CBSE CLASS X

Science (086)

ANSWER KEY

AI-generated question paper

Code: 9J5PBM **Questions: 29** **Maximum Marks: 67** **Generated: 2026-06-25 17:44**

SELECTIONS USED

Subject	Science
Lessons	4 Carbon and its Compounds
Level of understanding	Exam-ready
Question selection	CBSE board paper, whole lesson (~80 marks across Sections A-E)
Model	claude-sonnet-4-6

Composition — Difficulty: 4 straightforward · 19 medium · 6 deep | Types: 9 MCQ · 6 Short · 5 Very short · 3 Assertion–reason · 3 Long · 3 Case-based | Sections: A 12Q/12m · B 5Q/10m · C 6Q/18m · D 3Q/15m · E 3Q/12m

Q1. straightforward exam-ready **[1]**

Ethanol reacts with sodium metal to produce hydrogen gas. What is the other product of this reaction?

A Sodium oxide
B Sodium ethoxide
C Sodium carbonate
D Sodium hydroxide

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Model Answer

B — Sodium ethoxide

When ethanol reacts with sodium metal: $2Na + 2CH_3CH_2OH \rightarrow 2CH_3CH_2O^-Na^+ + H_2$. The other product is **sodium ethoxide**.

Source: Properties of Ethanol, Chapter 4

Explanation

The reaction of ethanol with sodium is a standard 1-mark fact. Examiners expect you to recall the chemical equation and name the ionic product — sodium ethoxide ($CH_3CH_2O^-Na^+$). Do not confuse it with sodium hydroxide (which forms when sodium reacts with **water**, not ethanol).

Q2. straightforward exam-ready **[1]**

Which of the following hydrocarbons decolourises bromine water and also undergoes hydrogenation in the presence of a nickel catalyst?

((A)) Methane

((B)) Ethane

((C)) Ethene

((D)) Propane

A CH_4

B C_2H_6

C C_3H_8

D C_2H_2

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Model Answer

(C) Ethene (C_2H_4)

Ethene is an unsaturated hydrocarbon with a C=C double bond; it decolourises bromine water and undergoes hydrogenation with H_2 in the presence of a nickel catalyst.

(Note: Option (D) listed as C_2H_2/ethyne also fits, but among the named options, ***Ethene*** *is the standard answer.)*

Explanation

The question tests knowledge of addition reactions. Only **unsaturated hydrocarbons** (alkenes/alkynes) decolourise bromine water (by adding Br_2 across the double/triple bond) and undergo hydrogenation. Methane, ethane, and propane are saturated; they do neither. The question's option list names "Ethene" as (C), making it the correct choice. Ethyne (C_2H_2) also qualifies chemically, but it is not among the named options (A–D) as stated in the question stem—the option (D) in the stem is "Propane."

Q3. medium exam-ready **[1]**

A carbon compound on reaction with alkaline potassium permanganate gets oxidised to form ethanoic acid. The original compound is:

A Methanol
B Ethanol
C Propanol
D Butanol

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Model Answer

Option B: Ethanol

Ethanol (C_2H_5OH) on oxidation with alkaline potassium permanganate forms ethanoic acid (CH_3COOH).

Source: Oxidation, Chapter 4, Section 4.3.2

Explanation

The key is matching the product (ethanoic acid, a 2-carbon compound) to its alcohol precursor. Ethanol is also the 2-carbon alcohol, so oxidation preserves the carbon chain and converts –OH to –COOH. The passage explicitly uses ethanol in Activity 4.5 to demonstrate this oxidation. Other options (methanol = 1C, propanol = 3C, butanol = 4C) would not yield ethanoic acid.

Q4. medium exam-ready **[1]**

Cyclohexane has the molecular formula C_6H_{12}. Which class of compounds does it belong to?

A Alkene
B Alkyne
C Alkane
D Aromatic hydrocarbon

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Model Answer

Answer: C — Alkane

Cyclohexane (C_6H_{12}) is a cyclic compound with all single bonds between carbon atoms, making it a saturated hydrocarbon, i.e., an alkane.

Explanation

The textbook states that cyclohexane has formula C_6H_{12} and is a ring (cyclic) structure with only single bonds — hence saturated. Saturated hydrocarbons are called **alkanes**. Don't confuse it with alkenes (double bond) or aromatics like benzene (C_6H_6). The "cyclo" prefix simply indicates the ring form of an alkane.

Q5. straightforward exam-ready **[1]**

Which of the following functional groups is present in propanal?
((A)) –OH
((B)) –COOH
((C)) –CHO
((D)) –CO–

A —OH
B —COOH
C —CHO
D >C=O (ketone)

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Model Answer

(C) –CHO

Propanal belongs to the aldehyde class (suffix *-al*), so it contains the **–CHO** (aldehyde) functional group.

Source: Chapter 4, Table 4.3 and Table 4.4

Explanation

The suffix **-al** in "propanal" directly indicates an aldehyde functional group (–CHO). Remember: –OH = alcohol, –COOH = carboxylic acid, –CO– (flanked by two carbon chains) = ketone. Examiners expect you to link the IUPAC suffix to the correct functional group.

Q6. medium exam-ready **[1]**

When soap is added to hard water, a white curdy precipitate is formed. What causes this?

A Soap reacts with dissolved oxygen to form insoluble oxides
B Soap reacts with calcium and magnesium salts in hard water to form insoluble salts
C Soap molecules clump together when cooled by hard water
D Hard water contains chlorine that destroys the soap molecules

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Model Answer

Answer: B

Soap reacts with calcium and magnesium salts present in hard water to form insoluble salts, which appear as a white curdy precipitate (scum).

Source: Soaps and Detergents, Chapter 4

Explanation

The textbook explicitly states: *"This is caused by the reaction of soap with the calcium and magnesium salts, which cause the hardness of water"* — forming an insoluble precipitate. Options A, C, and D are factually incorrect and not supported by the text. Examiners expect students to identify the correct chemical cause (reaction with Ca/Mg salts) and the result (insoluble/curdy precipitate).

Q7. medium exam-ready **[1]**

Heating ethanol at 443 K with excess concentrated sulphuric acid produces ethene. The role of concentrated sulphuric acid in this reaction is:

A Oxidising agent
B Reducing agent
C Dehydrating agent
D Catalyst

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Model Answer

Answer: C — Dehydrating agent

Concentrated H_2SO_4 removes water from ethanol during dehydration, converting it to ethene at 443 K. It acts as a **dehydrating agent**.

Source: Chapter 4, Section 4.4.1 (Properties of Ethanol)

Explanation

The textbook explicitly states: *"The concentrated sulphuric acid can be regarded as a dehydrating agent which removes water from ethanol."* Examiners expect you to recall this specific term. Do not confuse it with a catalyst (though H_2SO_4 can act as one in esterification) — here, the question context points to dehydration, making **C** the only correct option.

Q8. medium exam-ready **[1]**

In the reaction of methane with chlorine in the presence of sunlight, what type of bond in methane is broken and what type of reaction takes place?
((A)) C–C bond; addition reaction
((B)) C–H bond; substitution reaction
((C)) C–H bond; addition reaction
((D)) C–C bond; substitution reaction

A A C—C bond is broken and chlorine replaces a carbon atom
B A C—H bond is broken and chlorine replaces a hydrogen atom
C Two C—H bonds are broken and a double bond forms
D The entire molecule is decomposed by chlorine

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Model Answer

(B) C–H bond; substitution reaction

In the reaction $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ (sunlight), the C–H bond in methane is broken and chlorine replaces a hydrogen atom. This is a substitution reaction.

Source: Chapter 4, Section 4.3.4 – Substitution Reaction

Explanation

- The key facts are: methane has **no C–C bond** (single carbon), so options A and D are eliminated immediately.
- It is not an addition reaction (no double/triple bond present in saturated methane), so option C is wrong.
- Examiners expect you to name both the bond broken (**C–H**) and the reaction type (**substitution**) with a brief reason. Writing the chemical equation earns full credit.

Q9. medium exam-ready **[1]**

Why do covalent compounds generally not conduct electricity?
((A)) They have high melting points and therefore resist electron flow.
((B)) They exist as molecules with no free ions or electrons to carry charge.
((C)) They dissolve in water to form neutral solutions.
((D)) Their molecules are too large to allow electron movement.

A Their molecules are too large to move in solution
B Electrons are shared between atoms so no charged particles (ions) are formed
C They have very high boiling points so they cannot melt
D They react with water to form non-conducting products

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Model Answer

(B) Electrons are shared between atoms so no charged particles (ions) are formed.

Covalent compounds exist as molecules; since electrons are shared, no free ions or electrons are produced to carry electric charge, making them poor conductors.

Source: Carbon and its Compounds, Section 4.1

Explanation

The textbook states: *"Since the electrons are shared between atoms and no charged particles are formed, such covalent compounds are generally poor conductors of electricity."* Examiners expect you to link **electron sharing → no ions formed → no charge carriers → poor conduction**. Option B matches this exactly. Options A and C are incorrect (covalent compounds have *low* melting points); Option D is not a reason given in the text.

Q10. medium exam-ready **[1]**

Assertion (A): Saponification is the process used in the preparation of soap.
Reason (R): When an ester is treated with sodium hydroxide, it gives back the alcohol and the sodium salt of the carboxylic acid.

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.

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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).

Saponification is the alkaline hydrolysis of an ester with NaOH, giving alcohol and sodium salt of carboxylic acid; this reaction is used in soap preparation.

Source: Chapter 4, Section 4.4.2 (Properties of Ethanoic Acid)

Explanation

The textbook explicitly states: *"On treating with sodium hydroxide...the ester is converted back to alcohol and sodium salt of carboxylic acid. This reaction is known as saponification because it is used in the preparation of soap."* So the Reason directly and correctly explains the Assertion — choose **Option A**.

Q11. medium exam-ready **[1]**

Assertion (A): Carbon forms a very large number of compounds compared to any other element.
Reason (R): Carbon has the unique ability to form bonds with other carbon atoms (catenation) and also has a valency of four (tetravalency).

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.

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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's tetravalency and catenation together enable it to form millions of compounds, more than all other elements combined.

Explanation

The textbook explicitly states: *"The two characteristic features seen in carbon, that is, tetravalency and catenation, put together give rise to a large number of compounds."* Both the assertion (carbon forms the most compounds) and the reason (catenation + tetravalency) are correct, and the reason directly explains the assertion — so option A is the answer. Examiners look for you to confirm **both** statements are true **and** that R correctly explains A.

Q12. deep exam-ready **[1]**

Assertion (A): Detergents are more effective than soaps in hard water.
Reason (R): Unlike soap molecules, the charged ends of detergent molecules do not form insoluble precipitates with calcium and magnesium ions present in hard water.
((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.

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.

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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).

Explanation

The textbook states that the charged ends of detergent molecules do not form insoluble precipitates with Ca^{2+} and Mg^{2+} ions in hard water, which is exactly why detergents remain effective in hard water — making R the direct and correct explanation of A.

Q13. medium exam-ready **[2]**

What is catenation? Why does carbon exhibit catenation to a much greater extent than silicon?

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Model Answer

Catenation is the unique ability of carbon atoms to form bonds with other carbon atoms, giving rise to large molecules with long chains, branched chains, or ring structures.

Carbon exhibits catenation to a much greater extent than silicon because the **carbon–carbon bond is very strong and stable**. Silicon can form chains of only up to 7–8 atoms, but those compounds are very reactive and unstable.

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

Explanation

- Define catenation clearly in one line — examiners expect the exact term and its meaning.
- The key reason for the difference is **bond strength**: C–C bond is stronger than Si–Si bond due to carbon's **small atomic size**, allowing the nucleus to hold shared electrons more tightly.
- Mentioning silicon's chain limit (7–8 atoms) and their reactivity adds a comparative point that fetches the second mark.

Q14. straightforward exam-ready **[2]**

State two characteristics of a homologous series. A compound belonging to the carboxylic acid series has the molecular formula $C_3H_6O_2$. Write the molecular formulae of the next two higher members of this series.

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Model Answer

Two characteristics of a homologous series:

1. All members have the same functional group and similar chemical properties.
2. Successive members differ by a $-CH_2-$ unit (molecular mass difference of 14 u).

Next two higher members of $C_3H_6O_2$ (carboxylic acid series):

- $C_4H_8O_2$ (Butanoic acid)
- $C_5H_{10}O_2$ (Pentanoic acid)

Source: Carbon and its Compounds, Section 4.2.4 – Homologous Series

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Explanation

- The question has two parts — state characteristics first, then write the formulae.
- Each successive member of a homologous series adds one $-CH_2-$ unit: $C_3H_6O_2 \rightarrow C_4H_8O_2 \rightarrow C_5H_{10}O_2$.
- The general formula for carboxylic acids is $C_nH_{2n}O_2$; apply it to n = 4 and n = 5.
- Examiners look for both characteristics clearly stated and both formulae correct. Names are a bonus but formulae are essential.

Q15. medium exam-ready **[2]**

Ethanoic acid reacts with sodium hydrogencarbonate. Write the balanced chemical equation for this reaction and identify the gas evolved.

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Model Answer

Balanced chemical equation:

$$CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2 \uparrow$$

Gas evolved: Carbon dioxide (CO_2) is the gas evolved. It turns lime-water milky, confirming its identity.

Source: Carbon and its Compounds, Section 4.4.2 – Reactions of ethanoic acid

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Explanation

- Examiners expect the **balanced equation** (1 mark) and **identification of gas** (1 mark) — both are needed for full credit.
- Write the upward arrow (↑) after CO_2 to indicate it is a gas; this is good exam practice.
- Mentioning the lime-water test is a bonus detail that strengthens the answer within the word limit.
- The products are sodium ethanoate (CH_3COONa), water, and CO_2 — do not omit any product.

Q16. deep exam-ready **[2]**

Why does graphite conduct electricity while diamond does not, even though both are allotropes of carbon?

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Model Answer

In **graphite**, each carbon atom is bonded to only **three** other carbon atoms, leaving one electron free. These free electrons can move through the layers, allowing graphite to conduct electricity.

In **diamond**, each carbon atom is bonded to **four** other carbon atoms in a rigid 3D structure, leaving **no free electrons**. Hence, diamond cannot conduct electricity.

Source: Chapter 4, Allotropes of Carbon (More to Know)

Explanation

- The key concept is **free/delocalized electrons**: graphite has them (one bond is a double bond, freeing an electron per atom); diamond has none (all four valence electrons are used in bonding).
- Examiners expect you to clearly state the bonding difference (3 vs 4 bonds) AND directly link it to presence/absence of free electrons for conduction.
- Don't just say "different structures" — explain *why* that structure affects conductivity.

Q17. medium exam-ready **[2]**

Name one oxidising agent that can convert ethanol to ethanoic acid. Explain, in terms of the change in the compound, why this conversion is regarded as an oxidation reaction.

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Model Answer

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

Why it is oxidation: In this conversion, oxygen is added to ethanol (CH_3CH_2OH) to form ethanoic acid (CH_3COOH). Since the reaction involves addition of oxygen to the starting material, it is regarded as an oxidation reaction.

Source: Chapter 4, Section 4.3.2 Oxidation

Explanation

- **1 mark** for naming a correct oxidising agent — either alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$ is accepted.
- **1 mark** for the explanation — examiners want the key idea that **oxygen is added** to ethanol, which is the definition of oxidation used in this chapter. Avoid vague statements; mention both reactant (ethanol) and product (ethanoic acid) to make it clear.
- Do not write lengthy definitions of oxidation; one crisp sentence is enough for 1 mark.

Q18. medium exam-ready **[3]**

(i) Draw the electron dot structure of ethyne (C_2H_2).
(ii) State whether ethyne is saturated or unsaturated, giving a reason.
(iii) Write the chemical equation for the reaction of ethyne with hydrogen in the presence of a nickel catalyst. Name the product formed.

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Model Answer

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

$$H :\ddot{C}:\ddot{C}: H$$

H — C ≡ C — H (with each C sharing 3 pairs of electrons, forming a triple bond, and one bond each with H)

(ii) Ethyne is an **unsaturated** compound because it contains a **triple bond** between the two carbon atoms. Compounds with double or triple bonds between carbon atoms are called unsaturated carbon compounds.

(iii)

$$C_2H_2 + 2H_2 \xrightarrow{Ni} C_2H_6$$

The product formed is **ethane**.

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

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Explanation

- For (i), show the triple bond clearly — three pairs of shared electrons between the two C atoms, with one H on each end. Examiners award marks for correct depiction of the triple bond.
- For (ii), one line identifying it as unsaturated + one reason (triple bond) is sufficient for 1 mark.
- For (iii), balance the equation correctly: ethyne needs **2 moles of H_2** (since it has a triple bond, two bonds must be broken and hydrogenated). Naming the product (ethane) is essential — don't skip it.

Q19. medium exam-ready **[3]**

Carbon cannot form C^{4+} or C^{4-} ions easily. Explain why, and describe how carbon instead achieves noble gas configuration.

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Model Answer

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 need to gain 4 electrons, which would be difficult for the nucleus to hold. Both processes are energetically unfavourable.

Instead, carbon achieves noble gas configuration (8 electrons in outermost shell) by **sharing** its 4 valence electrons with other atoms, forming **4 covalent bonds**. Carbon's small size allows its nucleus to hold shared electron pairs strongly, making these bonds stable. For example, in methane (CH_4), carbon shares one electron each with four hydrogen atoms.

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

Explanation

- Examiners expect **two parts**: (1) why ionic bonding fails for carbon, and (2) how covalent bonding solves it.
- Mention both C^{4+} and C^{4-} separately — each is worth a point.
- Naming **covalent bonds / sharing of electrons** and giving **methane as an example** shows application.
- The phrase "small size → nucleus holds shared pairs strongly" is directly from the textbook and scores well.

Q20. medium exam-ready **[3]**

(i) Write the IUPAC names of the following compounds:
(a) $CH_3CH_2CH_2OH$
(b) CH_3CH_2Br
(c) $CH_3COCH_2CH_3$
(ii) Which of the above compounds belongs to the ketone functional group?

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Model Answer

(i) IUPAC Names:

(a) **$CH_3CH_2CH_2OH$** — It has 3 carbon atoms with —OH (alcohol) functional group.
IUPAC name: **Propan-1-ol**

(b) **CH_3CH_2Br** — It has 2 carbon atoms with bromo substituent.
IUPAC name: **Bromoethane**

(c) **$CH_3COCH_2CH_3$** — It has 4 carbon atoms with ketone (—CO—) functional group.
IUPAC name: **Butan-2-one**

(ii) Compound **(c) $CH_3COCH_2CH_3$** belongs to the **ketone** functional group. The ketone group (>C=O) is present between carbon atoms, and its IUPAC suffix is **-one**.

Source: Chapter 4, Section 4.2.5 Nomenclature of Carbon Compounds

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Explanation

- For alcohols, suffix **-ol** is added; for haloalkanes, the halogen name is used as a **prefix** (bromo, chloro).
- For ketones, suffix **-one** is used. The position of the functional group must be indicated (butan-**2**-one).
- Examiners expect correct spelling and position numbers. "Propan-1-ol" is preferred over just "propanol" to show the position.

Q21. medium exam-ready **[3]**

Vegetable oils are hydrogenated industrially to produce vanaspati ghee.
(i) Name the catalyst used.
(ii) Write the chemical equation for the hydrogenation of ethene as an example of this type of reaction.
(iii) Why is it advisable to use oils containing unsaturated fatty acids rather than animal fats for cooking?

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Model Answer

(i) The catalyst used is **nickel (Ni)**.

(ii) Chemical equation for hydrogenation of ethene:

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

(Ethene → Ethane)

(iii) Animal fats contain **saturated fatty acids**, which are harmful to health. Oils with **unsaturated fatty acids** are healthier and therefore advisable for cooking.

Source: Chapter 4, Section 4.3.3 Addition Reaction

Explanation

- **(i)** Both Ni and Pd are acceptable, but the passage specifically highlights **nickel** for the industrial hydrogenation of vegetable oils — write Ni for full marks.
- **(ii)** Show the double bond in ethene, the reagent H_2, the catalyst (Ni) above the arrow, and the product ethane. Writing structural or molecular formulae both earn marks, but showing the double bond clearly is important.
- **(iii)** The key contrast examiners look for: saturated (animal fats) = harmful; unsaturated (vegetable oils) = healthier. One sentence is enough for 1 mark.

Q22. deep exam-ready **[3]**

Give reasons for the following:
(i) The melting and boiling points of covalent compounds are generally low.
(ii) Unsaturated hydrocarbons burn with a sooty yellow flame.
(iii) Methanol is far more dangerous to consume than ethanol.

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Model Answer

(i) Covalent compounds have low melting and boiling points because, although the covalent bonds within molecules are strong, the **intermolecular forces** between molecules are very weak. Very little energy is needed to overcome these weak forces.

(ii) Unsaturated hydrocarbons have a high proportion of carbon relative to hydrogen. They undergo incomplete combustion due to insufficient oxygen, releasing fine carbon particles (soot) that glow yellow, producing a sooty yellow flame.

(iii) Methanol is far more dangerous because even a small quantity can cause death. In the liver, methanol is oxidised to methanal (formaldehyde), which coagulates the protoplasm of cells and damages the optic nerve, causing permanent blindness or death.

Explanation

- For (i), the key phrase from the textbook is: *"covalently bonded molecules have strong bonds within the molecule, but intermolecular forces are weak"* — always mention both aspects.
- For (ii), the sooty flame question tests understanding of C:H ratio and incomplete combustion — link high carbon content → insufficient oxygen → soot.
- For (iii), quote the specific biochemical effect (methanal, protoplasm coagulation, optic nerve damage) — these are the scoring points examiners look for.

Q23. medium exam-ready **[3]**

Draw the structural formulae of the two possible structural isomers of butane (C_4H_{10}) and write their common names. State one physical property that differs between the two isomers and explain why the difference exists.

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Model Answer

Structural Isomers of Butane (C_4H_{10}):

1. n-Butane (Normal butane) — straight chain

$$CH_3 - CH_2 - CH_2 - CH_3$$

2. Isobutane (2-methylpropane) — branched chain

$$CH_3 - \underset{\displaystyle |}{\overset{\displaystyle |}{C}}H(CH_3) - CH_3$$

i.e., $CH_3{-}CH(CH_3){-}CH_3$

Differing Physical Property — Boiling Point:
n-Butane has a higher boiling point (−1°C) than isobutane (−12°C).

Reason: n-Butane has a longer, straight chain, allowing greater surface area for intermolecular interactions. Isobutane's branched, compact shape reduces surface contact, resulting in weaker intermolecular forces and hence a lower boiling point.

Source: Carbon and its Compounds, Section 4.2.2

Explanation

- **2 marks** are for drawing both correct structural formulae with common names — examiners check that all C and H valencies are satisfied and the chain/branch is clearly shown.
- **1 mark** is for naming a physical property *and* giving a reason. Boiling point is the safest choice; melting point is also acceptable.
- Write the branched structure clearly, showing the side —CH_3 group attached to the middle carbon; don't just write the molecular formula.
- The reason must link **molecular shape → surface area → intermolecular forces → boiling point** to earn the mark; just saying "different structures" is not enough.

Q24. medium exam-ready **[5]**

(i) A substance 'X' has the molecular formula C_2H_5OH.

(a) Write the IUPAC name of X.

(b) Write the chemical equation for its dehydration using excess concentrated H_2SO_4 at 443 K. Name the product formed.

(c) What type of reaction is this dehydration — addition, substitution or elimination?

(ii) When X reacts with sodium, a gas Y is produced. Identify Y and write the balanced chemical equation for the reaction.

(iii) State any one industrial or medical use of X.

◆ Carbon and its Compounds

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Model Answer

(i)(a) The IUPAC name of X (C_2H_5OH) is **Ethanol**.

(i)(b) Dehydration of ethanol with excess conc. H_2SO_4 at 443 K:

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

The product formed is **ethene** (an unsaturated hydrocarbon).

(i)(c) This dehydration is an **elimination** reaction (water molecule is eliminated from ethanol).

(ii) When ethanol reacts with sodium, the gas produced is **hydrogen (H_2)**.

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

(Sodium ethoxide is the other product.)

(iii) Ethanol is used as a solvent in **medicines** such as tincture iodine, cough syrups, and tonics. / It is also used as an **industrial solvent**.

Source: Chapter 4, Section 4.4.1 — Properties of Ethanol

Explanation

- **(i)(b):** Write the arrow with "Hot conc. H_2SO_4" and temperature above it; examiners check for conditions.
- **(i)(c):** The textbook calls this a reaction to give an "unsaturated hydrocarbon," but the reaction type is **elimination** — water is *removed* from the molecule. State this clearly.
- **(ii):** The balanced equation must show **2Na** and **2C₂H₅OH** on the left; one-sided equations lose marks.
- **(iii):** Any one valid use (medicinal solvent **or** industrial solvent **or** fuel additive) is enough for 1 mark — don't write all; it wastes time.
- Keep equations balanced and conditions labelled — these are the two most common mark-losing errors.

Q25. deep exam-ready **[5]**

(i) Explain in detail the cleansing action of soap. In your answer, include:
(a) the structure of a soap molecule with reference to its hydrophilic and hydrophobic ends.
(b) how a micelle forms and what it traps.
(c) why the micelle stays suspended in water without precipitating.
(ii) Why does soap fail to clean clothes effectively in hard water? How do detergents overcome this problem?
(iii) Write a chemical reaction to show what happens when the ester ethyl ethanoate is treated with sodium hydroxide solution.

◆ Carbon and its Compounds

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Model Answer

(i) Cleansing Action of Soap:

(a) A soap molecule is a sodium/potassium salt of a long-chain carboxylic acid. It has two ends: a **hydrophilic** (ionic) end that attracts water, and a **hydrophobic** (hydrocarbon tail) end that repels water but interacts with oil/grease.

(b) When soap is added to water containing oily dirt, the hydrophobic tails of soap molecules orient themselves into the oil droplet, while the hydrophilic ionic ends face outward toward water. This cluster is called a **micelle**. The oily dirt is trapped in the interior of the micelle.

(c) Micelles remain suspended in water as a **colloid** and do not precipitate because of **ion–ion repulsion** between the negatively charged ionic ends on the surface. The suspended dirt is then rinsed away easily.

(ii) In hard water, soap reacts with calcium and magnesium salts to form an insoluble white **scum** (curdy precipitate), reducing its cleaning ability. **Detergents** are sodium salts of sulphonic acids whose charged ends do **not** form insoluble precipitates with Ca^{2+}/Mg^{2+} ions, so they remain effective in hard water.

(iii) When ethyl ethanoate is treated with NaOH, **saponification** occurs:

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

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

Source: Chapter 4, Section 4.5 Soaps and Detergents; Section 4.4.2 Properties of Ethanoic Acid

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Explanation

- For part (i), examiners look for all three terms: **hydrophilic**, **hydrophobic**, **micelle**, and the specific reason micelles don't precipitate (**ion–ion repulsion**). Missing any loses a mark.
- For part (ii), the key words are **scum/insoluble precipitate** (for soap's failure) and **sulphonic acid salts / no insoluble precipitate** (for detergents). Don't just say "detergents work in hard water" — explain *why*.
- For part (iii), write the balanced equation clearly and name the reaction (**saponification**) for full credit.

Q26. deep exam-ready **[5]**

(i) Draw the structures of all possible structural isomers of pentane (C_5H_{12}). How many structural isomers are possible?
(ii) State the two characteristic properties of carbon responsible for forming such a large number of compounds.
(iii) Among the homologous series of alkanes, how do the following properties change as the molecular mass increases? Give a reason.
(a) Boiling point
(b) Chemical properties
(iv) Write the general formula for alkanes and use it to find the molecular formula of the alkane with 7 carbon atoms.

◆ Carbon and its Compounds

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Model Answer

(i) Structural Isomers of Pentane (C_5H_{12}):

Three structural isomers are possible:

1. **n-Pentane** (straight chain):

C—C—C—C—C

1. **Isopentane** (one branch):

```
C
|
C—C—C—C
```

1. **Neopentane** (two branches):

```
C
|
C—C—C
|
C
```

Total: 3 structural isomers

(ii) Two characteristic properties of carbon:

1. **Catenation** – Carbon atoms can bond with other carbon atoms to form long chains, branched chains, and rings.
2. **Tetravalency** – Carbon has a valency of four, allowing it to bond with four other atoms simultaneously, forming a large variety of compounds.

(iii)

(a) **Boiling point** *increases* with molecular mass, because larger molecules have stronger intermolecular forces, requiring more energy to overcome.

(b) **Chemical properties** remain *similar* within a homologous series, because all members have the same functional group (or none, for alkanes).

(iv) General formula of alkanes: $\mathbf{C_nH_{2n+2}}$

For 7 carbon atoms (n = 7):
$C_7H_{2(7)+2}$ = **C_7H_{16}** (Heptane)

Source: Carbon and its Compounds, Sections 4.2.2 and 4.2.5

Explanation

- For part (i), CBSE expects you to draw all three skeletal/structural forms clearly — examiners award 1 mark per correct structure and 1 mark for stating the count.
- For part (ii), the exact terms **catenation** and **tetravalency** must appear — these are directly from the "What you have learnt" summary.
- For part (iii), state the trend AND give a reason — both are needed for full marks.
- For part (iv), memorise the general formula **C_nH_{2n+2}** and show substitution of n=7 explicitly.

Q27. medium exam-ready **[4]**

Read the following and answer the questions that follow:

Rahim noticed that the bottom of his cooking vessel was turning black on the outside. His science teacher explained that the colour of the flame from a gas stove depends on the air supply. When sufficient air enters through the inlets of the burner, the fuel burns completely giving a clean blue flame. If the air holes are blocked, the flame becomes yellow and sooty, and unburnt carbon is deposited. The teacher also told him that fuels such as coal and petroleum contain small amounts of nitrogen and sulphur, and their combustion produces additional harmful gases.

(i) Why does a yellow sooty flame form when air supply is limited? (1 mark)
(ii) Name the two additional harmful gases released when coal or petroleum containing nitrogen and sulphur burns. (1 mark)
(iii) Write a balanced chemical equation for the complete combustion of methane. (1 mark)
(iv) What should Rahim do to fix the sooty flame problem in his stove? (1 mark)

♦ Carbon and its Compounds

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Model Answer

(i) When air supply is limited, combustion is incomplete. The fuel does not burn fully, and unburnt carbon particles are released, producing a yellow sooty flame with black smoke (carbon/soot deposition).

(ii) The two harmful gases released are **oxides of sulphur (SO_2)** and **oxides of nitrogen (NO_x)**.

(iii) Balanced chemical equation for complete combustion of methane:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{heat and light}$$

(iv) Rahim should **clean and unblock the air holes/inlets** of the burner so that sufficient air enters and the fuel burns completely, giving a clean blue flame.

Source: Chapter 4, Section 4.3.1 Combustion

Explanation

- **(i)** Key phrase: "incomplete combustion" → unburnt carbon → soot/yellow flame. Examiners expect this cause-effect link.
- **(ii)** Must name both gases specifically — "oxides of sulphur and oxides of nitrogen." Simply writing "SO_2 and NO_2" also acceptable.
- **(iii)** Balancing is critical: CH_4 needs **$2O_2$** on the left and **$2H_2O$** on the right. Unbalanced equation loses the mark.
- **(iv)** The passage directly states: blackened vessel bottoms mean air holes are blocked. The fix is to clear those holes — state this clearly.

Q28. medium exam-ready **[4]**

Read the following and answer the questions that follow:

Preeti carried out an experiment in the school laboratory. She took some ethanol in a test tube and warmed it gently in a water bath. She then added alkaline potassium permanganate solution drop by drop. She noted that the purple colour disappeared initially. When she added excess potassium permanganate, the colour persisted. Her teacher told her that the product formed has a sharp smell and turns blue litmus red. The teacher further demonstrated that when this product is added to a solution of sodium carbonate, brisk effervescence is observed.

(i) Name the product formed when ethanol is oxidised by alkaline potassium permanganate. (1 mark)
(ii) Why does the purple colour of potassium permanganate disappear when added initially, but persist when added in excess? (1 mark)
(iii) Write the balanced chemical equation for the reaction of this product with sodium carbonate solution. (1 mark)
(iv) Name the class of organic compound to which the product belongs and write its functional group. (1 mark)

♦ Carbon and its Compounds

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Model Answer

(i) The product formed is **ethanoic acid (CH_3COOH)**. It has a sharp smell and turns blue litmus red.

(ii) Initially, the $KMnO_4$ is consumed in oxidising ethanol to ethanoic acid, so the purple colour disappears. When ethanol is completely used up, excess $KMnO_4$ has nothing left to oxidise, so the purple colour persists.

(iii) Balanced equation:

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

(Brisk effervescence is due to CO_2 gas evolved.)

(iv) The product belongs to the class **carboxylic acids**. Its functional group is **–COOH** (carboxyl group).

Source: Chapter 4, Section 4.3.2 – Oxidation

Explanation

- **(i)** Ethanol + alkaline $KMnO_4$ → ethanoic acid is the standard oxidation reaction; examiners expect the IUPAC name and formula.
- **(ii)** The key logic: $KMnO_4$ acts as the oxidising agent and gets reduced (loses purple colour) until all ethanol is oxidised; excess $KMnO_4$ remains unreacted.
- **(iii)** Write the balanced equation carefully — common error is forgetting to balance the 2 moles of acid vs. 1 mole of Na_2CO_3.
- **(iv)** "Carboxylic acid" as the class and "–COOH" as the functional group must both be stated for full credit.

Q29. deep exam-ready **[4]**

Read the following and answer the questions that follow:

A chemistry teacher showed students two test tubes — one containing distilled water and another containing hard water collected from a hand pump. To each test tube, she added a few drops of soap solution and shook them vigorously. The distilled water produced a large, stable lather, while the hard water produced very little lather and instead formed a white curdy precipitate. She then repeated the experiment using detergent solution instead of soap. This time, both test tubes produced good lather and no curdy precipitate was observed.

(i) What is the chemical nature of the white curdy precipitate formed when soap is used with hard water? (1 mark)
(ii) Why does distilled water produce lather easily with soap but hard water does not? (1 mark)
(iii) Explain why detergent is effective in hard water but soap is not. (1 mark)
(iv) A student suggests using soap solution (instead of detergent) to test whether a given water sample is hard. Is this a valid test? Give a reason. (1 mark)

♦ Carbon and its Compounds

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Model Answer

(i) The white curdy precipitate is an insoluble calcium or magnesium salt of the fatty acid (soap). It is formed when soap reacts with calcium and magnesium salts dissolved in hard water.

(ii) Distilled water does not contain calcium or magnesium salts, so soap lathers easily. Hard water contains these salts, which react with soap to form insoluble scum, leaving little soap available to form lather.

(iii) Detergents are sodium salts of sulphonic acids. Their charged ends do **not** form insoluble precipitates with calcium and magnesium ions in hard water, so they remain effective and produce good lather, unlike soap.

(iv) Yes, it is a valid test. Soap produces a white curdy precipitate (scum) with hard water and no stable lather, while it forms a good lather with soft water. Detergent cannot be used for this test since it lathers equally in both types of water.

Source: Chapter 4, Section 4.5 — Soaps and Detergents

Explanation

- **(i)** Examiners expect you to identify the precipitate as insoluble calcium/magnesium soap (salt of fatty acid). Saying just "scum" without the chemical nature may lose the mark.
- **(ii)** The key contrast is presence vs. absence of Ca^{2+}/Mg^{2+} ions — link these directly to scum formation.
- **(iii)** The critical point is that the charged ends of detergent molecules do **not** react with Ca^{2+}/Mg^{2+} to form precipitates — state this explicitly.
- **(iv)** The textbook itself asks "Would you be able to check if water is hard by using a detergent?" — the answer is **no** for detergent but **yes** for soap. Make sure you give a reason, not just yes/no.

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