon dioxide (CO_2) and water (H_2O), along with the release of heat energy.

(iv) Why does a mixture of zinc and hydrochloric acid acts as a reducing agent?

(a) Because zinc acts as a reducing agent.

(b) Because atomic hydrogen is produced with Zn / HCl which acts as a reducing agent.



(c) Because molecular hydrogen is produced with Zn / HCl which acts as a reducing agent.

(d) Because chloride ions are produced with Zn / HCl which act as a reducing agent.

Explanation: When Zn reacts with HCl, it produces hydrogen gas. However, the hydrogen gas is initially produced in the form of *nascent hydrogen* (atomic hydrogen, denoted as [H]). This atomic hydrogen is highly reactive and unstable. It immediately attaches to the substance being reduced. Molecular hydrogen (H_2) is much more stable and a weaker reducing agent compared to nascent hydrogen.

(v) Which alkane will evolve the most amount of heat when it is burnt with oxygen?

(a) Ethane

(b) Propane

(c) n-Butane



(d) iso-Butane

Explanation: The amount of heat evolved during combustion (heat of combustion) increases with the number of carbon atoms in the alkane. n-Butane has 4 carbon atoms, whereas ethane has 2 and propane has 3. Between n-butane and iso-butane, n-butane has a slightly higher heat of combustion because it is a straight-chain alkane with a larger surface area, leading to stronger intermolecular van der Waals forces compared to the branched iso-butane.

(vi) Which reaction is not given by alkanes?

(a) Substitution

(b) Combustion

(c) Addition



(d) Cracking

Explanation: Alkanes are saturated hydrocarbons containing only single bonds (C-C and C-H). Because they are “saturated,” they cannot undergo addition reactions (which require breaking a double or triple bond to add atoms). They primarily undergo substitution (like halogenation), combustion, and cracking.

(vii) Which hydrocarbon is responsible for explosions in coal mines?

(a) Butane

(b) Pentane

(c) Methane



(d) Ethene

Explanation: Coal mines contain trapped methane gas (CH_4), often referred to as “fire-damp.” When this methane mixes with air in specific proportions and encounters a spark or flame, it triggers a violent, rapid exothermic reaction (an explosion).

(viii) Which product will be formed when ethyl bromide ($\text{CH}_3\text{CH}_2\text{Br}$) is treated with Zn/HCl ?

(a) CH_4

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



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

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

Explanation: Treatment of alkyl halides with Zn/HCl results in a reduction reaction where the halogen atom (Br) is replaced by a hydrogen atom. Ethyl bromide ($\text{CH}_3\text{CH}_2\text{Br}$) becomes ethane. The molecular formula for ethane is $\text{CH}_3\text{-CH}_3$.

(ix) Which of the following is not a process of halogenation of alkanes?

(a) Cracking



(b) Chlorination

(c) Bromination

(d) Iodination

Explanation: Halogenation is the chemical reaction where a halogen atom is introduced into a compound. Chlorination, Bromination, and Iodination are all types of halogenation. Cracking, however, is the process of breaking down large hydrocarbon molecules into smaller ones using heat and pressure.

(x) How many moles of oxygen will be required to completely burn propane?

(a) 4 moles

(b) 5 moles



(c) 3 moles

(d) 6 moles

Explanation: The balanced chemical equation for the complete combustion of propane (C_3H_8) is:
$$\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$$
From the stoichiometry of the balanced equation, 1 mole of propane requires exactly 5 moles of oxygen gas for complete combustion.

2 | Questions for Short Answers

i. Differentiate between an organic and an inorganic compound.

Organic compounds primarily contain carbon atoms bonded covalently to hydrogen and other elements. They typically have low melting and boiling points, are generally insoluble in water but soluble in organic

solvents, and are highly flammable. In contrast, inorganic compounds generally lack carbon-hydrogen bonds (though exceptions like carbonates exist), form ionic or highly polar bonds, have high melting and boiling points, are usually soluble in water, and are generally non-flammable.

ii. Why are organic compounds found in large numbers?

Organic compounds are found in massive numbers due to two unique properties of the carbon atom:

Tetravalency (the ability to form four strong covalent bonds) and **Catenation** (the ability to bond with other carbon atoms to form long chains, branched structures, and rings). This allows carbon to form millions of different structural combinations with other elements like hydrogen, oxygen, nitrogen, and halogens.

iii. Name the products which are obtained when natural gas is oxidized under controlled conditions.

When natural gas (which is primarily methane) is oxidized under controlled conditions (often using a catalyst), the products obtained are typically Methanol (CH_3OH) and Formaldehyde (HCHO).

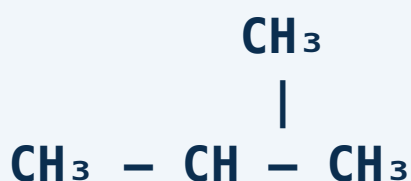
iv. How naphtha fraction is decomposed to give lower hydrocarbons?

The naphtha fraction is decomposed into lower hydrocarbons through a process called **Cracking** (specifically thermal or catalytic cracking). In this process, the larger hydrocarbon molecules in naphtha are heated to high temperatures (and sometimes subjected to high pressure or catalysts) to break their carbon-carbon bonds, yielding smaller, more useful hydrocarbons like alkenes and smaller alkanes.

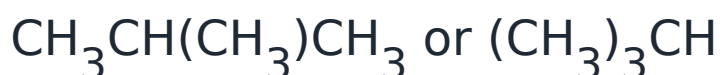
v. Write down the molecular formula, structural formula and the condensed structural formula for iso-butane.

● **Molecular Formula:** C_4H_{10}

● **Structural Formula:**



● **Condensed Structural Formula:**

**vi. How are organic compounds useful for us?**

Organic compounds are indispensable to our daily lives. They form the basis of all living organisms (carbohydrates, proteins, fats, nucleic acids). They serve as essential fuels (natural gas, petrol, diesel, LPG) for transportation, heating, and electricity. They are crucial for medicines (antibiotics, painkillers), agriculture (fertilizers, pesticides), clothing (cotton, nylon, polyester), plastics, detergents, cosmetics, and dyes.

vii. Write down the names of five such organic compounds which exist naturally?

1. Methane (Natural gas)
2. Ethanol (Alcohol)
3. Acetic Acid (Vinegar)
4. Glucose (Sugar)
5. Urea (Waste product in urine)

viii. Give IUPAC name to the following compound:

Structure given in the image: $\text{CH}_3 - \text{CH} - \text{CH}_2 - \text{CH}_3$
(with a CH_3 attached to the second carbon).

IUPAC Name: 2-Methylbutane

Explanation: The longest continuous carbon chain is 4 carbons (butane). Numbering starts from the end

closest to the substituent, placing the methyl group ($-\text{CH}_3$) on carbon number 2.

ix. How do the melting and boiling points of alkanes change when we move from lower members to higher members?

As we move from lower members (smaller alkanes) to higher members (larger alkanes), their melting and boiling points gradually **increase**. This is because larger alkanes have greater molecular mass and a larger surface area, which leads to stronger van der Waals forces of attraction between the molecules. To overcome these stronger intermolecular forces, more energy (heat) is required.

3 | Constructed Response Questions

i. Why do alkanes show little reactivity towards the other reagents?

Alkanes are saturated hydrocarbons. Their molecules consist entirely of strong, non-polar sigma (σ) bonds (C-C and C-H). These bonds are highly stable and are not easily broken by common chemical reagents like acids, bases, or oxidizing agents. Because they lack any functional groups (like $-\text{OH}$, $-\text{COOH}$, or $\text{C}=\text{C}$ double

bonds) and have no sites of high electron density (no lone pairs or π -bonds), they are generally inert and unreactive under normal conditions.

ii. Why does a mixture of natural gas and air explode?

Natural gas is primarily methane (CH_4), which is highly combustible. When it leaks into the air, it mixes with oxygen. If the ratio of methane to air falls within a specific explosive range (typically between 5% and 15% methane in air) and encounters an ignition source (like a spark or a lit match), it triggers a rapid, highly exothermic combustion reaction. The sudden release of a massive volume of hot gases (CO_2 , H_2O , and heat) causes a violent pressure wave, resulting in an explosion.

iii. How do you compare the melting and boiling points of inorganic and organic compounds?

Inorganic compounds generally have much higher melting and boiling points compared to organic compounds. This is because inorganic compounds are typically held together by strong ionic or electrostatic forces (e.g., NaCl), requiring a significant amount of energy to break. In contrast, organic compounds are held together by relatively weak intermolecular van der

Waals forces. Consequently, they require much less energy to melt or boil.

iv. Reactions of alkanes with chlorine takes place in the presence of sunlight. What is the role of sunlight in the reaction?

Sunlight (specifically ultraviolet light) serves as a source of energy for the **initiation step** of the free radical substitution reaction. The UV light provides enough energy to homolytically cleave the strong Cl-Cl bond, breaking it into two highly reactive chlorine free radicals ($\text{Cl}\cdot$). These radicals then start the chain reaction that leads to the substitution of hydrogen atoms in the alkane.

v. How do you compare the boiling point of n - butane with that of iso - butane?

The boiling point of n-butane is higher than that of iso-butane. n-Butane has a straight-chain structure, which gives it a larger surface area. This increased surface area allows for stronger van der Waals forces of attraction between neighboring molecules. Iso-butane has a branched structure, making its molecules more compact and spherical, which reduces the surface area of contact and weakens the intermolecular forces, thus lowering its boiling point.

vi. Why are organic compounds not generally soluble in water?

The principle of “like dissolves like” applies here. Water is a highly polar molecule. Most organic compounds (like hydrocarbons) are non-polar. Non-polar molecules cannot form favorable hydrogen bonds with polar water molecules. Because the intermolecular forces between organic molecules are stronger than their attraction to water, they do not dissolve and instead separate into distinct layers.

4 | Descriptive Questions

i. Describe the importance of organic compounds in daily life.

Organic compounds are the foundation of life itself and modern society. They make up the food we eat (carbohydrates, proteins, lipids), the clothes we wear (natural and synthetic fibers), and the fuels that power our vehicles and homes (petrol, natural gas). They are vital in healthcare as medicines, antibiotics, and vitamins. Additionally, they are used to manufacture plastics, detergents, cosmetics, fertilizers, and countless other products that define modern living standards.

ii. Why is carbon so important as an element that the whole branch of chemistry is based on it?

Carbon is uniquely important because it possesses four valence electrons, allowing it to form four strong covalent bonds (tetravalency). More importantly, carbon atoms can bond with each other to form long chains, branched structures, and rings of virtually any size (catenation). This ability allows carbon to form millions of different, stable compounds, giving rise to a vast and diverse branch of chemistry dedicated entirely to its study.

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

A functional group is defined as an atom or group of atoms that dictates the characteristic chemical properties of a compound. The C-C single bond in alkanes is highly stable, non-polar, and chemically inert. It does not readily participate in chemical reactions, so it is not considered a functional group. However, the C=C double bond in alkenes consists of a strong sigma bond and a weaker, exposed pi (π) bond. This high electron density makes it highly reactive,

allowing alkenes to readily undergo addition reactions. Because it dictates the reactivity of alkenes, it acts as a functional group.

iv. Explain IUPAC system of nomenclature for alkanes.

The IUPAC (International Union of Pure and Applied Chemistry) system provides a standardized method for naming organic compounds. For alkanes, the rules are:

- 1.** Identify the longest continuous carbon chain to determine the parent name (e.g., 4 carbons = butane).
- 2.** Number the carbon atoms in the chain starting from the end nearest to a substituent.
- 3.** Identify and name the alkyl groups (substituents) attached to the chain.
- 4.** Combine the names, placing the substituents in alphabetical order and using prefixes like di-, tri- if there are multiple identical groups.
- 5.** Use numbers (locants) to indicate the position of each substituent, separated by hyphens (e.g., 2-methylbutane).

v. How combustion reaction of alkanes is useful for us?

The combustion of alkanes is extremely useful because it is a highly exothermic reaction that releases a large amount of heat energy. This energy is harnessed for:

- 1. Cooking and Heating:** Natural gas (methane) and LPG (propane/butane) are burned in stoves and heaters.
- 2. Transportation:** Petrol and diesel (mixtures of alkanes) are burned in internal combustion engines to power cars, trucks, and planes.
- 3. Electricity Generation:** Power plants burn fossil fuels to generate steam, which spins turbines to produce electricity.

5 | Investigative Questions

i. When 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 of this explosion and how can you avoid it?

Reason: Natural gas (methane) is highly flammable and lighter than air. When a valve is left open, it rapidly diffuses and mixes with the oxygen in the air. If the mixture reaches its explosive limit and is exposed to any ignition source (like a spark from turning on a light

switch, a refrigerator motor, or a lit match), a catastrophic explosion occurs due to rapid combustion.

How to Avoid:

- 1.** Immediately turn off the main gas valve.
- 2.** Do not operate any electrical switches (on or off).
- 3.** Open all doors and windows to create cross-ventilation and allow the gas to escape safely.
- 4.** Leave the premises and call for professional help if the smell persists.

ii. “Neem” is a common tree grown throughout our country. Comment on the medicinal benefits of this tree.

The Neem tree (*Azadirachta indica*) is often called the “village pharmacy” due to its immense medicinal properties. Almost every part of the tree—leaves, bark, seeds, and oil—has therapeutic value. It possesses powerful antibacterial, antifungal, antiviral, and anti-inflammatory properties. Neem leaves are used to treat skin infections, acne, and chickenpox. Neem twigs are traditionally used as toothbrushes to maintain oral hygiene and fight plaque. Neem oil is used in insecticides and to treat various skin disorders. It is also known to boost immunity and purify the blood.

iii. Name a few popular medicines which are, in fact, organic compounds?

Many popular medicines are organic compounds. A few prominent examples include:

1. **Aspirin** (Acetylsalicylic acid) - used for pain relief and fever reduction.
2. **Paracetamol** (Acetaminophen) - a common painkiller and fever reducer.
3. **Penicillin** - an antibiotic used to treat bacterial infections.
4. **Ibuprofen** - a nonsteroidal anti-inflammatory drug (NSAID).
5. **Morphine** - a powerful painkiller used in severe pain management.

CHAPTER 11 • HYDROCARBONS

Thank You!

You have completed all the exercise questions of Chapter 11. Keep practising, keep exploring, and let curiosity lead your way in chemistry!

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