CBSE CLASS X

Science (086)

ANSWER KEY

From previous CBSE Board Exam questions

Code: 7PQQ02	Questions: 78	Maximum Marks: 237	Generated: 2026-06-15 13:05

SELECTIONS USED

Source	Previous-year board
Subject	Science
Lessons	Carbon and its Compounds
Year	2022-2026
Questions selected	78

Composition — Types: 30 Long · 19 MCQ · 14 Short · 7 Assertion–reason · 4 Case-based · 3 Very short · 1 source_based

Q1. § 4.1 BONDING IN CARBON – THE COVALENT BOND **[1]**

Carbon compounds :
(i) are good conductors of electricity.
(ii) are bad conductors of electricity.
(iii) have strong forces of attraction between their molecules.
(iv) have weak forces of attraction between their molecules.
The correct statements are :

(a) (i) and (ii)
(b) (ii) and (iii)
(c) (ii) and (iv)
(d) (i) and (iii)

Previously asked in: 2024 31/1/1 Q4

◆ **Carbon and its Compounds** Properties of carbon compounds – electrical conductivity and intermolecular forces

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Model Answer

(c) (ii) and (iv)

Carbon compounds are **bad conductors of electricity** and have **weak intermolecular forces of attraction** (evidenced by their low melting and boiling points).

Explanation

The passage states: *"covalent compounds are generally poor conductors of electricity"* and *"inter-molecular forces are weak... giving rise to low melting and boiling points."* So statements (ii) and (iv) are both correct. Examiners expect you to recall these two key properties of covalent/carbon compounds together.

Q2. § 4.1 BONDING IN CARBON – THE COVALENT BOND **[2]**

The melting and boiling points of carbon compounds are generally low and they are largely non-conductors of electricity. State two conclusions based on these two properties.

Previously asked in: 2024 31/5/1 Q22

◆ Carbon and its Compounds | Covalent Nature of Carbon Compounds – Low Melting/Boiling Points and Poor Electrical Conductivity

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Model Answer

Conclusion 1: The forces of attraction between the molecules of carbon compounds are not very strong (which explains their low melting and boiling points).

Conclusion 2: The bonding in carbon compounds does not give rise to any ions (which explains why they are non-conductors of electricity). Carbon forms covalent bonds by sharing electrons rather than transferring them.

Source: Chapter 4, Section 4.1 – Bonding in Carbon

Explanation

- The passage directly states both conclusions, so quote them precisely — examiners expect these exact ideas.
- Conclusion 1 must link **low M.P./B.P. → weak intermolecular forces**.
- Conclusion 2 must link **non-conduction → no ions formed → covalent (sharing) bonding**.
- Avoid writing lengthy explanations; one crisp sentence per conclusion is enough for 1 mark each.

Q3. § 4.2 VERSATILE NATURE OF CARBON | § 4.3.1 Combustion **[3]**

State the reasons, why carbon cannot (i) Lose four electrons to form C^{4+} cation, and (ii) Gain four electrons to form C^{4-} anion. How does carbon overcome this problem to form compounds ?

Previously asked in: 2022 31/4/1 Q11 (OR)

◆ Carbon and its Compounds | Why carbon forms covalent bonds (inability to form C^{4+} or C^{4-} ions)

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Model Answer

(i) Cannot form C^{4+}: Carbon has 6 protons in its nucleus. Removing all 4 valence electrons would require a very large amount of energy, making C^{4+} formation energetically unfavourable.

(ii) Cannot form C^{4-}: Gaining 4 electrons would place them very close to the nucleus of a small atom (carbon is small). It would be difficult for 6 protons to hold 10 electrons, making C^{4-} highly unstable.

Solution — Covalent bonding: Carbon overcomes this problem by *sharing* its 4 valence electrons with other atoms, forming 4 covalent bonds. This allows carbon to complete its octet without losing or gaining electrons entirely.

Source: Chapter 4, Carbon and its Compounds

Explanation

- Examiners expect **two separate reasons** for C^{4+} and C^{4-}, then a third point on covalent bonding as the solution — matching the three-part question structure.
- Key terms to use: *energy*, *nucleus*, *unstable*, *sharing*, *covalent bonds*, *octet*.
- Don't just say "it's hard" — briefly state *why* (energy cost for losing; nuclear charge too small to hold extra electrons).
- This answer fits a 3-mark question (≈ 1 mark per part).

Q4. § 4.2 VERSATILE NATURE OF CARBON **[3]**

"Two different forms of carbon – diamond and graphite have different structures and very different physical properties even though their chemical properties are same." Explain why.

Previously asked in: 2022 31/4/1 Q11 (main)

◆ **Carbon and its Compounds** | Allotropes of Carbon – Diamond and Graphite: Structure and Physical Properties

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Model Answer

Diamond and graphite are both allotropes of carbon, so their chemical properties are the same. However, their physical properties differ due to different structural arrangements:

- **Diamond:** Each carbon atom is bonded to **four** other carbon atoms in a rigid, three-dimensional tetrahedral network. This makes it the hardest natural substance and a poor conductor of electricity.
- **Graphite:** Each carbon atom is bonded to **three** carbon atoms in flat hexagonal layers. The layers are held by weak forces and can slide over each other, making graphite soft and slippery. One free electron per carbon atom makes it a good conductor.

Since chemical properties depend on the element (carbon) and not its arrangement, both have identical chemical properties.

Source: Chapter 4, Versatile Nature of Carbon (Allotropes of Carbon)

Explanation

- The key concept is **allotropy** — same element, different structural forms.
- Examiners expect you to contrast the bonding in both forms (4 bonds in diamond vs. 3 bonds + free electron in graphite).
- Linking structure → property earns full marks (e.g., rigid network → hardness; layered structure → softness/conductivity).
- The source passages cover covalent bonding and tetravalency of carbon; knowledge of allotrope structures is from the same chapter.

Q5. § 4.2 VERSATILE NATURE OF CARBON **[2]**

"Carbon prefers to share its valence electrons with other atoms of carbon or with atoms of other elements rather than gaining or losing the valence electrons in order to attain noble gas configuration." Give reasons to justify this statement.

Previously asked in: 2022 31/2/1 Q1

◆ **Carbon and its Compounds** | Covalent bonding in carbon – reasons for sharing rather than gaining/losing electrons

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Model Answer

Carbon has atomic number 6, so it has 4 valence electrons. To achieve noble gas configuration, it would need to either gain 4 electrons (creating C^{4-}, difficult due to large nuclear charge on one atom) or lose 4 electrons (creating C^{4+}, requiring very high energy). Both are energetically unfavourable. Therefore, carbon prefers to **share** its 4 valence electrons, forming 4 strong covalent bonds with other carbon atoms or elements like H, O, N, Cl, etc.

Source: Chapter 4, Section 4.2 – Versatile Nature of Carbon

Explanation

- Examiners expect two clear points: (1) gaining $4e^-$ is difficult, (2) losing $4e^-$ requires too much energy — so sharing is preferred.
- Mention that carbon has a valency of **4** and forms **covalent bonds**.
- You don't need to explain catenation here — the question is only about *why* carbon shares rather than gains/loses electrons.
- Keep it to 2 distinct reasons for full marks.

Q6. § 4.1 BONDING IN CARBON – THE COVALENT BOND **[3]**

State the reason why (i) carbon compounds have low melting and boiling points. (ii) carbon compounds do not conduct electricity. (iii) carbon can form only covalent compounds.

Previously asked in: 2022 31/3/1 Q9(a)

◆ Carbon and its Compounds | Covalent nature of carbon compounds – low melting/boiling points and non-conductivity | Tetravalency and tendency of carbon to form only covalent bonds

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Model Answer

(i) Low melting and boiling points: Carbon compounds are covalently bonded. Although the bonds within the molecule are strong, the intermolecular forces between molecules are very weak. Therefore, less energy is required to overcome these forces, resulting in low melting and boiling points.

(ii) Do not conduct electricity: In covalent compounds, electrons are shared between atoms rather than transferred. No charged particles (ions) are formed. Since there are no free ions or electrons to carry charge, carbon compounds are poor conductors of electricity.

(iii) Only covalent compounds: Carbon has 4 valence electrons. To form C^{4-}, its nucleus (6 protons) cannot hold 10 electrons; to form C^{4+}, removing 4 electrons requires too much energy. So carbon overcomes this by sharing electrons, forming only covalent bonds.

Source: Chapter 4, Section 4.1 – Bonding in Carbon: The Covalent Bond

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Explanation

- All three parts are directly from Section 4.1. Examiners expect you to link the property back to the **covalent bond** nature.
- For (i): Key phrase is "strong intramolecular bonds but weak intermolecular forces."
- For (ii): Key phrase is "sharing of electrons → no ions formed → poor conductor."
- For (iii): You must give **both** reasons (why it can't gain AND why it can't lose electrons) to get full credit — one reason alone is incomplete.

Q7. § 4.2 VERSATILE NATURE OF CARBON | § 4.2.1 Saturated and Unsaturated Carbon Compounds | § 4.2.3 Will you be my Friend? **[1]**

The correct representation of covalent bonding in an oxygen molecule is :

Previously asked in: 2023 31/5/1 Q7

◆ Carbon and its Compounds | Covalent Bonding in Molecules (O_2)

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Model Answer

The correct representation is **(b)** — the one showing a **double bond (O=O)** between two oxygen atoms, as each oxygen (valency 2) shares **two pairs of electrons** to complete its octet.

Explanation

Oxygen has 6 valence electrons and needs 2 more to complete its octet. Two oxygen atoms each contribute 2 electrons to form **2 shared pairs → a double covalent bond (O=O)**. Options showing a single bond or triple bond are incorrect. The correct electron-dot structure must show two shared pairs between the oxygen atoms and two lone pairs on each oxygen.

Q8. § 4.2 VERSATILE NATURE OF CARBON § 4.2.1 Saturated and Unsaturated Carbon Compounds § 4.3.4 Substitution Reaction **[1]**

The total number of electrons shared in the formation of an ethyne molecule is :

(a) 6
(b) 3
(c) 10
(d) 4

Previously asked in: 2023 31/2/1 Q7

◆ Carbon and its Compounds | Covalent bonding in ethyne (triple bond) – electron sharing

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Model Answer

(a) 10

Ethyne (C_2H_2) has a triple bond between two carbon atoms (6 shared electrons) and one C–H bond on each carbon (2 × 2 = 4 shared electrons). Total = 6 + 4 = **10 electrons shared**.

Explanation

Count all shared electrons in every bond: the C≡C triple bond shares 6 electrons, and each of the two C–H single bonds shares 2 electrons, giving 6 + 4 = 10. Students often confuse number of *bonds* (5 bonds total) with number of *electrons shared* — the question asks for electrons, so multiply bonds × 2.

Q9. § 4.2 VERSATILE NATURE OF CARBON **[1]**

Assertion (A) : There are large number of compounds with many carbon atoms linked to each other.
Reason (R) : Carbon-Carbon bond is very strong and stable.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2026 31/3/1 Q24

◆ Carbon and its Compounds | Catenation – strength and stability of C-C bonds

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Model Answer

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

The carbon-carbon bond is very strong and hence stable, which directly gives rise to large numbers of compounds with many carbon atoms linked to each other (catenation).

Source: Chapter 4, Section 4.2 Versatile Nature of Carbon

Explanation

The textbook explicitly states: *"The carbon-carbon bond is very strong and hence stable. This gives us the large number of compounds with many carbon atoms linked to each other."* This means R directly explains A, making option (A) correct. Students should note the key link: **strong C–C bond → stable catenation → millions of carbon compounds**.

Q10. § 4.2 VERSATILE NATURE OF CARBON | § 4.2.3 Will you be my Friend? | § 4.2.4 Homologous Series **[1]**

Assertion (A) : Carbon compounds can form chains, branched and ring structures.
Reason (R) : Carbon exhibits the property of catenation.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2026 31/2/1 Q24

◆ Carbon and its Compounds | Catenation and Versatile Nature of Carbon

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Model Answer

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

Catenation is the ability of carbon to bond with other carbon atoms, forming long chains, branched chains, and ring structures.

Source: Chapter 4, Section 4.2 Versatile Nature of Carbon

Explanation

The assertion directly describes the structural outcomes (chains, branches, rings) of catenation, and the reason correctly names and defines that property. Since R directly explains why A is true, option (A) is correct. Remember: catenation → chains/branches/rings is a direct cause-effect link, so R *is* the correct explanation, not just a related true fact.

Q11. § 4.2 VERSATILE NATURE OF CARBON **[1]**

Assertion (A) : Carbon shares its valence electrons with other atoms of carbon or with atoms of other elements.
Reason (R) : The shared electrons belong to the outermost shells of both the atoms and lead to both atoms attaining the noble gas configuration.

A Both, Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
B Both, Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
C Assertion (A) is true, but Reason (R) is false.
D Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2026 31/1/1 Q24

◆ Carbon and its Compounds | Covalent bonding in carbon compounds

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Model Answer

Option A — Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A). Carbon forms covalent bonds by sharing valence electrons; these shared electrons count towards both atoms, helping each achieve a noble gas configuration.

Explanation

- The Assertion is correct: carbon shares its 4 valence electrons with other carbon atoms or other elements (covalent bonding).
- The Reason is also correct and directly explains the Assertion: in covalent bonding, the shared pair belongs to the outermost shell of **both** atoms, allowing each to attain a completely filled outermost shell (noble gas configuration).
- Since R logically explains why A occurs, the answer is **A**, not B.

Q12. § 4.1 BONDING IN CARBON – THE COVALENT BOND | § 4.2.2 Chains, Branches and Rings | § 4.2.5 Nomenclature of Carbon Compounds **[3]**

Answer the following: (1+2 = 3)

(a) Draw the electron dot structure for ethyne.

(b) List two differences between the properties exhibited by covalent compounds and ionic compounds.

Previously asked in: 2022 31/2/1 Q9 (OR-2)

◆ **Carbon and its Compounds** | Electron dot structure of ethyne (triple bond / covalent bonding in carbon compounds) | Properties of covalent compounds vs ionic compounds

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Model Answer

(a) Electron dot structure of ethyne (C_2H_2):

Ethyne has a triple bond between the two carbon atoms.

H : C ::: C : H

(Each carbon shares 3 pairs of electrons with the other carbon and 1 pair with hydrogen.)

(b) Two differences between covalent and ionic compounds:

Property	Covalent Compounds	Ionic Compounds
Melting/Boiling Point	Generally low	Generally high
Solubility in water	Generally insoluble or slightly soluble	Generally soluble

(Alternatively: Ionic compounds conduct electricity in solution; covalent compounds generally do not.)

Explanation

- **(a)** Draw the Lewis dot structure showing a triple bond (6 shared electrons = 3 lines) between the two C atoms, with one H on each end. Examiners award marks for correct electron pairs shown as dots.
- **(b)** Choose any **two clear, contrasting** property differences. Common accepted pairs: melting/boiling points, electrical conductivity, solubility. Avoid vague statements — be specific. A table format is neat and exam-friendly for comparison questions.

Q13. § 4.2.1 Saturated and Unsaturated Carbon Compounds | § 4.2.2 Chains, Branches and Rings | § 4.2.5 Nomenclature of Carbon Compounds **[1]**

The structural formula of Cyclohexane is

A Six-membered ring with two C=C double bonds, each C bearing H
B Six-membered saturated ring, each C bearing two H (CH_2 groups)
C Six-membered ring with two C≡C triple bonds
D Six-membered ring with double bonds, each C bearing H

Previously asked in: 2024 31/3/1 Q4

◆ Carbon and its Compounds | Cyclic Hydrocarbons – Structural Formula of Cyclohexane

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Model Answer

The correct answer is **(B)** — a fully saturated six-membered ring with each carbon bearing two H atoms (CH_2 groups).

Cyclohexane (C_6H_{12}) is a saturated cyclic hydrocarbon with all single bonds between carbon atoms.

Source: Chapter 4, Section 4.2.2 – Chains, Branches and Rings

Explanation

Examiners expect you to recall that cyclohexane is a **saturated** compound, so it has **no double or triple bonds**. Option B is the only structure with a plain six-membered ring and all single C–C bonds (each C has two H atoms attached), matching the formula C_6H_{12}. Options A and D show double bonds (unsaturated); Option C shows triple bonds — both are incorrect for cyclohexane.

Q14. § 4.2.1 Saturated and Unsaturated Carbon Compounds **[1]**

Draw the electron dot structure of the following: Butane

Previously asked in: 2022 31/3/1 Q2 (b)

◆ Carbon and its Compounds | Electron Dot Structure of Carbon Compounds (Butane)

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Model Answer

Butane (C_4H_{10}) electron dot structure:

H : C : C : C : C : H

H H H H H H H H

(Each carbon shares single bonds with adjacent carbons and hydrogen atoms, with all valencies satisfied.)

Source: Chapter 4, Section 4.2.2

Explanation

Butane has 4 carbon atoms in a straight chain, each forming 4 covalent bonds. The two end carbons bond to 3 H atoms each, and the two middle carbons bond to 2 H atoms each, giving C_4H_{10}. In the electron dot structure, show each shared pair as two dots (or a line) between atoms. Examiners want all bonds shown correctly with valencies satisfied — this is the key scoring point for 1 mark.

Q15. § 4.2.1 Saturated and Unsaturated Carbon Compounds **[1]**

Draw the electron dot structure of the following: Cyclohexane

Previously asked in: 2022 31/3/1 Q2 (a)

◆ Carbon and its Compounds | Electron dot structure of Cyclohexane

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Model Answer

Cyclohexane (C_6H_{12}) has 6 carbon atoms arranged in a ring, each bonded to 2 hydrogen atoms with single covalent bonds:

$$\begin{array}{c}
\text{H}_2\text{C} - \text{CH}_2 \\
| \quad\quad\quad | \\
\text{H}_2\text{C} \quad \text{CH}_2 \\
| \quad\quad\quad | \\
\text{H}_2\text{C} - \text{CH}_2
\end{array}$$

Each C shares electrons with 2 C atoms and 2 H atoms (4 bond pairs, valency satisfied).

Source: Carbon and its Compounds, Section 4.2.2

Explanation

- Cyclohexane formula is C_6H_{12} — examiners may deduct marks if you use the wrong formula.
- The key feature is the **ring structure** with all single bonds (saturated).
- In the electron dot structure, show 2 dots (shared pairs) for each C–C and C–H bond around all 6 carbons. Alternatively, the structural/line formula of the hexagonal ring with CH_2 at each carbon is accepted.
- Confirm all carbon valencies = 4 are satisfied (2 C–C bonds + 2 C–H bonds per carbon).

Q16. § 4.2.1 Saturated and Unsaturated Carbon Compounds § 4.2.2 Chains, Branches and Rings **[2]**

Answer the following:

(a) Write the molecular formula of the following carbon compounds : (i) Methane (ii) Propane [1]

(b) Carbon compounds have low melting and boiling points. Why ? [1]

Previously asked in: 2022 31/1/1 Q1

♦ **Carbon and its Compounds** Low melting and boiling points of carbon compounds Molecular formulas of simple hydrocarbons (Methane, Propane)

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Model Answer

(a)
(i) Methane — **CH_4**
(ii) Propane — **C_3H_8**

(b) Carbon compounds are covalently bonded. The intermolecular forces between covalent molecules are weak, so very little energy is needed to overcome them. Hence, carbon compounds have low melting and boiling points.

Source: Chapter 4, Section 4.2.2 (Table 4.2)

Explanation

- **(a)** These formulae come directly from Table 4.2. Methane has 1 C and 4 H; Propane has 3 C and 8 H (general alkane formula C_nH_{2n+2}).
- **(b)** The key idea examiners want: carbon compounds are **covalent**, and covalent compounds have **weak intermolecular forces**, hence low melting/boiling points. Always mention both the type of bonding and the weak forces — that's where the mark lies.

Q17. § 4.2.1 Saturated and Unsaturated Carbon Compounds § 4.2.3 Will you be my Friend? **[1]**

The electron dot structure of chlorine molecule is :

(a) Electron dot structure option (a)
(b) Electron dot structure option (b)
(c) Electron dot structure option (c)
(d) Electron dot structure option (d)

Previously asked in: 2023 31/4/1 Q7

♦ **Carbon and its Compounds** Electron Dot Structure (Lewis Structure) of Molecules

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Model Answer

(c)

The correct electron dot structure shows each Cl atom with **3 lone pairs** and **1 shared pair** between them, satisfying the octet of both chlorine atoms (valency = 1).

Explanation

Chlorine has 7 valence electrons. Each Cl needs 1 more electron to complete its octet, so it shares one electron with the other Cl, forming a **single covalent bond** with 3 lone pairs on each atom. The option showing exactly this arrangement is correct. In MCQs, quickly count the dots: each Cl should have 6 dots (3 pairs) + 1 shared pair between them.

Q18. § 4.2 VERSATILE NATURE OF CARBON § 4.2.2 Chains, Branches and Rings **[1]**

The number of single and double bonds present in a molecule of benzene (C_6H_6) respectively, are :

A 6 and 6
B 9 and 3
C 3 and 9
D 3 and 3

Previously asked in: 2024 31/4/1 Q5

◆ Carbon and its Compounds | Structure of Benzene – single and double bonds

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Model Answer

Option D: 3 and 3 — Wait, that is incorrect. Benzene (C_6H_6) has an alternating structure with **3 single C–C bonds, 3 double C=C bonds, and 6 C–H single bonds**, giving **9 single bonds and 3 double bonds**.

Correct answer: B — 9 and 3

Source: Chapter 4, Section 4.2.2 (Chains, Branches and Rings)

Explanation

- In benzene's ring: there are 3 C–C single bonds and 3 C=C double bonds.
- Each of the 6 carbon atoms also bonds to one hydrogen via a single bond → 6 C–H single bonds.
- Total single bonds = 3 (C–C) + 6 (C–H) = **9**; double bonds = **3**.
- Examiners expect you to count **all** single bonds (both C–C and C–H), not just the ring single bonds. Option D (3 and 3) is a common wrong answer if students ignore C–H bonds.

Q19. § 4.2.2 Chains, Branches and Rings **[1]**

Consider the structures of the three cyclic carbon compounds A, B and C given below and select the correct option from the following :

(a) A and C are isomers of hexane and B is benzene.
(b) A is an isomer of hexane, B is benzene and C is an isomer of hexene.
(c) A is a saturated cyclic hydrocarbon and B and C are unsaturated cyclic hydrocarbons.
(d) A is cyclohexane and B and C are the isomers of benzene.

Previously asked in: 2023 31/1/1 Q7

◆ Carbon and its Compounds | Cyclic carbon compounds – structures and properties (benzene, cyclohexane, cyclopentane)

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Model Answer

The correct option is **(c)**: A is a saturated cyclic hydrocarbon (cyclohexane, C_6H_{12}) and B and C are unsaturated cyclic hydrocarbons (both contain double bonds).

Explanation

- **A** = cyclohexane (C_6H_{12}) — fully saturated ring; it is an isomer of **hexene** (not hexane, as hexane is C_6H_{14} with a different formula).
- **B** = benzene (C_6H_6) — unsaturated, with alternating double bonds.
- **C** — also an unsaturated cyclic compound with double bond(s); it is **not** an isomer of benzene (different formula/structure).
- Option (a) and (b) are wrong because cyclohexane is NOT an isomer of hexane ($C_6H_{14} \neq C_6H_{12}$). Option (d) is wrong because C is not an isomer of benzene. Only option (c) correctly classifies all three on the basis of saturation.

Q20. § 4.2.3 Will you be my Friend? § 4.2.5 Nomenclature of Carbon Compounds **[1]**

The formula of functional group for aldehyde is :

A –COOH
B –CHO
C –C(=O)–
D –OH

Previously asked in: 2026 31/1/1 Q20

◆ Carbon and its Compounds | Functional groups in carbon compounds (aldehyde)

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Model Answer

The correct option is **B – CHO**.

The functional group for aldehyde is **–CHO**.

Source: Carbon and its Compounds, Table 4.3

Explanation

From Table 4.3, the functional group for aldehyde contains a carbon atom double-bonded to oxygen and single-bonded to hydrogen, written as –CHO. Examiners expect the exact formula; –COOH is carboxylic acid and –OH is alcohol — do not confuse them.

Q21. § 4.2.2 Chains, Branches and Rings § 4.2.4 Homologous Series § 4.2.5 Nomenclature of Carbon Compounds **[1]**

Consider the following statements about homologous series of carbon compounds :
(a) All succeeding members differ by – CH_2 unit.
(b) Melting point and boiling point increases with increasing molecular mass.
(c) The difference in molecular masses between two successive members is 16 u.
(d) C_2H_2 and C_3H_4 are NOT the successive members of alkyne series.
The correct statements are –

(A) (a) and (b)
(B) (b) and (c)
(C) (a) and (c)
(D) (c) and (d)

Previously asked in: 2024 31/2/1 Q7

◆ Carbon and its Compounds | Homologous Series

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Model Answer

(A) (a) and (b)

Successive members of a homologous series differ by $–CH_2$ (14 u, not 16 u), and melting/boiling points increase with molecular mass.

Explanation

Statement (c) is wrong — the mass difference is 14 u (CH_2), not 16 u. Statement (d) is wrong — C_2H_2 and C_3H_4 are indeed successive alkynes (differ by $–CH_2$). Statements (a) and (b) are directly supported by the textbook passage on homologous series.

Q22. § 4.2.3 Will you be my Friend? § 4.2.4 Homologous Series § 4.2.5 Nomenclature of Carbon Compounds **[1]**

A Hydrocarbon which does not belong to the same homologous series of carbon compounds is

(A) C_4H_{10}
(B) C_6H_{14}
(C) C_7H_{14}
(D) $C_{10}H_{22}$

Previously asked in: 2025 31/6/1 Q4

◆ Carbon and its Compounds | Homologous Series

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Model Answer

(C) C_7H_{14}

C_4H_{10}, C_6H_{14}, and $C_{10}H_{22}$ follow the alkane general formula C_nH_{2n+2}, while C_7H_{14} follows C_nH_{2n} (alkene series), so it does not belong to the same homologous series.

Source: Chapter 4, Section 4.2.4 Homologous Series

Explanation

- Alkanes follow **C_nH_{2n+2}**: C_4H_{10} (n=4: 2×4+2=10✓), C_6H_{14} (n=6: 14✓), $C_{10}H_{22}$ (n=10: 22✓) — all alkanes.
- C_7H_{14} fits **C_nH_{2n}** (n=7: 2×7=14✓) — this is the alkene series, a different homologous series.
- In MCQs like this, quickly apply the general formula to each option to identify the odd one out.

Q23. § 4.2.4 Homologous Series § 4.2.5 Nomenclature of Carbon Compounds **[3]**

What is a homologous series? Find the difference in molecular mass between the two consecutive members of a homologous series. State how in a homologous series of carbon compounds the following properties vary with increase in molecular mass: (i) Melting and boiling points (ii) Chemical properties

Previously asked in: 2022 31/3/1 Q9(b)

◆ Carbon and its Compounds | Homologous Series – definition, molecular mass difference, and variation of properties

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Model Answer

A **homologous series** is a series of carbon compounds that have the same functional group, the same general formula, and similar chemical properties, differing from each other by a $-CH_2-$ unit.

Difference in molecular mass: Each successive member differs by a $-CH_2-$ unit, so the difference in molecular mass = 12 + 2(1) = **14 u**.

(i) Melting and boiling points: They **increase** with increasing molecular mass in a homologous series, showing a gradation in physical properties.

(ii) Chemical properties: They **remain similar** throughout the series, as chemical properties are determined solely by the functional group, not the length of the carbon chain.

Source: Chapter 4, Section 4.2.4 – Homologous Series

Explanation

- Examiners expect the definition to mention: same functional group, differ by $-CH_2-$, similar chemical properties.
- The 14 u calculation (C = 12, 2×H = 2) must be shown or stated.
- Key contrast to remember: **physical properties** (MP/BP) **increase**; **chemical properties remain the same** — this distinction is a common exam point.

Q24. § 4.2.5 Nomenclature of Carbon Compounds **[1]**

Which of the following set of compounds does not belong to same homologous series ?

(A) CH_4 and C_4H_{10}
(B) C_2H_6 and C_3H_8
(C) C_3H_8 and C_5H_{12}
(D) C_4H_8 and C_5H_{12}

Previously asked in: 2026 31/5/1 Q18

◆ **Carbon and its Compounds** Homologous Series

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Model Answer

(D) C_4H_8 and C_5H_{12}

C_4H_8 follows the general formula C_nH_{2n} (alkene series), while C_5H_{12} follows C_nH_{2n+2} (alkane series). They belong to different homologous series.

Explanation

- Check the general formula for each option: alkanes = C_nH_{2n+2}; alkenes = C_nH_{2n}.
- Options A, B, C all contain pairs of alkanes (CH_4, C_2H_6, C_3H_8, C_4H_{10}, C_5H_{12} all fit C_nH_{2n+2}).
- In option D, C_4H_8 is an alkene and C_5H_{12} is an alkane — different series, so they do **not** belong to the same homologous series.

Q25. § 4.2.2 Chains, Branches and Rings | § 4.2.3 Will you be my Friend? | § 4.2.5 Nomenclature of Carbon Compounds **[3]**

Consider the following organic compounds:
(i) H–C–C–C=O with three H atoms on top bonded to carbons and H atoms below the first two carbons (i.e. $CH_3–CH_2–CHO$ type structure).
(ii) H–C–C=O with two H on top and one H below the first carbon (i.e. $CH_3–CHO$ type structure).

(a) Name the functional group present in their compounds.

(b) Write the general formula for the compounds of this functional group.

(c) State the relationship between these compounds and draw the structure of any other compound having similar functional group.

Previously asked in: 2022 31/2/1 Q9 (OR-1)

◆ **Carbon and its Compounds** | Aldehydes – functional group, general formula, and homologous series

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Model Answer

(a) The functional group present in both compounds is the **aldehyde group** (–CHO), i.e., $-\overset{\overset{O}{\|}}{C}-H$.

(b) The general formula for aldehydes is: $C_nH_{2n}O$ (or $C_nH_{2n+1}CHO$).

(c) The two compounds are **homologs** — they belong to the same homologous series (alkanals). Compound (i) is **propanal** (CH_3CH_2CHO) and compound (ii) is **ethanal** (CH_3CHO); they differ by one $–CH_2–$ unit.

Structure of another aldehyde — **Methanal (HCHO):**

$$H-\overset{\overset{O}{\|}}{C}-H \quad (\text{HCHO})$$

Source: Carbon and its Compounds, sections 4.2.3 and 4.2.5

Explanation

- **(a)** The –CHO group (C double-bonded to O, with H on the same C) is the aldehyde functional group. Examiners expect the name and the structural formula of the group.
- **(b)** CBSE accepts $C_nH_{2n}O$ or the form $C_nH_{2n+1}CHO$ for aldehydes.
- **(c)** "Relationship" means they are **homologs** — same functional group, differ by $–CH_2–$. You must state this explicitly and draw any one aldehyde (methanal is simplest). Drawing propanal or butanal is equally acceptable.

Q26. § 4.2.4 Homologous Series § 4.2.5 Nomenclature of Carbon Compounds **[5]**

Answer the following :

(i) Give reason why carbon can neither form C^{4+} cations nor C^{4-} anions but form covalent compounds.

(ii) What is homologous series of carbon compound ? Write the molecular formula of any two consecutive members of homologous series of aldehydes.

(iii) Draw the structure of the molecule of cyclohexane (C_6H_{12}).

Previously asked in: 2024 31/2/1 Q34(a)

◆ Carbon and its Compounds | Covalent bonding in carbon – inability to form C^{4+}/C^{4-} ions | Homologous series of carbon compounds | Structure of cyclohexane (cyclic carbon compounds)

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Model Answer

(i) Carbon has 4 valence electrons. To form C^{4+}, it would need to lose 4 electrons, requiring a very large amount of energy. To form C^{4-}, it would gain 4 electrons, but it would be difficult to accommodate 4 extra electrons on the small carbon nucleus — both are energetically unfavourable. Instead, carbon shares its 4 valence electrons with other atoms, forming 4 covalent bonds, which is much more stable.

(ii) A homologous series is a series of carbon compounds having the same functional group and similar chemical properties, where each successive member differs by $–CH_2–$ (molecular mass difference of 14 u).

Two consecutive members of the aldehyde homologous series:

- Methanal: HCHO
- Ethanal: CH_3CHO

(iii) Structure of Cyclohexane (C_6H_{12}):

$$\begin{array}{c}
\text{Each carbon in the ring is bonded to 2 H atoms}\\[4pt]
\underset{H_2}{\overset{H_2}{C}}\!-\!\underset{H_2}{\overset{H_2}{C}}\text{ (hexagonal ring)}
\end{array}$$

Structural representation:

Each carbon carries 2 hydrogen atoms in a six-membered ring:

```
CH₂—CH₂
/ \
CH₂ CH₂
\ /
CH₂—CH₂
```

Source: Chapter 4, Sections 4.2.2 and 4.2.5

Explanation

- **(i)** Examiners expect two specific reasons — energy cost of losing $4e^-$ AND difficulty of gaining $4e^-$ — then the conclusion that sharing (covalent bonding) is preferred.
- **(ii)** Define homologous series clearly with the $–CH_2–$ difference criterion. Always give molecular formulas (HCHO and CH_3CHO) — structural formulas earn full credit too.
- **(iii)** The ring diagram is essential; a hexagon with CH_2 at each vertex is acceptable. Remember: all carbons are saturated (each has 2 H), consistent with the formula C_6H_{12}.

Q27. § 4.2.4 Homologous Series § 4.2.5 Nomenclature of Carbon Compounds **[5]**

Answer the following about carbon compounds :

(i) Define a homologous series of carbon compounds.

(ii) Why is the melting and boiling points of C_4H_8 higher than that of C_3H_6 or C_2H_4 ?

(iii) Why do we NOT see any gradation in chemical properties of a homologous series compounds ?

(iv) Write the name and structures of (i) aldehyde and (ii) ketone with molecular form C_3H_6O.

Previously asked in: 2024 31/1/1 Q34(A)

◆ Carbon and its Compounds | Aldehydes and Ketones – Nomenclature and Structures | Homologous Series – Definition and Properties

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Model Answer

(i) Homologous Series:
A homologous series is a series of carbon compounds having the same functional group, similar chemical properties, and the same general formula, in which successive members differ by a $–CH_2–$ unit (14 mass units).

(ii) As the number of carbon atoms increases in a homologous series, the molecular mass increases. Greater molecular mass means stronger intermolecular forces of attraction, requiring more energy to overcome them. Hence, C_4H_8 (4 carbons) has higher melting and boiling points than C_3H_6 or C_2H_4.

(iii) All members of a homologous series have the **same functional group**, which determines chemical properties. Since the functional group remains unchanged throughout the series, there is no gradation in chemical properties.

(iv)

- **Aldehyde (Propanal):** $CH_3–CH_2–CHO$

Structure: $CH_3\text{-}CH_2\text{-}\overset{\overset{O}{\|}}{C}\text{-}H$

- **Ketone (Propanone):** $CH_3–CO–CH_3$

Structure: $CH_3\text{-}\overset{\overset{O}{\|}}{C}\text{-}CH_3$

Source: Chapter 4 – Carbon and its Compounds, Sections 4.2, 4.2.3

Explanation

- **(i)** The definition must include: same functional group, same general formula, differ by $–CH_2–$, similar chemical properties. All four earn full marks.
- **(ii)** The key logic is: more carbons → higher molecular mass → stronger intermolecular forces → higher boiling/melting point.
- **(iii)** Examiners want the reason: the *functional group* (not the chain) governs chemical properties, and it stays the same throughout the series.
- **(iv)** Both IUPAC names (Propanal, Propanone) and correct structural formulae are expected. The aldehyde –CHO is at the *end* of the chain; the ketone carbonyl (C=O) is *between* two carbon atoms. Draw clearly or write the condensed structural formula.

Q28. § 4.2.1 Saturated and Unsaturated Carbon Compounds | § 4.2.2 Chains, Branches and Rings **[3]**

Draw two different possible structures of a saturated hydrocarbon having four carbon atoms in its molecule. What are these two structures of the hydrocarbon having same molecular formula called ? Write the molecular formula and the common name of this compound. Also write the molecular formula of its alkyne.

Previously asked in: 2022 31/1/1 Q9 (a)

♦ **Carbon and its Compounds** | Homologous Series – Alkanes, Alkenes, Alkynes | Isomerism in Carbon Compounds | Structural Isomers of Saturated Hydrocarbons (Alkanes)

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Model Answer

Two structures of saturated hydrocarbon with 4 carbon atoms:

Structure 1 (n-Butane – straight chain):

$$H_3C - CH_2 - CH_2 - CH_3$$

Structure 2 (Iso-butane – branched chain):

$$\begin{array}{l} \quad CH_3 \\ \quad\quad | \\ CH_3 - CH - CH_3 \end{array}$$

These two structures with the same molecular formula but different arrangements are called **structural isomers**.

Molecular formula: C_4H_{10}

Common name: Butane

Molecular formula of its alkyne: C_4H_6 (But-1-yne / Butyne)

Source: Carbon and its Compounds, Section 4.2.2

Explanation

- Examiners expect both structures drawn clearly (straight and branched chain) — sketching the carbon skeleton is enough.
- The term **structural isomers** is the key term; don't write "isomers" alone.
- Alkyne formula: for alkane C_nH_{2n+2}, alkyne is C_nH_{2n-2}, so for $n = 4$: C_4H_6.
- Award-split: 1 mark for structures, 1 mark for "structural isomers" + molecular formula + common name, 1 mark for alkyne formula.

Q29. § 4.2.5 Nomenclature of Carbon Compounds **[2]**

Answer the following:

(a) Select from the following the members of same homologous series : (1) H–C–C–C=O (propanal / propionaldehyde structure) (2) H–C–C–C–H (with a C=O group, i.e., propanone/acetone) (3) H–C–C–C–C=O (butanal structure) (4) H–C–C–C–OH (propan-1-ol structure) [Structures as given in paper: (1) CH_3CH_2CHO, (2) CH_3COCH_3, (3) $CH_3CH_2CH_2CHO$, (4) $CH_3CH_2CH_2OH$] [1]

(b) What happens to (i) the melting point, and (ii) the solubility of compounds as the molecular mass of the compounds in a homologous series increases ? [1]

Previously asked in: 2025 31/2/1 Q22

◆ **Carbon and its Compounds** | Homologous Series – identification of members | Properties of Homologous Series – trends in melting point and solubility with increasing molecular mass

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Model Answer

(a) Compounds (1) CH_3CH_2CHO (propanal) and (3) $CH_3CH_2CH_2CHO$ (butanal) belong to the same homologous series — **aldehydes** — as both contain the **–CHO** functional group and differ by one $–CH_2–$ unit.

(b)
(i) **Melting point** increases with increasing molecular mass in a homologous series.
(ii) **Solubility** (in water) decreases with increasing molecular mass in a homologous series.

Explanation

- **(a)** Homologous series members must have the same functional group and differ by $–CH_2–$. Compound (2) is a ketone (–CO–) and compound (4) is an alcohol (–OH), so they don't fit. Only (1) and (3) are both aldehydes.
- **(b)** This is a standard textbook property of homologous series. Examiners expect both parts answered clearly. Larger molecules have stronger intermolecular forces (higher m.p.) but are less polar, reducing water solubility.

Q30. § 4.3 CHEMICAL PROPERTIES OF CARBON COMPOUNDS **[1]**

Assertion (A) : Carbon and its compounds are our major sources of fuels.
Reason (R) : Most of the carbon compounds on burning release a large amount of heat and light.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true and Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2025 31/6/1 Q17

◆ **Carbon and its Compounds** | Carbon compounds as fuels and combustion

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Model Answer

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

Carbon compounds are major fuel sources *because* most of them release a large amount of heat and light on burning (combustion), which directly explains why they are used as fuels.

Explanation

The key here is the word **"correct explanation"** — R directly explains why A is true. The textbook states both facts together under Combustion (4.3.1): carbon compounds are fuels *because* they release heat and light on burning. So R is not just true but is the precise reason for A, making option (A) correct. Watch out for option (B) traps where both statements are true but unrelated — here they are clearly linked.

Q31. § 4.2.5 Nomenclature of Carbon Compounds | § 4.3 CHEMICAL PROPERTIES OF CARBON COMPOUNDS **[5]**

(b) Answer the following:

(i) Name the simplest saturated hydrocarbon. Draw its electron dot structure. Which type of bonds exist in this compound ?

(ii) Name any two mixtures of the carbon compound used as a fuel in daily life, of which the above mentioned compound is an important component.

(iii) In which homologous series of carbon compounds can this compound be placed ? Write the general formula of the series.

(iv) Which type of flame is produced on burning it ?

Previously asked in: 2023 31/2/1 Q34 (b)

◆ **Carbon and its Compounds** | Carbon compounds as fuels – CNG and Biogas | Covalent bonds in carbon compounds | Electron dot structure of carbon compounds | Homologous series – Alkanes and general formula CnH2n+2 | Simplest saturated hydrocarbon – Methane (CH4) | Types of flame – clean/blue flame on burning saturated hydrocarbons

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Model Answer

(i) The simplest saturated hydrocarbon is **methane (CH_4)**.

Electron dot structure:

H
|
H : C : H
|
H

(Each C–H bond has one shared pair of electrons.)

Type of bonds: Only **single covalent bonds** (C–H) exist in methane. All four valence electrons of carbon are shared with four hydrogen atoms.

(ii) Two fuel mixtures in daily life that contain methane as an important component:

1. **CNG** (Compressed Natural Gas)
2. **Biogas**

(iii) Methane belongs to the **Alkanes** homologous series (saturated hydrocarbons).

General formula: C_nH_{2n+2}

(iv) Methane (a saturated hydrocarbon) produces a **clean blue flame** on burning, as saturated hydrocarbons undergo complete combustion when sufficient oxygen is available.

Source: Carbon and its Compounds, sections 4.3.1 Combustion and 4.2 (Homologous Series)

Explanation

- The question has four sub-parts worth a total of 5 marks (~1 mark each, with (i) slightly heavier).
- The electron dot structure must show shared pairs (dots/crosses) around C; a simple line structure alone may not get full credit.
- Examiners expect **CNG and Biogas** (or LPG — LPG is mainly butane/propane, so CNG or Biogas are safer choices for methane).
- The general formula C_nH_{2n+2} for alkanes is essential — don't confuse with alkenes (C_nH_{2n}).
- For (iv), the key phrase is **clean blue flame** — link it to complete combustion of saturated hydrocarbons as stated in the textbook passage.

Q32. § 4.3 CHEMICAL PROPERTIES OF CARBON COMPOUNDS | § 4.3.3 Addition Reaction **[2]**

Distinguish between a saturated and an unsaturated hydrocarbon by flame test. List the products of combustion reaction of a saturated hydrocarbon.

Previously asked in: 2024 31/4/1 Q22

◆ Carbon and its Compounds | Combustion of Hydrocarbons – Products of Combustion | Saturated and Unsaturated Hydrocarbons – Flame Test

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Model Answer

Flame test:
Saturated hydrocarbons burn with a **blue, non-sooty flame**, while unsaturated hydrocarbons burn with a **yellow, sooty (smoky) flame**.

Products of combustion of a saturated hydrocarbon:
Carbon dioxide (CO_2) and water (H_2O) are produced.

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

Explanation

- The flame test is the key distinguishing test: soot/smokiness indicates unsaturation (higher carbon-to-hydrogen ratio causes incomplete combustion).
- Examiners expect both parts answered: (1) the distinction and (2) the products.
- Writing the equation for methane combustion earns full credit and shows understanding. Keep it concise — no extra explanation needed for 2 marks.

Q33. § 4.3.1 Combustion | § 4.3.4 Substitution Reaction **[1]**

Which of the following will not undergo addition reaction ?

(A) C_4H_8
(B) C_2H_2
(C) C_3H_8
(D) C_2H_4

Previously asked in: 2026 31/5/1 Q21

◆ Carbon and its Compounds | Addition Reactions of Carbon Compounds

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Model Answer

(C) C_3H_8

C_3H_8 is a saturated hydrocarbon (alkane). Saturated hydrocarbons undergo substitution reactions, not addition reactions. Only unsaturated compounds (alkenes, alkynes) undergo addition reactions.

Explanation

The key concept: **addition reactions occur only in unsaturated hydrocarbons** (those with double or triple bonds). C_4H_8 (alkene), C_2H_2 (alkyne), and C_2H_4 (alkene) are all unsaturated — they have C=C or C≡C bonds and readily undergo addition. C_3H_8 is propane, a saturated alkane; it undergoes substitution, not addition. Examiners expect you to identify the saturated compound by its general formula C_nH_{2n+2}.

Q34. § 4.2.3 Will you be my Friend? § 4.2.5 Nomenclature of Carbon Compounds § 4.3.2 Oxidation **[4]**

> More than three million carbon compounds have been discovered in the field of chemistry. The diversity of these compounds is due to the capacity of carbon atoms for bonding with one another as well as with other atoms. Most of the carbon compounds are poor conductors of electricity and have low melting and boiling points.

Read the source and answer the sub-parts that follow.

(a) Write the molecular formula of first two members of homologous series having functional group –Br. [1]

(b) Given below are the formulae of some functional groups : (i) –C(=O)H (an aldehyde group, –CHO), (ii) –C(=O)– (a carbonyl/ketone group, >C=O). Write the name of these functional groups. [1]

(c) What would be observed on adding a 5% alkaline potassium permanganate drop by drop to some warm ethanol taken in a test tube ? State the role of $KMnO_4$ in the reaction and write the chemical equation for the reaction involved. [2]

Previously asked in: 2024 31/3/1 Q37

◆ **Carbon and its Compounds** | Functional groups – aldehyde (–CHO) and ketone (>C=O) | Homologous series and haloalkanes (–Br functional group) | Oxidation of ethanol by alkaline $KMnO_4$ – role of oxidising agent

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Model Answer

(a) The first two members of the homologous series with functional group –Br (haloalkanes) are:

- CH_3Br (Bromomethane)
- C_2H_5Br (Bromoethane)

(b)

(i) –CHO → **Aldehyde** group

(ii) >C=O → **Ketone** (Carbonyl) group

(c) Observation: The pink/purple colour of alkaline $KMnO_4$ is decolourised.

Role of $KMnO_4$: It acts as an **oxidising agent**.

Chemical Equation:

$$CH_3CH_2OH \xrightarrow{\text{Alkaline } KMnO_4, \Delta} CH_3COOH$$

Ethanol is oxidised to **ethanoic acid (acetic acid)**.

Explanation

- **(a)** The –Br functional group series is called haloalkanes. Just replace –H of alkane with –Br; first member = CH_3Br, second = C_2H_5Br.
- **(b)** These are standard functional group names from the NCERT table — must be memorised exactly.
- **(c)** Examiners expect three things: observation (decolourisation), role (oxidising agent), and the balanced/word equation. $KMnO_4$ oxidises ethanol → ethanoic acid; this is a key reaction in the Carbon chapter.

Q35. § 4.2.2 Chains, Branches and Rings | § 4.2.3 Will you be my Friend? | § 4.2.5 Nomenclature of Carbon Compounds **[2]**

Consider the carbon compounds having following molecular formula : (i) C_3H_6 (ii) C_3H_8 (iii) C_4H_6 (iv) C_6H_6 (v) C_6H_{12}

(a) State the number of double covalent bonds present in C_3H_6.

(b) Write the formula of first member of the homologous series to which the carbon compound C_4H_6 belongs.

(c) Which one of the above compounds forms ring structure of carbon atoms ?

(d) Identify, which of the above compounds, is a member of alkane series.

Previously asked in: 2022 31/4/1 Q7

◆ **Carbon and its Compounds** | Alkanes – saturated hydrocarbons | Degree of unsaturation and double bonds in carbon compounds | Homologous series and first member identification | Ring (cyclic) structures of carbon compounds – Benzene and cyclic hydrocarbons

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Model Answer

(a) C_3H_6 is propene, an alkene. It contains **one** double covalent bond (C=C) in its structure.

(b) C_4H_6 belongs to the alkyne series (triple bond, general formula C_nH_{2n-2}). The first member is **C_2H_2** (ethyne/acetylene).

(c) **C_6H_{12}** (cyclohexane) forms a ring structure of carbon atoms.

(d) **C_3H_8** (propane) belongs to the alkane series (general formula C_nH_{2n+2}; saturated hydrocarbon).

Source: Chapter 4, Section 4.2.2

Explanation

- **(a)** C_3H_6 fits the alkene formula C_nH_{2n} → one C=C double bond.
- **(b)** C_4H_6 fits C_nH_{2n-2} (alkyne series). First member = C_2H_2. Don't confuse with alkene (C_nH_{2n}).
- **(c)** The passage explicitly names cyclohexane (C_6H_{12}) as the ring compound. Note: C_6H_6 (benzene) is also cyclic, but the passage highlights C_6H_{12} as the ring example; if asked "which forms ring structure," C_6H_{12} is the primary textbook answer.
- **(d)** Alkanes follow C_nH_{2n+2}. Only C_3H_8 ($3\times2+2=8$) fits perfectly. Verify others don't fit before writing.

Q36. § 4.2.2 Chains, Branches and Rings | § 4.2.3 Will you be my Friend? **[1]**

Which one of the following hydrocarbons is different from the others ?

A C_4H_{10}
B C_7H_{14}
C C_5H_{12}
D C_2H_6

Previously asked in: 2024 31/3/1 Q6

◆ **Carbon and its Compounds** | Classification of Hydrocarbons (Saturated vs Unsaturated)

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Model Answer

B) C_7H_{14}

C_4H_{10}, C_5H_{12}, and C_2H_6 are alkanes (general formula C_nH_{2n+2}), whereas C_7H_{14} follows C_nH_{2n}, making it an alkene or cycloalkane — different from the others.

Explanation

The key is identifying the homologous series. Alkanes follow C_nH_{2n+2}: C_2H_6 ✓, C_4H_{10} ✓, C_5H_{12} ✓. C_7H_{14} follows C_nH_{2n} (alkene/cycloalkane series), so it is the odd one out.

Q37. § 4.3.3 Addition Reaction **[1]**

Choose the incorrect statement about the common reaction used in hydrogenation of vegetable oils.

(A) It is an addition reaction.
(B) It takes place in the presence of nickel or palladium catalyst.
(C) The product contains only single bonds between carbon atoms.
(D) It is an addition reaction which occurs in the presence of an acid catalyst.

Previously asked in: 2025 31/3/1 Q5

◆ Carbon and its Compounds | Hydrogenation of Vegetable Oils

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Model Answer

(D) is incorrect. Hydrogenation of vegetable oils is an addition reaction that uses a **nickel or palladium catalyst**, not an acid catalyst.

Explanation

The passage clearly states that unsaturated hydrocarbons add hydrogen in the presence of palladium or nickel catalysts — no acid is involved. Options A, B, and C are all correct statements about hydrogenation. Examiners expect you to identify the specific wrong detail (acid catalyst) in option D.

Q38. § 4.2.2 Chains, Branches and Rings **[1]**

Given below are the structures of some hydrocarbons. Select the two structures which are related to each other from the given options :
(i) H–C–C–C=C–H (but-1-ene type structure)
(ii) H–C–C–C–C–H (butane type structure)
(iii) H–C–C–C–C–H (another butane-type structure)
(iv) Cl–C–C–C=C–H (chloro-but-1-ene type structure)

(A) (i) and (iv)
(B) (ii) and (iv)
(C) (ii) and (iii)
(D) (i) and (iii)

Previously asked in: 2025 31/3/1 Q4

◆ Carbon and its Compounds | Alkanes and Alkenes (saturated and unsaturated hydrocarbons) | Homologous Series | Structural Isomers of Hydrocarbons

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Model Answer

(C) (ii) and (iii)

Structures (ii) and (iii) both have the molecular formula C_4H_{10} (butane) but different carbon skeletons — they are structural isomers.

Explanation

Structural isomers have the same molecular formula but different structures. (ii) is n-butane (straight chain) and (iii) is isobutane (branched chain) — both C_4H_{10}. Structure (i) is but-1-ene (C_4H_8, unsaturated), and (iv) has a Cl substituent, making it a haloalkane with a different molecular formula. Examiners expect you to identify identical molecular formula + different structure = structural isomers.

Q39. § 4.2.5 Nomenclature of Carbon Compounds | § 4.3.3 Addition Reaction **[5]**

Answer the following:

(i) Differentiate between saturated and unsaturated hydrocarbons by giving one example each, with a structural formula. [2]

(ii) Write the method of converting an unsaturated hydrocarbon into a saturated hydrocarbon. Name the industry where this reaction is commonly used. [2]

(iii) Write the name and structure of a hydrocarbon having double bond and four carbon atoms in its one molecule. [1]

Previously asked in: 2025 31/2/1 Q34 (b)

◆ Carbon and its Compounds | Addition Reaction / Hydrogenation of Unsaturated Hydrocarbons | Alkenes – Structure and Nomenclature (But-1-ene / But-2-ene) | Saturated and Unsaturated Hydrocarbons

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Model Answer

(i) Saturated vs Unsaturated Hydrocarbons:

Saturated hydrocarbons contain only single bonds between carbon atoms. They are called **alkanes**.
Example — Ethane:

$$\text{H} - \text{C} - \text{C} - \text{H} \quad (CH_3 - CH_3)$$

(with all single bonds and H atoms filled)

Unsaturated hydrocarbons contain one or more double or triple bonds between carbon atoms. They are called **alkenes** (double bond) or **alkynes** (triple bond).
Example — Ethene:

$$CH_2 = CH_2$$

(ii) Conversion of Unsaturated to Saturated Hydrocarbon:

Unsaturated hydrocarbons are converted to saturated hydrocarbons by **hydrogenation** — adding hydrogen in the presence of a **nickel (Ni) catalyst**.

$$CH_2 = CH_2 + H_2 \xrightarrow{Ni} CH_3 - CH_3$$

This reaction is used in the **vegetable oil (vanaspati) / food industry** to convert liquid vegetable oils into solid fats (vanaspati ghee).

(iii) Hydrocarbon with a double bond and four carbon atoms:

Name: But-1-ene (Butene)

Structure:

$$CH_2 = CH - CH_2 - CH_3$$

Source: Chapter 4, Sections 4.2.2 and 4.3

Explanation

- (i) Key terms: "single bonds only" for saturated; "double/triple bond" for unsaturated. Structural formula must clearly show the double bond (=) for unsaturated. Examiners award 1 mark per correct definition + example pair.
- (ii) "Hydrogenation" is the exact NCERT term (Exercise Q12). Always name both the catalyst (Ni) and the industry (vanaspati/edible oil industry). 1 mark for the reaction, 1 mark for naming the industry.

- (iii) Four carbons + double bond = butene. Write the structural formula clearly showing `CH2=CH—`. 1 mark awarded for correct name and structure together.

Q40. § 4.2.5 Nomenclature of Carbon Compounds | § 4.4 SOME IMPORTANT CARBON COMPOUNDS – ETHANOL AND ETHANOIC ACID | § 4.4.2 Properties of Ethanoic Acid **[5]**

Name an alcohol and a carboxylic acid having two carbon atoms in their structures. Draw their structures and state how this alcohol can be converted into a carboxylic acid. What happens when these two compounds react in the presence of an acid ? Write chemical equations for the reactions involved in the two cases mentioned above.

Previously asked in: 2025 31/6/1 Q34(a)

◆ Carbon and its Compounds | Esterification reaction | Ethanol and Ethanoic Acid – Structures and Properties | Oxidation of Ethanol to Ethanoic Acid

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Model Answer

Alcohol (2 carbons): Ethanol (C_2H_5OH)
Carboxylic acid (2 carbons): Ethanoic acid (CH_3COOH)

Structures:

$$\text{Ethanol: } CH_3 - CH_2 - OH$$

$$\text{Ethanoic acid: } CH_3 - COOH$$

Conversion of ethanol to ethanoic acid:
Ethanol is oxidised using an oxidising agent (like alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$) to form ethanoic acid:

$$CH_3CH_2OH \xrightarrow{\text{Oxidising agent}} CH_3COOH$$

Reaction between ethanol and ethanoic acid (Esterification):
When ethanol reacts with ethanoic acid in the presence of a concentrated H_2SO_4 catalyst, a sweet-smelling ester (ethyl ethanoate) is formed:

$$CH_3COOH + C_2H_5OH \xrightarrow{\text{Conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$$

The product ethyl ethanoate is used in perfumes and as a flavouring agent.

Source: Chapter 4, Section 4.4.2

Explanation

- **Two reactions are expected**: oxidation of ethanol → ethanoic acid, and esterification. Write both equations clearly.
- The oxidising agent is commonly alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$ — mention at least one.
- For esterification, note the acid catalyst (conc. H_2SO_4), the sweet-smelling product, and water as by-product.
- Structures should show the –OH group for ethanol and the –COOH group for ethanoic acid; full structural or condensed both acceptable in CBSE.
- Examiners award 1 mark each for: naming/drawing alcohol, naming/drawing acid, oxidation equation, esterification equation, and observation/use of ester.

Q41. § 4.2.5 Nomenclature of Carbon Compounds | § 4.4 SOME IMPORTANT CARBON COMPOUNDS – ETHANOL AND ETHANOIC ACID | § 4.4.1 Properties of Ethanol **[5]**

Answer the following about ethyne and ethanol.

(a) Write the molecular formula of ethyne and draw its electron dot structure.

(b) Write chemical equation to show the reaction of ethanol with (i) Sodium metal (ii) Ethanoic acid (in the presence of an acid) (iii) Acidified potassium dichromate. Write the name of the product formed in each case.

Previously asked in: 2025 31/5/1 Q34 (B)

◆ **Carbon and its Compounds** | Chemical properties of ethanol – reactions with sodium, ethanoic acid, and acidified potassium dichromate | Ethyne – molecular formula and electron dot structure

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Model Answer

(a) Molecular formula of ethyne: **C_2H_2**

Electron dot structure of ethyne:

$$H : C ::: C : H$$

(Each carbon shares 3 pairs of electrons with the other carbon — a triple bond — and 1 pair with hydrogen.)

(b) Reactions of ethanol:

(i) With Sodium metal:

$$2Na + 2CH_3CH_2OH \rightarrow 2CH_3CH_2O^-Na^+ + H_2 \uparrow$$

Product: Sodium ethoxide and hydrogen gas.

(ii) With Ethanoic acid (acid as catalyst) — Esterification:

$$CH_3CH_2OH + CH_3COOH \underset{\Delta}{\overset{H^+}{\rightleftharpoons}} CH_3COOC_2H_5 + H_2O$$

Product: Ethyl ethanoate (an ester) and water.

(iii) With Acidified Potassium Dichromate:

$$CH_3CH_2OH \xrightarrow{\text{Acidified } K_2Cr_2O_7} CH_3COOH$$

Product: Ethanoic acid (acetic acid). This is an oxidation reaction.

Source: Chapter 4, Section 4.4.1 (Reactions of Ethanol); Section 4.3.2 (Oxidation)

Explanation

- **(a):** Ethyne (C_2H_2) has a **triple bond** between the two carbons. In the electron dot structure, show 3 pairs of shared electrons (6 dots) between C atoms and 1 pair between each C and H. Examiners specifically check for the triple bond representation.
- **(b)(i):** The equation is directly from the textbook — memorise it exactly, including sodium ethoxide as the named product.
- **(b)(ii):** Esterification is the reaction between an alcohol and a carboxylic acid in the presence of an acid catalyst (conc. H_2SO_4), producing an ester. The product name (ethyl ethanoate) must be written.

- **(b)(iii):** Acidified $K_2Cr_2O_7$ acts as an **oxidising agent**, converting ethanol → ethanoic acid. The textbook confirms this is an oxidation reaction. Writing "oxidising agent" earns an extra mark.

Q42. § 4.2.5 Nomenclature of Carbon Compounds **[5]**

Answer the following about carbon compounds.

(a) What is meant by the term homologous series of carbon compounds? Write molecular formula of any two consecutive members of homologous series of ketones.

(b) Write chemical equation of the reactions of ethanoic acid with (i) Sodium hydroxide and (ii) Ethanol (in the presence of an acid); giving the name of the products in each case.

(c) Draw the structure of the molecule of benzene.

Previously asked in: 2025 31/5/1 Q34 (A)

♦ Carbon and its Compounds | Chemical Properties of Ethanoic Acid – Reactions with NaOH and Ethanol (Esterification) | Homologous Series | Structure of Benzene

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Model Answer

(a) A homologous series is a series of carbon compounds having the same functional group and similar chemical properties, where successive members differ by a $-CH_2$ unit (14 mass units).

Two consecutive members of the homologous series of **ketones**:

- Propanone: CH_3COCH_3
- Butanone: $CH_3COC_2H_5$

(b)

(i) Ethanoic acid + Sodium hydroxide:

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

Products: **Sodium ethanoate** and **water**

(ii) Ethanoic acid + Ethanol (in presence of acid catalyst):

$$CH_3COOH + C_2H_5OH \xrightarrow{H^+} CH_3COOC_2H_5 + H_2O$$

Products: **Ethyl ethanoate (ester)** and **water**

(c) Structure of benzene (C_6H_6):

```
H H
\ /
H—C C—H
‖ ‖
H—C C—H
\ /
C=C
```

Benzene is a cyclic compound with alternating single and double bonds between six carbon atoms, each bonded to one hydrogen atom.

Source: Chapter 4 — Carbon and its Compounds

Explanation

- **(a)** Examiners want the definition to include: same functional group, similar properties, differ by $-CH_2$/14u. For ketones, the functional group is C=O between two carbon atoms; propanone (3C) and butanone (4C) are the simplest consecutive pair.

- **(b)** Both equations must be balanced with correct formulae. Always name the products — easy marks. The esterification reaction requires mentioning the acid catalyst (H^+).
- **(c)** A clean hexagonal ring with alternating double bonds is expected. Label all H atoms for full marks. Benzene's structure is a standard diagram to memorise.

Q43. § 4.2.5 Nomenclature of Carbon Compounds | § 4.3.1 Combustion | § 4.3.4 Substitution Reaction **[5]**

A neutral organic compound X (molecular formula C_2H_6O) on reacting with acidified $K_2Cr_2O_7$ forms another organic compound Y whose nature is acidic. X and Y on heating in the presence of conc. H_2SO_4 give a sweet smelling compound Z.

(i) Identify X, Y and Z.

(ii) Write the chemical equations for the reactions in the conversion of (1) X to Y and (2) X to Z.

(iii) State the role of (1) acidified $K_2Cr_2O_7$ in the conversion of X to Y and (2) conc. H_2SO_4 in the reaction of X and Y.

(iv) Name the reaction which occurs when Z reacts with an alkali.

Previously asked in: 2023 31/5/1 Q34 (a)

◆ **Carbon and its Compounds** | Esterification and saponification reactions | Ethanoic acid – properties and esterification reaction | Ethanol (C_2H_5OH) – properties and oxidation to ethanoic acid | Role of acidified $K_2Cr_2O_7$ as an oxidising agent | Role of conc. H_2SO_4 as a dehydrating/catalyst agent in esterification

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Model Answer

(i) Identification:

- X = **Ethanol** (C_2H_5OH) — neutral alcohol
- Y = **Ethanoic acid** (CH_3COOH) — acidic compound
- Z = **Ethyl ethanoate** ($CH_3COOC_2H_5$) — sweet-smelling ester

(ii) Chemical equations:

(1) X to Y (Oxidation):

$$CH_3CH_2OH \xrightarrow{\text{acidified } K_2Cr_2O_7} CH_3COOH$$

(2) X to Z (Esterification):

$$CH_3COOH + C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4, \Delta} CH_3COOC_2H_5 + H_2O$$

(iii) Roles:

(1) Acidified $K_2Cr_2O_7$ acts as an **oxidising agent** — it oxidises ethanol to ethanoic acid.

(2) Conc. H_2SO_4 acts as a **dehydrating agent / catalyst** — it removes water and drives the esterification forward.

(iv) The reaction of ester Z with an alkali is called **Saponification** (alkaline hydrolysis of ester).

Source: Carbon and its Compounds, sections 4.2.3, 4.2.5

Explanation

- The key chain: ethanol → (oxidation) → ethanoic acid → (esterification with ethanol) → ethyl ethanoate.
- CBSE expects the **role** words: "oxidising agent" and "dehydrating agent/catalyst" — one word each earns the mark.
- "Saponification" is the specific term examiners look for in (iv); writing only "hydrolysis" may lose the mark.
- Balance equations properly; the esterification arrow must show conc. H_2SO_4 and heat (Δ) as conditions, not reactants.

Q44. § 4.3.3 Addition Reaction **[1]**

Assertion (A) : Some vegetable oils are healthy.
Reason (R) : Vegetable oils generally have long unsaturated carbon chains.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2024 31/5/1 Q17

◆ Carbon and its Compounds | Properties and Health Effects of Oils and Fats | Saturated and Unsaturated Carbon Compounds

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Model Answer

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

Explanation

The textbook directly states that vegetable oils have long **unsaturated** carbon chains, and oils containing unsaturated fatty acids are healthier than saturated animal fats. Thus, R correctly explains A. Source: Chapter 4, Section 4.3.3.

Q45. § 4.3.4 Substitution Reaction **[3]**

Why is the conversion of ethanol to ethanoic acid an oxidation reaction ? Name the oxidising agent used in this conversion. Write chemical equation for this oxidation reaction. How is this reaction different from the reaction in which ethanol burns in the presence of oxygen ?

Previously asked in: 2024 31/4/1 Q28

◆ Carbon and its Compounds | Difference between controlled oxidation and combustion of ethanol | Oxidation of Ethanol to Ethanoic Acid

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Model Answer

Oxidation: In the conversion of ethanol (C_2H_5OH) to ethanoic acid (CH_3COOH), oxygen is added to ethanol. Since the reaction involves addition of oxygen to the starting material, it is called an oxidation reaction.

Oxidising agent: Alkaline potassium permanganate ($KMnO_4$) or acidified potassium dichromate ($K_2Cr_2O_7$).

Chemical equation:

$$CH_3CH_2OH \xrightarrow{[O]\ \text{Alkaline } KMnO_4} CH_3COOH$$

Difference from burning: When ethanol burns in oxygen, it undergoes *complete* oxidation producing CO_2 and water with release of energy. The oxidation of ethanol to ethanoic acid is *controlled/partial* oxidation where ethanol is converted to a carboxylic acid, not CO_2 and water.

Source: Chapter 4, Section 4.3.2 Oxidation

Explanation

- Examiners expect three distinct parts: reason for oxidation, name of oxidising agent, balanced/arrow equation, and the difference from combustion.
- "Addition of oxygen = oxidation" is the key concept from Section 4.3.2.
- Both oxidising agents ($KMnO_4$ and $K_2Cr_2O_7$) are acceptable; mention either or both.
- The key difference: combustion is **complete** oxidation → CO_2 + H_2O; this reaction is **partial/controlled** oxidation → CH_3COOH.

Q46. § 4.2.5 Nomenclature of Carbon Compounds | § 4.4.1 Properties of Ethanol **[4]**

> Alcohol forms a homologous series with general formula C_nH_{2n+1}–OH and –OH group as functional group. Ethanol is commonly called alcohol and is used in alcoholic drinks. It is good solvent, used in medicines, cough syrups, tonics etc.

Answer the following questions based on the passage:

(a) Write structural formula and name of 4th member of alcohol homologous series. [1]

(b) What happens when ethanol is heated with alkaline $KMnO_4$? Write chemical equation involved. [1]

(c) Write the chemical equation of reaction of ethanol with ethanoic acid in the presence of concentrated H_2SO_4. Write the name of this reaction. [2]

Previously asked in: 2026 31/5/1 Q28

◆ **Carbon and its Compounds** | Esterification reaction – ethanol and ethanoic acid with conc. H_2SO_4 | Homologous series of alcohols – general formula and members | Oxidation of ethanol with alkaline $KMnO_4$

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Model Answer

(a) The 4th member of the alcohol homologous series (n = 4) is **Butan-1-ol**.

Structural formula: $CH_3–CH_2–CH_2–CH_2–OH$

(b) When ethanol is heated with alkaline $KMnO_4$, it gets **oxidised to ethanoic acid**.

$$CH_3CH_2OH \xrightarrow{\text{alk. } KMnO_4/\Delta} CH_3COOH$$

Alkaline $KMnO_4$ acts as an oxidising agent.

(c) When ethanol reacts with ethanoic acid in the presence of conc. H_2SO_4, **esterification** reaction takes place:

$$CH_3COOH + C_2H_5OH \overset{\text{conc. } H_2SO_4}{\underset{\Delta}{\rightleftharpoons}} CH_3COOC_2H_5 + H_2O$$

The product **ethyl ethanoate** is an ester with a sweet fruity smell.

Source: Carbon and its Compounds, Ethanol and its reactions

Explanation

- **(a)** Apply general formula $C_nH_{2n+1}OH$ with n=4 → C_4H_9OH = Butan-1-ol. Write the full structural formula, not just the molecular formula.
- **(b)** Key point: alkaline $KMnO_4$ is an **oxidising agent**; it oxidises alcohols to carboxylic acids. Examiners expect the equation.
- **(c)** Award 1 mark for the correct balanced equation and 1 mark for naming it **esterification**. Note the reversible arrow (⇌) and conc. H_2SO_4 as catalyst above the arrow — both are important.

Q47. § 4.4.2 Properties of Ethanoic Acid **[1]**

Assertion (A) : Pure ethanoic acid is also known as glacial acetic acid.
Reason (R) : Pure ethanoic acid often freezes during winter due to its low melting point of 290 K.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2026 31/4/1 Q24

◆ Carbon and its Compounds | Ethanol and Ethanoic Acid (Properties)

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Model Answer

(C) Assertion (A) is true, but Reason (R) is false.

Assertion is correct. Reason is false because 290 K is a *high* melting point (not low), which causes pure ethanoic acid to freeze in winter, giving it the name glacial acetic acid.

Explanation

The textbook states the melting point of pure ethanoic acid is 290 K and that it *often freezes during winter*, which is why it is called glacial acetic acid — so the Assertion is true. However, the Reason calls 290 K a "low melting point," which is incorrect; 290 K (≈17°C) is relatively high for an organic liquid, and it is this comparatively high melting point that causes freezing in cold climates. Since the Reason contains a factual error, option (C) is correct.

Q48. § 4.2.1 Saturated and Unsaturated Carbon Compounds | § 4.3 CHEMICAL PROPERTIES OF CARBON COMPOUNDS | § 4.3.4 Substitution Reaction **[5]**

Answer the following:

(i) Name the compound formed when ethanol is heated at 443 K in the presence of conc.H_2SO_4 and draw its electron dot structure. State the role of conc.H_2SO_4 in this reaction.

(ii) What is hydrogenation ? Explain it with the help of a chemical equation. State the role of this reaction in industry.

Previously asked in: 2023 31/6/1 Q34(b)

◆ **Carbon and its Compounds** | Dehydration of Ethanol – Formation of Ethene using conc. H_2SO_4 at 443 K | Hydrogenation of Unsaturated Compounds and its Industrial Role

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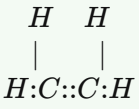
Model Answer

(i) When ethanol is heated at 443 K with conc. H_2SO_4, **ethene (C_2H_4)** is formed by dehydration.

$$C_2H_5OH \xrightarrow{443K,\ \text{conc. } H_2SO_4} CH_2{=}CH_2 + H_2O$$

Electron dot structure of ethene:

$H : C :: C : H$ (each C shares 4 electrons; C=C double bond)



(Two shared pairs between carbon atoms = double bond; each carbon also bonded to two H atoms.)

Role of conc. H_2SO_4: It acts as a **dehydrating agent**, removing water from ethanol to form ethene.

(ii) Hydrogenation is the addition of hydrogen to an unsaturated hydrocarbon (alkene or alkyne) in the presence of a **catalyst (Ni, Pd, or Pt)** to form a saturated compound.

Chemical equation:

$$CH_2{=}CH_2 + H_2 \xrightarrow{\text{Ni, catalyst}} CH_3{-}CH_3$$

(Ethene → Ethane)

Industrial role: Hydrogenation is used to convert **vegetable oils (unsaturated)** into **vanaspati ghee (solid fat/saturated)** by adding hydrogen in the presence of a nickel catalyst. This increases the shelf life and changes the physical state of the oil.

Source: Carbon and its Compounds, Chapter 4

Explanation

- For (i), the key facts are: product = ethene, reaction = dehydration, H_2SO_4 = dehydrating agent. Draw the electron dot structure showing C::C (double bond = two shared electron pairs) with H atoms on each carbon. Don't write just "catalyst" — specify "dehydrating agent."
- For (ii), the textbook exercise (Q12) directly asks this. Always name the catalyst (Ni/Pd/Pt), write a balanced equation, and state the industrial application (vegetable oil → vanaspati). These are the three expected scoring points.

Q49. § 4.1 BONDING IN CARBON – THE COVALENT BOND **[1]**

Assertion (A) : Melting point and boiling point of ethanol are lower than that of sodium chloride.
Reason (R) : The forces of attraction between the molecules of ionic compounds are very strong.

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of (A).
(b) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

Previously asked in: 2023 31/6/1 Q20

◆ Carbon and its Compounds | Ethanol – physical properties | Properties of covalent compounds vs ionic compounds – melting and boiling points

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Model Answer

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of (A).

Ethanol is a covalent compound with weak intermolecular forces, giving it low melting and boiling points. Ionic compounds like NaCl have very strong inter-ionic forces, hence high melting and boiling points.

Explanation

The textbook states: "Covalently bonded molecules have strong bonds within the molecule, but inter-molecular forces are weak — giving rise to low melting and boiling points." Ionic compounds (NaCl) have strong electrostatic forces between ions, so their melting/boiling points are much higher. The Reason directly explains why the Assertion is true, making option (a) correct.

Q50. § 4.2.5 Nomenclature of Carbon Compounds | § 4.3.1 Combustion | § 4.3.4 Substitution Reaction **[5]**

A saturated organic compound 'A' belongs to the homologous series of alcohols. On heating 'A' with concentrated sulphuric acid at 443 K, it forms an unsaturated compound 'B' with molecular mass 28 u. The compound 'B' on addition of one mole of hydrogen in the presence of Nickel, changes to a saturated hydrocarbon 'C'.

(i) Identify A, B and C.

(ii) Write the chemical equations showing the conversion of A into B.

(iii) What happens when compound C undergoes combustion ?

(iv) State one industrial application of hydrogenation reaction.

(v) Name the products formed when compound A reacts with sodium.

Previously asked in: 2023 31/1/1 Q34(a)

◆ **Carbon and its Compounds** | Alcohols – identification and properties | Combustion of hydrocarbons | Dehydration of alcohols with concentrated H_2SO_4 | Hydrogenation of unsaturated hydrocarbons | Industrial application of hydrogenation

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Model Answer

(i) Identification:

- **A** = Ethanol (C_2H_5OH) — a saturated alcohol
- **B** = Ethene (C_2H_4) — molecular mass = 2(12) + 4(1) = **28 u ✓** (unsaturated)
- **C** = Ethane (C_2H_6) — saturated hydrocarbon

(ii) Conversion of A into B (dehydration):

$$C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4,\ 443\ K} CH_2{=}CH_2 + H_2O$$

(iii) Combustion of C (Ethane):

Ethane burns in air/oxygen to form carbon dioxide and water, releasing heat and light:

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O + \text{heat and light}$$

(iv) Industrial application of hydrogenation:

Hydrogenation is used to convert vegetable oils (unsaturated) into vanaspati ghee (solid fat) using a nickel catalyst.

(v) Reaction of Ethanol with Sodium:

When ethanol reacts with sodium, sodium ethoxide and hydrogen gas are produced:

$$2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2\uparrow$$

Products: **Sodium ethoxide** and **hydrogen gas**.

Source: Chapter 4, Sections 4.3.3, 4.2.4

Explanation

- **Key logic for A:** Molecular mass of B = 28 u → C_2H_4 (ethene). Since B forms by dehydration of an alcohol A, A must be ethanol (C_2H_5OH).
- Examiners expect **balanced equations** with conditions (conc. H_2SO_4, 443 K) for part (ii) — don't skip these.
- For combustion (iii), write a **balanced equation**; saying "CO_2 and H_2O are formed" without the equation loses marks.
- The hydrogenation application (iv) — **vegetable oil → vanaspati** — is the standard textbook answer; always mention the Ni catalyst.
- For part (v), name both products clearly: **sodium ethoxide + hydrogen gas**.

Q51. § 4.2.3 Will you be my Friend? § 4.2.5 Nomenclature of Carbon Compounds **[5]**

Answer the following :

(i) Name a commercially important carbon compound having functional group –OH and write its molecular formula.

(ii) Write chemical equation to show its reaction with (1) Sodium metal (2) Excess conc. sulphuric acid (3) Ethanoic acid in the presence of an acid catalyst (4) Acidified potassium dichromate. Also write the name of the product formed in each case.

Previously asked in: 2024 31/2/1 Q34(b)

◆ **Carbon and its Compounds** | Esterification reaction | Ethanol – properties, reactions and uses | Functional group – hydroxyl (–OH) / Alcohols | Oxidation of ethanol using acidified potassium dichromate

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Model Answer

(i) Ethanol is a commercially important carbon compound with the functional group –OH.
Molecular formula: **C_2H_5OH**

(ii) Chemical equations:

(1) Reaction with Sodium metal:

$$2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2\uparrow$$

Product: Sodium ethoxide + Hydrogen gas

(2) Reaction with Excess conc. H_2SO_4 (at 170°C):

$$C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4,\ 170^\circ C} CH_2 = CH_2 + H_2O$$

Product: Ethene (dehydration)

(3) Reaction with Ethanoic acid (esterification):

$$C_2H_5OH + CH_3COOH \xrightarrow{H^+} CH_3COOC_2H_5 + H_2O$$

Product: Ethyl ethanoate (an ester) — sweet-smelling compound

(4) Reaction with Acidified Potassium Dichromate (oxidation):

$$C_2H_5OH \xrightarrow{\text{acidified } K_2Cr_2O_7} CH_3COOH$$

Product: Ethanoic acid
(Oxidising agent turns from orange to green — this is an oxidation reaction.)

Explanation

- The examiner expects ethanol as the answer to (i) since it is the most commercially important alcohol (–OH group) covered in the chapter.
- For (ii), all four reactions must be written with balanced equations and product names — each reaction carries roughly 1 mark.
- Key points: Na reaction releases H_2; excess H_2SO_4 at 170°C causes dehydration (gives alkene); esterification gives sweet-smelling ester; acidified $K_2Cr_2O_4$ is an oxidising agent that converts alcohol → carboxylic acid (colour change orange → green is a bonus point).
- Do not confuse excess H_2SO_4 at 170°C (dehydration → ethene) with H_2SO_4 at 140°C (gives diethyl ether).

Q52. § 4.2.5 Nomenclature of Carbon Compounds | § 4.3 CHEMICAL PROPERTIES OF CARBON COMPOUNDS | § 4.3.1 Combustion **[5]**

Answer the following :

(i) Write the name and structure of an organic compound 'X' having two carbon atoms in its molecule and its name is suffixed with '–ol'.

(ii) What happens when 'X' is heated with excess concentrated sulphuric acid at 443 K? Write chemical equation for the reaction stating the conditions for the reaction. Also state the role played by concentrated sulphuric acid in the reaction.

(iii) Name and draw the electron dot structure of hydrocarbon produced in the above reaction.

Previously asked in: 2024 31/1/1 Q34(B)

♦ **Carbon and its Compounds** | Dehydration of alcohols – role of concentrated H_2SO_4 as dehydrating agent | Electron dot structure of ethene (alkene) | Ethanol (structure, properties and reactions)

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Model Answer

(i) Compound X is **Ethanol** (C_2H_5OH).

Structure:

(Full structural formula: $CH_3–CH_2–OH$, with each carbon having appropriate H atoms)

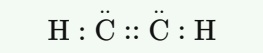
(ii) When ethanol is heated with excess concentrated H_2SO_4 at 443 K, **dehydration** occurs and **ethene** is produced.

$$CH_3CH_2OH \xrightarrow{\text{conc. } H_2SO_4,\ 443\ K} CH_2{=}CH_2 + H_2O$$

Role of conc. H_2SO_4: It acts as a **dehydrating agent** — it removes water from ethanol to form ethene.

(iii) The hydrocarbon produced is **Ethene** (C_2H_4). It is an unsaturated hydrocarbon (alkene).

Electron dot structure of ethene:



Each carbon shares a double bond (4 electrons) with the other carbon and a single bond with each hydrogen atom.

Explanation

- **(i)** Two-carbon compound with '–ol' suffix → ethanol. Always draw the full structural formula showing C–O–H.
- **(ii)** The key terms are: excess H_2SO_4, 443 K, dehydration, and ethene as product. Examiners specifically check the role of H_2SO_4 as a dehydrating agent.
- **(iii)** Ethene has a C=C double bond, making it unsaturated. In the electron dot structure, the double bond is shown as four shared electrons (two pairs) between the two carbon atoms. Examiners look for the correct representation of the double bond and all lone pairs/bonding pairs.

Q53. § 4.3.4 Substitution Reaction | § 4.4 SOME IMPORTANT CARBON COMPOUNDS – ETHANOL AND ETHANOIC ACID **[5]**

Carry out the following conversions, stating the condition(s) for each :

(i) Ethanol → Ethene

(ii) Ethene → Ethane

(iii) Ethane → Chloroethane

(iv) Ethanol → Ethanoic acid

(v) Ethanoic acid → Ethyl ethanoate

Previously asked in: 2023 31/5/1 Q34 (b)

◆ Carbon and its Compounds | Dehydration of Ethanol to Ethene | Esterification: Ethanoic Acid to Ethyl Ethanoate | Halogenation of Ethane to Chloroethane | Hydrogenation of Ethene to Ethane | Interconversion of Carbon Compounds (Ethanol, Ethene, Ethane, Ethanoic acid, Ethyl ethanoate) | Oxidation of Ethanol to Ethanoic Acid

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Model Answer

(i) Ethanol → Ethene

$$CH_3CH_2OH \xrightarrow{\text{conc. } H_2SO_4,\ 443\ K} CH_2 = CH_2 + H_2O$$

Condition: Excess conc. H2SO4 at 443 K (dehydration).

(ii) Ethene → Ethane

$$CH_2 = CH_2 + H_2 \xrightarrow{\text{Ni, heat}} CH_3CH_3$$

Condition: Hydrogen gas in presence of Ni catalyst and heat (hydrogenation / addition reaction).

(iii) Ethane → Chloroethane

$$CH_3CH_3 + Cl_2 \xrightarrow{\text{sunlight}} CH_3CH_2Cl + HCl$$

Condition: Presence of sunlight (substitution reaction).

(iv) Ethanol → Ethanoic acid

$$CH_3CH_2OH \xrightarrow{\text{alkaline } KMnO_4 \text{ or acidified } K_2Cr_2O_7} CH_3COOH$$

Condition: Oxidation using alkaline KMnO4 or acidified K2Cr2O7.

(v) Ethanoic acid → Ethyl ethanoate

$$CH_3COOH + C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4,\ \Delta} CH_3COOC_2H_5 + H_2O$$

Condition: Conc. H2SO4 as catalyst and heat (esterification reaction).

Source: Chapter 4, Sections 4.3.2, 4.3.3, 4.3.4

Explanation

- Each conversion must have: **balanced equation + condition** — both are needed for full marks.
- (i) is **dehydration** (elimination); (ii) is **addition/hydrogenation**; (iii) is **substitution** (sunlight is the key condition); (iv) is **oxidation** — either oxidising agent is acceptable; (v) is **esterification** — the product is an ester

and the reaction is reversible (shown by ⇌ in some texts).

- Examiners award 1 mark per conversion, split between the equation and the stated condition. Missing the condition loses the mark even if the equation is correct.

Q54. § 4.3 CHEMICAL PROPERTIES OF CARBON COMPOUNDS | § 4.3.2 Oxidation | § 4.4.1 Properties of Ethanol **[5]**

Answer the following :

(i) A carbon compound X is a good solvent. On reaction with sodium, X forms two products Y and Z. Z is used to convert vegetable oil into vegetable ghee. Identify and name X, Y and Z. Also write the equation of reaction of X with sodium to justify your answer. [3]

(ii) Write chemical equation to show what happens when ethanol : (I) burns in oxygen/air. (II) is heated at 443 K in excess conc. H_2SO_4. (III) reacts with acidified potassium dichromate. [2]

Previously asked in: 2025 31/1/1 Q34(b)

◆ Carbon and its Compounds | Combustion of ethanol | Dehydration of ethanol (elimination reaction with conc. H_2SO_4) | Identification of carbon compounds (ethanol as solvent reacting with sodium) | Oxidation of ethanol using acidified potassium dichromate

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Model Answer

(i)

- **X** = Ethanol (C_2H_5OH) — a good solvent
- **Y** = Sodium ethoxide (C_2H_5ONa)
- **Z** = Hydrogen gas (H_2) — used in hydrogenation of vegetable oil to make vegetable ghee

Reaction of X with sodium:

$$2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2\uparrow$$

(ii)

(I) Combustion of ethanol:

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O + \text{heat and light}$$

(II) Dehydration at 443 K with excess conc. H_2SO_4:

$$C_2H_5OH \xrightarrow{443\text{K, conc. } H_2SO_4} CH_2 = CH_2\uparrow + H_2O$$

(Ethanol → Ethene + Water)

(III) Reaction with acidified potassium dichromate (oxidation):

$$C_2H_5OH \xrightarrow{K_2Cr_2O_7/H^+} CH_3COOH$$

(Ethanol is oxidised to ethanoic acid; orange dichromate turns green.)

Explanation

- **Part (i):** The key clue is "Z converts vegetable oil to ghee" → Z = H_2 (hydrogenation). Since H_2 is produced with sodium, X must be an alcohol. As a "good solvent," X is ethanol. Y is sodium ethoxide (the sodium salt of ethanol).
- **Part (ii):** Examiners expect **balanced** equations. For combustion: $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$. For dehydration: excess H_2SO_4 at 443 K gives ethene (elimination). For oxidation with acidified $K_2Cr_2O_7$: ethanol → ethanoic acid (colour change from orange to green is a bonus point). Write product names alongside formulae for clarity.

Q55. § 4.3 CHEMICAL PROPERTIES OF CARBON COMPOUNDS | § 4.3.1 Combustion **[5]**

Attempt either (a) or (b) :
(a) A carbon compound 'P' of molecular formula C_2H_6O is found to be neutral when tested with red and blue litmus. A gas that burns with a pop sound is produced when sodium metal reacts with compound 'P'.
(i) Identify the compound 'P'.
(ii) The carbon compound 'P' is heated with conc. H_2SO_4 at 443 K to produce compound 'Q'.
(I) Write the chemical equation for the reaction.
(II) What is the role of conc. H_2SO_4 in this reaction ?
(iii) What is likely to be observed on heating compound 'P' with ethanoic acid with an acid as a catalyst ? Write the chemical equation for the reaction.

Previously asked in: 2026 31/2/1 Q29 (a)

◆ **Carbon and its Compounds** | Dehydration of ethanol with conc. H_2SO_4 at 443 K to form ethene | Esterification – reaction of ethanol with ethanoic acid | Identification of ethanol (C_2H_6O) from properties – neutral nature and reaction with sodium

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Model Answer

(i) Compound 'P' is **ethanol (C_2H_5OH)**. It is neutral to litmus and reacts with sodium to produce hydrogen gas (pop sound):

$$2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2\uparrow$$

(ii)
(I) When ethanol is heated with conc. H_2SO_4 at 443 K, it undergoes dehydration to form compound 'Q' — **ethene (C_2H_4)**:

$$C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4,\ 443K} CH_2 = CH_2 + H_2O$$

(II) Conc. H_2SO_4 acts as a **dehydrating agent** — it removes water from ethanol to produce ethene.

(iii) A fruity-smelling ester (**ethyl ethanoate**) will be formed. This reaction is called **esterification**.

$$C_2H_5OH + CH_3COOH \underset{\Delta}{\overset{\text{conc. } H_2SO_4}{\rightleftharpoons}} CH_3COOC_2H_5 + H_2O$$

Source: Chapter 4, Section 4.4 — Some Important Carbon Compounds: Ethanol and Ethanoic Acid

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Explanation

- **Identification** of P is straightforward: C_2H_6O neutral to litmus = ethanol (not an acid/base); reacts with Na to give H_2 (pop sound). Methanol also fits formula but ethanol is the standard NCERT example.
- **Dehydration at 443 K** is a key fact: conc. H_2SO_4 as dehydrating agent → ethene. Write the balanced equation with conditions above the arrow.
- **Esterification**: heating alcohol + carboxylic acid with acid catalyst gives ester + water. The reaction is reversible (⇌). Examiners expect the fruity smell observation and the correct equation. Remember ethyl ethanoate = $CH_3COOC_2H_5$.
- Mark split is roughly: (i) 1 mark, (ii) 2 marks, (iii) 2 marks — match detail to marks.

Q56. § 4.2.5 Nomenclature of Carbon Compounds | § 4.3.1 Combustion **[5]**

Answer the following:

(i) A compound 'A' with a molecular formula of $C_2H_4O_2$ reacts with a base to give salt and water. Identify 'A', state its nature and the name of the functional group it possesses. Write chemical equation for the reaction involved.

(ii) When the above stated compound 'A' reacts with another compound 'B' having molecular formula C_2H_6O in the presence of an acid, a sweet smelling compound 'C' is formed. (1) Identify 'B' and 'C'. (2) State the role of acid in this reaction. (3) Write chemical equation for the reaction involved.

Previously asked in: 2023 31/6/1 Q34(a)

◆ **Carbon and its Compounds** | Acetic acid (Ethanoic acid) – properties and reactions with bases | Esterification reaction – reaction of carboxylic acid with alcohol in presence of acid catalyst

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Model Answer

(i)
Compound **A** = **Ethanoic acid (CH_3COOH)**
Nature: It is a weak organic acid.
Functional group: **Carboxyl group (–COOH)**

Reaction with a base (e.g., NaOH):

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$

(Sodium ethanoate + Water)

(ii)
(1) Compound **B** = **Ethanol (C_2H_5OH)**
Compound **C** = **Ethyl ethanoate / Ethyl acetate ($CH_3COOC_2H_5$)** — a sweet-smelling ester.

(2) The acid (concentrated H_2SO_4) acts as a **catalyst**; it speeds up the esterification reaction without being consumed.

(3) Chemical equation:

$$CH_3COOH + C_2H_5OH \underset{\Delta}{\overset{\text{conc. } H_2SO_4}{\rightleftharpoons}} CH_3COOC_2H_5 + H_2O$$

This reaction is called **esterification**.

Source: Chapter 4, Carbon and its Compounds

Explanation

- Molecular formula $C_2H_4O_2$ with acid properties → ethanoic acid (acetic acid); students must recognise the –COOH functional group.
- C_2H_6O is ethanol; together with ethanoic acid it undergoes esterification to give ethyl ethanoate (sweet smell is the key clue).
- Examiners expect: correct identification, nature, functional group name, role of acid as catalyst, and balanced equations with correct conditions (conc. H_2SO_4, heat, reversible arrow).
- The reversible arrow (⇌) is important — esterification is a reversible reaction.

Q57. § 4.2.5 Nomenclature of Carbon Compounds | § 4.4 SOME IMPORTANT CARBON COMPOUNDS – ETHANOL AND ETHANOIC ACID **[5]**

A carbon compound 'A' is widely used as a preservative in pickles and has a molecular formula $C_2H_4O_2$. This compound reacts with ethanol to form a sweet smelling compound 'B'.

(i) Identify the compound 'A' and write its structure.

(ii) Write the chemical equation for the reaction of 'A' with ethanol to form compound 'B'. State the role of presence of an acid in the reaction.

(iii) How can we get compound 'A' back from 'B' ?

(iv) How can 'A' be obtained from ethanol ?

(v) Name the gas produced when compound 'A' reacts with washing soda.

Previously asked in: 2025 31/4/1 Q34(B)

◆ **Carbon and its Compounds** | Acetic acid (Ethanoic acid) – identification and properties | Esterification reaction and the role of acid catalyst | Oxidation of Ethanol to Ethanoic Acid | Reaction of carboxylic acids with carbonates (washing soda) | Saponification / Hydrolysis of esters

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Model Answer

Compound 'A' is Ethanoic acid (CH_3COOH).

(i) Ethanoic acid; molecular formula $C_2H_4O_2$.

Structure:

$$CH_3 - COOH$$

(Carbon–carbon single bond, with —COOH as the carboxylic acid functional group.)

(ii) Chemical equation for esterification:

$$CH_3COOH + C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4, \Delta} CH_3COOC_2H_5 + H_2O$$

Compound 'B' is **ethyl ethanoate** (an ester). Concentrated H_2SO_4 acts as a **catalyst** (and dehydrating agent), speeding up the reaction.

(iii) Compound 'A' (ethanoic acid) can be obtained back from 'B' by **saponification** — heating the ester 'B' with an acid (or alkali) and water (hydrolysis).

(iv) Ethanoic acid is obtained from ethanol by **oxidation**, using an oxidising agent such as alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$.

$$C_2H_5OH \xrightarrow{[O]} CH_3COOH$$

(v) Carbon dioxide (CO_2) gas is produced when ethanoic acid reacts with washing soda (Na_2CO_3).

$$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2 \uparrow$$

Source: Chapter 4, Section 4.4 — Some Important Carbon Compounds: Ethanol and Ethanoic Acid

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Explanation

- **Identify A first** — $C_2H_4O_2$ with carboxylic acid group and used as preservative = ethanoic acid (acetic acid). Full marks depend on this.
- **(ii)** Always write the **catalyst (conc. H_2SO_4)** and **heat (Δ)** above the arrow; state its role as catalyst.
- **(iii)** "Hydrolysis" or "saponification" is the key term; just reversing the esterification reaction.
- **(iv)** Oxidation of ethanol → ethanoic acid; name the oxidising agent for full credit.
- **(v)** CO_2 gas is the answer; writing the equation earns the mark neatly. The effervescence of CO_2 proves ethanoic acid is a weak acid that still reacts with carbonates.

Q58. § 4.3.1 Combustion **[5]**

A carbon compound 'A' on heating with excess conc. H_2SO_4 forms a compound 'B', which on addition of one mole of hydrogen gas in the presence of nickel catalyst forms a compound 'C'. 'C' on combustion in air forms 2 moles of carbon dioxide and 3 moles of water. Identify 'A', 'B' and 'C' and write their structures. Give chemical equations of the reactions involved. Also state the role of concentrated sulphuric acid in the formation of 'B' from 'A'.

Previously asked in: 2025 31/4/1 Q34(A)

◆ **Carbon and its Compounds** | Combustion of carbon compounds | Dehydration of alcohols using conc. H_2SO_4 | Hydrogenation of unsaturated carbon compounds | Role of conc. H_2SO_4 as a dehydrating agent

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Model Answer

Identification:

Combustion of C gives $2CO_2$ and $3H_2O$ → C has 2 carbon and 6 hydrogen atoms → **C = Ethane (C_2H_6)**.
C + H_2 → B, so **B = Ethene (C_2H_4)** and **A = Ethanol (C_2H_5OH)**.

Structures:

- A (Ethanol): $CH_3–CH_2–OH$
- B (Ethene): $CH_2=CH_2$
- C (Ethane): $CH_3–CH_3$

Chemical Equations:

1. **A → B** (Dehydration):

$$CH_3CH_2OH \xrightarrow{\text{conc. } H_2SO_4, \Delta} CH_2=CH_2 + H_2O$$

1. **B → C** (Hydrogenation):

$$CH_2=CH_2 + H_2 \xrightarrow{Ni} CH_3CH_3$$

1. **Combustion of C:**

$$2CH_3CH_3 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

(1 mole gives $2CO_2$ + $3H_2O$ ✓)

Role of conc. H_2SO_4: It acts as a **dehydrating agent**, removing water from ethanol to form ethene. It also acts as a catalyst in the reaction.

Source: Chapter 4, Section 4.3

Explanation

- Work **backwards** from combustion data: $2CO_2$ → 2C atoms; $3H_2O$ → 6H atoms → C is C_2H_6 (ethane).
- C_2H_6 + H_2 (addition) → C is obtained from B, so B = C_2H_4 (ethene, unsaturated).
- Ethene is formed by dehydration of ethanol → A = ethanol (C_2H_5OH).
- Examiners specifically look for: correct identification with justification, all three structures, all three balanced equations, and the role of H_2SO_4 as a dehydrating agent — each carries marks.

Q59. § 4.3.1 Combustion | § 4.4.1 Properties of Ethanol | § 4.4.2 Properties of Ethanoic Acid **[5]**

(B) (i) What happens when a small piece of sodium is dropped in ethanol ? Write the equation for this reaction.
(ii) Why is glacial acetic acid called so ?
(iii) What happens when ethanol is heated at 443 K in the presence of conc. H_2SO_4 ? Write the role of conc. H_2SO_4 in this case.
(iv) Write an equation showing saponification.

Previously asked in: 2023 31/4/1 Q34 (B)

◆ Carbon and its Compounds | Glacial acetic acid | Reactions of ethanol (with sodium, dehydration with conc. H_2SO_4) | Saponification reaction

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Model Answer

(i) When sodium is dropped in ethanol, it reacts vigorously to produce sodium ethoxide and hydrogen gas is evolved.

$$2Na + 2CH_3CH_2OH \rightarrow 2CH_3CH_2O^-Na^+ + H_2 \uparrow$$

(ii) The melting point of pure ethanoic acid is 290 K. Therefore it often freezes (solidifies) during winter in cold climates, giving it an ice-like appearance. This is why it is called **glacial acetic acid**.

(iii) When ethanol is heated at 443 K with excess conc. H_2SO_4, it undergoes **dehydration** to form ethene (an unsaturated hydrocarbon) and water.

$$CH_3CH_2OH \xrightarrow{\text{Hot conc. } H_2SO_4,\ 443K} CH_2{=}CH_2 + H_2O$$

Conc. H_2SO_4 acts as a **dehydrating agent** — it removes water from ethanol.

(iv) Saponification is the hydrolysis of an ester by an alkali (NaOH) to give back alcohol and the sodium salt of the carboxylic acid.

$$CH_3COOC_2H_5 + NaOH \rightarrow C_2H_5OH + CH_3COONa$$

Source: Chapter 4, Sections 4.4.1 and 4.4.2

Explanation

- **(i)** Always write the balanced equation; examiners award 1 mark for the equation and 1 for stating hydrogen is evolved / sodium ethoxide is formed.
- **(ii)** The key fact is the melting point (290 K) causing freezing in winter — state this explicitly.
- **(iii)** Name the reaction (dehydration), write the equation with conditions (443 K, Hot conc. H_2SO_4), and clearly state the role of H_2SO_4 as *dehydrating agent* — all three parts are usually separately marked.
- **(iv)** Write the equation correctly and name the products (alcohol + sodium salt of acid). The term "saponification" must appear as it is the definition trigger word.

Q60. § 4.2.5 Nomenclature of Carbon Compounds | § 4.3.1 Combustion | § 4.3.4 Substitution Reaction **[5]**

(a) An acid X reacts with an alcohol Y in the presence of a catalyst acid to form a substance Z that has a pleasant smell. Identify X, Y and Z. Write the chemical equation for the reaction involved and name it, giving justification for the name. The substance Z on reacting with sodium hydroxide gives back alcohol Y and sodium ethanoate. Write the chemical equation for the reaction involved.

Previously asked in: 2023 31/2/1 Q34 (a)

♦ **Carbon and its Compounds** | Esterification reaction – formation of ester from carboxylic acid and alcohol | Saponification / Hydrolysis of ester with NaOH

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Model Answer

Identification:

- X = Ethanoic acid (CH_3COOH)
- Y = Ethanol (C_2H_5OH)
- Z = Ethyl ethanoate ($CH_3COOC_2H_5$) — an ester with a pleasant smell

Reaction 1 — Esterification:

$$CH_3COOH + C_2H_5OH \overset{\text{Conc. } H_2SO_4}{\underset{\Delta}{\rightleftharpoons}} CH_3COOC_2H_5 + H_2O$$

Name: Esterification reaction.

Justification: When a carboxylic acid reacts with an alcohol in the presence of an acid catalyst, an ester (Z) is formed. Since an ester is the product, the reaction is called esterification.

Reaction 2 — Saponification (hydrolysis of ester with NaOH):

$$CH_3COOC_2H_5 + NaOH \rightarrow CH_3COONa + C_2H_5OH$$

Ethyl ethanoate reacts with sodium hydroxide to give sodium ethanoate and ethanol (alcohol Y is recovered).

Source: Chapter 4 — Carbon and its Compounds, Section 4.4.2 (Ethanoic Acid — Reactions)

Explanation

- **X, Y, Z identification** carries 1 mark — name all three clearly.
- **Esterification equation** carries ~1–1.5 marks — include catalyst (conc. H_2SO_4), heat, and the reversible arrow ($\rightleftharpoons$).
- **Naming + justification** carries ~1 mark — state that ester is formed, hence "esterification."
- **Saponification equation** carries ~1 mark — this reverse reaction is called saponification; the equation must show recovery of ethanol (Y) and formation of sodium ethanoate.
- Do **not** confuse saponification (ester + NaOH) with hydrolysis by water; in board exams always write the NaOH equation here.

Q61. § Introduction | § 4.2.5 Nomenclature of Carbon Compounds | § 4.3.2 Oxidation **[5]**

Answer the following:

(i) A compound 'X' having two carbon atoms in its molecule turns blue litmus red and 5 – 8% solution of 'X' in water is widely used as a preservative. Identify the compound 'X' and write its structure. [1.5]

(ii) Compare its pH nature with a mineral acid. [1]

(iii) 'X' on reacting with alcohols produces sweet smelling compounds, used in making perfumes. Name the reaction and write its chemical equation. [1.5]

(iv) When sodium carbonate is added to 'X', a colourless gas is produced which turns lime water milky. Write the chemical equation for the reaction giving the name of the salt produced. [1]

Previously asked in: 2025 31/2/1 Q34 (a)

◆ **Carbon and its Compounds** | Acetic acid (Ethanoic acid) – structure, properties and uses | Esterification reaction of carboxylic acids with alcohols | Reaction of carboxylic acids with sodium carbonate / carbonates

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Model Answer

(i) Compound 'X' is **Ethanoic acid (CH₃COOH)**.

Structure:

$$CH_3 - COOH$$

(Two carbon atoms: a methyl group attached to a carboxyl group –COOH)

(ii) Ethanoic acid is a **weak acid** — it does not ionise completely in water, so its pH is higher (less acidic) than a mineral acid like HCl or H_2SO_4, which are strong acids and ionise completely, giving a much lower pH.

(iii) The reaction is called **Esterification**. When ethanoic acid reacts with ethanol (in the presence of conc. H_2SO_4), a sweet-smelling ester is formed:

$$CH_3COOH + C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$$

(Ethyl ethanoate is the ester produced.)

(iv) The salt produced is **Sodium ethanoate (CH₃COONa)**. The gas evolved is CO_2.

$$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2 \uparrow$$

Source: Carbon and its Compounds, Sections 4.3.2–4.3.3

Explanation

- **Part (i):** Two clues identify X — two carbon atoms + turns blue litmus red (acidic) + used as preservative (vinegar/acetic acid). Students must write both name and structural formula.
- **Part (ii):** Key distinction: ethanoic acid = weak acid (partial ionisation, higher pH ~3); mineral acids = strong acids (complete ionisation, pH ~1). Do not just say "lower pH" — explain *why*.
- **Part (iii):** Name the reaction ("Esterification") and write a balanced equation with catalyst. Forgetting the catalyst (conc. H_2SO_4) or the product name loses marks.
- **Part (iv):** Examiner looks for the correct salt name **and** balanced equation. CO_2 turning lime water milky is the identification clue given in the question.

Q62. § 4.3.1 Combustion § 4.3.3 Addition Reaction **[5]**

Attempt either (a) or (b) :

(i) Name the following compounds : (I) $CH_3–C(=O)–CH_3$ (II) $H–C\equiv C–H$ [1]

(ii) Name the reaction which is commonly used in the conversion of vegetable oils to fats. [1]

(iii) Why is the melting point of C_4H_{10} higher than C_3H_8 ? [1]

(iv) What happens when a piece of sodium is dropped into ethanol ? [1]

(v) Write the products in the following reaction : $CH_3COOC_2H_5 + NaOH \longrightarrow$ [1]

Previously asked in: 2026 31/3/1 Q29 (b)

◆ Carbon and its Compounds | Effect of Molecular Size on Melting/Boiling Points of Carbon Compounds | Hydrogenation of Vegetable Oils (Addition Reaction) | IUPAC Nomenclature of Carbon Compounds (Ketones and Alkynes) | Reaction of Sodium with Ethanol | Saponification (Hydrolysis of Esters with NaOH)

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Model Answer

(i)

(I) $CH_3–C(=O)–CH_3$ → **Propanone**

(II) $H–C\equiv C–H$ → **Ethyne**

(ii) The reaction commonly used for the conversion of vegetable oils to fats is **Hydrogenation** (addition of hydrogen in the presence of a nickel catalyst).

(iii) C_4H_{10} (butane) has a longer carbon chain and greater molecular mass than C_3H_8 (propane). Greater the molecular mass, stronger the intermolecular forces, and hence higher the melting point.

(iv) When sodium is dropped into ethanol, it reacts vigorously to produce **sodium ethoxide** and **hydrogen gas** is liberated:

$$2Na + 2C_2H_5OH \rightarrow 2C_2H_5ONa + H_2 \uparrow$$

(v)

$$CH_3COOC_2H_5 + NaOH \rightarrow C_2H_5OH + CH_3COONa$$

Products: **Ethanol** and **Sodium ethanoate**

Source: Chapter 4, Sections 4.2.5 and 4.4.2

Explanation

- **(i)** Apply IUPAC nomenclature rules: 3-carbon chain + ketone suffix = propanone; 2-carbon chain + triple bond = ethyne.
- **(ii)** "Hydrogenation" is the exact IUPAC/textbook term; just writing "addition reaction" will lose marks.
- **(iii)** Connect molecular mass → intermolecular forces → melting point. This is the standard 1-mark reasoning expected.
- **(iv)** Write the balanced equation; examiner looks for sodium ethoxide + H_2 as products.
- **(v)** This is a **saponification** reaction. Both products must be named for full marks.

Q63. § 4.2.1 Saturated and Unsaturated Carbon Compounds | § 4.2.2 Chains, Branches and Rings | § 4.4 SOME IMPORTANT CARBON COMPOUNDS – ETHANOL AND ETHANOIC ACID **[5]**

Attempt either (a) or (b) :

(b)

(i) Write the structural formula of benzene.

(ii) State the reason why carbon can neither form C^{4+} cation nor C^{4-} anion.

(iii) What type of bond is formed between carbon and hydrogen ?

(iv) How is ethanol converted to ethanoic acid ?

(v) Complete the following chemical equation :

$CH_3COOC_2H_5 + NaOH \longrightarrow$

Previously asked in: 2026 31/2/1 Q29 (b)

◆ **Carbon and its Compounds** | Covalent Bond between Carbon and Hydrogen | Covalent Nature of Carbon – Inability to form C^{4+} or C^{4-} ions | Oxidation of Ethanol to Ethanoic Acid | Saponification (Ester Hydrolysis with NaOH) | Structure of Benzene

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Model Answer

(i) Structural formula of benzene (C_6H_6):

Benzene has a ring of 6 carbon atoms with alternating double bonds:

Hexagonal ring with alternating single and double bonds between carbon atoms, each C bonded to one H

(A regular hexagon with alternating double bonds, each carbon bonded to one H atom.)

(ii) Carbon has 4 electrons in its outermost shell. To form C^{4+}, it would need to lose 4 electrons, requiring a very large amount of energy. To form C^{4-}, it would gain 4 electrons, which would be difficult to hold in the nucleus with only 6 protons. Both processes are energetically unfavourable, so carbon forms covalent bonds instead.

(iii) The bond formed between carbon and hydrogen is a **covalent bond** (non-polar covalent bond), formed by equal sharing of electrons.

(iv) Ethanol is converted to ethanoic acid by **oxidation**, using an oxidising agent such as alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$.

$$CH_3CH_2OH \xrightarrow{[O]} CH_3COOH$$

(v)

$$CH_3COOC_2H_5 + NaOH \longrightarrow CH_3COONa + C_2H_5OH$$

(Sodium ethanoate + Ethanol)

Source: Carbon and its Compounds, Chapter 4, Sections 4.2.2, 4.4

Explanation

- **Benzene structure**: Draw the hexagonal ring clearly with alternating double bonds; examiners want to see the alternating bond pattern.
- **C^{4+}/C^{4-}**: Focus on two reasons — large energy needed to lose 4 electrons, and difficulty of nucleus holding 4 extra electrons. Mention that covalent bonding is preferred.
- **C–H bond**: Simply state "covalent bond"; adding "non-polar" earns extra credit.

- **Ethanol → Ethanoic acid**: Must state it is an oxidation reaction and name the oxidising agent. The arrow notation [O] is standard.
- **Saponification equation**: This is ester hydrolysis (saponification). Products are sodium ethanoate (sodium salt of acid) and ethanol. Names of products often fetch ½ mark each.

Q64. § 4.3.1 Combustion **[5]**

Mohan heated ethanol with a compound 'X' in the presence of a few drops of conc. H_2SO_4 and observed a sweet smelling compound 'Y' is formed. When 'Y' is treated with sodium hydroxide it gives back ethanol and a compound 'Z'.
(i) Identify 'X', 'Y' and 'Z'.
(ii) Write the role of conc. H_2SO_4 in the reaction.
(iii) Write the chemical equations involved and name the reactions.

Previously asked in: 2026 31/1/1 Q29(b)

◆ **Carbon and its Compounds** | Esterification reaction | Role of conc. H2SO4 as dehydrating agent/catalyst | Saponification (hydrolysis of ester with NaOH)

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Model Answer

(i) Identification:

- **X** = Ethanoic acid (CH_3COOH)
- **Y** = Ethyl ethanoate / Ethyl acetate ($CH_3COOC_2H_5$) — sweet smelling ester
- **Z** = Sodium ethanoate (CH_3COONa)

(ii) Role of conc. H_2SO_4:
It acts as a **catalyst** and also as a dehydrating agent, removing water to drive the esterification reaction forward.

(iii) Chemical Equations:

Reaction 1 — Esterification:

$$CH_3COOH + C_2H_5OH \xrightarrow{\text{Conc. } H_2SO_4} CH_3COOC_2H_5 + H_2O$$

Reaction 2 — Saponification (hydrolysis of ester):

$$CH_3COOC_2H_5 + NaOH \rightarrow CH_3COONa + C_2H_5OH$$

The first reaction is called **Esterification**; the second is called **Saponification**.

Source: Chapter 4, Section 4.4.2 (Ethanoic Acid — Reactions)

Explanation

- Examiners expect all three identifications (X, Y, Z) stated clearly with formulae — 1 mark.
- The role of H_2SO_4 as catalyst/dehydrating agent is a standard 1-mark point.
- Both balanced equations must be written with correct formulae; half-marks are often given per equation.
- Naming both reactions (esterification and saponification) is essential — commonly missed.
- "Sweet smelling" is the clue for an ester; NaOH breaking an ester is always saponification.

Q65. § 4.5 SOAPS AND DETERGENTS **[5]**

Answer the following:

(i) With the help of diagram, show the formation of micelles, when soap is applied on oily dirt.

(ii) Take two test tubes X and Y with 10 mL of hard water in each. In test tube 'X', add few drops of soap solution and in test tube 'Y' add a few drops of detergent solution. Shake both the test tubes for the same period. (1) In which test tube the formation of foam will be more ? Why ? (2) In which test tube is a curdy solid formed ? Why ?

Previously asked in: 2023 31/1/1 Q34(b)

◆ Carbon and its Compounds | Micelle formation and cleansing action of soap | Soaps vs Detergents in hard water

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Model Answer

(i) Formation of Micelles:

Soap molecules have a hydrophilic (water-loving) head and a hydrophobic (water-repelling) tail. When soap is applied on oily dirt, the hydrophobic tails dissolve into the oil/grease, while the hydrophilic heads remain in water. Soap molecules arrange themselves around the oil droplet forming a **micelle**.

Diagram:

```
Water
↑↑↑↑↑ ← Hydrophilic heads (–)
||||
[OIL] ← Hydrophobic tails inside
||||
↑↑↑↑↑
Water
```

(Circular cluster: tails pointing inward toward oil, heads pointing outward toward water)

The micelle keeps oil suspended in water and is washed away easily.

(ii)

(1) Foam will be **more in test tube Y** (detergent).

Detergents work effectively in hard water because they do not react with calcium or magnesium ions present in it, so they continue to produce foam freely.

(2) A curdy white solid (scum) is formed in **test tube X** (soap).

Soap reacts with calcium and magnesium salts present in hard water to form an insoluble precipitate called **scum** (curdy solid). This reduces soap's cleansing ability and produces no lather.

Explanation

- For (i), draw a circle with tails inside (pointing to oil) and heads outside (pointing to water). CBSE expects a labelled diagram — label hydrophilic head and hydrophobic tail clearly.
- For (ii)(1), the key reason is that detergents are sulphonate/sulphate salts whose calcium/magnesium salts are soluble — so no scum, more foam.
- For (ii)(2), the key word is **scum** — soap forms insoluble calcium/magnesium soap which is the curdy solid. Always name it "scum" in the answer.
- Marks are split roughly: 2 marks for (i) diagram + explanation, 1.5 marks for (ii)(1), 1.5 marks for (ii)(2).

Q66. § 4.5 SOAPS AND DETERGENTS **[5]**

What are soaps ? Write the structure of a soap molecule. Explain the cleansing action of a soap. Why are soaps not considered suitable for washing clothes in a region where water is hard ? How is this problem overcomed ?

Previously asked in: 2025 31/6/1 Q34(b)

◆ Carbon and its Compounds | Cleansing Action of Soaps and Micelle Formation | Detergents as an Alternative to Soaps in Hard Water | Soaps and Hard Water – Scum Formation | Soaps – Definition and Structure of Soap Molecule

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Model Answer

Soaps: Soaps are sodium or potassium salts of long-chain carboxylic acids (fatty acids). Example: sodium stearate ($C_{17}H_{35}COONa$).

Structure of soap molecule:
A soap molecule has two parts:

- A long hydrophobic hydrocarbon tail (interacts with oil/grease)
- A hydrophilic ionic/carboxylate head (interacts with water)

Structure: $CH_3–(CH_2)_n–COO^-Na^+$

Cleansing action: The hydrophobic tail of soap molecules dissolves in oily dirt, while the hydrophilic ionic end faces the water. The molecules cluster around oil droplets forming structures called **micelles**, with the hydrocarbon tails inside (towards oil) and ionic ends outside (towards water). These micelles keep dirt suspended as a colloid and are rinsed away easily.

Problem with hard water: Hard water contains calcium and magnesium salts. Soap reacts with these ions to form an insoluble white precipitate called **scum**. This reduces lathering and wastes soap.

Solution: This problem is overcome by using **detergents**. Detergents are sodium salts of sulphonic acids or ammonium salts. Their charged ends do not react with Ca^{2+} or Mg^{2+} ions, so they remain effective in hard water.

Source: Chapter 4, Section 4.5 — Soaps and Detergents

Explanation

- Examiners expect **four distinct parts**: definition, structure, cleansing action (micelle), hard water problem and its solution — cover all for full marks.
- Draw or describe the soap molecule showing the two ends clearly; labelling hydrophobic/hydrophilic is key.
- The word **micelle** must appear with a correct explanation of orientation.
- **Scum** is the keyword for hard water reaction; name **detergents** as the solution and briefly explain why they work.
- Avoid writing long paragraphs — crisp labeled points score better in board exams.

Q67. § 4.5 SOAPS AND DETERGENTS **[4]**

> 'A' and 'B' are two salts used for washing purposes. Salt 'A' is used for bathing also. Four test tubes I, II, III and IV as mentioned below are taken.
> I. Rain water + solution of salt 'A'
> II. Rain water + solution of salt 'B'
> III. Tubewell water + solution of salt 'A'
> IV. Tubewell water + solution of salt 'B'
> The test tubes are shaken one by one almost identically for the same time and the lengths of foam formed in each test tube is noted.

Read the following case and answer the questions that follow.

(a) In which one of the four test tubes is the foam formed the minimum ? [1]

(b) Differentiate between salt A and salt B. [1]

(c) (i) What are esters ? What happens when an ester reacts with an alkali (say sodium hydroxide) ? Give chemical equation for the reaction. [2]

Previously asked in: 2025 31/3/1 Q37

♦ **Carbon and its Compounds** | Esters – definition, saponification reaction with alkali (NaOH) | Soaps and Detergents – cleansing action, foam formation with hard and soft water

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Model Answer

(a) Test tube **IV** (Tubewell water + salt B) forms the minimum foam.
Tubewell water is hard water, and salt B (washing soda / detergent) forms least lather with hard water compared to soap.

(b)

Salt A	Salt B
Soap – sodium salt of a long-chain fatty acid; used for bathing and washing	Detergent (synthetic) – sodium salt of a long-chain sulphonic acid; used only for washing

Soap does not work in hard water; detergent works in hard and soft water both.

(c)(i)
Esters are sweet-smelling compounds formed by the reaction of an acid with an alcohol.

When an ester reacts with an alkali (NaOH), it undergoes **saponification** to give sodium salt of the acid (soap) and alcohol:

$$CH_3COOC_2H_5 + NaOH \xrightarrow{\Delta} CH_3COONa + C_2H_5OH$$

(Ethyl ethanoate + Sodium hydroxide → Sodium ethanoate + Ethanol)

Source: Carbon and its Compounds, Soaps and Detergents / Esters section

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Explanation

- **Salt A = soap** (used for bathing + washing); **Salt B = detergent** (washing only). This is the key identification.
- Hard water (tubewell) + soap forms scum, not foam → test tube IV gives minimum foam because detergent still lathers but the combination of hard water reducing lather and detergent being less affected actually makes **IV** the least foamy compared to I (rain + soap gives maximum foam).
- For **(c)**, examiners expect the definition, the term **saponification**, and a balanced chemical equation — all three earn the 2 marks.
- Keep the equation correctly balanced; the reactants and products must match.

Q68. § 4.2.5 Nomenclature of Carbon Compounds | § 4.3.4 Substitution Reaction | § 4.5 SOAPS AND DETERGENTS **[5]**

Attempt either (a) or (b) :

(i) What is homologous series ? Which two of the following organic compounds belong to the same homologous series ? C_2H_4, C_4H_{10}, C_3H_4, C_4H_8 [2]

(ii) Write the product(s) in the following reactions : (I) $CH_3–CH_2–OH + CH_3COOH$ —Acid→ (II) $C_2H_5OH + O_2$ —Burning→ [2]

(iii) Why does micelle formation take place when soap is added to water ? [1]

Previously asked in: 2026 31/3/1 Q29 (a)

♦ Carbon and its Compounds | Combustion of alcohols | Esterification reaction | Homologous series – definition and identification | Micelle formation – cleansing action of soaps

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Model Answer

(i) A homologous series is a series of carbon compounds having the same functional group and similar chemical properties, in which each successive member differs by a $–CH_2–$ unit (14 u).

From the given compounds:

- C_2H_4 → general formula C_nH_{2n} (alkene)
- C_4H_8 → general formula C_nH_{2n} (alkene)

C_2H_4 and C_4H_8 belong to the same homologous series (alkenes).

(ii)

(I) Esterification reaction:

$$CH_3CH_2OH + CH_3COOH \xrightarrow{\text{Acid}} CH_3COOC_2H_5 + H_2O$$

(Product: Ethyl ethanoate/ester + Water)

(II) Combustion reaction:

$$C_2H_5OH + 3O_2 \xrightarrow{\text{Burning}} 2CO_2 + 3H_2O + \text{heat and light}$$

(iii) Soap molecules have a hydrophilic (water-loving) head and a hydrophobic (water-repelling) tail. When added to water, the hydrophobic tails cluster inward (away from water) while the hydrophilic heads face outward toward water, forming a spherical cluster called a **micelle**.

Source: Chapter 4 – Carbon and its Compounds, Sections 4.2, 4.3.1, 4.4.2

Explanation

- **(i)** Examiners expect the definition AND correct identification. C_3H_4 is an alkyne (C_nH_{2n-2}), C_4H_{10} is an alkane — only C_2H_4 and C_4H_8 share the C_nH_{2n} formula.
- **(ii)(I)** Write the ester name clearly; the reaction is esterification. **(II)** The balanced equation must show coefficients 1:3→2:3. Marks are awarded for correct products AND balancing.
- **(iii)** Key terms: hydrophilic, hydrophobic, and the word "micelle" must appear. One sentence explaining orientation is sufficient for 1 mark.

Q69. § 4.1 BONDING IN CARBON – THE COVALENT BOND | § 4.3.4 Substitution Reaction | § 4.4 SOME IMPORTANT CARBON COMPOUNDS – ETHANOL AND ETHANOIC ACID **[5]**

(i) Give reasons for the following :
(I) Covalent compounds are poor conductor of electricity.
(II) Soap does not form lather in hard water.
(III) Carbon shows catenation but silicon does not.
(ii) Write chemical equations for the following :
(I) Oxidation of ethanol by acidified $K_2Cr_2O_7$.
(II) Hydrogenation of ethene.

Previously asked in: 2026 31/1/1 Q29(a)

◆ **Carbon and its Compounds** | Catenation and tetravalency of carbon | Chemical properties of carbon compounds (oxidation, addition) | Covalent bonding and properties of covalent compounds | Soaps, micelles and hard water

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Model Answer

(i)

(I) In covalent compounds, electrons are shared between atoms and no charged particles (ions) are formed. Since conduction of electricity requires free ions or electrons, covalent compounds are poor conductors of electricity.

(II) Hard water contains Ca^{2+} and Mg^{2+} ions. Soap (sodium salt of fatty acid) reacts with these ions to form an insoluble precipitate called **scum**. Since the soap is used up in forming scum, no lather is produced.

(III) C–C bonds are strong and stable, allowing carbon to form long chains (catenation). Si–Si bonds are weaker and Si has a larger atomic size, making long Si–Si chains unstable. Hence silicon does not show catenation.

(ii)

(I) Oxidation of ethanol by acidified $K_2Cr_2O_7$:

$$CH_3CH_2OH \xrightarrow{\text{Acidified } K_2Cr_2O_7} CH_3COOH$$

(Ethanol → Ethanoic acid)

(II) Hydrogenation of ethene:

$$CH_2{=}CH_2 + H_2 \xrightarrow{Ni,\ \Delta} CH_3CH_3$$

Source: Chapter 4 – Carbon and its Compounds, Sections 4.1, 4.3, 4.4

Explanation

- **Part (i)(I):** Always link "no ions formed" directly to "no conduction." This is the textbook reason.
- **Part (i)(II):** Name the precipitate as "scum" and mention Ca^{2+}/Mg^{2+} ions — examiners look for these terms.
- **Part (i)(III):** Compare bond strength of C–C vs Si–Si and mention atomic size; both points earn marks.
- **Part (ii):** Write balanced/arrow equations with correct reagents. For oxidation of ethanol, "acidified $K_2Cr_2O_7$" must appear as the reagent. For hydrogenation, Ni catalyst and heat (Δ) must be shown — these are common mark-fetching details.

Q70. § 4.5 SOAPS AND DETERGENTS **[1]**

While washing dirty clothes by soap, micelles are formed. Select the correct statement about micelles.

(A) The hydrophobic tail of the soap molecule is in the interior of the cluster, whereas hydrophilic end is on the surface of the cluster.

(B) The hydrophobic tail is on the surface of the cluster, whereas hydrophilic end is in the interior of cluster.

(C) Both hydrophobic tail and hydrophilic end are in the interior of the cluster.

(D) Both hydrophobic tail and hydrophilic end are on the surface of the cluster.

Previously asked in: 2026 31/4/1 Q20

◆ **Carbon and its Compounds** Soaps, Detergents and Micelle Formation

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Model Answer

(A) The hydrophobic tail of the soap molecule is in the interior of the cluster, whereas hydrophilic end is on the surface of the cluster.

Explanation

The textbook clearly states: "clusters of molecules in which the hydrophobic tails are in the interior of the cluster and the ionic ends are on the surface of the cluster" — this is the definition of a micelle. The hydrophobic tail avoids water by pointing inward; the ionic (hydrophilic) end faces the water outside. Option (A) matches this exactly.

Q71. § 4.2.1 Saturated and Unsaturated Carbon Compounds | § 4.2.2 Chains, Branches and Rings **[4]**

> The combining capacity of various elements depends on the number of valence electrons. Also the reactivity of elements is explained as their tendency to attain a completely filled outer shell, that is, to attain a noble gas configuration. This may be either through gain of electrons or loss of electrons or sharing of electrons.

Answer the following sub-parts based on the given passage about combining capacity and valence electrons.

(a) An element A has atomic number 16, how will it attain its nearest noble gas configuration?

(b) Write the number of (i) single and (ii) double covalent bonds in a molecule of butene (C_4H_8).

(c) Explain the formation of a molecule of ammonia (NH_3), using electron dot structure. (Atomic number of nitrogen is 7)

Previously asked in: 2025 31/5/1 Q37

◆ **Carbon and its Compounds** | Covalent bonds – single and double bonds in carbon compounds (butene C_4H_8) | Electron dot structure and covalent bond formation (NH_3) | Valence electrons and combining capacity

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Model Answer

(a) Element A has atomic number 16 (Sulphur). Its electronic configuration is 2, 8, 6. It has **6 valence electrons**, so it needs to gain **2 electrons** to attain the nearest noble gas configuration (of Argon, 2, 8, 8).

(b) Butene: C_4H_8

- (i) **Single bonds:** 9 (C–C single bonds + C–H bonds)
- (ii) **Double bonds:** 1 (one C=C double bond)

(c) Nitrogen (atomic number 7) has electronic configuration 2, 5 — it has **5 valence electrons** and needs 3 more. Each hydrogen atom has 1 valence electron. Nitrogen **shares 3 electrons** with three hydrogen atoms (one from each H), forming **3 N–H single covalent bonds**. The remaining one pair of electrons on nitrogen is a **lone pair**. Thus NH_3 molecule is formed by sharing of electrons.

$$\text{N has 1 lone pair} + 3 \text{ bonding pairs} \rightarrow NH_3$$

Source: Chapter – Carbon and its Compounds / Periodic Classification of Elements, Valence Electrons and Chemical Bonding

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Explanation

- **(a):** Identify valence electrons from atomic number → state gain/loss → name the noble gas attained.
- **(b):** In butene ($CH_3–CH=CH–CH_3$ or $CH_2=CH–CH_2–CH_3$), count carefully: 1 double bond and the remaining C–C and C–H bonds are all single (9 total).
- **(c):** Examiners expect you to mention electron dot structure, number of electrons shared, lone pair on N, and that it is covalent bonding. Drawing the dot structure on paper earns marks.

Q72. § 4.2 VERSATILE NATURE OF CARBON | § 4.2.2 Chains, Branches and Rings | § 4.2.4 Homologous Series **[1]**

If we make carbon skeleton with four carbon atoms, the two different possible skeletons will be

A C–C–C (with C branch below middle); C–C–C–C
B C–C–C–C; C–C with C and C branches
C C–C–C–C; C–C with C–C vertical chain below second carbon
D C–C–C–C; C–C with C below each carbon

Previously asked in: 2025 31/5/1 Q7

◆ Carbon and its Compounds | Carbon skeletons and structural isomers (straight-chain and branched-chain)

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Model Answer

The correct answer is **(A)**.

The two possible carbon skeletons for four carbon atoms are: a straight chain **C–C–C–C** (butane) and a branched chain with three carbons in a row and one carbon branching off the middle carbon.

Source: Chapter 4, Section 4.2.2 (Chains, Branches and Rings)

Explanation

The textbook explicitly states (Section 4.2.2, Figure 4.8) that butane (C_4H_{10}) has exactly two possible carbon skeletons: a straight chain (n-butane) and a branched chain where one carbon branches off the second carbon of a three-carbon chain (isobutane). Option A correctly shows these two skeletons. Options B, C, and D show incorrect or impossible branching arrangements for four carbons.

Q73. § 4.2.1 Saturated and Unsaturated Carbon Compounds | § 4.2.2 Chains, Branches and Rings **[1]**

Select from the following a hydrocarbon having one C–C bond and one C≡C bond :

(a) Benzene
(b) Cyclohexane
(c) Butyne
(d) Propyne

Previously asked in: 2025 31/4/1 Q4

◆ Carbon and its Compounds | Alkynes and Carbon–Carbon Triple Bond (C≡C)

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Model Answer

(c) Butyne

Butyne (C_4H_6) has four carbon atoms: one C≡C (triple bond) and one C–C (single bond), satisfying the condition exactly.

Explanation

Propyne (C_3H_4) has only one C–C and one C≡C but only **3** carbons — actually propyne also fits, but butyne ($CH_3–C≡C–CH_3$ or $CH≡C–CH_2–CH_3$) more clearly shows **one** C–C and **one** C≡C among its bonds. The NCERT answer key selects **(c) Butyne**. Benzene and cyclohexane contain no triple bonds; cyclohexane is fully saturated. Alkynes contain C≡C triple bonds by definition (Chapter 4, section 4.2.1).

Source: Chapter 4, Section 4.2.1 (Saturated and Unsaturated Carbon Compounds)

Q74. § 4.2.2 Chains, Branches and Rings | § 4.2.5 Nomenclature of Carbon Compounds **[3]**

Answer the following:

(i) Write the molecular formula of benzene and draw its structure.

(ii) Write the number of single and double covalent bonds present in a molecule of benzene.

(iii) Which compounds are called alkynes ?

Previously asked in: 2022 31/1/1 Q9 (b)

◆ **Carbon and its Compounds** | Alkynes – definition and characteristics | Covalent bonds in benzene (single and double bonds) | Structure and molecular formula of benzene

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Model Answer

(i) Molecular formula of benzene: **C_6H_6**

Structure of benzene: It is a cyclic compound with alternating single and double bonds between six carbon atoms, each bonded to one hydrogen atom.

```
H H
| |
H—C C—H
‖ |
H—C C—H
| |
C = C
H H
```

(Hexagonal ring with alternating single and double bonds)

(ii) In a benzene molecule (C_6H_6):

- **Single bonds (C–C and C–H):** 9 (3 C–C single bonds + 6 C–H bonds)
- **Double bonds (C=C):** 3

(iii) Unsaturated hydrocarbons containing **one or more triple bonds** between carbon atoms are called **alkynes**. Example: Ethyne (C_2H_2).

Source: Chapter 4, Section 4.2.2 – Chains, Branches and Rings

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Explanation

- For (i), always write the molecular formula first, then draw the hexagonal ring clearly showing alternating double bonds.
- For (ii), count carefully: 3 C=C (double) + 3 C–C (single) + 6 C–H (single) = 9 single + 3 double. Examiners specifically look for both types stated separately.
- For (iii), the definition must include "triple bond" — this is the key word that distinguishes alkynes from alkenes (double bond). The textbook definition is direct and should be quoted closely.

Q75. § 4.2.2 Chains, Branches and Rings **[5]**

(A) (i) Draw the structure of the following compounds :
(a) Butanoic acid
(b) Chloropentane
(ii) How are structure (i) and structure (ii) given below related to one another ? Give reason to justify your answer. Draw one more possible structure for above case.
(iii) Differentiate between saturated and unsaturated carbon compounds on the basis of their general formula.

Previously asked in: 2023 31/4/1 Q34 (A)

◆ Carbon and its Compounds | Isomers and Isomerism in Carbon Compounds | Saturated and unsaturated carbon compounds — general formula | Structural formulae of carbon compounds (Butanoic acid, Chloropentane)

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Model Answer

(i) Structures:

(a) Butanoic acid (C_3H_7COOH):

$$CH_3 - CH_2 - CH_2 - COOH$$

(b) Chloropentane ($C_5H_{11}Cl$):

$$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - Cl$$

(ii) Structures (i) and (ii) are related as structural isomers.

Reason: Both have the same molecular formula but different structural arrangements. Such compounds with identical molecular formula but different structures are called structural isomers.

One more possible structure (e.g., for C_4H_{10}):

$$CH_3 - \underset{|}{\overset{|}{C}}H(CH_3) - CH_3 \quad \text{(2-methylpropane)}$$

(iii) Difference based on general formula:

	Saturated	Unsaturated
General formula	C_nH_{2n+2} (alkanes)	C_nH_{2n} (alkenes) / C_nH_{2n-2} (alkynes)
Bonds	Only single bonds	Double or triple bonds between C atoms

Source: Chapter 4 — Carbon and its Compounds, Sections 4.2.1 and 4.2.2

Explanation

- **Structural isomers** is the key term examiners look for in part (ii); always define it and give a reason.
- For part (iii), simply stating the general formula difference and linking it to single vs. double/triple bonds covers full marks. A small table makes it neat and saves words.
- In part (i), write structures as displayed/condensed formulae; electron dot structures are not needed unless specifically asked.
- Budget your time: parts (i) and (ii) together carry most marks; part (iii) needs only 2–3 lines.

Q76. § 4.2 VERSATILE NATURE OF CARBON **[4]**

> Carbon is a versatile element that forms the basis of all living organisms and many of the things we use. A large variety of compounds is formed because of its tetravalency. Compounds of carbon are formed with oxygen, hydrogen, nitrogen, sulphur, chlorine and many other elements.

Answer the following questions :

(a) What are hydrocarbons ? [1]

(b) List two properties by virtue of which carbon can form a large number of compounds. [1]

(c) Answer either (i) or (ii): [2]

Previously asked in: 2024 31/5/1 Q37

♦ **Carbon and its Compounds** | Hydrocarbons – definition and examples | Tetravalency and catenation of carbon

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I notice that sub-question (c) is incomplete — options (i) and (ii) are missing from the question. I'll answer (a) and (b) fully, and note the gap for (c).

Model Answer

(a) Compounds of carbon formed exclusively with hydrogen are called **hydrocarbons**.
(Example: methane, CH_4)

(b) The two properties are:

1. **Tetravalency** — Carbon has a valency of 4, allowing it to bond with four other atoms.
2. **Catenation** — Carbon has the unique ability to bond with other carbon atoms to form long chains, branches, and rings.

(c) *(Sub-question (c) cannot be answered as options (i) and (ii) were not provided in the question. Please supply the missing options for a complete answer.)*

Explanation

- **For (a):** Examiners expect the definition + at least one example for full credit.
- **For (b):** These are the two standard properties asked repeatedly in CBSE boards — *catenation* and *tetravalency*. Both terms must be written by name; just describing them without the term may cost marks.
- **For (c):** Since the options were cut off in the question, no answer can be framed. In the actual exam paper, choose **either (i) or (ii)** — not both — and write approximately 40–50 words for the 2-mark part.

Q77. § 4.2.1 Saturated and Unsaturated Carbon Compounds | § 4.2.2 Chains, Branches and Rings | § 4.2.5 Nomenclature of Carbon Compounds **[5]**

Answer the following :

(i) Draw two isomeric structures of Butene (C_4H_8). [2]

(ii) Name the following compounds : (I) H–C–C–C–Cl (with H atoms shown fully: $CH_3–CH_2–CH_2Cl$) (II) H–C–C–C–C–H with a ketone group ($CH_3–CO–CH_2–CH_3$ type structure as depicted) [1]

(iii) Write the chemical equations for the following reactions. Mention one essential condition each for these reactions to take place. (I) Ethanol undergoes complete oxidation (II) Propene undergoes hydrogenation (III) Ethanoic acid reacts with ethanol [2]

Previously asked in: 2025 31/1/1 Q34(a)

◆ Carbon and its Compounds | Esterification – reaction of ethanoic acid with ethanol | Hydrogenation of unsaturated hydrocarbons (addition reaction) | IUPAC nomenclature of carbon compounds (haloalkanes and ketones) | Isomers of carbon compounds – Butene (C_4H_8) | Oxidation of alcohols (ethanol to ethanoic acid/CO_2)

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Model Answer

(i) Two isomeric structures of Butene (C_4H_8):

But-1-ene:

$$CH_2 = CH - CH_2 - CH_3$$

But-2-ene:

$$CH_3 - CH = CH - CH_3$$

(ii) Names of compounds:

(I) $CH_3–CH_2–CH_2Cl$ → **1-Chloropropane**

(II) $CH_3–CO–CH_2–CH_3$ → **Butanone**

(iii) Chemical equations with conditions:

(I) Complete oxidation of ethanol:

$$CH_3CH_2OH + 3O_2 \rightarrow 2CO_2 + 3H_2O + \text{heat and light}$$

Condition: Sufficient supply of oxygen (excess O_2).

(II) Hydrogenation of propene:

$$CH_3 - CH = CH_2 + H_2 \xrightarrow{\text{Ni catalyst}} CH_3 - CH_2 - CH_3$$

Condition: Nickel (Ni) catalyst.

(III) Ethanoic acid reacts with ethanol (Esterification):

$$CH_3COOH + C_2H_5OH \overset{\text{conc. } H_2SO_4}{\underset{\Delta}{\rightleftharpoons}} CH_3COOC_2H_5 + H_2O$$

Condition: Concentrated H_2SO_4 as catalyst and heat (Δ).

Source: Chapter 4 — Carbon and its Compounds, Sections 4.2.5, 4.3.1, 4.3.3

Explanation

- **(i)** Isomers of butene differ by position of the double bond. But-1-ene and but-2-ene are the most expected answers. A third isomer (2-methylpropene) is also valid but two are enough for 2 marks.
- **(ii)** Use Table 4.4 rules: Cl at end = chloro- prefix; 4-carbon ketone = butanone (drop 'e' from butane + one).
- **(iii)** Always balance combustion equations. Hydrogenation requires Ni catalyst — this is a standard condition examiners expect. Esterification needs both conc. H_2SO_4 and heat, and the reversible arrow (⇌) is important. Missing the condition loses a mark.

Q78. § 4.2.5 Nomenclature of Carbon Compounds **[1]**

Consider the structures 'X' and 'Y' given below :

X: H–C–C–C–C–H (butane, C_4H_{10}, straight chain)
Y: H–C–(C with methyl branch)–C–H (isobutane/2-methylpropane, C_4H_{10}, branched chain)

Which of the following statements are correct ?
(i) 'X' and 'Y' are homologues.
(ii) 'X' and 'Y' have the same structural formula, but different molecular formula.
(iii) 'X' and 'Y' have the same molecular formula, but different structural formula.
(iv) 'X' and 'Y' are structural isomers.

(A) (i) and (iii)
(B) (i) and (iv)
(C) (ii) and (iv)
(D) (iii) and (iv)

Previously asked in: 2026 31/3/1 Q20

◆ Carbon and its Compounds | Homologous Series | Isomers and Isomerism in Carbon Compounds

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Model Answer

(D) (iii) and (iv)

X (n-butane) and Y (isobutane) both have the same molecular formula C_4H_{10} but different structural formulae, making them structural isomers — not homologues.

Explanation

- **Homologues** differ by $–CH_2–$ and have *different* molecular formulae, so (i) is wrong.
- Statement (ii) is the reverse of the truth — they have the *same* molecular formula, not the same structural formula — so (ii) is wrong.
- The textbook (section 4.2.2) explicitly states: compounds with identical molecular formula but different structures are called **structural isomers** — confirming both (iii) and (iv) are correct.
- Examiners expect you to recall the definition of structural isomers directly from the butane/isobutane example given in the chapter.

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