

# UNIQUE STUDY POINT

By Sumeet Sahu

[www.uniquestudyonline.com](http://www.uniquestudyonline.com)

Unique Study Point, Amitesh Nagar, Indore, MP | Contact: 8103405051

|   |                         |                         |
|---|-------------------------|-------------------------|
| <b>Class:</b> X                               | <b>Subject:</b> Science | <b>Session:</b> 2025-26 |
| <b>Chapter:</b> 04 - Carbon and its Compounds | <b>Time:</b> 1½ Hours   | <b>Max. Marks:</b> 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 electron dot structure of nitrogen molecule shows:

- (a) A single bond between two nitrogen atoms
- (b) A double bond between two nitrogen atoms
- (c) A triple bond between two nitrogen atoms
- (d) No bond between nitrogen atoms

**Q2.** Which of the following hydrocarbons undergo addition reactions?

- (a) C<sub>2</sub>H<sub>6</sub>
- (b) C<sub>3</sub>H<sub>8</sub>
- (c) C<sub>3</sub>H<sub>6</sub>
- (d) CH<sub>4</sub>

**Q3.** Ethanol on oxidation with alkaline KMnO<sub>4</sub> gives:

- (a) Methanol
- (b) Methanal
- (c) Ethanoic acid
- (d) Ethane

**Q4.** The correct structural formula of butanone is:

- (a) CH<sub>3</sub>-CH<sub>2</sub>-CH<sub>2</sub>-CHO
- (b) CH<sub>3</sub>-CO-CH<sub>2</sub>-CH<sub>3</sub>
- (c) CH<sub>3</sub>-CH<sub>2</sub>-COOH

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

**Q5.** Which of the following is used to convert ethanol into ethene?

- (a) Alkaline  $\text{KMnO}_4$
- (b) Conc.  $\text{H}_2\text{SO}_4$  at 443 K
- (c) Dilute HCl
- (d) Water

**Q6.** Carbon forms four covalent bonds because it has:

- (a) 2 electrons in outermost shell
- (b) 4 electrons in outermost shell
- (c) 6 electrons in outermost shell
- (d) 8 electrons in outermost shell

**Q7.** The smell of esters is:

- (a) Pungent like vinegar
- (b) Sweet and fruity
- (c) Rotten eggs
- (d) Odorless

**Q8.** The difference in molecular mass between successive members of a homologous series is:

- (a) 12 u
- (b) 14 u
- (c) 16 u
- (d) 18 u

**Q9.** Scum formation is due to:

- (a) Reaction of soap with soft water
- (b) Reaction of soap with hard water containing  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions
- (c) Reaction of detergent with hard water
- (d) Micelle formation

**Q10.** In graphite, each carbon atom is bonded to how many other carbon atoms?

- (a) One
- (b) Two
- (c) Three
- (d) Four

### SECTION B - Short Answer Questions (2 marks each)

**Q11.** What is the role of concentrated sulphuric acid in esterification reaction? Write the equation for the formation of ethyl ethanoate.

**Q12.** Write two tests to distinguish between ethanol and ethanoic acid.

**Q13.** Why is the conversion of ethanol to ethanoic acid an oxidation reaction?

**Q14.** Draw the structures of the following compounds:

- (i) Propanone
- (ii) Propanal

### SECTION C - Short Answer Questions (3 marks each)

**Q15.** (a) What are hydrocarbons? Give examples.

(b) Classify hydrocarbons based on the nature of carbon-carbon bonds.

(c) Write the general formula for each class.

**Q16.** Three students A, B and C prepared soap solutions by dissolving equal amounts of soap in hard water, soft water and distilled water respectively.

(i) In which case will the soap work most effectively?

(ii) In which case will scum formation be maximum?

(iii) Explain the reason for your answers.

**Q17.** Write balanced chemical equations for the following reactions:

(i) Ethene reacts with hydrogen in presence of nickel catalyst

(ii) Methane burns in presence of oxygen

(iii) Ethanoic acid reacts with sodium hydrogencarbonate

### SECTION D - Long Answer Question (5 marks)

**Q18.** (a) Explain why carbon exhibits the property of catenation to a much greater extent than silicon, even though both are in the same group of the periodic table.

(b) What are the two features seen in carbon that give rise to a large number of carbon compounds?

(c) Write the molecular formula and draw the structures of:

(i) Ethyne

(ii) Benzene

(iii) Cyclopentane

(d) What are alkanes, alkenes and alkynes? Write one example of each.

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

#### **Q19. Case Study 1: Covalent Bonding in Carbon Compounds**

Carbon has four electrons in its outermost shell and needs four more electrons to achieve noble gas configuration. It could gain four electrons forming  $C^{4-}$  anion, but it would be difficult for the nucleus with six protons to hold ten electrons. It could lose four electrons forming  $C^{4+}$  cation, but it would require a large amount of energy. Therefore, carbon overcomes this problem by sharing its valence electrons with other atoms through covalent bonding. The shared electrons belong to the outermost shells of both atoms. Carbon forms single, double or triple bonds with other carbon atoms or with atoms of other elements.

**Answer the following questions:**

(i) Why is it difficult for carbon to form  $C^{4+}$  ion? (1 mark)

(ii) What is a covalent bond? (1 mark)

(iii) How many bonds are present in a molecule of ethane ( $C_2H_6$ )? (1 mark)

(iv) Name the type of bond present in  $N_2$  molecule. (1 mark)

## Q20. Case Study 2: Functional Groups and Nomenclature

In a hydrocarbon chain, one or more hydrogens can be replaced by elements such as oxygen, nitrogen, sulphur or halogens. The element replacing hydrogen is called a heteroatom. These heteroatoms confer specific properties to the compound and are called functional groups. The presence of a functional group decides the properties of the carbon compound regardless of the length of the carbon chain. For example, all alcohols have similar chemical properties because they contain the -OH functional group.

### Answer the following questions:

- (i) What is a functional group? (1 mark)
- (ii) Name the functional group present in  $\text{CH}_3\text{COOH}$ . (1 mark)
- (iii) Write the general formula of alcohols. (1 mark)
- (iv) What is the IUPAC name of  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$ ? (1 mark)

---

Made with ♥ by Sumeet Sahu

Unique Study Point, Amitesh Nagar, Indore, MP

Website: [uniquestudyonline.com](http://uniquestudyonline.com)



## SECTION A - Answers to MCQs

**Q1.** (c) A triple bond between two nitrogen atoms

**Explanation:** Nitrogen (atomic number 7) has 5 valence electrons. To achieve noble gas configuration, each nitrogen shares 3 electrons with another nitrogen atom, forming a triple bond ( $\text{N}\equiv\text{N}$ ).

**Q2.** (c)  $\text{C}_3\text{H}_6$

**Explanation:**  $\text{C}_3\text{H}_6$  (Propene) is an unsaturated hydrocarbon containing a double bond. Only unsaturated hydrocarbons undergo addition reactions.  $\text{C}_2\text{H}_6$ ,  $\text{C}_3\text{H}_8$ , and  $\text{CH}_4$  are saturated hydrocarbons.

**Q3.** (c) Ethanoic acid

**Explanation:**  $\text{C}_2\text{H}_5\text{OH} + [\text{O}] \rightarrow \text{CH}_3\text{COOH}$  (using alkaline  $\text{KMnO}_4$  or acidified  $\text{K}_2\text{Cr}_2\text{O}_7$ ). Ethanol is oxidized to ethanoic acid.

**Q4.** (b)  $\text{CH}_3\text{-CO-CH}_2\text{-CH}_3$

**Explanation:** Butanone has 4 carbon atoms with a ketone group ( $\text{C}=\text{O}$ ) on the second carbon. Structure:  $\text{CH}_3\text{-CO-CH}_2\text{-CH}_3$ .

**Q5.** (b) Conc.  $\text{H}_2\text{SO}_4$  at 443 K

**Explanation:**  $\text{C}_2\text{H}_5\text{OH} \rightarrow \text{C}_2\text{H}_4 + \text{H}_2\text{O}$  (using conc.  $\text{H}_2\text{SO}_4$  at 443 K). This is a dehydration reaction where water is removed from ethanol.

**Q6.** (b) 4 electrons in outermost shell

**Explanation:** Carbon (atomic number 6) has electronic configuration 2, 4. It has 4 valence electrons and forms 4 covalent bonds to achieve stable octet configuration.

**Q7.** (b) Sweet and fruity

**Explanation:** Esters are sweet-smelling substances with fruity odors. They are used in making perfumes and as flavoring agents.

**Q8.** (b) 14 u

**Explanation:** Successive members of a homologous series differ by  $-\text{CH}_2-$  unit. Molecular mass of  $-\text{CH}_2-$  =  $12 + 2(1) = 14$  u.

**Q9.** (b) Reaction of soap with hard water containing  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions

**Explanation:** Soap reacts with calcium and magnesium ions in hard water to form insoluble calcium and magnesium salts (scum), reducing cleaning efficiency.

**Q10.** (c) Three

**Explanation:** In graphite, each carbon atom is bonded to three other carbon atoms in the same plane, forming hexagonal layers. The fourth electron is free to move.

## SECTION B - Answers to Short Answer Questions

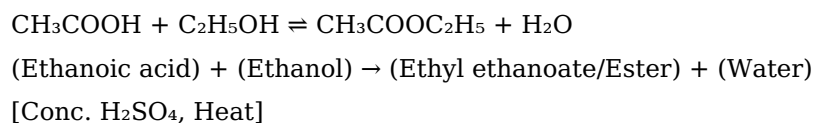
**Q11.** Role of concentrated sulphuric acid in esterification reaction and equation.

**Answer:**

**Role of Concentrated Sulphuric Acid:**

- Acts as a catalyst to speed up the esterification reaction
- Acts as a dehydrating agent by removing water formed during the reaction
- This helps shift the equilibrium forward, increasing ester formation

**Equation for formation of Ethyl Ethanoate:**



**Q12.** Write two tests to distinguish between ethanol and ethanoic acid.

**Answer:**

**Test 1: Litmus Test**

- **Ethanol:** Does not affect litmus paper (neither red nor blue litmus changes)
- **Ethanoic acid:** Turns blue litmus paper red (acidic nature)

**Test 2: Sodium Carbonate/Sodium Hydrogencarbonate Test**

- **Ethanol:** No reaction occurs, no gas evolved
- **Ethanoic acid:** Brisk effervescence occurs, CO<sub>2</sub> gas is evolved

Chemical equation:



or



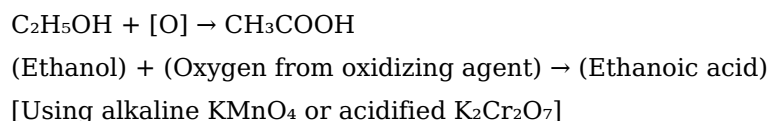
The CO<sub>2</sub> gas can be tested by passing it through lime water, which turns milky.

**Q13.** Why is the conversion of ethanol to ethanoic acid an oxidation reaction?

**Answer:**

The conversion of ethanol to ethanoic acid is an oxidation reaction because:

**Chemical Equation:**



## Reasons:

### 1. Addition of oxygen:

- Oxygen is added to ethanol molecule
- $-\text{CH}_2\text{OH}$  group is converted to  $-\text{COOH}$  group
- This involves addition of oxygen atom

### 2. Removal of hydrogen:

- Hydrogen atoms are removed from ethanol
- $\text{C}_2\text{H}_5\text{OH}$  (6 H atoms)  $\rightarrow$   $\text{CH}_3\text{COOH}$  (4 H atoms)

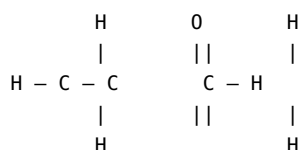
### 3. Definition of oxidation:

- Oxidation is defined as addition of oxygen or removal of hydrogen
- Both processes occur in this reaction
- Hence, it is an oxidation reaction

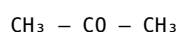
**Q14.** Draw the structures of (i) Propanone (ii) Propanal

## Answer:

### (i) Propanone ( $\text{CH}_3\text{COCH}_3$ ):

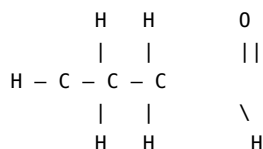


or simply

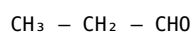


(Ketone group on middle carbon)

### (ii) Propanal ( $\text{CH}_3\text{CH}_2\text{CHO}$ ):



or simply



(Aldehyde group at terminal carbon)

## SECTION C - Answers to Short Answer Questions

**Q15.** (a) What are hydrocarbons? (b) Classify hydrocarbons (c) General formula

(a) **Hydrocarbons:**

Hydrocarbons are organic compounds containing only carbon and hydrogen atoms.

**Examples:**

- Methane (CH<sub>4</sub>)
- Ethene (C<sub>2</sub>H<sub>4</sub>)
- Ethyne (C<sub>2</sub>H<sub>2</sub>)
- Benzene (C<sub>6</sub>H<sub>6</sub>)

(b) **Classification of Hydrocarbons based on carbon-carbon bonds:**

**1. Saturated Hydrocarbons (Alkanes):**

- Contain only single bonds between carbon atoms
- All carbon atoms are bonded to maximum number of hydrogen atoms
- Less reactive
- Example: Methane (CH<sub>4</sub>), Ethane (C<sub>2</sub>H<sub>6</sub>)

**2. Unsaturated Hydrocarbons:**

(i) **Alkenes:**

- Contain one or more carbon-carbon double bonds (C=C)
- More reactive than alkanes
- Example: Ethene (C<sub>2</sub>H<sub>4</sub>), Propene (C<sub>3</sub>H<sub>6</sub>)

(ii) **Alkynes:**

- Contain one or more carbon-carbon triple bonds (C≡C)
- Most reactive among hydrocarbons
- Example: Ethyne (C<sub>2</sub>H<sub>2</sub>), Propyne (C<sub>3</sub>H<sub>4</sub>)

(c) **General Formula for each class:**

| Class   | General Formula                  | Example (n=2)                          |
|---------|----------------------------------|--|
| Alkanes | C <sub>n</sub> H <sub>2n+2</sub> | C <sub>2</sub> H <sub>6</sub> (Ethane) |
| Alkenes | C <sub>n</sub> H <sub>2n</sub>   | C <sub>2</sub> H <sub>4</sub> (Ethene) |
| Alkynes | C <sub>n</sub> H <sub>2n-2</sub> | C <sub>2</sub> H <sub>2</sub> (Ethyne) |

**Q16.** Soap solutions in hard water, soft water and distilled water - effectiveness and scum formation

**Answer:**

(i) **Most effective soap solution:**

Student C (who prepared soap solution in distilled water) will find soap working most effectively. Student B (soft water) will also get good results, but distilled water is purest.

(ii) **Maximum scum formation:**

Student A (who used hard water) will observe maximum scum formation.

(iii) **Explanation:**

**Hard Water (Student A):**

- Contains dissolved calcium ( $\text{Ca}^{2+}$ ) and magnesium ( $\text{Mg}^{2+}$ ) ions
- Soap reacts with these ions to form insoluble calcium and magnesium salts
- $2\text{C}_{17}\text{H}_{35}\text{COONa} + \text{Ca}^{2+} \rightarrow (\text{C}_{17}\text{H}_{35}\text{COO})_2\text{Ca} + 2\text{Na}^+$   
(Soap)                      (Insoluble scum)
- Scum is a white curdy precipitate
- A lot of soap is wasted in scum formation
- Soap cannot form lather until all  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  are removed
- Least effective cleaning

**Soft Water (Student B):**

- Contains very few or no  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions
- Little or no scum formation
- Soap works effectively
- Forms lather easily
- Good cleaning action

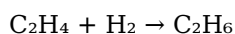
**Distilled Water (Student C):**

- Completely free from all dissolved salts and impurities
- No scum formation at all
- Soap works most effectively
- Forms lather immediately
- Best cleaning action

**Q17.** Write balanced chemical equations for given reactions

**Answer:**

(i) **Ethene reacts with hydrogen in presence of nickel catalyst:**

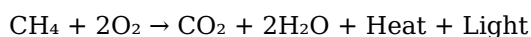


(Ethene) + (Hydrogen) → (Ethane)

[Ni catalyst, Heat]

- This is an addition reaction (hydrogenation)
- Unsaturated ethene is converted to saturated ethane
- Used in conversion of vegetable oils to vegetable ghee

(ii) **Methane burns in presence of oxygen:**



(Methane) + (Oxygen) → (Carbon dioxide) + (Water)

- This is a combustion reaction (oxidation)
- Complete combustion in sufficient oxygen
- Produces CO<sub>2</sub>, H<sub>2</sub>O, heat and light
- Clean blue flame is observed

(iii) **Ethanoic acid reacts with sodium hydrogencarbonate:**



(Ethanoic acid) + (Sodium hydrogencarbonate) → (Sodium ethanoate) + (Water) + (Carbon dioxide)

- Brisk effervescence occurs
- CO<sub>2</sub> gas is evolved
- Salt (sodium ethanoate) and water are formed
- This reaction is used to test for carboxylic acids

## SECTION D - Answer to Long Answer Question

**Q18.** (a) Why carbon shows more catenation than silicon (b) Two features of carbon (c) Structures (d) Alkanes, alkenes, alkynes

(a) **Why carbon exhibits catenation to a greater extent than silicon:**

Although both carbon and silicon belong to Group 14 and have 4 valence electrons, carbon shows much greater catenation due to:

**1. Atomic Size:**

- Carbon has smaller atomic radius (77 pm) compared to silicon (118 pm)
- Smaller size allows stronger orbital overlap
- Nucleus can hold shared electrons more strongly

**2. Bond Strength:**

- C-C bond energy = 347 kJ/mol (very strong)
- Si-Si bond energy = 226 kJ/mol (weaker)
- Stronger C-C bonds are more stable
- Silicon compounds are more reactive and less stable

**3. Chain Length:**

- Carbon can form very long stable chains (thousands of atoms)
- Silicon forms chains of only 7-8 atoms maximum
- Silicon-hydrogen compounds (silanes) are highly reactive

Therefore, carbon shows maximum catenation among all elements.

(b) **Two features of carbon that give rise to large number of compounds:**

**1. Catenation:**

- Unique ability to form bonds with other carbon atoms
- Forms long chains, branched chains, or rings
- Carbon atoms can be linked by single, double or triple bonds
- C-C bond is very strong and stable

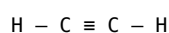
## 2. Tetravalency:

- Carbon has 4 valence electrons
- Can form 4 covalent bonds
- Can bond with 4 other carbon atoms or other elements
- Forms compounds with H, O, N, S, Cl and many other elements
- Each carbon can bond in multiple ways

These two properties together enable carbon to form millions of compounds.

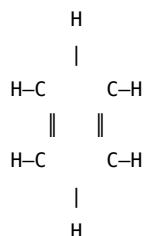
### (c) Molecular formula and structures:

#### (i) Ethyne (C<sub>2</sub>H<sub>2</sub>):



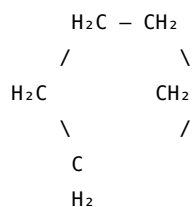
(Triple bond between two carbon atoms)

#### (ii) Benzene (C<sub>6</sub>H<sub>6</sub>):



(Hexagonal ring with alternating double bonds)

#### (iii) Cyclopentane (C<sub>5</sub>H<sub>10</sub>):



(Pentagon/five-membered ring)

### (d) Alkanes, Alkenes and Alkynes:

|  |  |  |  |
|--|--|--|--|
|  |  |  |  |
|--|--|--|--|

| Type           | Definition  | General Formula | Example                                      |
|----------------|---|-----------------|--|
| <b>Alkanes</b> | Saturated hydrocarbons with only single bonds between carbon atoms          | $C_nH_{2n+2}$   | Propane<br>( $C_3H_8$ )<br>$CH_3-CH_2-CH_3$  |
| <b>Alkenes</b> | Unsaturated hydrocarbons with one or more double bonds between carbon atoms | $C_nH_{2n}$     | Propene<br>( $C_3H_6$ )<br>$CH_3-CH=CH_2$    |
| <b>Alkynes</b> | Unsaturated hydrocarbons with one or more triple bonds between carbon atoms | $C_nH_{2n-2}$   | Propyne<br>( $C_3H_4$ )<br>$CH_3-C\equiv CH$ |

## SECTION E - Answers to Case Study Based Questions

### Q19. Case Study 1: Covalent Bonding in Carbon Compounds

#### (i) Why is it difficult for carbon to form $C^{4+}$ ion?

It is difficult for carbon to form  $C^{4+}$  ion because:

- Carbon would need to lose 4 electrons from its outermost shell
- This requires a very large amount of energy (high ionization energy)
- After losing 4 electrons, only 2 electrons remain with 6 protons in nucleus
- The nucleus cannot stably hold such a small electron cloud
- Therefore, formation of  $C^{4+}$  is energetically very unfavorable

#### (ii) What is a covalent bond?

A covalent bond is a chemical bond formed by the sharing of electron pairs between two atoms.

#### Features:

- Electrons are shared, not transferred
- Shared electrons belong to both atoms
- Both atoms achieve stable electronic configuration
- Strong bonds within molecule, weak forces between molecules
- Forms when atoms have similar electronegativity

Example: H-H bond in  $H_2$  molecule (each H shares one electron)

#### (iii) How many bonds are present in ethane ( $C_2H_6$ )?

Total number of bonds in ethane = 7 bonds

Structure:  $H_3C-CH_3$

- 1 C-C single bond (between two carbon atoms)
- 6 C-H single bonds (3 from each carbon)
- Total = 1 + 6 = 7 covalent bonds

(iv) **Type of bond present in N<sub>2</sub> molecule:**

Triple covalent bond (N≡N)

- Each nitrogen has 5 valence electrons
- Each nitrogen needs 3 more electrons to complete octet
- Both nitrogen atoms share 3 pairs of electrons
- Forms very strong triple bond
- This makes N<sub>2</sub> very stable and unreactive

**Q20.** Case Study 2: Functional Groups and Nomenclature

(i) **What is a functional group?**

A functional group is an atom or group of atoms that replaces hydrogen in a hydrocarbon and determines the characteristic chemical properties of the compound.

**Key points:**

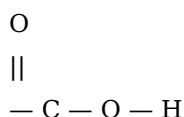
- Confers specific properties to the compound
- Properties remain same regardless of carbon chain length
- Same functional group gives similar chemical behavior
- Different from just substituents - they define chemical class

Examples: -OH (alcohol), -CHO (aldehyde), -COOH (carboxylic acid)

(ii) **Functional group present in CH<sub>3</sub>COOH:**

Carboxylic acid group (-COOH) or Carboxyl group

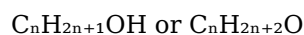
Structure of functional group:



It consists of:

- Carbonyl group (C=O)
- Hydroxyl group (-OH)
- Together forming -COOH group

(iii) **General formula of alcohols:**



where n = number of carbon atoms

Examples:

- n=1: CH<sub>3</sub>OH (Methanol)
- n=2: C<sub>2</sub>H<sub>5</sub>OH (Ethanol)
- n=3: C<sub>3</sub>H<sub>7</sub>OH (Propanol)

All contain the -OH (hydroxyl) functional group attached to a carbon chain.

(iv) **IUPAC name of CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>CHO:**

**Butanal**

**Explanation:**

- But- indicates 4 carbon atoms
- -al is the suffix for aldehyde functional group (-CHO)
- Aldehyde group is always at terminal position
- Structure: CH<sub>3</sub>-CH<sub>2</sub>-CH<sub>2</sub>-CHO

(Also called Butyraldehyde in common nomenclature)

---

Made with ♥ by Sumeet Sahu

Unique Study Point, Amitesh Nagar, Indore, MP

Website: [uniquestudyonline.com](http://uniquestudyonline.com)