

Hydrocarbons

AS & A Level

Question Paper 1

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Core Organic Chemistry
Topic	Hydrocarbons
Paper	AS & A Level
Booklet	Question Paper 1

Time allowed: 86 minutes

Score: /64

Percentage: /100

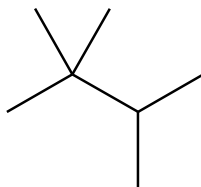
Grade Boundaries:

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

Question 1

This question is about different alkanes present in crude oil.

(a) Compound **A**, shown below, is one of the structural isomers of C_7H_{16} .



Compound **A**

(i) What is meant by the term *structural isomers*? [1]

(i) Name compound **A**. [1]

[1]

(b) The structural isomers of C_5H_{12} have different boiling points.

Draw the **skeletal formula** of the structural isomer of C_5H_{12} with the highest boiling point.

(c) A molecule of an alkane has 24 carbon atoms.

State the empirical formulae of this alkane. [1]

(d) Alkanes are used as fuels.

(i) Construct an equation for the complete combustion of octane C_8H_{18} . [1]

(ii) Combustion of 36.48 g of octane produced 2.50 mol of carbon dioxide.
Show that this combustion was incomplete. [2]

(e) Alkanes in crude oil can be used to manufacture ethene. Two stages are required.

(i) Name the **two** stages. [1]

(ii) Write an equation for the preparation of ethene from an alkane. [1]

[Total 9 Marks]

Question 2

Allyl bromide, $\text{CH}_2=\text{CHCH}_2\text{Br}$, is used in the production of polymers.

- (a) Part of the $\text{C}=\text{C}$ double bond in allyl bromide is called a π -bond.

Draw a labelled diagram to show the formation of the π -bond.

[2]

- (b) Allyl bromide is a member of a homologous series. Compounds in this series have the same general formula.

- (i) What is meant by the term *homologous series*?

[2]

- (ii) What is the general formula of the homologous series that has allyl bromide as a member?

[1]

- (iii) Give the systematic name for allyl bromide.

[1]

- (c) Reaction mechanisms use curly arrows and can involve electrophiles and nucleophiles.

- (i) What does a *curly arrow* represent in mechanisms?

[1]

- (i) What is meant by the term *nucleophile*?

[1]

(d) Allyl bromide, $\text{CH}_2=\text{CHCH}_2\text{Br}$, reacts with aqueous sodium hydroxide.

(i) Outline the mechanism of this reaction.

Include curly arrows, relevant dipoles and final product(s).

[3]

(ii) Name the type of mechanism.

[1]

(e) Allyl bromide, $\text{CH}_2=\text{CHCH}_2\text{Br}$, reacts with bromine, Br_2 .

(i) Outline the mechanism of this reaction.

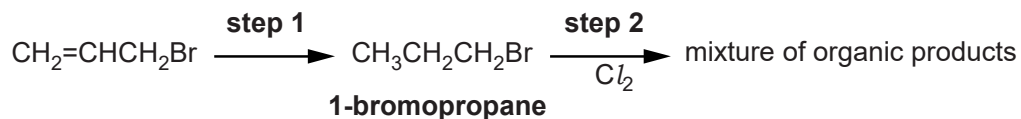
Include curly arrows, relevant dipoles and the structures of the intermediate and final product(s).

[4]

(ii) Name the type of mechanism.

[1]

(f) Allyl bromide is reacted as shown below.



(i) State the reagents and conditions for **step 1**

[1]

(ii) In **step 2**, 1-bromopropane reacts with chlorine by radical substitution.

Outline the mechanism for the monochlorination of 1-bromopropane.
In your mechanism, you can show the formula of 1-bromopropane as $\text{C}_3\text{H}_7\text{Br}$.

Include the names of the three stages in this mechanism, state the essential conditions and all termination steps.

[5]

(iii) Radical substitution produces a mixture of organic products.

Suggest **two** reasons why.


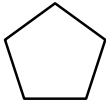
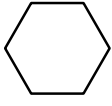
[2]

[Total 25 Marks]

Question 3

This question is about cyclic organic compounds.

The table shows some information about cycloalkanes.

Cycloalkane	Skeletal formula	Boiling point / °C
Cyclopropane		-33
Cyclopentane		49
Cyclohexane		81

(a) These cycloalkanes are members of the same homologous series and have the same general formula.

(i) What is meant by the term *homologous series*? [2]

(ii) State the general formula for these cycloalkanes. [1]

(iii) Explain the increase in boiling points of the cycloalkanes shown in the table. [2]

- (b) The C–C–C bond angles in **cyclohexane** are 109.5° .
State and explain the shape around each carbon atom in cyclohexane. [2]
- (c) In the absence of ultraviolet radiation, **cyclopropane** undergoes an addition reaction with bromine.
Suggest the structure of the organic product formed in this reaction. [1]
- (d) Petrol contains both **cyclohexane**, C_6H_{12} , and hexane.
Cyclohexane can be prepared from hexane.
- (i) Construct the equation for this reaction. [1]
- (i) Suggest **one** advantage of adding cyclohexane to hexane in petrol. [1]
- (e) **Cyclobutane** is another cycloalkane.
There are several **unsaturated** isomers of cyclobutane that are alkenes. Two of these isomers are stereoisomers.
- (i) Explain what is meant by the term *stereoisomers*. [1]
- (i) Draw these **two** stereoisomers. [2]

- (f) In the presence of ultraviolet radiation, **cyclohexane** reacts with bromine.

A mixture of cyclic organic compounds is formed, including $C_6H_{11}Br$.

- (i) Complete the table below to show the mechanism of the reaction between bromine and cyclohexane to form $C_6H_{11}Br$.

Include all possible termination steps in your answer.

[5]

Step	Equation
Initiation	
Propagation	
Termination	

- (ii) The initiation step involves homolytic fission.

Explain why the initiation step is an example of *homolytic fission*.

[1]

- (g) The reaction between cyclohexane and bromine in (f) also forms $C_6H_{10}Br_2$.

- (i) Write an equation, using molecular formulae, for the reaction of cyclohexane and bromine in the presence of ultraviolet radiation to form $C_6H_{10}Br_2$.

[1]

- (i) Name **one** of the structural isomers of $C_6H_{10}Br_2$ formed in the reaction between cyclohexane and bromine.

[1]

[Total 21 Marks]

Question 4

Crude oil is a complex mixture of many hydrocarbons.

Crude oil is processed by the petroleum industry to make fuels and petrochemicals.

(a) The straight-chain alkane, **A**, is present in crude oil.

A has molecules with ten carbon atoms.

(i) What is the molecular formula of **A**?

[1]

(ii) **B** is a branched-chain isomer of **A**.

Draw the skeletal formula of a possible structure for **B**.

Name your structure.

[2]

(iii) The branched-chain isomer **B** has a lower boiling point than the straight chain alkane **A**.

Explain why.

[2]

(b) A chemist heats a pure sample of $C_{15}H_{32}$ in the presence of a catalyst.

A reaction called cracking happens.

(i) Construct an equation to show the cracking of $C_{15}H_{32}$.

[1]

(i) When cracking takes place, a large number of products are formed.

Suggest why a large number of products are formed.

[1]

(c) The petroleum industry processes straight-chain alkanes into cyclic hydrocarbons.

For example, octane can be processed into a cyclic hydrocarbon and hydrogen.

(i) Suggest the structure of this cyclic hydrocarbon. [1]

(ii) Why does the petroleum industry process straight-chain alkanes into cyclic hydrocarbons? [1]

[Total 9 Marks]