

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.** Which of the following is the main reason for carbon forming a large number of compounds?
- (a) Small size and low electronegativity
 - (b) Catenation and tetravalency
 - (c) High melting and boiling points
 - (d) Ability to form ionic bonds
- Q2.** The formula C_nH_{2n} represents:
- (a) Alkanes
 - (b) Alkenes
 - (c) Alkynes
 - (d) Aromatic compounds
- Q3.** Which compound will give a yellow sooty flame on burning?
- (a) Methane
 - (b) Ethane
 - (c) Benzene
 - (d) Propane
- Q4.** The functional group present in ethanol is:
- (a) -COOH
 - (b) -CHO
 - (c) -OH
 - (d) -CO-
- Q5.** Soap molecules have:
- (a) Only hydrophobic end
 - (b) Only hydrophilic end
 - (c) Both hydrophobic and hydrophilic ends
 - (d) Neither hydrophobic nor hydrophilic end

Q6. The IUPAC name of $\text{CH}_3\text{-CH}_2\text{-CHO}$ is:

- (a) Propanal
- (b) Propanone
- (c) Propanol
- (d) Propanoic acid

Q7. Which allotrope of carbon conducts electricity?

- (a) Diamond
- (b) Graphite
- (c) Fullerene
- (d) Coal

Q8. Detergents are preferred over soaps because:

- (a) They are cheaper
- (b) They work well in hard water
- (c) They are biodegradable
- (d) They produce more foam

Q9. The conversion of ethanol to ethanoic acid is an example of:

- (a) Reduction
- (b) Oxidation
- (c) Hydration
- (d) Substitution

Q10. Which gas is evolved when sodium reacts with ethanol?

- (a) Oxygen
- (b) Hydrogen
- (c) Carbon dioxide
- (d) Methane

SECTION B - Short Answer Questions (2 marks each)

Q11. Draw the electron dot structure of ethyne (C_2H_2). What type of bond exists between the two carbon atoms?

Q12. Define catenation. Why is carbon able to show this property more than silicon even though silicon belongs to the same group?

Q13. Write the structural formula for the following compounds:

- (i) Butanone
- (ii) Ethanoic acid

Q14. Why do carbon compounds generally have low melting and boiling points? What type of bonding exists in these compounds?

SECTION C - Short Answer Questions (3 marks each)

Q15. Explain the cleansing action of soap. Why does soap not work well in hard water?

Q16. (a) What is hydrogenation? Write the chemical equation for the hydrogenation of ethene.
(b) What happens when vegetable oils are hydrogenated? Name the catalyst used.

Q17. Differentiate between saturated and unsaturated hydrocarbons with two examples of each. Which one is more reactive and why?

SECTION D - Long Answer Question (5 marks)

- Q18.** (a) What is a homologous series? Write any two characteristics of a homologous series.
(b) The first member of alkene series is ethene. Write the molecular formula of:
(i) Third member
(ii) Fifth member
(c) What is the difference in molecular mass between any two consecutive members of this series?

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

Q19. Case Study 1: Carbon is a versatile element that forms the basis of all living organisms. The ability of carbon atoms to form long chains and rings by bonding with other carbon atoms is called catenation. Carbon exhibits tetravalency and forms strong covalent bonds with other carbon atoms as well as with atoms of other elements like hydrogen, oxygen, nitrogen, sulfur and halogens. This property gives rise to a large number of carbon compounds.

Based on the above information, answer the following questions:

- (i) Why does carbon form compounds mainly by covalent bonding? (1 mark)
(ii) What would happen if carbon formed C^{4+} or C^{4-} ions? (1 mark)
(iii) Draw the electron dot structure of methane (CH_4). (2 marks)

Q20. Case Study 2: Ethanoic acid, commonly known as acetic acid, is an important carboxylic acid with the formula CH_3COOH . Pure ethanoic acid is called glacial acetic acid because it freezes during winter in cold climates. A 5-8% solution of acetic acid in water is called vinegar and is used as a preservative in pickles. Ethanoic acid reacts with alcohols in the presence of an acid catalyst to form sweet-smelling esters.

Based on the above information, answer the following questions:

- (i) Why is pure ethanoic acid called glacial acetic acid? (1 mark)
(ii) Write the chemical equation for the reaction between ethanoic acid and sodium carbonate. (1 mark)
(iii) What is esterification? Write the chemical equation for the formation of an ester from ethanoic acid and ethanol. (2 marks)

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SECTION A - Answers to MCQs

Ans 1. (b) Catenation and tetravalency

Explanation: Carbon can form long chains, branched chains, and rings due to catenation (self-linking). Its tetravalency allows it to bond with four other atoms, creating enormous structural diversity.

Ans 2. (b) Alkenes

Explanation: The general formula C_nH_{2n} represents alkenes (unsaturated hydrocarbons with one double bond). For example: C_2H_4 (ethene), C_3H_6 (propene).

Ans 3. (c) Benzene

Explanation: Unsaturated hydrocarbons like benzene burn with a yellow, sooty flame due to incomplete combustion. The soot contains unburnt carbon particles.

Ans 4. (c) -OH

Explanation: Ethanol (C_2H_5OH) belongs to the alcohol family and contains the hydroxyl (-OH) functional group.

Ans 5. (c) Both hydrophobic and hydrophilic ends

Explanation: Soap molecules have a long hydrocarbon chain (hydrophobic) that repels water and an ionic end (hydrophilic) that attracts water, enabling cleansing action.

Ans 6. (a) Propanal

Explanation: CH_3-CH_2-CHO has three carbon atoms (propane) with an aldehyde group (-CHO), hence the name is propanal.

Ans 7. (b) Graphite

Explanation: In graphite, each carbon atom is bonded to three others in hexagonal layers with one free electron per atom, allowing electrical conductivity.

Ans 8. (b) They work well in hard water

Explanation: Detergents do not form insoluble precipitates with calcium and magnesium ions in hard water, unlike soaps which form scum.

Ans 9. (b) Oxidation

Explanation: Oxidation involves addition of oxygen or removal of hydrogen. Ethanol (C_2H_5OH) is oxidized to ethanoic acid (CH_3COOH) by adding oxygen.

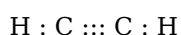
Ans 10. (b) Hydrogen

Explanation: $2Na + 2C_2H_5OH \rightarrow 2C_2H_5O^-Na^+ + H_2 \uparrow$. Sodium reacts with ethanol to produce hydrogen gas and sodium ethoxide.

SECTION B - Answers to Short Answer Questions

Ans 11. Electron dot structure of ethyne and type of bond

Electron dot structure:



Each carbon shares three electrons with the other carbon and one with hydrogen.

Type of bond: A triple covalent bond exists between the two carbon atoms in ethyne.

Ans 12. Catenation and comparison with silicon

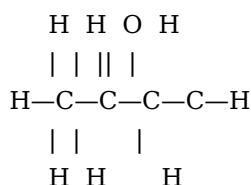
Catenation: The ability of an element to form bonds with atoms of the same element to form long chains or rings is called catenation.

Comparison: Carbon shows catenation more than silicon because:

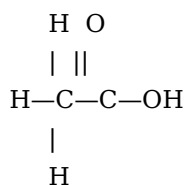
- The C-C bond (356 kJ/mol) is much stronger than the Si-Si bond (296 kJ/mol)
- Carbon's smaller atomic size allows stronger overlap of orbitals, forming more stable bonds

Ans 13. Structural formulae

(i) **Butanone:**



(ii) **Ethanoic acid:**



Ans 14. Low melting and boiling points of carbon compounds

Carbon compounds have low melting and boiling points because:

- They form covalent bonds where electrons are shared, not transferred
- The intermolecular forces between molecules are weak (van der Waals forces)
- Less energy is required to break these weak intermolecular forces

Type of bonding: Covalent bonding exists in carbon compounds where atoms share electrons to complete their octets.

SECTION C - Answers to Short Answer Questions

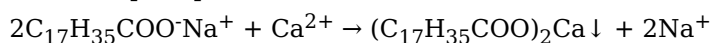
Ans 15. Cleansing action of soap and behavior in hard water

Cleansing action:

- Soap molecules have a hydrophobic tail (hydrocarbon chain) and hydrophilic head (ionic part)
- The hydrophobic tail attaches to oil/dirt while the hydrophilic head remains in water
- Soap molecules arrange themselves in spherical structures called micelles with dirt trapped inside
- The micelles remain suspended in water and can be rinsed away, removing dirt

Behavior in hard water:

Soap does not work well in hard water because it reacts with calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions to form insoluble precipitates called scum:

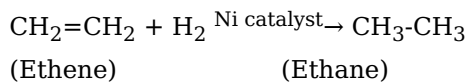


This wastes soap and reduces cleaning efficiency.

Ans 16. Hydrogenation and its application

(a) **Hydrogenation:** The process of adding hydrogen to unsaturated hydrocarbons in the presence of a catalyst (usually nickel) to convert them into saturated hydrocarbons is called hydrogenation.

Chemical equation:



(b) Hydrogenation of vegetable oils:

- Vegetable oils contain unsaturated fatty acids with C=C double bonds
- When hydrogenated, these double bonds are broken and hydrogen is added
- The oils are converted into solid or semi-solid fats (like margarine or vanaspati ghee)
- **Catalyst used:** Nickel (Ni) or Palladium (Pd)

Ans 17. Difference between saturated and unsaturated hydrocarbons

Saturated Hydrocarbons	Unsaturated Hydrocarbons
Have only single bonds (C-C)	Have double (C=C) or triple (C≡C) bonds
General formula: $\text{C}_n\text{H}_{2n+2}$	Alkenes: C_nH_{2n} , Alkynes: $\text{C}_n\text{H}_{2n-2}$
Examples: Methane (CH_4), Ethane (C_2H_6)	Examples: Ethene (C_2H_4), Ethyne (C_2H_2)
Burn with clean blue flame	Burn with yellow, sooty flame
Less reactive	More reactive

More reactive compound: Unsaturated hydrocarbons are more reactive because they have double or triple bonds which can easily break and add other atoms (addition reactions). Saturated hydrocarbons have stable single bonds and mainly undergo substitution reactions.

SECTION D - Answer to Long Answer Question

Ans 18. Homologous series

(a) **Homologous series:** A series of organic compounds having the same functional group and similar chemical properties, where successive members differ by a $-\text{CH}_2$ unit (or 14 u in molecular mass), is called a homologous series.

Characteristics:

1. All members have the same general formula. For example, alkenes have C_nH_{2n}
2. All members have similar chemical properties as they have the same functional group
3. Successive members differ by $-\text{CH}_2$ unit with a mass difference of 14 u
4. Physical properties like melting point, boiling point, and density show gradation

(b) Molecular formulae:

Alkene series general formula: C_nH_{2n}

First member: Ethene (C_2H_4), $n=2$

Second member: Propene (C_3H_6), $n=3$

(i) **Third member:** $n=4$

Molecular formula: C_4H_8 (Butene)

(ii) **Fifth member:** $n=6$

Molecular formula: C_6H_{12} (Hexene)

(c) Difference in molecular mass:

Each $-\text{CH}_2$ unit has mass = $12 + 2(1) = 14$ u

Therefore, the difference in molecular mass between any two consecutive members = 14 u

Ans 19. Case Study 1 - Versatile nature of carbon**(i) Why covalent bonding?** (1 mark)

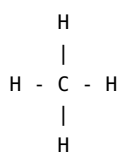
Carbon (atomic number 6) has 4 valence electrons and needs 4 more to complete its octet. Gaining or losing 4 electrons is not feasible:

- Forming C^{4+} requires too much energy
- Forming C^{4-} would make the nucleus (6 protons) unable to hold 10 electrons

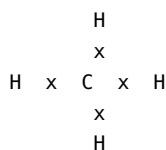
Therefore, carbon shares electrons to form covalent bonds.

(ii) Formation of C^{4+} or C^{4-} : (1 mark)

- C^{4+} : Would require enormous energy to remove 4 electrons, making it highly unstable
 - C^{4-} : The small nucleus with 6 protons cannot effectively hold 10 electrons ($6 + 4$), making it highly unstable
- Both ions are energetically unfavorable.

(iii) Electron dot structure of methane (CH_4): (2 marks)

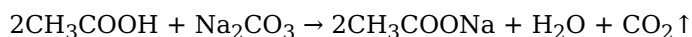
Or in electron dot notation:



Carbon shares one electron each with four hydrogen atoms, forming four single covalent bonds. Both carbon and hydrogen achieve stable electronic configurations.

Ans 20. Case Study 2 - Ethanoic acid**(i) Why 'glacial acetic acid'?** (1 mark)

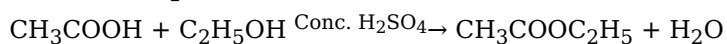
Pure ethanoic acid has a melting point of 290 K (17°C). In cold climates during winter, it freezes and forms ice-like crystals. Hence, pure ethanoic acid is called glacial acetic acid.

(ii) Reaction with sodium carbonate: (1 mark)

(Ethanoic acid) (Sodium carbonate) (Sodium acetate) (Water) (Carbon dioxide)

(iii) Esterification: (2 marks)

Definition: The reaction between a carboxylic acid and an alcohol in the presence of an acid catalyst to form an ester and water is called esterification.

Chemical equation:

(Ethanoic acid) + (Ethanol) \rightarrow (Ethyl acetate/Ester) + (Water)

Esters have sweet, fruity smells and are used in perfumes and flavoring agents.

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