

Chapter 14:

Hydrocarbons

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Short Questions (Exercise)

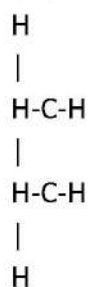
1. Give three examples of saturated hydrocarbons.

- Methane (CH_4)
- Ethane (C_2H_6)
- Propane (C_3H_8)

Explanation: Saturated hydrocarbons, also called alkanes, contain only single bonds between carbon atoms.

2. Draw the structure for ethane.

Structure of Ethane (C_2H_6):



Ethane consists of two carbon atoms connected by a single bond, with each carbon atom bonded to three hydrogen atoms.

3. Draw structural formulas of an alkane containing five carbon atoms.

Pentane (C_5H_{12}):



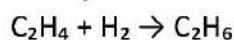
Explanation: Pentane is a straight-chain alkane with five carbon atoms and twelve hydrogen atoms.

4. What do you mean by hydrogenation reaction? Give one example.

Definition:

Hydrogenation is a chemical reaction where hydrogen (H_2) is added to an unsaturated hydrocarbon (alkene or alkyne) to convert it into a saturated hydrocarbon (alkane).

Example:



(Ethene reacts with hydrogen to form ethane in the presence of a catalyst like nickel or palladium.)

5. What is meant by cracking?

Definition:

Cracking is the process of breaking down long-chain hydrocarbons into smaller, more useful hydrocarbons such as alkanes and alkenes.

Types of Cracking:

1. Thermal Cracking: Uses high temperature and pressure.
2. Catalytic Cracking: Uses a catalyst to lower the required temperature.

Example:

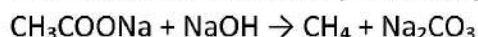


(Long-chain hydrocarbons are broken into smaller ones like hexene and hexane.)

6. Discuss methods for the preparation of ethane.

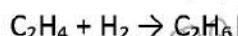
Preparation of Ethane (C_2H_6):

1. **From Sodium Ethanoate (Decarboxylation Reaction):**



(Heating sodium ethanoate with soda lime produces methane. Ethane can also be formed similarly.)

2. **From Ethene (Hydrogenation):**



(Ethene reacts with hydrogen in the presence of a nickel catalyst to produce ethane.)

7. Describe properties of alkanes.

Physical Properties

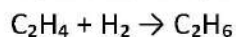
- Alkanes are nonpolar and insoluble in water.
- Boiling and melting points increase with molecular size.
- Lower alkanes (C₁-C₄) are gases, while higher alkanes are liquids or solids.

Chemical Properties

- Alkanes are relatively inert due to strong C-C and C-H bonds.
 - They undergo combustion:
 $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
-

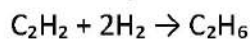
8. Write a chemical equation to show the preparation of an alkane from an alkene and an alkyne.

From Alkene to Alkane (Hydrogenation):



(Ethene reacts with hydrogen to form ethane.)

From Alkyne to Alkane:



(Ethyne reacts with hydrogen to form ethane.)

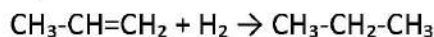
Think Tank

Chemical Equations for the Preparation of Propane

1. **Preparation of Propane by Hydrogenation of Propene**

Propene reacts with hydrogen in the presence of a nickel catalyst to produce propane.

Equation:

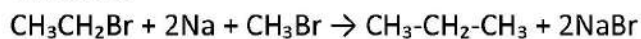


(Propene + Hydrogen → Propane)

2. **Preparation of Propane by Wurtz Reaction**

Ethyl bromide reacts with sodium in the presence of dry ether to form propane.

Equation:

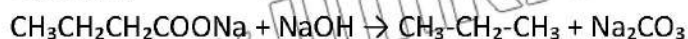


(Ethyl bromide + Methyl bromide + Sodium → Propane + Sodium bromide)

3. **Preparation of Propane by Decarboxylation of Butanoic Acid**

Sodium butanoate is heated with soda lime to produce propane.

Equation:



(Sodium butanoate + Soda lime → Propane + Sodium carbonate)

Exera Short Questions (Topic Wise)

14.1: Alkanes

Questions and Answers:

1. **What are alkanes?**

Alkanes are saturated hydrocarbons containing only single bonds between carbon atoms. They follow the general formula C_nH_{2n+2} .

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

2. **What are the physical properties of alkanes?**

- Alkanes are generally nonpolar, insoluble in water, and have low boiling points.
- Boiling points increase with molecular size due to stronger van der Waals forces.
Example: Methane (CH_4) is a gas, while hexane (C_6H_{14}) is a liquid at room temperature.

3. **How do alkanes react chemically?**

Alkanes undergo substitution reactions, such as halogenation, where hydrogen atoms are replaced by halogen atoms.

Example: $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ (chloromethane).

4. **Why are alkanes called saturated hydrocarbons?**

Alkanes are "saturated" because all carbon atoms are bonded to the maximum number of hydrogen atoms via single bonds.

14.2: Alkenes

Questions and Answers:

1. **What are alkenes?**

Alkenes are unsaturated hydrocarbons containing at least one double bond between carbon atoms. They follow the general formula C_nH_{2n} .

Example: Ethene (C_2H_4), Propene (C_3H_6).

2. **What are the properties of alkenes?**

- Alkenes are more reactive than alkanes due to the presence of a double bond.
- They are nonpolar and insoluble in water.
Example: Ethene is a colorless gas used to ripen fruits.

3. **What type of reactions do alkenes undergo?**

Alkenes primarily undergo **addition reactions**, such as hydrogenation and halogenation.

Example: $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$ (dibromoethane).

4. **Why are alkenes considered unsaturated hydrocarbons?**

Alkenes are unsaturated because the presence of double bonds allows more atoms to add to the molecule.

14.3: Alkynes

Questions and Answers:

1. **What are alkynes?**

Alkynes are unsaturated hydrocarbons containing at least one triple bond between carbon atoms. They follow the general formula C_nH_{2n-2} .

Example: Ethyne (C_2H_2), Propyne (C_3H_4).

2. **What are the physical properties of alkynes?**

- Alkynes are nonpolar and insoluble in water.
- They are more reactive than alkenes due to the triple bond.

Example: Ethyne (acetylene) is used in welding torches.

3. **What type of reactions do alkynes undergo?**

Alkynes undergo addition reactions similar to alkenes, where the triple bond is broken to form single bonds.

Example: $C_2H_2 + H_2 \rightarrow C_2H_4$ (ethene).

4. **What makes alkynes more reactive than alkanes and alkenes?**

The triple bond in alkynes has high electron density, making them highly reactive in chemical reactions.

14.4: Aromatic Compounds

Questions and Answers:

1. **What are aromatic compounds?**

Aromatic compounds are hydrocarbons with one or more benzene rings in their structure. They are characterized by delocalized π -electrons.

Example: Benzene (C_6H_6), Toluene ($C_6H_5CH_3$).

2. **What are the physical properties of aromatic compounds?**

- Aromatic compounds are generally nonpolar and insoluble in water.
- They have a characteristic smell and are liquids or solids at room temperature.

Example: Benzene is a liquid with a sweet odor.

3. **What type of reactions do aromatic compounds undergo?**

Aromatic compounds undergo **substitution reactions**, such as nitration and halogenation, instead of addition reactions to preserve the aromatic ring.

Example: $C_6H_6 + HNO_3 \rightarrow C_6H_5NO_2 + H_2O$ (nitrobenzene).

4. **Why is benzene stable despite its unsaturation?**

Benzene's stability is due to delocalized π -electrons, which create a resonance structure, reducing its reactivity.

Extera Long Questions (Topic Wise)

1. What are the differences between Alkanes, Alkenes, and Alkynes?

Definition

- **Alkanes:** Saturated hydrocarbons containing only single bonds between carbon atoms. General formula: C_nH_{2n+2} .
- **Alkenes:** Unsaturated hydrocarbons with at least one double bond. General formula: C_nH_{2n} .
- **Alkynes:** Unsaturated hydrocarbons with at least one triple bond. General formula: C_nH_{2n-2} .

Properties

1. Bonding:

- Alkanes have single bonds, making them less reactive.
- Alkenes have one or more double bonds, increasing their reactivity.
- Alkynes have one or more triple bonds, making them highly reactive.

2. Reactivity:

- Alkanes undergo substitution reactions, like halogenation.
- Alkenes undergo addition reactions, like hydrogenation.
- Alkynes also undergo addition reactions, but they can form double bonds in the process.

3. Physical State:

- Lower alkanes (C_1-C_4) are gases, while higher alkanes are liquids or solids.
- Lower alkenes and alkynes are gases, with higher members being liquids.

Examples

- **Alkane:** Methane (CH_4), a fuel source.
- **Alkene:** Ethene (C_2H_4), used in polymer production.
- **Alkyne:** Ethyne (C_2H_2), used in welding torches.

2. What are Aromatic Compounds and Their Unique Characteristics?

Definition

Aromatic compounds are hydrocarbons that contain one or more benzene rings. These compounds are characterized by delocalized π -electrons within a conjugated ring system.

Structure of Benzene

- Benzene (C_6H_6) is the simplest aromatic compound.

- It consists of six carbon atoms arranged in a hexagonal ring with alternating single and double bonds (resonance structure).

Unique Characteristics

1. Delocalized Electrons:

The π -electrons in the benzene ring are delocalized, which contributes to its stability.

Example: Benzene resists addition reactions that would disrupt the aromatic system.

2. Physical Properties:

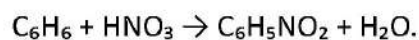
Aromatic compounds are nonpolar, insoluble in water, and have a distinct odor.

Example: Toluene is a liquid aromatic compound used as an industrial solvent.

3. Chemical Reactions:

Aromatic compounds undergo substitution reactions like nitration and halogenation to maintain the stability of the aromatic ring.

Example: Benzene reacts with HNO_3 to form nitrobenzene:



Uses

- Aromatic compounds are widely used in the production of dyes, plastics, and pharmaceuticals.
- **Example:** Aspirin, an aromatic compound derived from salicylic acid, is used as a pain reliever.

3. Why Are Hydrocarbons Important in Everyday Life?

Energy Source

Hydrocarbons, especially alkanes, are a major source of energy. Fossil fuels like natural gas (methane) and petroleum are composed of hydrocarbons.

- **Example:** Propane (C_3H_8) is used in cooking and heating.

Industrial Applications

1. **Polymers:** Hydrocarbons such as ethene and propene are used in producing plastics and synthetic fibers like polyethylene and polypropylene.

Example: Polyethylene is made from ethene.

2. **Chemical Synthesis:** Hydrocarbons serve as raw materials for creating alcohols, acids, and other organic compounds.

Example: Ethyne is used to produce vinyl chloride for making PVC.

Pharmaceuticals

Aromatic hydrocarbons are precursors for many medicines.

- **Example:** Benzene derivatives are used in creating aspirin, a widely used painkiller.

Environmental Concerns

While hydrocarbons are essential, their combustion releases CO₂, a greenhouse gas, contributing to global warming. Efforts are ongoing to develop cleaner fuels and renewable energy alternatives.

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14.1: Alkanes

- 1. What are alkanes?**
 - a) Saturated hydrocarbons ✓
 - b) Unsaturated hydrocarbons
 - c) Aromatic hydrocarbons
 - d) None of the above
- 2. What is the general formula of alkanes?**
 - a) C_nH_{2n}
 - b) C_nH_{2n-2}
 - c) **C_nH_{2n+2}** ✓
 - d) C_nH_n
- 3. Which is the first member of the alkane series?**
 - a) Ethane
 - b) **Methane** ✓
 - c) Propane
 - d) Butane
- 4. Which reaction is characteristic of alkanes?**
 - a) Addition reaction
 - b) **Substitution reaction** ✓
 - c) Polymerization
 - d) Nitration
- 5. What type of bonds are present in alkanes?**
 - a) **Single bonds** ✓
 - b) Double bonds
 - c) Triple bonds
 - d) Aromatic bonds
- 6. Which of the following is a gaseous alkane?**
 - a) Hexane
 - b) Butane
 - c) **Methane** ✓
 - d) Octane

14.2: Alkenes

- 7. What are alkenes?**
 - a) Saturated hydrocarbons
 - b) **Unsaturated hydrocarbons with at least one double bond** ✓

- c) Hydrocarbons with triple bonds
d) Aromatic hydrocarbons
8. **What is the general formula of alkenes?**
a) C_nH_{2n+2}
b) **C_nH_{2n}** ✓
c) C_nH_{2n-2}
d) C_nH_n
9. **Which is the simplest alkene?**
a) Methane
b) **Ethene** ✓
c) Propane
d) Butane
10. **What type of reactions do alkenes undergo?**
a) Substitution
b) Polymerization
c) **Addition reactions** ✓
d) Combustion
11. **What happens when ethene reacts with bromine?**
a) Ethyne is formed
b) **Dibromoethane is formed** ✓
c) Propene is formed
d) Methanol is formed
12. **Why are alkenes considered unsaturated hydrocarbons?**
a) They contain fewer carbon atoms
b) **They contain double bonds** ✓
c) They contain more hydrogen atoms
d) They have no functional group

14.3: Alkynes

13. **What are alkynes?**
a) Saturated hydrocarbons
b) Aromatic hydrocarbons
c) **Unsaturated hydrocarbons with at least one triple bond** ✓
d) Cyclic hydrocarbons
14. **What is the general formula of alkynes?**
a) C_nH_{2n}
b) C_nH_{2n+2}
c) **C_nH_{2n-2}** ✓
d) C_nH_n
15. **Which is the simplest alkyne?**
a) Ethene

- b) Propene
c) **Ethyne** ✓
d) Methane
16. **What is another name for ethyne?**
a) Propane
b) **Acetylene** ✓
c) Methanol
d) Butane
17. **What type of reaction is characteristic of alkynes?**
a) Substitution
b) Neutralization
c) **Addition reactions** ✓
d) Hydrolysis
18. **Which of the following is used in welding torches?**
a) Methane
b) **Ethyne** ✓
c) Propene
d) Benzene

14.4: Aromatic Compounds

19. **What are aromatic compounds?**
a) Saturated hydrocarbons
b) Unsaturated hydrocarbons
c) **Hydrocarbons with delocalized π -electrons in a ring structure** ✓
d) Aliphatic hydrocarbons
20. **What is the simplest aromatic compound?**
a) Ethane
b) **Benzene** ✓
c) Toluene
d) Phenol
21. **What is the molecular formula of benzene?**
a) C_2H_4
b) C_6H_{10}
c) **C_6H_6** ✓
d) C_7H_8
22. **What type of reactions do aromatic compounds undergo?**
a) Addition reactions
b) **Substitution reactions** ✓
c) Combustion reactions
d) Esterification

23. What is the functional group in toluene?
- a) Carboxyl group
 - b) Hydroxyl group
 - c) Methyl group (-CH₃) ✓
 - d) Carbonyl group
24. What is the resonance structure of benzene?
- a) A single structure
 - b) A triple bond
 - c) Delocalized π -electrons over a ring ✓
 - d) A zigzag chain
25. Which of the following is an aromatic hydrocarbon?
- a) Methane
 - b) Toluene ✓
 - c) Ethyne
 - d) Propene

General Hydrocarbons

26. Which of the following is an unsaturated hydrocarbon?
- a) Methane
 - b) Ethene ✓
 - c) Propane
 - d) Butane
27. What is the hybridization of carbon in alkanes?
- a) sp
 - b) sp³ ✓
 - c) sp²
 - d) None
28. What is the hybridization of carbon in benzene?
- a) sp
 - b) sp³
 - c) sp² ✓
 - d) None
29. Which hydrocarbon undergoes combustion to release energy?
- a) Ethyne
 - b) Propane
 - c) Benzene
 - d) All of the above ✓
30. What are hydrocarbons commonly used for?
- a) Fuel
 - b) Plastics
 - c) Pharmaceuticals
 - d) All of the above ✓