UNIQUE STUDY POINT

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Class: X	**Subject:** Science	**Session:** 2025-26
Chapter: 04 - Carbon and its Compounds	**Time:** 1½ Hours	**Max. Marks:** 40

General Instructions:

1. All questions are compulsory.
2. This question paper contains 20 questions divided into five sections A, B, C, D and E.
3. Section A contains 10 MCQs of 1 mark each.
4. Section B contains 4 questions of 2 marks each.
5. Section C contains 3 questions of 3 marks each.
6. Section D contains 1 question of 5 marks.
7. Section E contains 2 Case Study Based questions of 4 marks each.

SECTION A - Multiple Choice Questions (1 mark each)

Q1. The molecular formula C_5H_{12} represents:

(a) An alkene
(b) An alkane
(c) An alkyne
(d) An aromatic hydrocarbon

Q2. Which of the following will not conduct electricity?

(a) Sodium chloride solution
(b) Graphite
(c) Diamond
(d) Copper wire

Q3. The catalyst used in the hydrogenation of vegetable oils is:

(a) Iron
(b) Nickel
(c) Platinum
(d) Copper

Q4. The compound $CH_3CH_2CH_2Cl$ is named as:

(a) 1-chloropropane
(b) 2-chloropropane
(c) 3-chloropropane

(d) Chloroethane

Q5. The gas evolved when ethanoic acid reacts with sodium carbonate is:

(a) Oxygen
(b) Hydrogen
(c) Carbon dioxide
(d) Sulphur dioxide

Q6. Which of the following is not a property of covalent compounds?

(a) Low melting point
(b) Low boiling point
(c) Good conductor of electricity in solution
(d) Poor conductor of electricity

Q7. Ethene on treatment with hydrogen in presence of nickel gives:

(a) Methane
(b) Ethane
(c) Propane
(d) Butane

Q8. The formula of benzene is:

(a) C_6H_6
(b) C_6H_{12}
(c) C_6H_{14}
(d) C_6H_{10}

Q9. Micelle formation in soap solution is due to:

(a) Presence of two different types of groups in soap molecule
(b) High temperature
(c) Presence of hard water
(d) High concentration of acid

Q10. The organic acid present in vinegar is:

(a) Methanoic acid
(b) Ethanoic acid
(c) Propanoic acid
(d) Butanoic acid

SECTION B - Short Answer Questions (2 marks each)

Q11. Distinguish between saturated and unsaturated hydrocarbons. Give one example of each.

Q12. What is meant by substitution reaction? Give one example.

Q13. Why are detergents called soapless soaps? Give two advantages of detergents over soaps.

Q14. Draw the structure of ethanoic acid molecule and identify the carboxylic acid functional group.

SECTION C - Short Answer Questions (3 marks each)

Q15. (a) What happens when:
(i) Ethanoic acid reacts with sodium carbonate
(ii) Ethanoic acid reacts with sodium hydroxide
(b) How will you test for the gas evolved in reaction (i)?

Q16. (a) Define homologous series.
(b) Write the general formula of alkenes and alkynes.
(c) How do the physical properties vary in a homologous series?

Q17. Explain the following terms with one example each:
(i) Catenation
(ii) Isomerism
(iii) Functional group

SECTION D - Long Answer Question (5 marks)

Q18. (a) What are allotropes? Why does carbon exhibit allotropy?
(b) Compare the structure and properties of diamond and graphite under the following heads:
(i) Structure
(ii) Hardness
(iii) Electrical conductivity
(iv) Use
(c) Why are synthetic diamonds used for industrial purposes?

SECTION E - Case Study Based Questions (4 marks each)

Q19. Case Study 1: Ethanol and its Uses

Ethanol is a liquid at room temperature. It is commonly called alcohol and is the active ingredient of all alcoholic drinks. Because it is a good solvent, it is also used in medicines such as tincture iodine, cough syrups and many tonics. Ethanol is also soluble in water in all proportions. However, consumption of small quantities of dilute ethanol causes drunkenness. Long-term consumption of alcohol leads to many health problems. Ethanol is also an important industrial solvent. To prevent misuse of ethanol produced for industrial use, it is made unfit for drinking by adding poisonous substances like methanol to it.

Answer the following questions:

(i) Why is ethanol used in cough syrups and tincture iodine? (1 mark)

(ii) What is denatured alcohol? (1 mark)

(iii) Why is methanol considered poisonous? (1 mark)

(iv) Write the molecular formula of ethanol. (1 mark)

Q20. Case Study 2: Combustion of Carbon Compounds

Carbon and its compounds are major sources of fuels. Most of the fuels we use contain carbon. When carbon or its compounds are burnt in sufficient oxygen, they give carbon dioxide, water, heat and light. This is called complete combustion. However, when burnt in insufficient oxygen, carbon monoxide and soot (carbon particles) are formed along with water. This is called incomplete combustion. Saturated

hydrocarbons burn with a clean blue flame while unsaturated hydrocarbons burn with a yellow sooty flame. The gas/kerosene stove used at home has inlets for air so that a sufficiently oxygen-rich mixture is burnt.

Answer the following questions:

(i) What are the products of complete combustion of hydrocarbons? (1 mark)

(ii) Why is incomplete combustion harmful? (1 mark)

(iii) What is the purpose of air inlets in gas stoves? (1 mark)

(iv) Which hydrocarbon will burn with a clean flame - ethane or ethene? Why? (1 mark)

DETAILED ANSWER KEY - PAPER 03

SECTION A - Answers to MCQs

Q1. (b) An alkane

Explanation: The general formula of alkanes is C_nH_{2n+2}. For n=5, we get $C_5H_{10+2} = C_5H_{12}$ (Pentane).

Q2. (c) Diamond

Explanation: In diamond, all four electrons of each carbon atom are involved in covalent bonding with no free electrons available for conduction. Hence, diamond does not conduct electricity.

Q3. (b) Nickel

Explanation: Nickel (Ni) is used as a catalyst in the hydrogenation of vegetable oils to convert unsaturated oils into saturated fats (vegetable ghee).

Q4. (a) 1-chloropropane

Explanation: The compound has 3 carbon atoms (prop-) with chlorine on the first carbon. Hence it is named 1-chloropropane or chloropropane.

Q5. (c) Carbon dioxide

Explanation: $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2\uparrow$. Carbon dioxide gas is evolved with brisk effervescence.

Q6. (c) Good conductor of electricity in solution

Explanation: Covalent compounds are generally poor conductors of electricity because electrons are shared and no charged particles (ions) are formed.

Q7. (b) Ethane

Explanation: $C_2H_4 + H_2 \rightarrow C_2H_6$ (Ni catalyst). Ethene undergoes addition reaction with hydrogen to form ethane.

Q8. (a) C_6H_6

Explanation: Benzene has 6 carbon atoms arranged in a hexagonal ring with alternating single and double bonds. Its molecular formula is C_6H_6.

Q9. (a) Presence of two different types of groups in soap molecule

Explanation: Soap molecules have a hydrophilic head and hydrophobic tail. In water, they arrange themselves to form micelles with tails inside and heads outside.

Q10. (b) Ethanoic acid

Explanation: Vinegar contains 5-8% ethanoic acid (acetic acid) in water and is used as a preservative.

SECTION B - Answers to Short Answer Questions

Q11. Distinguish between saturated and unsaturated hydrocarbons. Give one example of each.

Answer:

Saturated Hydrocarbons	Unsaturated Hydrocarbons
Carbon atoms are linked by only single bonds	Carbon atoms are linked by double or triple bonds
General formula: C_nH_{2n+2} (for alkanes)	General formula: C_nH_{2n} (alkenes) or C_nH_{2n-2} (alkynes)
Less reactive	More reactive
Burn with clean blue flame	Burn with yellow sooty flame

Examples:

- Saturated: Propane (C_3H_8) - CH_3-CH_2-CH_3
- Unsaturated: Propene (C_3H_6) - CH_3-CH=CH_2

Q12. What is meant by substitution reaction? Give one example.

Answer:

Substitution Reaction: A reaction in which one atom or group of atoms in a molecule is replaced by another atom or group of atoms is called a substitution reaction.

Characteristics:

- Occurs in saturated hydrocarbons
- One type of atom takes the place of another
- Common in alkanes

Example:

$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$
(Methane) + (Chlorine) → (Chloromethane) + (Hydrogen chloride)
[In presence of sunlight]

In this reaction, one hydrogen atom of methane is substituted by one chlorine atom.

Q13. Why are detergents called soapless soaps? Give two advantages of detergents over soaps.

Answer:

Soapless Soaps:

Detergents are called soapless soaps because:
- They have similar cleansing action as soaps
- However, they are not made from oils/fats like soaps
- They are synthetic cleansing agents made from petroleum products

• Their chemical composition is different from traditional soaps

Two Advantages of Detergents over Soaps:

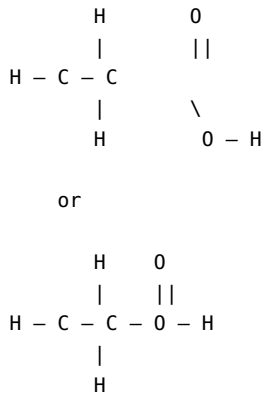
1. **Effectiveness in hard water:**
• Detergents work effectively even in hard water
• They do not form insoluble precipitates with Ca^{2+} and Mg^{2+} ions
• Soaps form scum in hard water, reducing cleaning efficiency

2. **Better cleaning power:**
• Detergents have stronger cleansing action
• They work well in both acidic and alkaline conditions
• More effective for removing oil and grease

Q14. Draw the structure of ethanoic acid molecule and identify the carboxylic acid functional group.

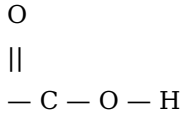
Answer:

Structure of Ethanoic Acid (CH_3COOH):



Carboxylic Acid Functional Group:

The functional group is -COOH (carboxyl group)



This group consists of:
• A carbonyl group (C=O)
• A hydroxyl group (-OH)
• Together they form the carboxylic acid group (-COOH)

SECTION C - Answers to Short Answer Questions

Q15. (a) What happens when ethanoic acid reacts with sodium carbonate and sodium hydroxide? (b) Test for gas.

(a) **Reactions:**

(i) **Reaction with sodium carbonate:**
$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2\uparrow$
(Ethanoic acid) + (Sodium carbonate) → (Sodium ethanoate) + (Water) + (Carbon dioxide)

- Brisk effervescence occurs
- Carbon dioxide gas is evolved
- Sodium ethanoate (salt) and water are formed

(ii) **Reaction with sodium hydroxide:**
$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$
(Ethanoic acid) + (Sodium hydroxide) → (Sodium ethanoate) + (Water)

- Neutralization reaction occurs
- Salt (sodium ethanoate) and water are formed
- No gas is evolved

(b) **Test for Carbon Dioxide Gas:**

1. Pass the gas through freshly prepared lime water [$Ca(OH)_2$]

2. **Observation:**
- Lime water turns milky/cloudy

3. **Chemical Reaction:**
$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$
(Lime water) + (Carbon dioxide) → (Calcium carbonate - white precipitate) + (Water)

4. If excess CO_2 is passed, the milkiness disappears:
$CaCO_3 + H_2O + CO_2 \rightarrow Ca(HCO_3)_2$
(Calcium carbonate) → (Soluble calcium bicarbonate)

Q16. (a) Define homologous series. (b) General formula. (c) Variation of physical properties.

(a) **Homologous Series:**

A homologous series is a series of carbon compounds in which:
- Same functional group substitutes for hydrogen
- Successive members differ by $-CH_2-$ unit (difference of 14 u in molecular mass)
- Members have similar chemical properties
- Physical properties show gradation
- Can be represented by a general formula

(b) **General Formula:**

- **Alkenes:** C_nH_{2n} (where $n \geq 2$)
  Examples: C_2H_4 (Ethene), C_3H_6 (Propene), C_4H_8 (Butene)

• **Alkynes:** C_nH_{2n-2} (where n ≥ 2)
Examples: C_2H_2 (Ethyne), C_3H_4 (Propyne), C_4H_6 (Butyne)

(c) **Variation of Physical Properties in Homologous Series:**

1. **Melting and Boiling Points:**
• Increase gradually with increase in molecular mass
• Due to increase in molecular size and van der Waals forces

2. **Solubility:**
• Shows gradual change with molecular mass
• Lower members are more soluble in water
• Solubility decreases with increasing chain length

3. **State:**
• Lower members are gases (e.g., methane, ethane)
• Middle members are liquids (e.g., pentane, hexane)
• Higher members are solids (e.g., paraffin wax)

4. **Chemical Properties:**
• Remain similar throughout the series
• Determined by the functional group present

Q17. Explain: (i) Catenation (ii) Isomerism (iii) Functional group

(i) **Catenation:**

Catenation is the unique ability of carbon atoms to form bonds with other carbon atoms through covalent bonds, giving rise to large molecules.

Features:
• Results in formation of long chains, branched chains, or rings
• Carbon-carbon bonds can be single, double, or triple bonds
• Carbon shows maximum catenation due to small size and strong C-C bonds

Example:
Butane (C_4H_{10}): CH_3-CH_2-CH_2-CH_3
Four carbon atoms are linked together in a chain

(ii) **Isomerism:**

Isomerism is the phenomenon in which two or more compounds have the same molecular formula but different structural arrangements of atoms.

Types:
• Structural isomers have different structural formulae

• Same molecular formula, different physical properties

Example:
C_4H_{10} has two isomers:
1. n-Butane: CH_3-CH_2-CH_2-CH_3 (straight chain)
2. Iso-butane: CH_3-$CH(CH_3)$-CH_3 (branched chain)

(iii) **Functional Group:**

A functional group is an atom or group of atoms that determines the characteristic chemical properties of an organic compound.

Features:
• Replaces hydrogen atoms in hydrocarbon chain
• Determines chemical behavior of the compound
• Same functional group gives similar properties

Example:
• Alcohol group (-OH): Present in CH_3OH (Methanol), C_2H_5OH (Ethanol)
• Both show similar chemical reactions due to -OH group
• React with sodium to liberate hydrogen gas

SECTION D - Answer to Long Answer Question

Q18. (a) Allotropes and carbon allotropy (b) Compare diamond and graphite (c) Synthetic diamonds

(a) **Allotropes and Carbon Allotropy:**

Allotropes: Different structural forms of the same element in the same physical state are called allotropes.

Why carbon exhibits allotropy:
• Carbon atoms can bond with each other in different ways
• Different bonding patterns result in different structures
• Each carbon can form four covalent bonds
• Can form 3D networks, 2D layers, or molecular structures
• These different arrangements lead to allotropes with widely varying properties

Main allotropes of carbon: Diamond, Graphite, Fullerenes (C_{60})

(b) **Comparison of Diamond and Graphite:**

Property	Diamond	Graphite
(i) Structure	• Each carbon bonded to 4 other carbons • Rigid 3D tetrahedral structure • All electrons involved in	• Each carbon bonded to 3 other carbons • Layered hexagonal structure • Weak van der Waals forces

	bonding • No free electrons	between layers • One free electron per carbon
(ii) Hardness	• Hardest known natural substance • Very rigid 3D network • Cannot be compressed or scratched easily	• Soft and slippery • Layers can slide over each other • Weak forces between layers • Can be easily broken
(iii) Electrical Conductivity	• Non-conductor of electricity • No free electrons available • All electrons are in bonds	• Good conductor of electricity • Has free electrons • Electrons can move through structure
(iv) Use	• Jewelry (precious gemstone) • Cutting and drilling tools • Grinding and polishing • Glass cutting	• Lubricant (due to slippery nature) • Electrodes • Pencil lead • Crucibles for high temp.

(c) **Synthetic Diamonds for Industrial Use:**

Why synthetic diamonds are used industrially:

1. **Cost-effective:**
• Cheaper than natural diamonds
• Can be produced in large quantities

2. **Controlled quality:**
• Size and quality can be controlled
• Customized for specific applications
• Free from impurities

3. **Same properties:**
• Extremely hard like natural diamonds
• Same cutting and grinding capabilities
• Chemically identical to natural diamonds

4. **Industrial applications:**
• Cutting and drilling tools
• Grinding wheels
• Polishing equipment
• Where appearance doesn't matter

Production: Synthetic diamonds are made by subjecting pure carbon to very high pressure and temperature.

SECTION E - Answers to Case Study Based Questions

Q19. Case Study 1: Ethanol and its Uses

(i) **Why is ethanol used in cough syrups and tincture iodine?**

Ethanol is used because it is an excellent solvent. It can dissolve many organic compounds and medicinal substances that are not soluble in water. In tincture iodine, ethanol helps dissolve iodine, and in cough syrups, it helps dissolve various medicinal ingredients.

(ii) **What is denatured alcohol?**

Denatured alcohol is ethanol that has been made unfit for drinking by adding poisonous substances like methanol and blue dye. This is done to prevent misuse of industrial ethanol for consumption, while still allowing its use in industries, as a solvent, and in cleaning products.

(iii) **Why is methanol considered poisonous?**

Methanol is extremely poisonous because:
• It is oxidized to methanal (formaldehyde) in the liver
• Methanal reacts rapidly with cell components
• It coagulates protoplasm (similar to cooking an egg)
• Affects the optic nerve, causing permanent blindness
• Even very small quantities (as little as 10 mL) can cause death
• Cannot be treated easily once consumed

(iv) **Molecular formula of ethanol:**

C_2H_5OH or C_2H_6O

Structure: CH_3-CH_2-OH

Q20. Case Study 2: Combustion of Carbon Compounds

(i) **Products of complete combustion of hydrocarbons:**

The products of complete combustion are:
1. Carbon dioxide (CO_2)
2. Water (H_2O)
3. Heat energy
4. Light

Example: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + Heat + Light

(ii) **Why is incomplete combustion harmful?**

Incomplete combustion is harmful because:

1. **Carbon monoxide (CO) formation:**
• Poisonous gas produced when oxygen supply is limited
• Binds with hemoglobin in blood more strongly than oxygen

• Prevents oxygen transport in blood
• Can cause suffocation and death

2. **Soot (carbon) formation:**
• Unburnt carbon particles cause air pollution
• Blackens cookware and wastes fuel
• Causes respiratory problems

3. **Energy wastage:**
• Less energy is released compared to complete combustion
• Fuel is not utilized efficiently

(iii) **Purpose of air inlets in gas stoves:**

Air inlets in gas stoves serve to:
• Allow sufficient air (oxygen) to mix with the fuel gas
• Ensure complete combustion of the fuel
• Produce a clean blue flame instead of yellow sooty flame
• Prevent formation of carbon monoxide and soot
• Maximize heat output and fuel efficiency
• Prevent blackening of cooking vessels

(iv) **Which hydrocarbon will burn with a clean flame - ethane or ethene? Why?**

Answer: Ethane (C_2H_6) will burn with a clean blue flame.

Reason:
• Ethane is a saturated hydrocarbon (alkane) with only single bonds
• It has a lower percentage of carbon relative to hydrogen
• Burns more completely with sufficient oxygen
• Produces CO_2 and H_2O with clean blue flame

• Ethene is an unsaturated hydrocarbon (alkene) with a double bond
• Has a higher percentage of carbon
• Undergoes incomplete combustion more readily
• Produces unburnt carbon particles (soot)
• Burns with yellow sooty flame
