Class: 9th

Subject: Chemistry

Chapter 11: Hydrocarbons

Exercise MCQs:

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

(a) Oxygen

(b) Nitrogen

(c) Hydrogen ✅

(d) Halogen

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

(a) Al

(b) Mg ✅

(c) Ni

(d) Co

(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

(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.

(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 ✅

(vi) Which reaction is not given by alkanes?

(a) Substitution

(b) Combustion

(**c**) Addition ✅

(d) Cracking

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

(a) Butane

(b) Pentane

(**c**) Methane ✅

(d) Ethene

(viii) Which product will be formed when ethyl bromide (CH_3CH_2Br) is treated with Zn/HCl?

(a) CH_4

(**b**) CH_3-CH_3 ✅

(c) CH_3-CH_2-CH_2-CH_3

(d) CH_3-CH_2-CH_3

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

(a) Cracking ✅

(b) Chlorination

(c) Bromination

(d) Iodination

(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

Important MCQs:

1. What elements are hydrocarbons made of?

(a) Carbon and Oxygen

(b) Hydrogen and Oxygen

(c) Carbon and Nitrogen

(**d**) Carbon and Hydrogen ✅

2. Which of the following is a hydrocarbon?

(a) Water

(**b**) Methane ✅

(c) Glucose

(d) Ammonia

3. Which of the following fuels is composed of hydrocarbons?

(a) CNG

(b) LPG

(c) Petrol

(**d**) All of the above ✅

4. What type of bonds are present in alkanes?

(**a**) Only single bonds ✅

(b) Only double bonds

(c) Only triple bonds

(d) No bonds

5. What are alkanes also called?

(a) Unsaturated hydrocarbons

(b) Saturated hydrocarbons ✅

(c) Aromatic compounds

(d) Ketones

6. What is the chemical formula of methane?

(a) CH3

(b) CH4 ✅

(c) C2H6

(d) C3H8

7. How many carbon atoms are present in n-butane?

(a) 2

(b) 3

(c) 4 ✅

(d) 5

8. In the IUPAC naming system, what does the "Root" indicate?

(a) Name of the group

(b) Number of oxygen atoms

(c) Number of carbon atoms in the longest chain ✅

(d) Number of hydrogen atoms

9. In 2-Methylbutane, at which carbon is the methyl group attached?

(a) Carbon 1

(b) Carbon 2 ✅

(c) Carbon 3

(d) Carbon 4

10. In the IUPAC system, what does the "Suffix" represent?

(a) Class of the compound ✅

(b) Number of groups

(c) Number of oxygen atoms

(d) Length of the side chain

11. What is the process called in which large hydrocarbons are broken into smaller ones?

(a) Combustion

(b) Polymerization

(c) Cracking ✅

(d) Reduction

12. What catalyst is used in the cracking of naphtha?

(a) Platinum

(b) Iron

(c) Zeolite ✅

(d) Nickel

13. Which fraction of petroleum is used in the cracking process to produce smaller hydrocarbons?

(a) Kerosene

(b) Diesel

(c) Naphtha ✅

(d) Petrol

14. What is the temperature used for catalytic cracking of hydrocarbons?

(a) 100°C

(b) 200°C

(c) 300°C

(**d**) 500°C ✅

15. Which gas is added to alkenes to convert them into alkanes in hydrogenation?

(a) Oxygen

(b) Nitrogen

(**c**) Hydrogen ✅

(d) Chlorine

16. What metal catalyst is used in the hydrogenation of alkenes?

(a) Zinc

(b) Iron

(**c**) Nickel ✅

(d) Silver

17. Which compound is not prepared by hydrogenation of alkenes and alkynes?

(a) Propane

(b) Butane

(c) Methane ✅

(d) Ethane

18. Which chemical combination is used to reduce alkyl halides to alkanes?

(a) Ni/HCl

(b) Zn/HCl ✅

(c) H_2O/Na

(d) Cl_2/Fe

19. What type of reaction is halogenation of alkanes?

(a) Addition

(b) Substitution ✅

(c) Elimination

(d) Neutralization

20. What is required for the halogenation reaction of methane to occur?

(a) Heat

(b) Acid

(c) UV light ✅

(d) Water

Exercise Short Questions:

1. Differentiate between an organic and an inorganic compound.

Answer:

Organic compounds are mainly composed of carbon and hydrogen and are usually found in living organisms (e.g., methane, glucose).

Inorganic compounds consist of various elements and are mostly found in non-living matter (e.g., salts, water).

2. Why are organic compounds found in large numbers?

Answer:

Organic compounds are found in large numbers because carbon atoms can form strong covalent bonds with themselves and with other elements, creating chains, rings, and branched structures.

3. Name the products obtained when natural gas is oxidized under controlled conditions.

Answer:

Controlled oxidation of natural gas produces:

1. Carbon dioxide (CO_2)
2. Water (H_2O)

4. How is the naphtha fraction decomposed to give lower hydrocarbons?

Answer:

Naphtha is heated at about 500°C in the presence of a zeolite catalyst. This process, called cracking, breaks high-molecular-weight hydrocarbons into

smaller hydrocarbons like alkanes and alkenes.

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

Answer:

Molecular formula:

- C_4H_{10}

Structural formula:

- $CH_3 - CH(CH_3) - CH_3$

Condensed formula: $(CH_3)_2CHCH_3$

6. How are organic compounds useful for us?

Answer:

Organic compounds are useful in many ways. They are used as:

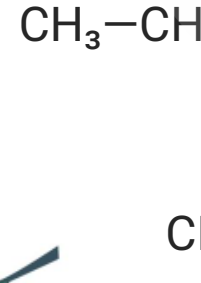
- Fuels (e.g., methane, petrol)
- Medicines
- Plastics
- Food preservatives
- Cosmetics

7. Write the names of five organic compounds which exist naturally.

Answer:

1. Glucose
2. Fructose
3. Methane
4. Ethanol
5. Citric acid

8. Give the IUPAC name of the following compound:



Answer: 2-Methylbutane

9. How do melting and boiling points of alkanes change from lower to higher members?

Answer:

Melting and boiling points increase as the molecular size of alkanes increases. This is due to

stronger van der Waals forces between larger molecules.

Important Short Questions:

1. What are hydrocarbons? Give two common examples.

Hydrocarbons are organic compounds composed only of carbon and hydrogen atoms. Examples include methane (CH_4) and ethane (C_2H_6).

2. Why are hydrocarbons considered important in our daily life?

Hydrocarbons are important because they are major fuels (like petrol, diesel, LPG) and serve as raw materials for producing plastics, medicines, synthetic fibers, paints, and varnishes.

3. Name four fuels that are hydrocarbons.

Natural gas, LPG (Liquefied Petroleum Gas), petrol, and diesel.

4. What is the difference between saturated and unsaturated hydrocarbons?

Saturated hydrocarbons have only single bonds between carbon atoms, while unsaturated hydrocarbons have one or more double or triple bonds.

5. Why are alkanes called saturated hydrocarbons?

Because all carbon atoms in alkanes form single bonds and have their four valencies fully satisfied by hydrogen or carbon atoms.

6. Write the general formula of alkanes.

The general formula of alkanes is C_nH_{2n+2}, where n is an integer.

7. Define IUPAC nomenclature. Why is it needed in organic chemistry?

IUPAC nomenclature is a standardized system for naming organic compounds to avoid confusion caused by many different names.

8. What are the three parts of an IUPAC name?

Root (number of carbon atoms), suffix (type of

compound), and prefix (substituents attached to the main chain).

9. Name the following compound using IUPAC rules: $CH_3–CH(CH_3)–CH_2–CH_3$

The compound is called 2-Methylbutane or iso-butane.

10. What is the difference between n-butane and iso-butane?

n-Butane has a straight chain of four carbon atoms, while iso-butane has a branched chain with a methyl group attached to the second carbon.

11. What is cracking and why is it important in the petroleum industry?

Cracking is the process of breaking large hydrocarbons into smaller, more useful ones by heating with a catalyst. It increases the supply of valuable fuels like petrol and diesel from heavy petroleum fractions.

12. How are alkanes prepared by the reduction of alkenes and alkynes? Give an example.

Alkenes and alkynes are reacted with hydrogen gas in the presence of a nickel catalyst, converting unsaturated bonds into single bonds and forming alkanes.

Example: Ethene + H_2 ⇒ Ethane

13. Why can methane not be prepared by the hydrogenation of alkenes or alkynes?

Because methane is the simplest alkane with no double or triple bonds, it cannot be formed by hydrogenation of unsaturated hydrocarbons.

14. Explain the reduction of alkyl halides to alkanes using Zn and HCl.

Zinc reacts with hydrochloric acid to produce atomic hydrogen, which reduces alkyl halides by replacing the halogen atom with hydrogen, forming alkanes.

15. Why are alkanes called paraffins?

Alkanes are called paraffins because they show little chemical reactivity or affinity towards other substances.

16. What makes alkanes chemically inert towards most reagents?

Alkanes are non-polar due to nearly equal electronegativities of carbon and hydrogen, so they do not easily react with acids, bases, or oxidizing agents.

17. Describe the halogenation reaction of alkanes with chlorine under UV light.

Under UV light, alkanes react with chlorine in a substitution reaction where hydrogen atoms are replaced by chlorine atoms, forming alkyl halides.

18. Write the chemical equation for the chlorination of methane.

$CH_4 + Cl_2 \Rightarrow CH_3Cl + HCl$ (in presence of UV light)

19. What type of reaction do alkanes mainly undergo? Explain briefly.

Alkanes mainly undergo substitution reactions, where hydrogen atoms are replaced by other atoms like halogens, because they lack double or triple bonds.

20. What products are formed when naphtha is cracked using zeolite catalyst?

Cracking naphtha with zeolite catalyst produces smaller alkanes and alkenes containing 5 to 10 carbon atoms.

Important Long Questions:

Q1: Explain the term hydrocarbons and describe their importance in daily life and industry.

Answer:

1. Definition of Hydrocarbons:

- Hydrocarbons are organic compounds made up of only carbon (C) and hydrogen (H) atoms.
- They form a large family of simple organic compounds.

2. Classification:

- Hydrocarbons are classified into alkanes, alkenes, alkynes, and aromatic hydrocarbons.

- This chapter mainly discusses alkanes.

3. Importance in Daily Life:

- Most common fuels like natural gas, LPG, CNG, petrol, diesel, and kerosene are hydrocarbons.
- These fuels are essential for cooking, heating, transportation, and electricity generation.

4. Importance in Industry:

- Hydrocarbons act as feedstocks or raw materials for producing complex and useful products.
- They are used in the manufacture of plastics, medicines, synthetic fibers, paints, varnishes, and many chemicals.

5. Additional Uses of Methane:

Methane, the simplest alkane, is used to make hydrogen gas, carbon black, carbon disulfide, chloroform, and hydrocyanic acid.

6. Overall Significance:

Hydrocarbons are vital for energy supply and

chemical industries, supporting modern life and economic growth.

Q2: Define alkanes and explain why they are called saturated hydrocarbons. Give an example.

Definition of Alkanes:

- Alkanes are hydrocarbons that contain only carbon (C) and hydrogen (H) atoms.
- All carbon atoms in alkanes are connected by single covalent bonds only.

Why are they called saturated hydrocarbons?

- In alkanes, each carbon atom forms four single bonds (with hydrogen or carbon).
- This means carbon atoms have the maximum number of hydrogen atoms attached (no double or triple bonds).
- Hence, they are “saturated” because no more hydrogen atoms can be added.

Example:

Ethane (C2H6)

Structure: CH3–CH3

Both carbons are bonded to the maximum hydrogens with only single bonds.

Q3: Describe the general formula of alkanes and explain the significance of methane as the parent hydrocarbon.

General Formula of Alkanes:

C_nH_{2n+2}

This formula represents all straight-chain (normal) alkanes.

Significance of Methane:

- **Methane** (CH4) is the simplest alkane with just one carbon atom.
- It is the parent hydrocarbon because:
- It forms the basic structure from which all other alkanes are derived.
- Naming of other alkanes is based on methane's structure by adding more carbons.

Q4: Explain the IUPAC system of nomenclature for naming alkanes. What are the three main parts of an organic compound's name according to this system?

IUPAC Nomenclature:

A systematic method used worldwide to name organic compounds uniquely and clearly.

Three main parts of the name:

1. Root (Base) Name:

Represents the number of carbon atoms in the longest continuous chain.

Example roots:

- 1 carbon = meth-
- 2 carbons = eth-
- 3 carbons = prop-
- 4 carbons = but-
- 5 carbons = pent- ... and so on.

2. Suffix:

- Shows the class of the compound.

- For alkanes, suffix is -ane (indicating all single bonds).

3. Prefix:

- Shows the substituents (branches or groups) attached to the longest chain.
- **For example**, methyl-, ethyl-, chloro-, etc.

Q5: Explain the difference between normal (n-) alkanes and branched alkanes with the help of examples.

Normal (n-) alkanes:

- Have all carbon atoms connected in a straight, unbranched chain.
- **Example**: n-butane (CH3-CH2-CH2-CH3), where 4 carbon atoms form a straight chain.

Branched alkanes:

- Contain one or more branches or side chains attached to the main carbon chain.
- Example: 2-methylbutane (also called iso-butane), where a methyl group (CH3)

branches off the second carbon of butane.

Structure:

CH3

|

CH3 - CH - CH2 - CH3

Q6: Given the following compound, explain step-by-step how to name it using IUPAC rules:

CH3

|

CH3 - CH - CH2 - CH3

Step 1: Identify the longest continuous chain of carbon atoms.

The longest chain here has 4 carbon atoms (CH3-CH-CH2-CH3).

Step 2: Determine the root name from the longest chain length.

4 carbons ⇒ root is but-.

Step 3: Identify substituents (branches) attached to the main chain.

There is a methyl group (CH3) attached to the second carbon of the main chain.

Step 4: Number the longest chain from the end nearest to the branch.

Numbering from left to right, the methyl group is on carbon 2.

Step 5: Combine prefix, root, and suffix.

Prefix: "2-methyl" (branch at carbon 2).

Root + suffix: "butane" (4 carbons, alkane).

Full name: 2-methylbutane.

3. Constructed Response Questions

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

- Alkanes have only single C–C and C–H bonds, which are very strong and stable.

- They lack polar bonds or reactive functional groups, making them chemically inert.
- This stability causes alkanes to show low reactivity towards most chemicals under normal conditions.

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

- Natural gas mainly contains methane (CH_4), which is highly flammable.
- When mixed with air (which contains oxygen), it forms a flammable mixture.
- If ignited, the gas-air mixture undergoes rapid combustion producing an explosion.
- The explosion occurs because methane burns quickly releasing a large amount of energy.

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

Inorganic compounds:

- Usually have high melting and boiling points due to strong ionic or covalent bonds.

- Example: Table salt melts at high temperatures.

Organic compounds:

- Generally have lower melting and boiling points because of weaker intermolecular forces (like Van der Waals forces).
- **Example**: Alkanes boil at much lower temperatures than salts.

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

- Sunlight provides energy to start the reaction by breaking Cl–Cl bonds into chlorine radicals (Cl·).
- This process is called photochemical initiation.
- These chlorine radicals then react with alkanes to form chlorinated products.

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

- n-Butane is a straight-chain alkane and has a higher boiling point due to stronger Van der

Waals forces (because of greater surface area).

- Iso-butane is branched and more compact, leading to weaker intermolecular forces and a lower boiling point than n-butane.

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

- Water is a polar solvent, while most organic compounds (like alkanes) are non-polar.
- "Like dissolves like" rule: polar solvents dissolve polar substances, and non-polar solvents dissolve non-polar substances.
- Therefore, organic compounds are generally insoluble in water but soluble in non-polar solvents like benzene or hexane.

4. Descriptive Questions

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

- Organic compounds contain carbon and are the

basis of all living organisms.

- They are found in foods, medicines, plastics, fuels, and textiles.
- Common fuels like petrol, diesel, natural gas are hydrocarbons, providing energy for transportation and heating.
- Organic compounds are used to make medicines that treat diseases and improve health.
- They are involved in the production of synthetic fibers like nylon and polyester used in clothing.
- Organic materials are essential in making paints, varnishes, detergents, and cosmetics.
- Overall, organic compounds support modern life and industry.

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

- Carbon has 4 valence electrons, allowing it to form 4 strong covalent bonds with other atoms.
- It can bond with other carbon atoms to form

long chains, branched structures, and rings, creating millions of compounds.

- Carbon forms stable single, double, and triple bonds, making its chemistry very versatile.
- Carbon compounds form the basis of all living things (biomolecules like proteins, carbohydrates, lipids, DNA).
- Carbon's ability to form complex, diverse molecules makes it central to organic chemistry.

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 a specific group of atoms responsible for the characteristic reactions of a compound.
- In **alkanes**, the C–C single bond is non-reactive and does not participate actively in chemical reactions.

- In **alkenes**, the C=C double bond is electron-rich and reactive, making it a functional group.
- The double bond allows alkenes to undergo addition reactions, changing chemical properties.
- Therefore, C=C is a functional group, but C–C is not.

iv. Explain IUPAC system of nomenclature for alkanes.

IUPAC provides a standard way to name organic compounds systematically.

The name of an alkane has three parts:

1. **Root**: Indicates the number of carbon atoms in the longest chain (e.g., meth-, eth-, prop-, but-).

2. **Suffix**: Shows the class of compound; for alkanes, the suffix is -ane.

3. **Prefix**: Indicates any substituent groups attached to the main chain (e.g., methyl-, ethyl-).

Number the longest carbon chain from the end nearest to the substituent to give the substituent

the lowest possible number.

Combine prefix, root, and suffix to form the complete name (e.g., 2-methylbutane).

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

- Combustion of alkanes produces energy in the form of heat and light.
- This energy is used for heating homes, cooking, and generating electricity.
- Combustion of fuels like petrol and diesel powers vehicles and machines.
- It produces carbon dioxide and water as by-products.
- The reaction is exothermic and provides a reliable source of energy in daily life and industries.

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

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Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.

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