



OCR A H432

Alkanes

Original exam questions | TEST IT → EXAM STYLE → HARDER MIXED → STRETCH

SPECIFICATION-LED. PROGRESSIVE. MECHANISM-PRECISE.

OCR A SPECIFICATION	4.1.2(a–g) structure, properties, combustion and radical substitution		
TEST IT	EXAM STYLE	HARDER MIXED	STRETCH
8	10	5	1
24 QUESTIONS ORIGINAL		147 MARKS TOTAL	

FINAL NOTES-ALIGNED EDITION | BONDING • BOILING • COMBUSTION • RADICALS

Independent practice material. Every question is original and mapped to OCR A Chemistry A H432 specification version 3.1 (May 2026).

START HERE

How to use this pack

Attempt each question independently, then use the worked answers to repair the first lost mark

- 1 Complete TEST IT without the notes, then move through the sections in order.
- 2 For boiling-point explanations, link structure to molecular contact, London forces, energy and boiling point.
- 3 For radical mechanisms, audit atoms, radical count, dot position and the stage before moving on.
- 4 Redraw every incorrect structure or mechanism rather than only reading the model answer.

OCR A BOUNDARY	This pack assesses OCR A 4.1.2(a–g): alkane bonding and shape, boiling-point trends, low reactivity, combustion, carbon monoxide and chlorine/bromine radical substitution.
HELD BACK	Crude oil, fractional distillation, cracking, hybridisation, fishhook arrows, extended pollution chemistry and later haloalkane reactions are not assessed.
QUESTION PAGES	There are no method grids or route prompts. Written parts have one visible grey dotted line per mark; drawing tasks use dedicated blank areas.
MECHANISM STANDARD	Every radical carries one clear dot. UV is shown only as the condition or on initiation. Propagation has one radical in and one out; termination has two in and none out.
DIAGRAM STANDARD	Model structures use equal bond lengths, correct atom attachment and clear wedge-and-dash geometry. Tetrahedral refers to the arrangement around each carbon.

SECTION A

TEST IT

Eight direct checks of the finished-notes mastery outcomes

QUESTION 1

TEST IT

(a) Define a hydrocarbon.

[1 mark]

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(b) State what is meant by saturated.

[1 mark]

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(c) State the general formula of an open-chain alkane.

[1 mark]

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(d) Deduce the molecular formula of the alkane containing seven carbon atoms.

[1 mark]

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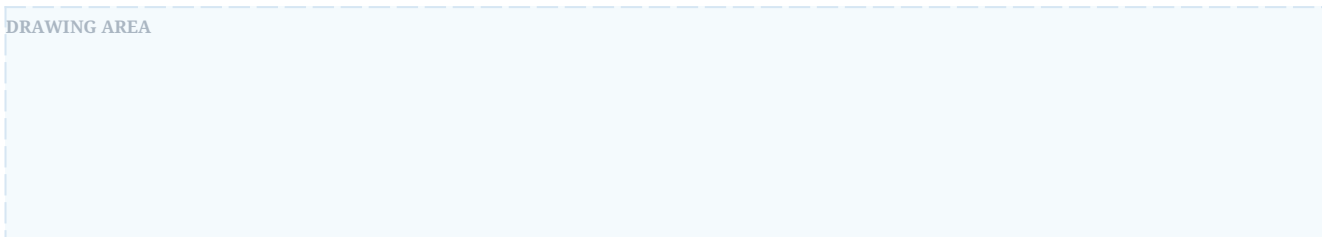
QUESTION 2

TEST IT

(a) Sketch and label how direct orbital overlap forms a C–C σ bond. Show the shared electron pair in the overlap.

[2 marks]

DRAWING AREA



(b) State and explain one consequence of this direct overlap.

[2 marks]

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QUESTION 3

TEST IT

(a) Draw a three-dimensional diagram of methane, CH₄.

[1 mark]

DRAWING AREA

(b) State the shape and H–C–H bond angle.

[2 marks]

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(c) Explain the shape using electron-pair repulsion.

[2 marks]

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QUESTION 4

TEST IT

(a) Explain why hexane has a higher boiling point than ethane.

[4 marks]

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QUESTION 5**TEST IT**

Pentane and 2,2-dimethylpropane are structural isomers.

(a) Predict which isomer has the higher boiling point.

[1 mark]

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(b) Explain your answer fully.

[3 marks]

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QUESTION 6**TEST IT**

(a) Explain why alkanes react with relatively few reagents.

[2 marks]

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QUESTION 7**TEST IT**

Butane is used as a fuel.

(a) Write a balanced equation for the complete combustion of butane.

[2 marks]

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(b) Butane burns in limited oxygen to form carbon monoxide and water. Write a balanced equation.

[2 marks]

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(c) Explain why carbon monoxide is dangerous.

[2 marks]

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QUESTION 8

TEST IT

(a) Define a radical.

[1 mark]

(b) Define homolytic fission in terms of the bonded pair of electrons.

[2 marks]

(c) State the role of ultraviolet radiation in the reaction of an alkane with bromine.

[1 mark]

(d) Write the initiation equation for bromine. Show every radical dot.

[1 mark]

SECTION B

EXAM STYLE

Ten original structured questions using OCR A command words and marking logic

QUESTION 9

EXAM STYLE

The boiling points of four straight-chain alkanes are shown.

ALKANE	BOILING POINT / °C
n-butane	-0.5
n-pentane	36.1
n-hexane	68.7
n-heptane	98.4

(a) State the trend shown by the data.

[1 mark]

(b) Explain the trend.

[4 marks]

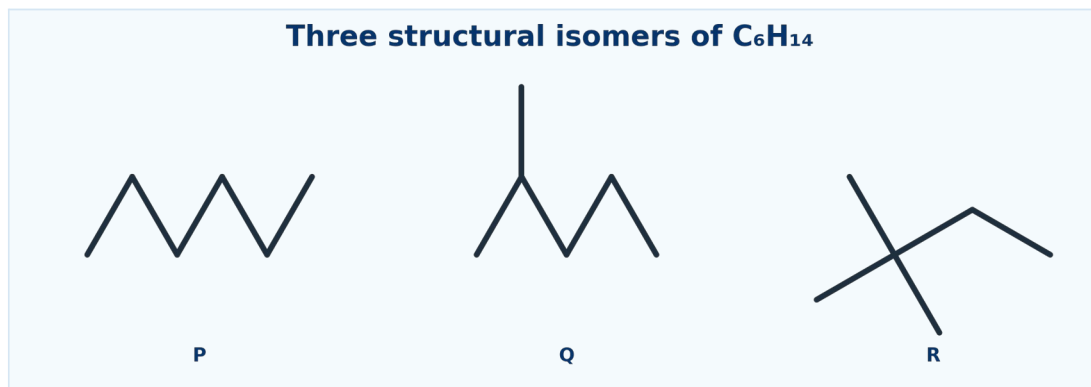
(c) Predict whether n-octane has a boiling point above or below 98.4 °C.

[1 mark]

QUESTION 10

EXAM STYLE

P, Q and R are three structural isomers of C_6H_{14} . Their boiling points are 49.7 °C, 60.3 °C and 68.7 °C.



(a) Match each boiling point to P, Q and R.

[3 marks]

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(b) Explain the order of boiling points.

[4 marks]

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QUESTION 11

EXAM STYLE

A student states: 'The arrangement around each carbon atom in ethane is square planar, with bond angles of 90° .'

- (a) Identify the two errors in the student's statement. [2 marks]

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- (b) Draw the correct three-dimensional arrangement around one carbon atom in ethane. [1 mark]

DRAWING AREA

- (c) State the correct shape and bond angle. [2 marks]

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- (d) Explain the shape using electron-pair repulsion. [1 mark]

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QUESTION 12

EXAM STYLE

A propane camping heater is used in a poorly ventilated room.

- (a) Write a balanced equation for combustion of propane to form carbon monoxide and water. [2 marks]

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- (b) Explain why carbon monoxide may not be noticed and why it is dangerous. [3 marks]

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- (c) Explain how better ventilation reduces the risk. [1 mark]

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QUESTION 13

EXAM STYLE

Methane reacts with chlorine by radical substitution.

- (a) State the condition and write the initiation equation.

[2 marks]

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- (b) Write both propagation equations for the formation of chloromethane.

[2 marks]

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- (c) Write three different termination equations involving the radicals present.

[3 marks]

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- (d) Explain why the propagation steps form a chain reaction.

[1 mark]

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QUESTION 14

EXAM STYLE

The following equations occur during the bromination of ethane.

EQUATION	REACTION
A	$\text{Br}_2 \rightarrow 2\text{Br}^\bullet$
B	$\text{Br}^\bullet + \text{C}_2\text{H}_6 \rightarrow \text{HBr} + \text{C}_2\text{H}_5^\bullet$
C	$\text{C}_2\text{H}_5^\bullet + \text{Br}_2 \rightarrow \text{C}_2\text{H}_5\text{Br} + \text{Br}^\bullet$
D	$\text{C}_2\text{H}_5^\bullet + \text{Br}^\bullet \rightarrow \text{C}_2\text{H}_5\text{Br}$

- (a) State the condition required for reaction A.

[1 mark]

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- (b) Classify A–D as initiation, propagation or termination.

[4 marks]

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- (c) Use the radical count to explain why C is a propagation step.

[1 mark]

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QUESTION 15

EXAM STYLE

Propane reacts with chlorine under ultraviolet radiation.

- (a) Draw and name both different monochlorinated organic products.

[4 marks]

DRAWING AREA

- (b) Explain why both products form.

[1 mark]

- (c) Write the overall equation for formation of 1-chloropropane.

[1 mark]

QUESTION 16

EXAM STYLE

Chloromethane undergoes further substitution with chlorine under ultraviolet radiation.

- (a) Write the two propagation equations that form dichloromethane, CH_2Cl_2 .

[2 marks]

- (b) State the formulae of the two still more substituted products that can form.

[2 marks]

- (c) Explain why CH_2Cl_2 is not the only organic product when irradiation continues.

[2 marks]

QUESTION 17

EXAM STYLE

A student says: 'Hexane is relatively unreactive, so it cannot burn.'

(a) Explain why hexane is relatively unreactive and why it nevertheless burns after ignition.

[4 marks]

QUESTION 18

EXAM STYLE

A reaction mixture contains $\text{Cl}\cdot$, $\text{CH}_3\text{CH}_2\cdot$ and $\text{H}_3\text{C}-\text{C}\cdot\text{H}-\text{CH}_3$. The dot in the last species is on the central carbon atom.

(a) Write termination equations that form (i) chloroethane, (ii) 2-chloropropane and (iii) a C_5 alkane.

[3 marks]

(b) Name the C_5 alkane formed.

[1 mark]

(c) Explain why all three equations are termination steps.

[1 mark]

SECTION C

HARDER MIXED

Five less-scaffolded applications requiring careful chemical audits

QUESTION 19

HARDER MIXED

A student writes four equations for bromination of propane. Every equation contains one chemical error.

EQUATION	STUDENT EQUATION
1	$\text{Br}_2 \xrightarrow{\text{UV}} \text{Br}^+ + \text{Br}^-$
2	$\text{Br}^\bullet + \text{CH}_3\text{CH}_2\text{CH}_3 \rightarrow \text{HBr} + \text{CH}_3\text{CH}_2\text{CH}_3^\bullet$
3	$\text{CH}_3\text{CH}_2\text{CH}_2^\bullet + \text{Br}_2 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$
4	$\text{CH}_3\text{CH}_2\text{CH}_2^\bullet + \text{Br}^\bullet \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{Br}^\bullet$

(a) For each equation, identify the error and write the fully corrected equation.

[8 marks]

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QUESTION 20

HARDER MIXED

Consider the claim: 'A more-branched alkane always boils below every straight-chain alkane.'

ALKANE	BOILING POINT / °C
n-pentane	36.1
2,2-dimethylbutane	49.7
n-hexane	68.7

(a) Evaluate the claim using the data and the molecular factors that control boiling point.

[6 marks]

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QUESTION 21

HARDER MIXED

An open-chain alkane has the formula C_nH_{2n+2} .

(a) Derive a balanced general equation for complete combustion.

[4 marks]

(b) Derive the corresponding general equation for incomplete combustion to carbon monoxide and water.

[3 marks]

(c) Use $n = 6$ to write the balanced equation for complete combustion of hexane.

[1 mark]

QUESTION 22

HARDER MIXED

A chemist uses a large excess of propane and a limited amount of chlorine under ultraviolet radiation to favour monochlorination, then attempts to isolate 1-chloropropane.

(a) Explain what this choice improves and why it still cannot produce pure 1-chloropropane.

[6 marks]

QUESTION 23

HARDER MIXED

Butane reacts with bromine under ultraviolet radiation.

(a) Draw and name both different monobrominated structural isomers.

[4 marks]

DRAWING AREA

(b) Write both propagation equations specifically for the formation of 2-bromobutane. Show the radical dot on the correct carbon.

[2 marks]

(c) Write a termination equation between two butan-2-yl radicals and give the molecular formula of the product.

[2 marks]

(d) Explain why longer irradiation produces more than the two monobrominated products.

[2 marks]

SECTION D

STRETCH / SYNOPTIC

One final problem connecting shape, intermolecular forces, combustion and substitution

QUESTION 24

STRETCH

Compound P is 2-methylbutane, $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$.

- (a) Draw the three-dimensional arrangement around carbon 2. State the shape and bond angle, then explain the arrangement.

[4 marks]

DRAWING AREA

- (b) Explain why P has a lower boiling point than pentane.

[4 marks]

- (c) Write the balanced equation for complete combustion of P.

[2 marks]

- (d) Draw every different monochlorinated structural isomer obtainable from P.

[4 marks]

DRAWING AREA

- (e) Explain why still more organic products form during prolonged irradiation.

[1 mark]



CrackingCHEM

GCSE | A-LEVEL

UNDERSTAND • APPLY • SUCCEED

OCR A H432

Alkanes

Fully worked answers | OCR A-style marking guidance

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OCR A SPECIFICATION	4.1.2(a–g) structure, properties, combustion and radical substitution		
TEST IT	EXAM STYLE	HARDER MIXED	STRETCH
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24 QUESTIONS MARKED		147 MARKS EXPLAINED	

FINAL NOTES-ALIGNED EDITION | BONDING • BOILING • COMBUSTION • RADICALS

Independent practice material. Every question is original and mapped to OCR A Chemistry A H432 specification version 3.1 (May 2026).

OCR A MAP

How this pack matches the specification

Full coverage of 4.1.2(a–g), with later organic chemistry held back

OCR A REF	WHAT IS ASSESSED	FREQUENT TRAP	QUESTIONS
4.1.2(a)	Saturation, σ bonding, direct overlap and free rotation.	Drawing π -type density above and below the bond.	1–2
4.1.2(b)	Tetrahedral arrangement around carbon and 109.5° .	Calling a displayed formula square planar.	3, 11, 24
4.1.2(c)	Chain length and branching effects on boiling point.	Breaking covalent bonds during boiling.	4–5, 9–10, 20, 24
4.1.2(d)	Low reactivity from high bond enthalpy and very low polarity.	Calling alkanes completely inert.	6, 17
4.1.2(e)	Complete/incomplete combustion and danger from CO.	Unbalanced oxygen or vague 'CO is toxic'.	7, 12, 17, 21, 24
4.1.2(f)	Cl ₂ and Br ₂ radical substitution under UV; all three stages.	Missing dots, HCl/HBr or regenerated radical.	8, 13–14, 16, 18–19, 23
4.1.2(g)	Mixtures from different positions and further substitution.	Claiming positional products form equally.	15–16, 22–24
BOUNDARY	No crude-oil processing, cracking, hybridisation, fishhook arrows, extended pollution chemistry, product-ratio predictions or later haloalkane reactions are assessed.		
MARKING LOGIC	Boiling marks require intermolecular reasoning. Mechanism marks require correct atoms, radical counts, dot positions and stages. Mixture marks require different substitution positions and further substitution.		

SECTION A

TEST IT ANSWERS

Exact definitions, explanation chains and equation checks

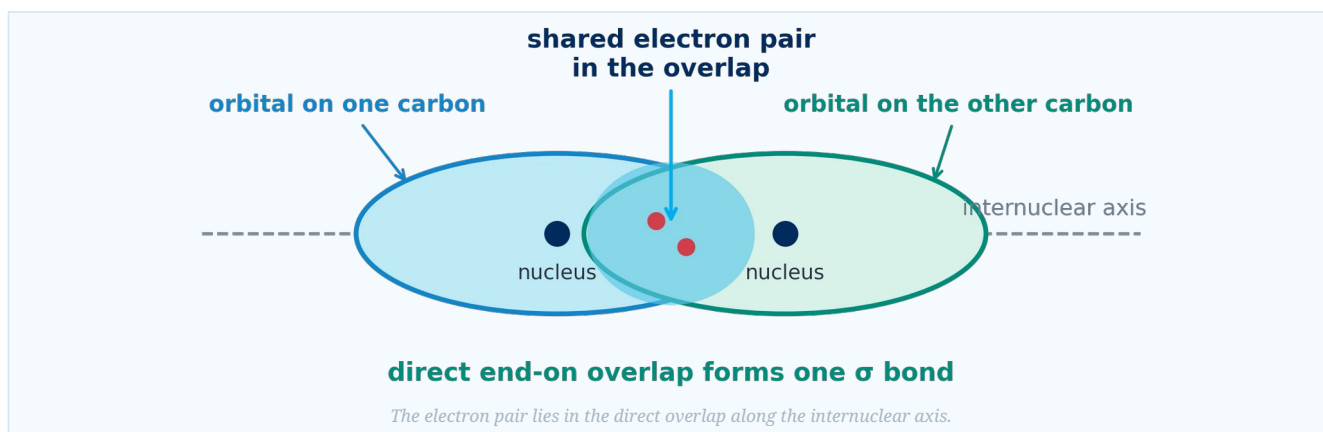
QUESTION 1 | TEST IT ANSWER

4 MARKS

- A hydrocarbon contains carbon and hydrogen only [1]
- Saturated means that there are only single carbon-carbon bonds [1]
- General formula: C_nH_{2n+2} [1]
- For $n = 7$: C_7H_{16} [1]

QUESTION 2 | TEST IT ANSWER

4 MARKS

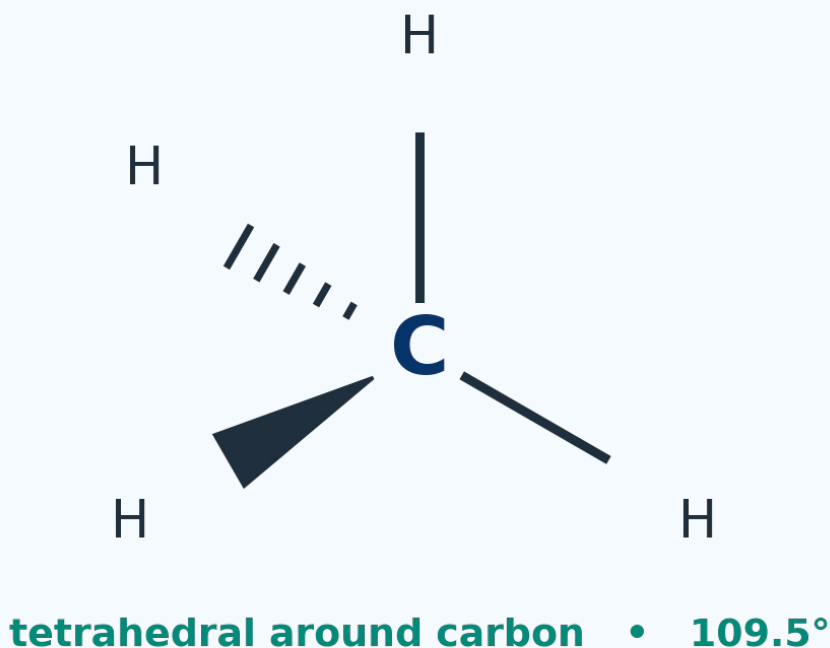


- Two orbitals overlap directly / end-on along the line joining the nuclei, with the shared pair in the overlap [2]
- There is free rotation about the C-C σ bond [1]
- Rotation about the bond axis does not remove the direct overlap [1]

EXAMINER
GUIDANCEElectron density above and below the bond would describe a π bond, not a σ bond.

QUESTION 3 | TEST IT ANSWER

5 MARKS



- Correct wedge-and-dash three-dimensional diagram [1]
- Tetrahedral [1]
- 109.5° [1]
- Four bonding electron pairs repel equally and arrange as far apart as possible [2]

**EXAMINER
GUIDANCE**

State that electron pairs repel. OCR does not award this explanation for saying that atoms repel.

QUESTION 4 | TEST IT ANSWER

4 MARKS

- Hexane has more electrons / a larger electron cloud [1]
- Hexane has greater contact between neighbouring molecules [1]
- Its induced dipole–dipole interactions (London forces) are stronger [1]
- More energy is required to overcome these intermolecular forces, so its boiling point is higher [1]

QUESTION 5 | TEST IT ANSWER

4 MARKS

- Pentane has the higher boiling point [1]
- Pentane is less compact and has greater contact between neighbouring molecules [1]
- Its London forces are stronger [1]
- More energy is required to overcome the forces [1]

**EXAMINER
GUIDANCE**

The two isomers have the same number of electrons. Do not use electron number to explain a branching comparison.

QUESTION 6 | TEST IT ANSWER

2 MARKS

- C–C and C–H σ bonds have high bond enthalpies, so considerable energy is needed to break them [1]
- The bonds have very low polarity, so there are no significant δ^+ or δ^- sites to attract polar or ionic reagents [1]

QUESTION 7 | TEST IT ANSWER

6 MARKS

(a)

- $2\text{C}_4\text{H}_{10} + 13\text{O}_2 \rightarrow 8\text{CO}_2 + 10\text{H}_2\text{O}$: correct formulae [1]
- Correct smallest whole-number coefficients [1]

(b)

- $2\text{C}_4\text{H}_{10} + 9\text{O}_2 \rightarrow 8\text{CO} + 10\text{H}_2\text{O}$: correct formulae [1]
- Correct smallest whole-number coefficients [1]

(c)

- Carbon monoxide binds strongly to haemoglobin [1]
- This reduces the blood's ability to transport oxygen [1]

QUESTION 8 | TEST IT ANSWER

5 MARKS

- A radical is a species with an unpaired electron [1]
- Homolytic fission divides the bonded pair equally so that each bonded atom receives one electron, forming two radicals [2]
- UV supplies energy to break the Br–Br bond homolytically [1]
- $\text{Br}_2 \xrightarrow{\text{UV}} 2\text{Br}\cdot$ [1]

EXAMINER
GUIDANCE

UV is an energy source and reaction condition, not a catalyst or reactant.

SECTION B

EXAM STYLE ANSWERS

Worked routes and OCR-style marking guidance

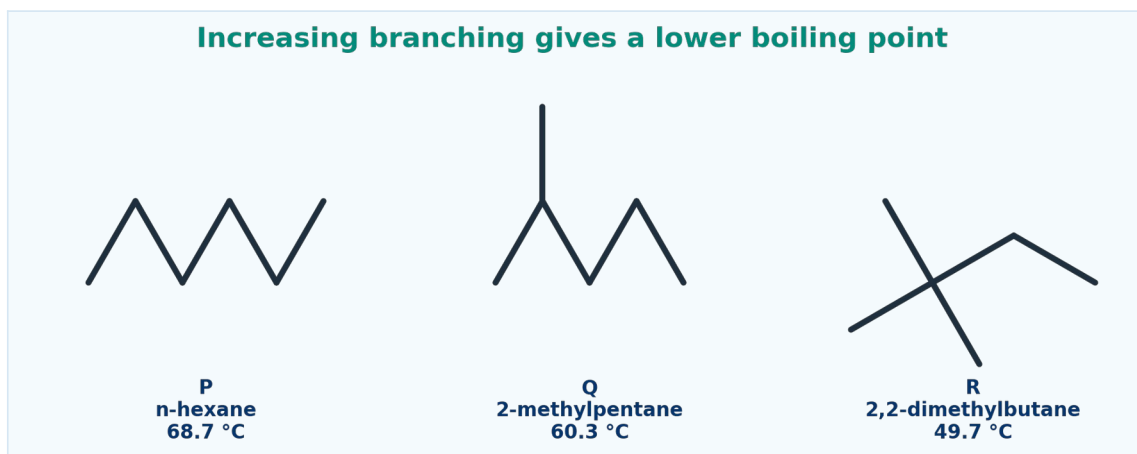
QUESTION 9 | EXAM STYLE ANSWER

6 MARKS

- Boiling point increases as the straight carbon chain becomes longer [1]
- Longer chains contain more electrons / have larger electron clouds [1]
- There is greater contact between neighbouring molecules [1]
- The London forces are stronger [1]
- More energy is required to overcome the intermolecular forces [1]
- n-octane should boil above 98.4°C [1]

QUESTION 10 | EXAM STYLE ANSWER

7 MARKS

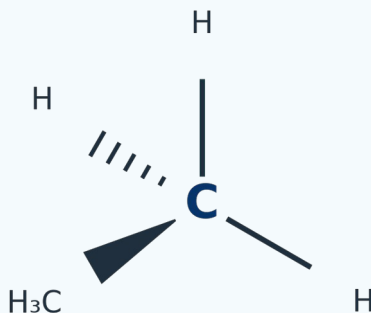


- $P = 68.7^\circ\text{C}$; $Q = 60.3^\circ\text{C}$; $R = 49.7^\circ\text{C}$ [3]
- The isomers have the same molecular formula and electron count [1]
- Increasing branching makes the molecule more compact and reduces contact between molecules [1]
- The London forces become weaker [1]
- Less energy is required to overcome the forces, so boiling point falls [1]

QUESTION 11 | EXAM STYLE ANSWER

6 MARKS

- The arrangement is not square planar [1]
- The bond angle is not 90° [1]



local arrangement in ethane • tetrahedral • 109.5°

- Correct wedge-and-dash local arrangement around the carbon [1]
- Tetrahedral [1]
- 109.5° [1]
- Four bonding electron pairs repel and arrange as far apart as possible [1]

QUESTION 12 | EXAM STYLE ANSWER

6 MARKS

- $2\text{C}_3\text{H}_8 + 7\text{O}_2 \rightarrow 6\text{CO} + 8\text{H}_2\text{O}$ [2]
- CO is colourless and odourless, so it may not be noticed [1]
- CO binds strongly to haemoglobin and reduces oxygen transport [2]
- Ventilation supplies more oxygen, favouring complete combustion and reducing CO formation [1]

QUESTION 13 | EXAM STYLE ANSWER

8 MARKS

- Ultraviolet radiation is required; $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$ [2]
- $\text{Cl}\cdot + \text{CH}_4 \rightarrow \text{HCl} + \text{CH}_3\cdot$ [1]
- $\text{CH}_3\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{Cl}\cdot$ [1]
- $\text{Cl}\cdot + \text{Cl}\cdot \rightarrow \text{Cl}_2$ [1]
- $\text{CH}_3\cdot + \text{Cl}\cdot \rightarrow \text{CH}_3\text{Cl}$ [1]
- $\text{CH}_3\cdot + \text{CH}_3\cdot \rightarrow \text{C}_2\text{H}_6$ [1]
- A chlorine radical is regenerated in propagation and can repeat the cycle [1]

EXAMINER
GUIDANCE

Every radical dot is part of the formula. A missing dot changes the species and loses the mechanism mark.

QUESTION 14 | EXAM STYLE ANSWER

6 MARKS

- A requires ultraviolet radiation [1]
- A is initiation [1]
- B is propagation [1]
- C is propagation [1]
- D is termination [1]
- C has one radical reactant and one radical product; $\text{Br}\cdot$ is regenerated [1]

QUESTION 15 | EXAM STYLE ANSWER

6 MARKS

STRUCTURAL FORMULA	NAME
$\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$	1-chloropropane
$\text{CH}_3\text{CHClCH}_3$	2-chloropropane

- Both correct structures [2]
- Both correct names [2]
- Hydrogen atoms can be replaced at different carbon positions in propane [1]
- $\text{CH}_3\text{CH}_2\text{CH}_3 + \text{Cl}_2 \xrightarrow{\text{UV}} \text{CH}_3\text{CH}_2\text{CH}_2\text{Cl} + \text{HCl}$ [1]

EXAMINER
GUIDANCE

Do not claim that the two positional products form in equal amounts.

QUESTION 16 | EXAM STYLE ANSWER

6 MARKS

- $\text{Cl}\cdot + \text{CH}_3\text{Cl} \rightarrow \text{HCl} + \cdot\text{CH}_2\text{Cl}$ [1]
- $\cdot\text{CH}_2\text{Cl} + \text{Cl}_2 \rightarrow \text{CH}_2\text{Cl}_2 + \text{Cl}\cdot$ [1]
- CHCl_3 [1]
- CCl_4 [1]
- CH_2Cl_2 still contains C–H bonds that can undergo substitution [1]
- Further substitution therefore gives additional chlorinated products in the mixture [1]

QUESTION 17 | EXAM STYLE ANSWER

4 MARKS

- C–C and C–H bonds have high bond enthalpies [1]
- The bonds have very low polarity [1]
- Ignition supplies the initial activation energy [1]
- Combustion is exothermic and releases energy overall [1]

QUESTION 18 | EXAM STYLE ANSWER

5 MARKS

- $\text{CH}_3\text{CH}_2\cdot + \text{Cl}\cdot \rightarrow \text{CH}_3\text{CH}_2\text{Cl}$ [1]
- $\text{H}_3\text{C}-\text{C}\cdot\text{H}-\text{CH}_3 + \text{Cl}\cdot \rightarrow \text{CH}_3\text{CHClCH}_3$ [1]
- $\text{CH}_3\text{CH}_2\cdot + \text{H}_3\text{C}-\text{C}\cdot\text{H}-\text{CH}_3 \rightarrow \text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$ [1]
- The C_5 product is 2-methylbutane [1]
- Each equation has two radicals as reactants and no radical product [1]

SECTION C

HARDER MIXED ANSWERS

Less-scaffolded reasoning with explicit chemical audits

QUESTION 19 | HARDER MIXED ANSWER

8 MARKS

- 1 forms ions instead of radicals; correct equation: $\text{Br}_2 \xrightarrow{\text{UV}} 2\text{Br}\cdot$ [2]
- 2 leaves an impossible extra H on the radical; correct equation: $\text{Br}\cdot + \text{CH}_3\text{CH}_2\text{CH}_3 \rightarrow \text{HBr} + \text{CH}_3\text{CH}_2\text{CH}_2\cdot$. Also accept formation of $\text{H}_3\text{C}-\text{C}\cdot\text{H}-\text{CH}_3$ if the radical dot is clearly on carbon 2 [2]
- 3 omits the regenerated radical; correct equation: $\text{CH}_3\text{CH}_2\text{CH}_2\cdot + \text{Br}_2 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{Br} + \text{Br}\cdot$ [2]
- 4 leaves a dot on a stable termination product; correct equation: $\text{CH}_3\text{CH}_2\text{CH}_2\cdot + \text{Br}\cdot \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$ [2]

EXAMINER
GUIDANCE

For each equation, audit atom count and radical count separately. A plausible product is not enough.

QUESTION 20 | HARDER MIXED ANSWER

6 MARKS

- The claim is false [1]
- Branched C_6H_{14} at 49.7°C still boils above straight-chain C_5H_{12} at 36.1°C [1]
- The C_6 molecule has more electrons / a larger, more polarizable electron cloud than C_5 [1]
- It therefore has stronger London forces overall, so more energy is needed to overcome them than for C_5 [1]
- Within the C_6H_{14} isomer set, branching makes molecules more compact, reduces contact and weakens London forces [1]
- Branching lowers boiling point relative to isomers of the same formula, but it does not override carbon number across different formulae [1]

QUESTION 21 | HARDER MIXED ANSWER

8 MARKS

(a)

- Carbon balance gives $2n\text{CO}_2$ when two alkane molecules are used [1]
- Hydrogen balance gives $2(n+1)\text{H}_2\text{O}$ [1]
- Oxygen balance gives $(3n+1)\text{O}_2$ [1]
- $2\text{C}_n\text{H}_{2n+2} + (3n+1)\text{O}_2 \rightarrow 2n\text{CO}_2 + 2(n+1)\text{H}_2\text{O}$ [1]

(b)

- Carbon balance gives $2n\text{CO}$ and hydrogen balance gives $2(n+1)\text{H}_2\text{O}$ [1]
- Oxygen balance gives $(2n+1)\text{O}_2$ [1]
- $2\text{C}_n\text{H}_{2n+2} + (2n+1)\text{O}_2 \rightarrow 2n\text{CO} + 2(n+1)\text{H}_2\text{O}$ [1]

(c)

- $2\text{C}_6\text{H}_{14} + 19\text{O}_2 \rightarrow 12\text{CO}_2 + 14\text{H}_2\text{O}$ [1]

EXAMINER
GUIDANCE

Equivalent equations with fractional oxygen coefficients are fully correct: $\text{C}_n\text{H}_{2n+2} + (3n+1)/2 \text{O}_2 \rightarrow n\text{CO}_2 + (n+1)\text{H}_2\text{O}$, and $\text{C}_n\text{H}_{2n+2} + (2n+1)/2 \text{O}_2 \rightarrow n\text{CO} + (n+1)\text{H}_2\text{O}$.

QUESTION 22 | HARDER MIXED ANSWER

6 MARKS

- With excess propane, a chlorine radical is more likely to encounter propane than a chloropropane molecule [1]
- This reduces further substitution [1]
- Propane contains hydrogen atoms at different carbon positions [1]
- Both 1-chloropropane and 2-chloropropane therefore form [1]
- The first chlorinated products still contain C-H bonds [1]
- Some further substitution can still occur, so the organic product is a mixture [1]

EXAMINER
GUIDANCE

OCR awards the limitation marks for different substitution positions and further substitution. Separation or yield comments do not replace those statements.

QUESTION 23 | HARDER MIXED ANSWER

10 MARKS

(a)

STRUCTURAL FORMULA	NAME
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$	1-bromobutane
$\text{CH}_3\text{CHBrCH}_2\text{CH}_3$	2-bromobutane

- Both correct structures [2]
- Both correct names [2]

(b)

- $\text{Br}\cdot + \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \rightarrow \text{HBr} + \text{H}_3\text{C}-\text{C}\cdot\text{H}-\text{CH}_2-\text{CH}_3$ [1]
- $\text{H}_3\text{C}-\text{C}\cdot\text{H}-\text{CH}_2-\text{CH}_3 + \text{Br}_2 \rightarrow \text{CH}_3\text{CHBrCH}_2\text{CH}_3 + \text{Br}\cdot$ [1]

(c)

- $\text{H}_3\text{C}-\text{C}\cdot\text{H}-\text{CH}_2-\text{CH}_3 + \text{H}_3\text{C}-\text{C}\cdot\text{H}-\text{CH}_2-\text{CH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)-\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$ [1]
- Molecular formula C_8H_{18} [1]

(d)

- The monobrominated products still contain C-H bonds [1]
- Further substitution produces additional polybrominated organic products [1]

EXAMINER
GUIDANCE

The carbon radical in both propagation equations is the same carbon that carries Br in 2-bromobutane.

SECTION D

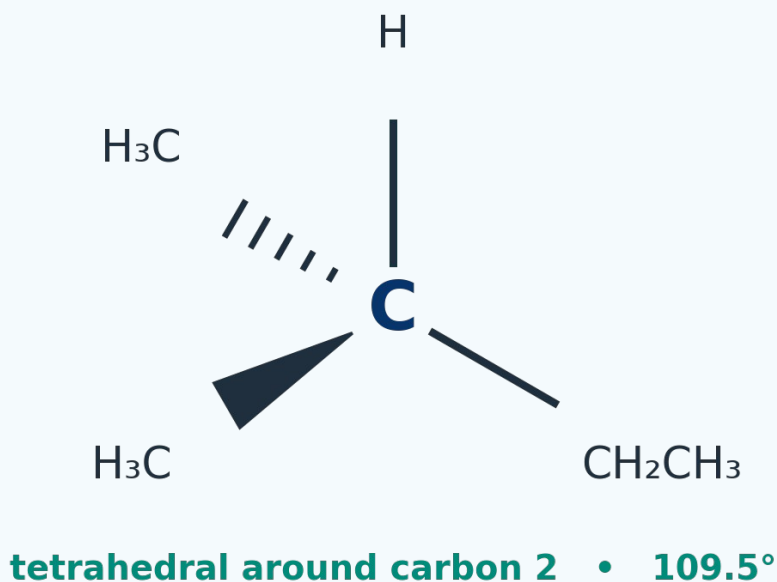
STRETCH / SYNOPTIC ANSWER

One complete model connecting four OCR A ideas

QUESTION 24 | STRETCH ANSWER

15 MARKS

(a)



- Correct local 3D arrangement around carbon 2 [1]
 - Tetrahedral [1]
 - 109.5° [1]
 - Four bonding electron pairs repel and arrange as far apart as possible [1]
- (b)
- P and pentane have the same molecular formula and electron count [1]
 - P is more branched / more compact and has less contact between neighbouring molecules [1]
 - P has weaker London forces [1]
 - Less energy is required to overcome the forces, so P has the lower boiling point [1]

(c)

- $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$: correct products [1]
- Correct balanced coefficients [1]

(d)

STRUCTURAL FORMULA	NAME
$ClCH_2CH(CH_3)CH_2CH_3$	1-chloro-2-methylbutane
$CH_3C(Cl)(CH_3)CH_2CH_3$	2-chloro-2-methylbutane
$CH_3CH(CH_3)CHClCH_3$	2-chloro-3-methylbutane
$CH_3CH(CH_3)CH_2CH_2Cl$	1-chloro-3-methylbutane

- One mark for each different correct structure; names are shown for checking [4]

(e)

- Each monochlorinated product still contains C-H bonds, so further substitution can occur [1]

EXAMINER
GUIDANCE

The two methyl groups directly attached to carbon 2 in 2-methylbutane are equivalent, so replacing H in either gives the same product.