Hydrocarbons
AS & A Level

Question Paper 2

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Core Organic Chemistry
Topic	Hydrocarbons
Paper	AS & A Level
Booklet	Question Paper 2

Time allowed: **85 minutes**

Score: **/63**

Percentage: **/100**

Grade Boundaries:

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

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Methane and ethane are important fuels.

(a) Methane could be manufactured by the reaction between carbon dioxide and hydrogen.

$$CO_2(g) + 4H_2(g) \longrightarrow CH_4(g) + 2H_2O(g)$$

Using the table of bond enthalpies, calculate the enthalpy change of reaction for this manufacture of methane.

bond	average bond enthalpy / kJ mol^{-1}
C–H	+415
H–H	+436
C=O	+805
O–H	+464

(b) Methane is a greenhouse gas. Scientists are concerned that the concentration of methane in the atmosphere is slowly increasing.

[3]

(i) Explain how atmospheric methane molecules can contribute to global warming. [2]

(ii) One way that scientists hope to minimise global warming is by developing Carbon Capture and Storage, CCS, techniques.

Describe **two** of these CCS techniques. [2]

(c) Ethane reacts with bromine in the presence of ultraviolet radiation to form many organic products.

(i) Two of these products are bromoethane and hydrogen bromide.

Describe the mechanism of the reaction between ethane and bromine that forms bromoethane and hydrogen bromide.

Include in your answer

- the type of bond fission that occurs
- equations for each step of the reaction
- the name of each step of the reaction.

Your answer needs to be clear and well organised using the correct terminology. [7]

(ii) Give **two** reasons why there are many organic products of the reaction between bromine and ethane. [2]

[Total: 16 Marks]

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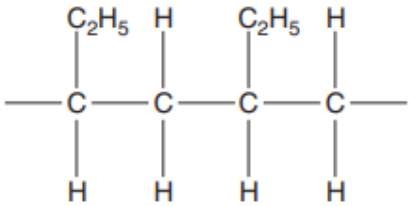
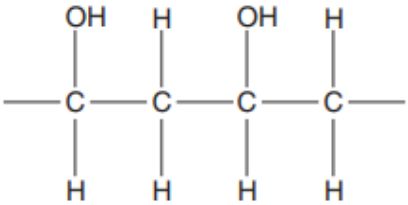
Plastics contain polymer molecules. The disposal of waste plastics is causing many environmental problems. In the middle of the Pacific Ocean, there is a huge area of sea water contaminated with very small pieces of plastic waste. In some parts of the Pacific Ocean, there are as many as one third of a million of small pieces of plastic waste per square kilometre of ocean.

(a) A short section of one of the polymers found in the Pacific Ocean is shown below.



(i) Name and draw the structure of the monomer used to produce this polymer. [2]

(ii) The short section of poly(ethenol) is shown below.



Large quantities of poly(ethene) and poly(ethenol) are disposed of each year.

Poly(ethene) is found as a waste plastic in the Pacific Ocean but poly(ethenol) is not because it slowly dissolves in water.

Suggest why poly(ethenol) dissolves in water. [2]

(b) One way of disposing of poly(chloroethene) is incineration.

This process can cause environmental damage. Incineration produces a mixture of carbon dioxide, carbon monoxide and hydrogen chloride.

Carbon dioxide can cause climate change because it is a greenhouse gas.

- Describe examples of environmental damage that may result from carbon monoxide and hydrogen chloride.
- Outline the methods developed by chemists to reduce environmental damage caused by incineration. [4]

(c) Explain why it is important to establish international cooperation to reduce the pollution levels of waste plastics. [2]

[Total: 10 Marks]

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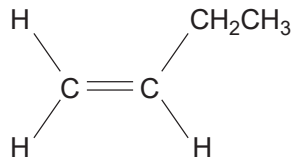
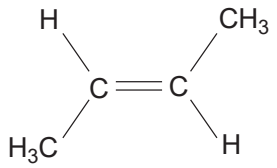
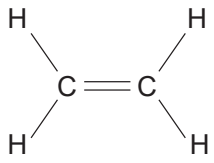
Alkenes **B**, **C**, **D**, **E** and **F** are shown below.



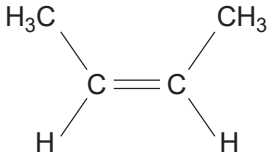
B



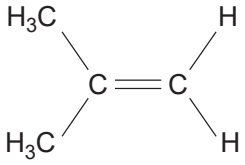
C



D



E



F

You will have to refer to these alkenes throughout the question.

(a) Describe, using the orbital overlap model, how the p-bond in alkene **D** is formed. [2]

(b) Many alkenes show *E*/*Z* isomerism.

(i) Explain why *E*/*Z* isomerism is shown in some alkenes. [2]

(ii) Which **two** alkenes are a pair of *E*/*Z* isomers?

Choose from **B**, **C**, **D**, **E** and **F**. [1]

(c) What is the main organic product of the reaction between alkene **D** and steam in the presence of a phosphoric acid catalyst? [1]

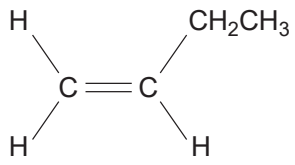
(d) Describe and explain the reaction of hydrogen bromide, HBr, with alkene **B** and with alkene **D**.

Include in your answer

- equations and structures of the products,
- why one of these alkenes gives just one product but the other gives more than one product,
- the reaction mechanism for the reaction with alkene **D** using the curly arrow model showing any relevant dipoles.

*Your answer needs to be clear and well organised using appropriate examples from the chemistry of alkenes **B** and **D**.* [9]

(e) Alkenes are a major source of polymers.
Alkene **B** can be polymerised.

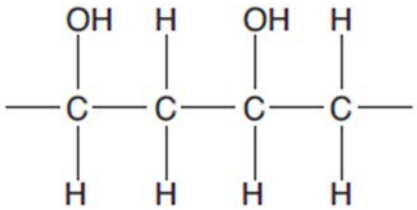


B

(i) Draw a section of the resultant polymer showing **two** repeat units. [1]

(ii) Give the name of this polymer. [1]

(f) Poly(ethenol) is a very unusual polymer because it can dissolve in water under certain conditions.



(i) Suggest why poly(ethenol) can dissolve in water. [2]

(ii) Waste poly(ethenol) does not cause many environmental problems.
Other polymers such as poly(ethene), PVC or PTFE cause significant environmental problems.

Outline **two** ways in which waste polymers can be processed to reduce their environmental impact. [2]

[Total 21 Marks]

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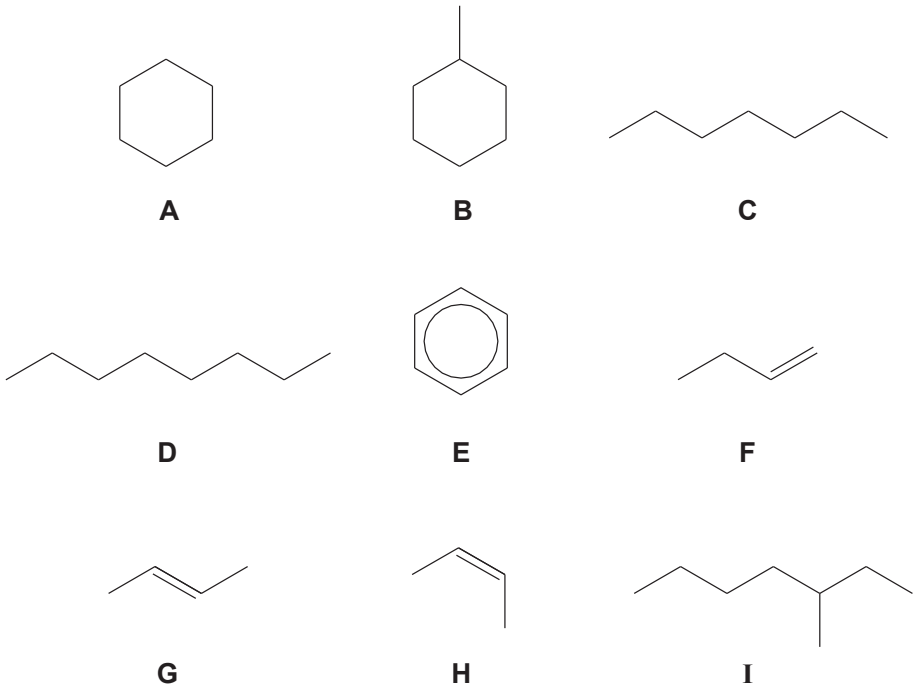
Crude oil is a source of many hydrocarbons.

The skeletal formulae of some of these hydrocarbons are shown below.



(a) Explain why compound **A** is both *saturated* and a *hydrocarbon*. [2]

(b) What is the empirical formula for compound **A**? [1]

(c) Give the letters, **A**, **B**, **C**, **D**, **E**, **F**, **G**, **H** or **I**, of two hydrocarbons that are structural isomers of each other. [1]

(d) The petroleum industry processes straight chain alkanes into cyclic hydrocarbons such as **A**, **B** and **E**.

(i) Explain why the petroleum industry processes straight chain alkanes into cyclic hydrocarbons. [1]

(ii) Hydrocarbon **C** can be processed into the cyclic hydrocarbon **B**. [1]

Construct an equation for this reaction.

(e) Explain why hydrocarbon **D** has a higher boiling point than hydrocarbon **C**. [2]

(f) Hydrocarbons **G** and **H** are stereoisomers of each other.

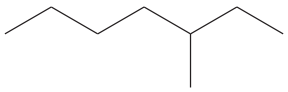
Explain what is meant by the term *stereoisomerism*. [2]

(g) Construct the equation for the **complete** combustion of hydrocarbon **C**. [2]

(h) A hydrocarbon molecule, $C_{16}H_{34}$, is cracked to form an octane molecule and two molecules of but-2-ene.

Construct the equation for this reaction. [1]

(i) Compound **I** is 3-methylheptane. It does not contain a functional group.



I

(i) What is meant by the term *functional group*? [1]

(ii) Compound **I** reacts with chlorine in the presence of ultraviolet radiation to give several structural isomers of $C_8H_{17}Cl$.

How many **structural** isomers could be formed in this reaction? [1]

(iii) The mechanism of the reaction involves radicals.

What is meant by the term *radical*? [1]

[Total: 16 Marks]