AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.7.1.4

Cracking and alkenes

Past-paper questions

Tier	**Higher**
Question groups	**26**
Available paper years	**2007–2019**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.7.1.4 Cracking and alkenes

Question 01

January 2007 | CHY1H | Original Q5 | Legacy

5 Crude oil is a mixture of mostly alkanes.

(a) Crude oil is separated into useful fractions by fractional distillation.

(i) Describe and explain how the mixture of alkanes is separated by fractional distillation.

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(3 marks)

(ii) The table gives the name and formula for each of the first three alkanes.

Complete the table to show the formula of butane.

Name of alkane	Formula
Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	

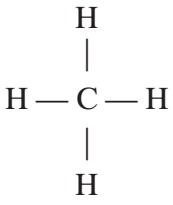
(1 mark)

4.7.1.4 Cracking and alkenes

Question 01 · continued

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(b) The structural formula of methane, CH_4, is:



Draw the structural formula of propane, C_3H_8

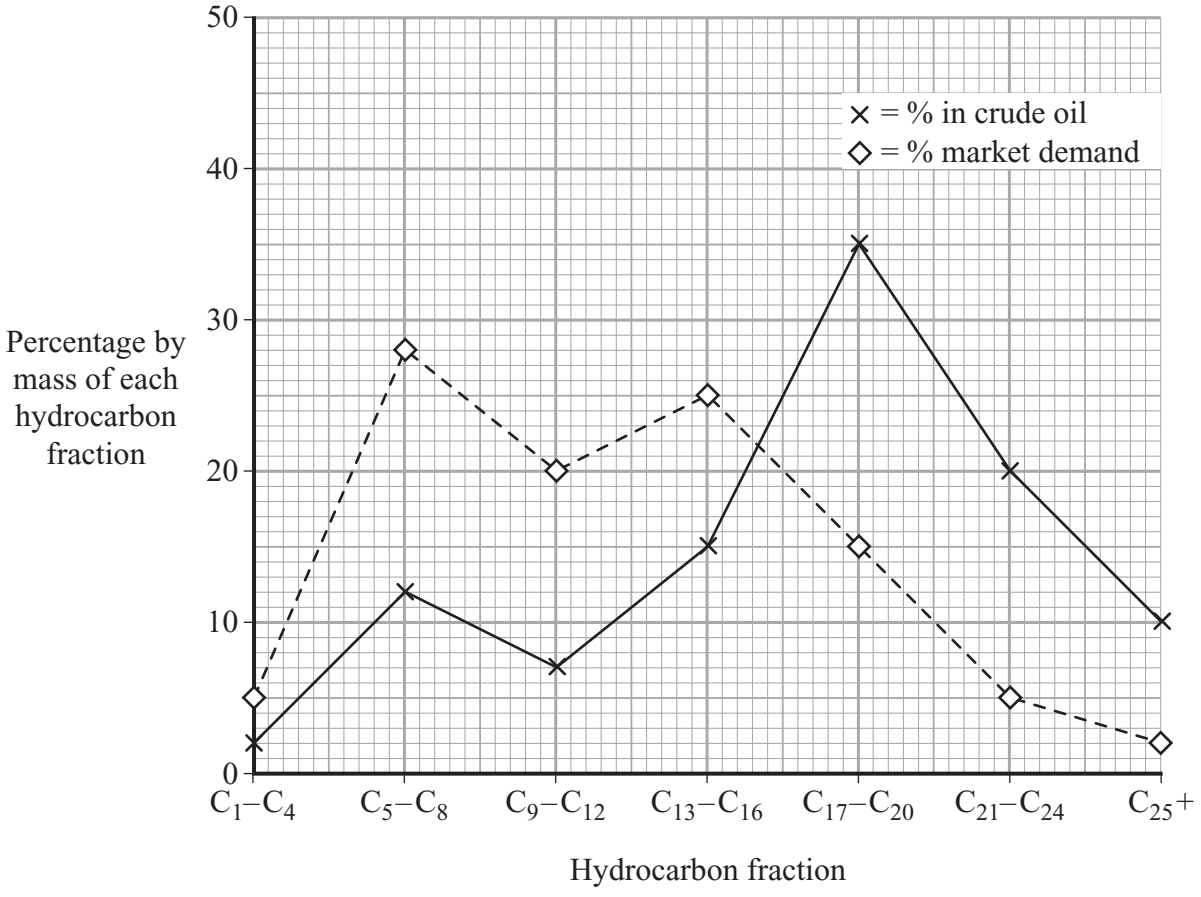
(1 mark)

Question 5 continues on the next page

Question 01 · continued

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(c) The relative amounts of and the market demand for some hydrocarbons from the fractional distillation of crude oil are shown in the graph.



(i) Why is the market demand for the $C_5–C_8$ fraction higher than the market demand for the $C_{21}–C_{24}$ fraction?

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(1 mark)

(ii) Cracking is used to break down large hydrocarbon molecules into smaller hydrocarbon molecules.

Complete the symbol equation by writing in the formula of the other hydrocarbon.

$C_{20}H_{42} \rightarrow C_{16}H_{34} + 2$ .....

(1 mark)

4.7.1.4 Cracking and alkenes

Question 01 · continued

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(iii) The C_5-C_8 fraction has low supply and high market demand.

Suggest **three** ways in which the oil industry could overcome this problem.

1 .....

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2 .....

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3 .....

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(3 marks)

10

4.7.1.4 Cracking and alkenes

Question 02

March 2007 | CHY1B | Original Q6 | Legacy

QUESTION SIX

Large hydrocarbon molecules can be broken down, by cracking, to produce smaller molecules.

An example of cracking is shown below:

$$C_{14}H_{30} \longrightarrow C_7H_{16} + C_3H_6 + 2C_2H_4$$

large hydrocarbon molecule — small hydrocarbon molecules

6A Which of the products of the cracking reaction could form polymers?

1 C_7H_{16} and C_3H_6

2 C_7H_{16} and C_2H_4

3 C_3H_6 and C_2H_4

4 C_7H_{16} only

6B The hydrocarbon with the formula C_2H_4 is . . .

1 ethane.

2 ethene.

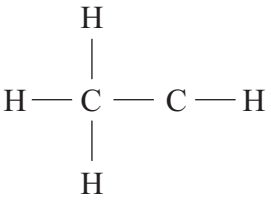
3 ethanol.

4 propene.

4.7.1.4 Cracking and alkenes

Question 02 · continued

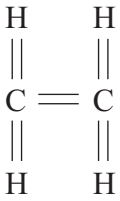
6C The hydrocarbon C_2H_4 can be represented as . . .



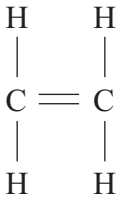
1



2



3



4

6D The general formula for the alkenes is . . .

1 C_nH_n

2 C_nH_{2n}

3 C_nH_{2n+2}

4 $C_{2n}H_n$

4.7.1.4 Cracking and alkenes

Question 03

June 2007 | CHY1B | Original Q7 | Legacy

QUESTION SEVEN

A compound, C_4H_{10}, was decomposed by passing it over a hot catalyst.

Analysis showed the product to be a mixture of two different hydrocarbons, hydrocarbon **A** (an alkane) and hydrocarbon **B**.
Both hydrocarbon **A** and hydrocarbon **B** had two carbon atoms in each molecule.

7A Which row in the table shows the correct formulae for these two hydrocarbons?

	Hydrocarbon A	Hydrocarbon B
1	C_2H_6	C_2H_4
2	C_2H_2	C_2H_8
3	C_2H_4	C_2H_6
4	C_2H_5	C_2H_5

7B The boiling point of hydrocarbon **A** is –89 °C and that of hydrocarbon **B** is –104 °C.

They could probably be separated and collected by . . .

1 thermal decomposition.

2 cracking.

3 condensation.

4 polymerisation.

7C Each of the two hydrocarbons was tested with bromine water.

Which row in the table correctly shows what happens to the bromine water?

	With hydrocarbon A	With hydrocarbon B
1	turns green	turns colourless
2	turns colourless	stays yellow-brown
3	stays yellow-brown	turns colourless
4	stays yellow-brown	turns green

4.7.1.4 Cracking and alkenes

Question 03 · continued

7D Of these two hydrocarbons, only hydrocarbon **B** can form polymers.

This is because . . .

1 it has a higher boiling point.

2 its molecule has a double carbon carbon bond.

3 its molecule is saturated.

4 it has smaller molecules.

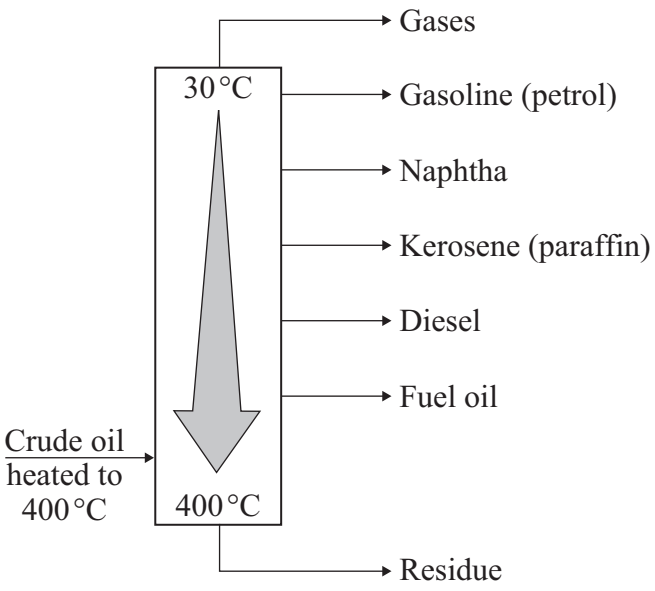
Turn over for the next question

4.7.1.4 Cracking and alkenes

Question 04

January 2008 | CHY1H | Original Q6 | Legacy

6 Crude oil is the source of many useful materials. Crude oil is separated into fractions by fractional distillation.



(a) Describe how the naphtha fraction separates from the other fractions.

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(2 marks)

(b) The naphtha fraction is often used to make other useful materials.
This involves the cracking of hydrocarbons in the naphtha fraction.

For example:

decane → hexane + ethene

$C_{10}H_{22} \rightarrow C_6H_{14} + C_2H_4$

(i) Balance the symbol equation given above.

(1 mark)

4.7.1.4 Cracking and alkenes

Question 04 · continued

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(ii) Describe how cracking is carried out.

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(2 marks)

(iii) Why does ethene have different chemical properties from decane and hexane?

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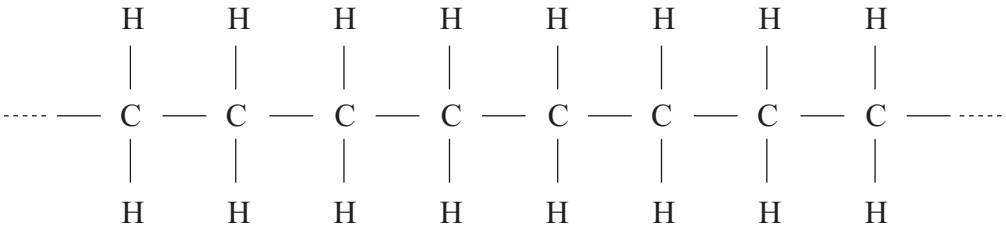
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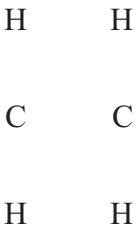
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(2 marks)

(c) Ethene is used as the starting material for many polymers. The most common polymer is poly(ethene). One hydrocarbon molecule in poly(ethene) will contain thousands of carbon atoms.



Complete the diagram to show the bonds in ethene.



(1 mark)

Question 6 continues on the next page

Question 04 · continued

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(d) Read the following information.

Landfill, Incineration, Recycling and Re-use of Poly(ethene)

People could be encouraged to re-use their poly(ethene) bags and containers.

Recycling poly(ethene) saves raw materials and energy needed to make new plastic. When polymers are recycled the plastics must be collected, transported, sorted into different types by hand and washed. This requires the use of fossil fuels and is expensive.

Poly(ethene) can be burnt in an incinerator with other household waste. The heat released could be used to make steam to drive an electric generator. Surplus heat could be used to heat greenhouses used for growing vegetables. Incineration at too low a temperature can produce harmful substances. The residue (ash) has to go to landfill.

Landfill is probably the easiest way to dispose of polymers and it is cheap. Polymers are often mixed in with other household rubbish. Household waste does not get sorted into different materials because it is disposed of in the same hole in the ground. When the hole is eventually full, the waste is covered by a layer of soil to stop it smelling. The waste gets compressed under its own weight. Most polymers, such as poly(ethene), are not biodegradable so will remain in the ground forever.

4.7.1.4 Cracking and alkenes

Question 04 · continued

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You are asked to decide which option for the disposal of poly(ethene) will be put forward in your area. You decide that recycling is the best option.

Suggest **one** economic argument and **one** environmental argument that will be made against recycling.

For each argument made, how will you persuade those making the argument to accept your option?
(You must use only one sentence for each argument made against your decision and only one sentence for your response to it.)

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(4 marks)

12

4.7.1.4 Cracking and alkenes

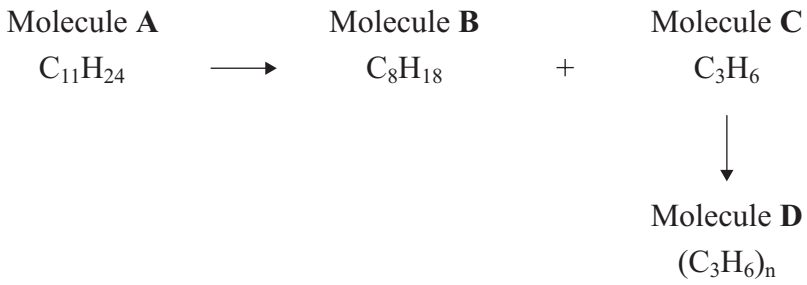
Question 05

March 2008 | CHY1BP | Original Q1 | Legacy

QUESTION ONE

This question is about cracking.

Match molecules, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.



Molecule . . . **1** . . . has been cracked.

Molecule . . . **2** . . . is an alkene.

Molecule . . . **3** . . . is a polymer.

Molecule . . . **4** . . . is the smallest alkane in the reaction.

4.7.1.4 Cracking and alkenes

Question 06

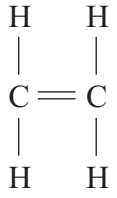
March 2008 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

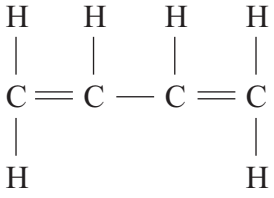
This question is about the formulae for four hydrocarbon compounds.

Match formulae, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

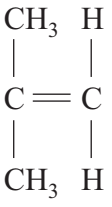
A



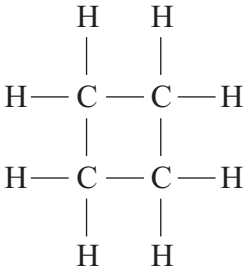
B

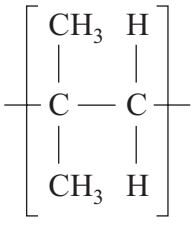


C



D



Hydrocarbon compound	Description
1	It does **not** fit the general formula C_nH_{2n}
2	It could be produced by cracking any of the other three.
3	It cannot be polymerised without further treatment.
4	It would produce a polymer with the repeating unit: 

4.7.1.4 Cracking and alkenes

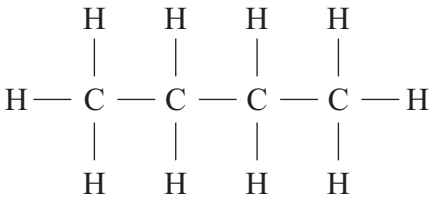
Question 07

June 2008 | CHY1BP | Original Q2 | Legacy

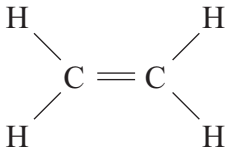
QUESTION TWO

This question is about carbon compounds.

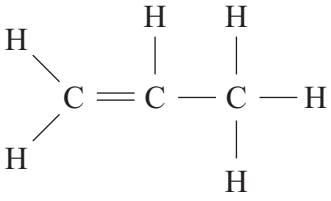
A



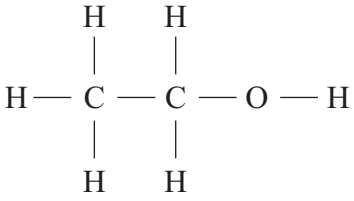
B



C



D



Match carbon compounds, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

	What we can say about the carbon compound
1	It is **not** a hydrocarbon.
2	It has the molecular formula C_2H_4
3	It is the monomer from which poly(propene) is made.
4	It can be cracked to produce propene.

4.7.1.4 Cracking and alkenes

Question 08

March 2009 | CHY1BP | Original Q6 | Legacy

QUESTION SIX

This question is about cracking large hydrocarbon molecules.

Cracking is achieved by using either a high temperature and pressure without a catalyst, or a low temperature and pressure with a catalyst.

Whichever method is chosen:

- the energy for cracking is provided by burning fossil fuels;
- the zeolite catalysts used are not very expensive;
- the catalyst is not used up in the process;
- the cracking plant is often built near the oil refinery.

6A Which of the following occurs during cracking?

1 Small hydrocarbon molecules join together.

2 The hydrocarbon molecules become saturated.

3 The hydrocarbon molecules react together.

4 The hydrocarbon molecules are decomposed.

6B In which equation do the products include two different alkenes?

1 $C_{15}H_{32} \rightarrow 2C_2H_4 + C_3H_6 + C_8H_{18}$

2 $C_{15}H_{32} \rightarrow C_2H_2 + C_5H_{10} + C_8H_{18} + H_2$

3 $C_{15}H_{32} \rightarrow C_8H_{18} + C_7H_{14}$

4 $C_{15}H_{32} \rightarrow C_7H_{16} + C_8H_{16}$

6C Which of the following shows only products that could be directly obtained by cracking $C_{10}H_{22}$?

1 alkanes up to $C_{20}H_{44}$, hydrogen and ethene

2 alkanes up to C_8H_{18}, carbon dioxide and ethene

3 propene, poly(ethene) and hydrogen

4 alkanes up to C_8H_{18}, ethene and propene

4.7.1.4 Cracking and alkenes

Question 08 · continued

6D These are the formulae for three hydrocarbons:

C_2H_4 C_2H_6 C_3H_6

Which row in the table shows the hydrocarbons that could form polymers, and gives the correct reason why they can polymerise?

	Hydrocarbons	Reason
1	C_2H_4 and C_2H_6	their molecules are saturated
2	C_2H_4 and C_3H_6	their molecules have a double carbon carbon bond
3	C_2H_4 and C_3H_6	their molecules are saturated
4	C_2H_4 and C_2H_6	their molecules have a double carbon carbon bond

Turn over for the next question

4.7.1.4 Cracking and alkenes

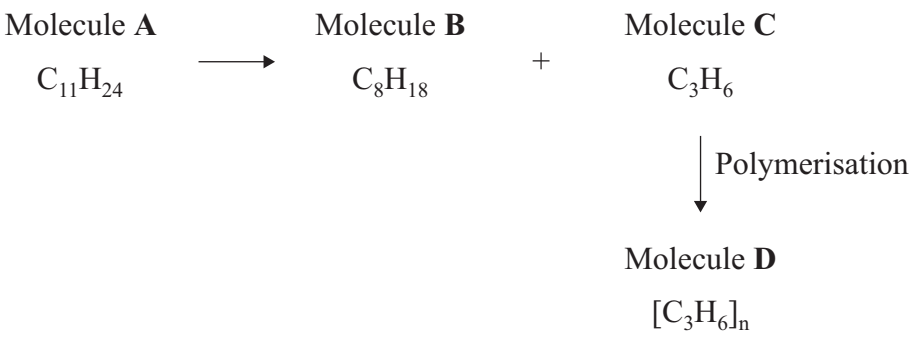
Question 09

June 2009 | CHY1BP | Original Q1 | Legacy

QUESTION ONE

This question is about reactions of some hydrocarbon molecules.

Match molecules, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.



The molecule that has been cracked is . . . **1** . . . .

The molecule that is an alkene is . . . **2** . . . .

The molecule that is a plastic is . . . **3** . . . .

The molecule that is the smallest alkane in these reactions is . . . **4** . . . .

4.7.1.4 Cracking and alkenes

Question 10

June 2009 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

This question is about obtaining useful substances from crude oil fractions.

Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A polymerisation

B thermal decomposition

C unsaturation

D hydration (addition of water)

Alkenes can be made from oil fractions by . . . **1** . . . .

Bromine can be used to test for . . . **2** . . . in any alkenes formed.

Ethene formed from oil fractions can be made into ethanol by . . . **3** . . . .

Alkene molecules can be joined together into long-chain molecules in the process called . . . **4** . . . .

4.7.1.4 Cracking and alkenes

Question 11

June 2009 | CHY1H | Original Q2 | Legacy

2 (a) Limestone is a hard rock that is used as a building material.
Limestone was used by the Egyptians to make plaster.

Reaction 1 – calcium carbonate, $CaCO_3$, was decomposed by heating limestone

$$CaCO_3 \rightarrow CaO + CO_2$$

Reaction 2 – water was added to the solid produced to make slaked lime

$$CaO + H_2O \rightarrow Ca(OH)_2$$

Reaction 3 – a mixture of slaked lime and water was used as plaster. After the plaster had set it became even harder with age

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

2 (a) (i) Name the solid formed when calcium carbonate decomposed.

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(1 mark)

2 (a) (ii) Use the reactions to explain how the plaster became even harder with age.

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(3 marks)

4.7.1.4 Cracking and alkenes

Question 11 · continued

for mark

2 (b) A gardener wanted to make a step up to his greenhouse door. He decided to use a mixture of cement and sand to make mortar.

He experimented using mixtures with different cement to sand ratios.

- The mortar mixtures were put in the same sized mould.
- Each mortar mixture was allowed to set hard.
- He then dropped a metal ball from increasing heights until the set mortar cracked.
- He recorded his results in a table.

Volume of sand in cm^3	Volume of cement in cm^3	Height the metal ball dropped to crack the set mortar in cm
800	100	17
700	100	24
600	100	30
500	100	36
400	100	37
300	100	48
200	100	54

2 (b) (i) What is the relationship between the volume of sand and the strength of the mortar?

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(1 mark)

2 (b) (ii) The gardener was not sure about some of his results.

Use the results to explain why.

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(2 marks)

7

4.7.1.4 Cracking and alkenes

Question 12

June 2009 | CHY1H | Original Q3 | Legacy

3 There are many ideas about the formation of the Earth and its atmosphere from a molten ball of rock and minerals.

3 (a) One idea is that the Earth's early atmosphere and average surface temperature were probably like that of Venus today.

The table shows information about the Earth and Venus today.

	Percentage composition of atmosphere	
Name of gas	**Earth today**	**Venus today**
Nitrogen	78	3.5
Oxygen	21	a trace
Argon	0.97	a trace
Carbon dioxide	0.03	96.5
Average surface temperature	20 °C	460 °C

There is a variable amount of water vapour in both atmospheres.

3 (a) (i) How was the Earth's early atmosphere formed?

.....

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(1 mark)

3 (a) (ii) The Earth's average surface temperature decreased over time. At what temperature would oceans have started to form?

Temperature = ... °C

(1 mark)

3 (a) (iii) Describe how the evolution of plants changed the Earth's atmosphere.

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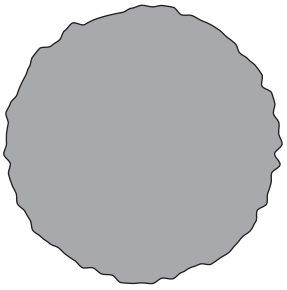
(2 marks)

4.7.1.4 Cracking and alkenes

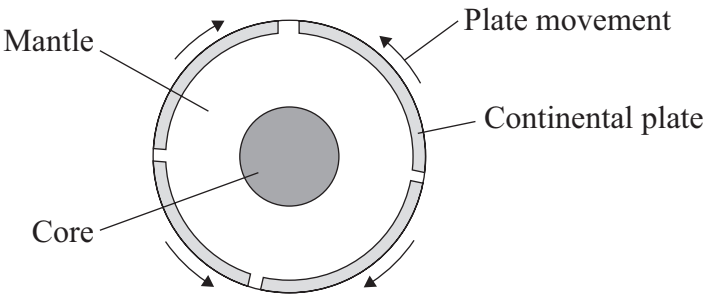
Question 12 · continued

for mark

3 (b) Another idea was that the Earth's mountains and continents formed in fixed positions as the molten ball of rock and minerals cooled and wrinkled.



Wegener, in 1915, had the idea that the Earth's crust and the upper part of the mantle had cracked into plates that were able to move. His idea meant that the mountains and continents were not in fixed positions.



3 (b) (i) Give **one** piece of evidence that led to Wegener's idea being accepted.

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(1 mark)

3 (b) (ii) Describe what causes the Earth's tectonic plates to move.

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(3 marks)

8

4.7.1.4 Cracking and alkenes

Question 13

June 2009 | CHY1H | Original Q6 | Legacy

6 (a) PEX is a material that is used as an alternative to copper for hot water pipes. PEX is made from poly(ethene).

6 (a) (i) Describe how ethene forms poly(ethene).

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(2 marks)

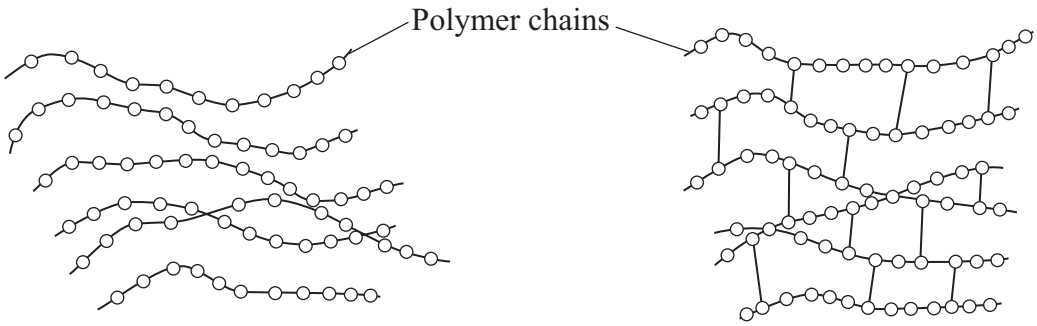
6 (a) (ii) PEX is a shape memory polymer. What property does a shape memory polymer have?

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(1 mark)

6 (a) (iii) The simplified structures of poly(ethene) and PEX are shown.



Poly(ethene) **PEX**

Poly(ethene) is a thermoplastic that softens easily when heated.

Suggest and explain how the structure of PEX changes this property.

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(3 marks)

4.7.1.4 Cracking and alkenes

Question 13 · continued

for mark

6 (b) Copper was considered to be the most suitable material to use for hot water pipes. PEX is now used as an alternative material for hot water pipes.

Copper is extracted from its ore by a series of processes.

1 The low-grade ore is powdered and concentrated.
2 Smelting is carried out in an oxygen flash furnace. This furnace is heated to 1100 °C using a hydrocarbon fuel. The copper ore is blown into the furnace with air, producing impure, molten copper.
3 Oxygen is blown into the impure, molten copper to remove any sulfur. The copper is cast into rectangular slabs.
4 The final purification of copper is done by electrolysis.

PEX is made from crude oil by a series of processes.

1 Fractional distillation
2 Cracking
3 Polymerisation
4 Conversion of poly(ethene) into PEX

Suggest the possible environmental advantages of using PEX instead of copper for hot water pipes.

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(4 marks)

10

4.7.1.4 Cracking and alkenes

Question 14

November 2009 | CHY1BP | Original Q6 | Legacy

QUESTION SIX

This question is about heating oil fractions.

$C_{20}H_{42}$ is found in one of the oil fractions. On heating, it can break down as shown in the equation:

$$C_{20}H_{42} \rightarrow C_8H_{16} + 2\mathbf{X} + \mathbf{Y}$$

6A Which row in the table correctly identifies **X** and **Y** in the equation?

	X	**Y**
1	C_2H_4	C_8H_{14}
2	C_3H_6	C_6H_{14}
3	C_4H_8	C_3H_8
4	C_5H_{10}	CH_4

6B From the information in the table, substance **X** is . . .

1 a saturated hydrocarbon.

2 an alkane.

3 an alkene.

4 a polymer.

6C In the reaction shown in the equation, which of the following is occurring?

1 Polymer chains are being cracked.

2 Only alkenes are produced.

3 Long-chain hydrocarbons are being emulsified.

4 Long-chain hydrocarbons are being changed into alkane fuels and alkenes.

4.7.1.4 Cracking and alkenes

Question 14 · continued

6D The process of heating certain oil fractions is carried out continuously night and day because . . .

1 this will provide more work for local people.

2 there is more demand for products at night.

3 extra fuel would be used if the process was restarted every day.

4 this will help to dispose of unwanted oil fractions.

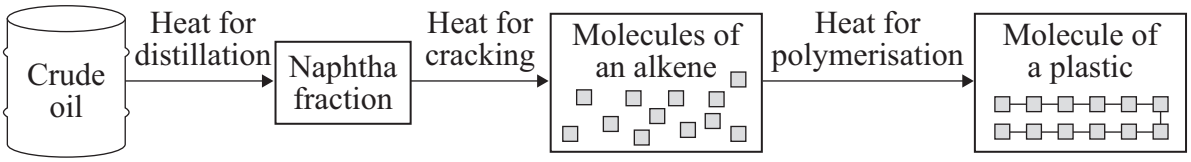
Turn over for the next question

4.7.1.4 Cracking and alkenes

Question 15

January 2010 | CHY1H | Original Q6 | Legacy

6 To make a plastic, such as poly(ethene), from crude oil involves many processes.



6 (a) Describe how crude oil is separated into fractions.

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(2 marks)

6 (b) Ethene is produced by cracking the hydrocarbons in the naphtha fraction.

6 (b) (i) Balance the symbol equation for this reaction.

$C_{10}H_{22}$	→	C_4H_{10}	+	C_2H_4
decane		butane		ethene

(1 mark)

6 (b) (ii) Describe how cracking is carried out.

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(2 marks)

4.7.1.4 Cracking and alkenes

Question 15 · continued

for mark

6 (c) Alkanes, such as butane (C_4H_{10}), do **not** form polymers.

Alkenes, such as ethene (C_2H_4), do form polymers.

Explain these statements.

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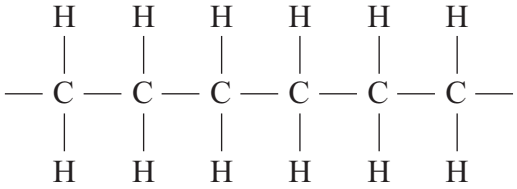
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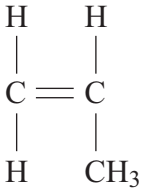
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(2 marks)

6 (d) Ethene molecules form the polymer poly(ethene). One molecule in poly(ethene) will contain thousands of carbon atoms. The diagram represents part of a poly(ethene) molecule.



Propene molecules form the polymer poly(propene).



Propene molecule

Draw a diagram to represent part of a poly(propene) molecule.

(2 marks)

9

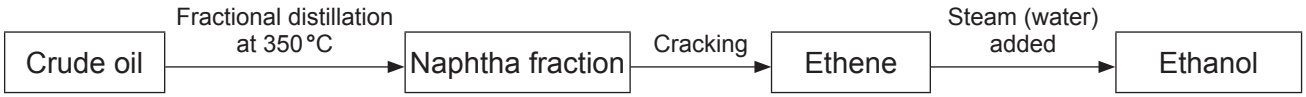
4.7.1.4 Cracking and alkenes

Question 16

June 2010 | CHY1H | Original Q6 | Legacy

6 Petrol sold in most countries now contains at least 5% ethanol.
The production of ethanol, for use as a fuel, is being increased.

The flow diagram shows how ethanol can be produced from crude oil.



6 (a) Why does crude oil need to be fractionally distilled?

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(1 mark)

6 (b) Hydrocarbons, such as decane, in the naphtha fraction are cracked to produce ethene.
The balanced chemical equation shows the cracking of decane.

$$\underset{\text{decane}}{C_{10}H_{22}} \rightarrow \underset{\text{octane}}{C_8H_{18}} + \underset{\text{ethene}}{C_2H_4}$$

6 (b) (i) Describe how cracking is done.

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(2 marks)

6 (b) (ii) Complete the structural formula of ethene by drawing lines to represent each covalent bond.

H H

C C

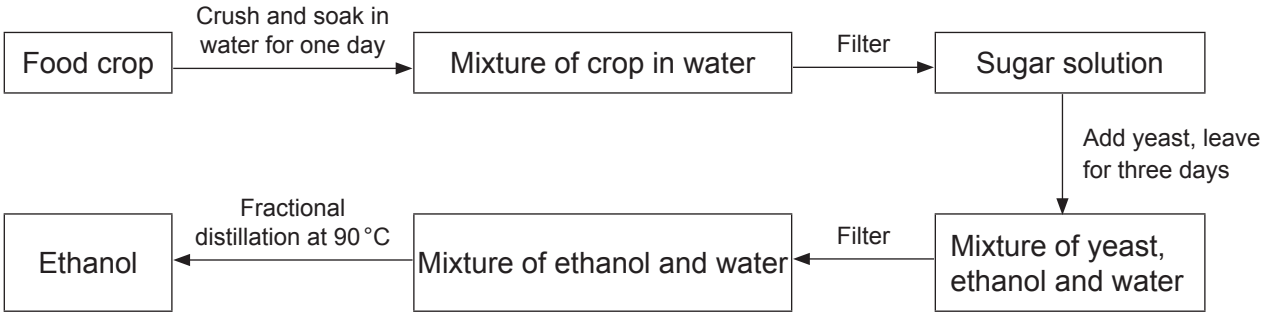
H H

(1 mark)

4.7.1.4 Cracking and alkenes

Question 16 · continued

6 (c) The flow diagram below shows how ethanol, for use as a fuel, can also be produced from food crops.



Use the information in the two flow diagrams and your own knowledge and understanding to evaluate whether more of this ethanol should be produced from food crops or from crude oil.

Remember to give a conclusion to your evaluation.

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(5 marks)

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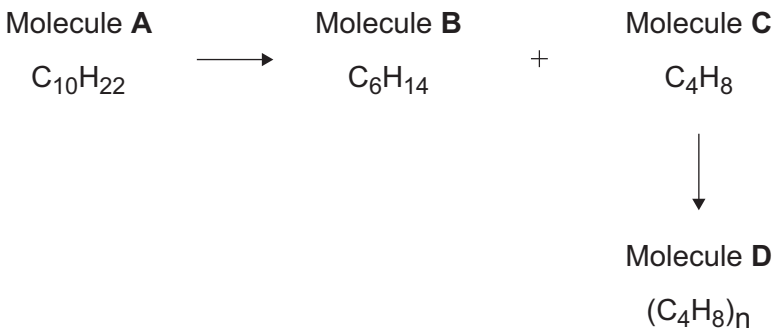
4.7.1.4 Cracking and alkenes

Question 17

March 2011 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

This question is about hydrocarbons.



Match molecules, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

Molecule . . . **1** . . . has been cracked.

Molecule . . . **2** . . . is an alkene.

Molecule . . . **3** . . . is a polymer.

Molecule . . . **4** . . . is the alkane in the reactions with the smallest molecules.

4.7.1.4 Cracking and alkenes

Question 18

June 2011 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

This question is about the cracking of hydrocarbons.

8A Which of the following is a correctly balanced equation for the cracking of $C_{15}H_{32}$ in which two different alkenes are produced?

1 $C_{15}H_{32} \rightarrow 2C_2H_4 + C_3H_6 + C_8H_{18}$

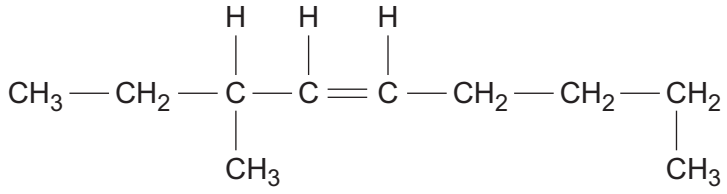
2 $C_{15}H_{32} \rightarrow 2CH_4 + C_3H_6 + C_4H_{10} + C_6H_{12}$

3 $C_{15}H_{32} \rightarrow 2C_3H_6 + C_9H_{20}$

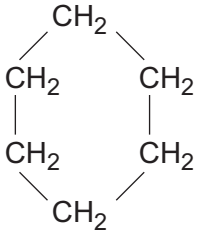
4 $C_{15}H_{32} \rightarrow C_4H_{10} + C_5H_{10} + C_6H_{14}$

8B Which of the following hydrocarbons that could be produced by the cracking of C_9H_{20} has the general formula C_nH_{2n} and decolourises bromine water?

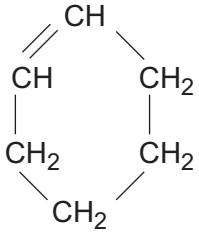
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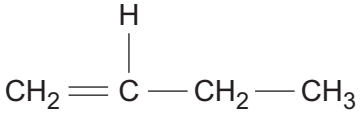
2



3



4

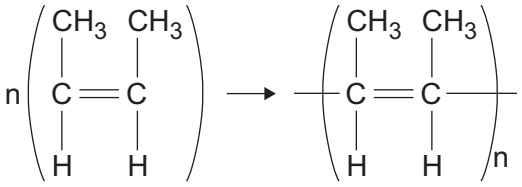


4.7.1.4 Cracking and alkenes

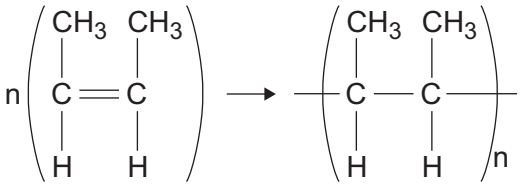
Question 18 · continued

8C Which of the following equations represents the polymerisation of butene?

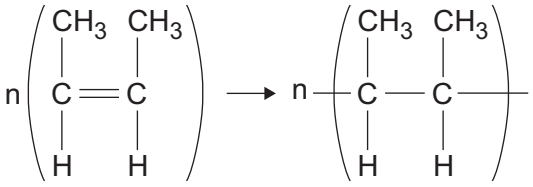
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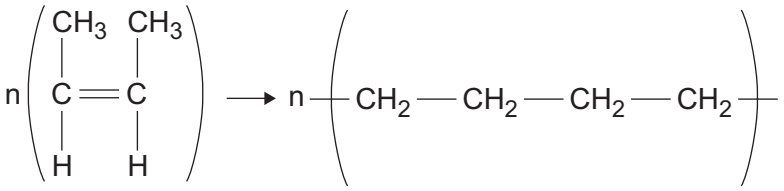
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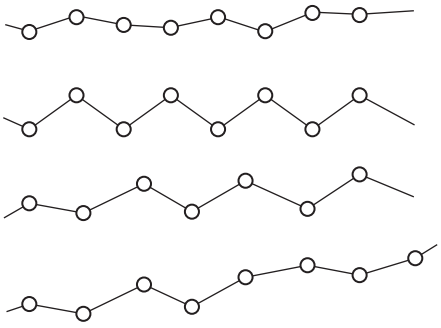
Question 8 continues on the next page

4.7.1.4 Cracking and alkenes

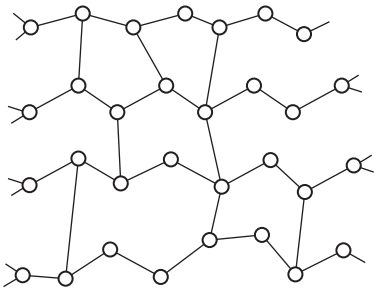
Question 18 · continued

8D The diagram shows the structures of a thermosoftening polymer and a thermosetting polymer.

Thermosoftening polymer



Thermosetting polymer



Which row in the table describes the properties of the two types of polymer?

	Thermosoftening polymer		Thermosetting polymer	
	Property 1	**Property 2**	**Property 1**	**Property 2**
1	Polymer molecules able to slide	Chemical bonds between the chains	Melt on heating	Short chain lengths
2	Long chain lengths	No chemical bonds between the chains	Chemical bonds between the chains	Polymer molecules able to slide
3	Long chain lengths	No chemical bonds between the chains	Do not melt on heating	Chemical bonds between the chains
4	Chemical bonds between the chains	Melt on heating	No chemical bonds between the chains	Long chain lengths

4.7.1.4 Cracking and alkenes

Question 19

June 2011 | CHY1H | Original Q2 | Legacy

2 The raw materials used to make the polymer polyvinyl chloride (PVC) are crude oil and sea salt (sodium chloride).

2 (a) There are three main stages in the production of PVC.

2 (a) (i) **Stage 1** Cracking of hydrocarbons from crude oil produces ethene, C_2H_4

$$C_{10}H_{22} \longrightarrow C_8H_{18} + C_2H_4$$

How are hydrocarbons cracked?

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(2 marks)

2 (a) (ii) **Stage 2** Electrolysis of sodium chloride solution produces chlorine.
Ethene from **Stage 1** is then reacted with this chlorine.
One of the hydrogen atoms in each ethene molecule is replaced by a chlorine atom to produce vinyl chloride.

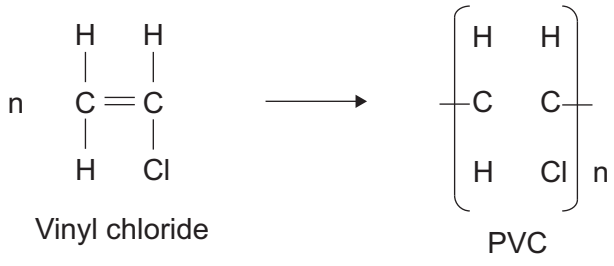
Complete the chemical equation by writing in the formula of the product vinyl chloride.

$$C_2H_4 + Cl_2 \longrightarrow \text{.....} + HCl$$

(1 mark)

2 (a) (iii) **Stage 3** Polymerisation of vinyl chloride produces polyvinyl chloride (PVC).

Complete the chemical equation by drawing in the missing bonds of the product, PVC.



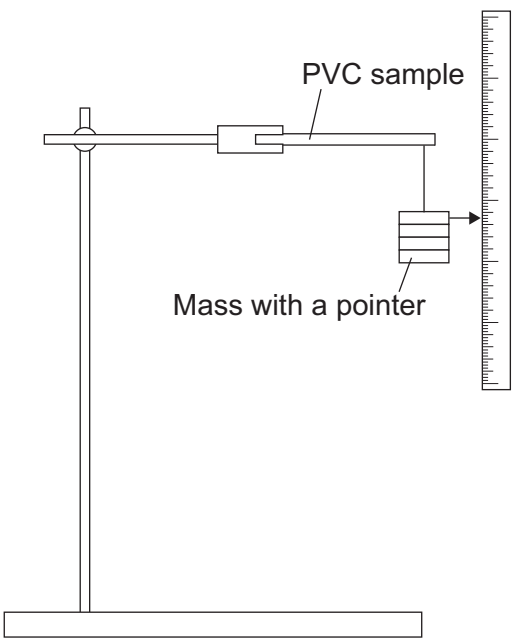
(1 mark)

Question 2 continues on the next page

Question 19 · continued

2 (b) Unplasticised polyvinyl chloride (uPVC) is used to make door and window frames.
PVC with a plasticiser added is used to make cling film for wrapping food.
A plasticiser is a chemical compound.

A student investigated how the percentage of plasticiser added to PVC affected its flexibility.
The student measured the bending of PVC samples when a mass was added.



The student's results are shown in the table.

Sample of PVC	Percentage (%) of plasticiser added	Bending of PVC sample in mm				
		Test 1	Test 2	Test 3	Test 4	Mean
A	**0**	2	3	3	4	3
B	**5**	22	15	23	24	
C	**10**	27	27	29	29	28
D	**15**	34	35	35	36	35

2 (b) (i) Each PVC sample should be the same size to make it a fair test.
Explain why.

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(1 mark)

4.7.1.4 Cracking and alkenes

Question 19 · continued

2 (b) (ii) The student repeated the test four times for each sample.
Explain why.

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(1 mark)

2 (b) (iii) Calculate the mean value for sample **B**.

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(2 marks)

2 (b) (iv) Each of the samples bent the most in test **4**.
Suggest a possible reason for this.

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(1 mark)

2 (c) Suggest why unplasticised polyvinyl chloride (uPVC) is used to make door and window frames.

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(1 mark)

10

4.7.1.4 Cracking and alkenes

Question 20

January 2012 | CH1HP | Original Q7 | Legacy

7 Ethene is used as a starting material for the production of many other substances, including ethanol.

7 (a) Ethene is produced when hydrocarbons are cracked. To do this hydrocarbons are heated to vaporise them. The vapours are then passed over a hot catalyst. The symbol equation shows the reaction for one hydrocarbon.

$$C_{28}H_{58} \rightarrow C_{11}H_{24} + C_{11}H_{22} + C_4H_8 + C_2H_4$$

7 (a) (i) One of the products is a different type of hydrocarbon to the other products.

Complete the sentences.

The formula of the product that is a different type of hydrocarbon is ..... .

The chemical structure of this product is different to the other products because

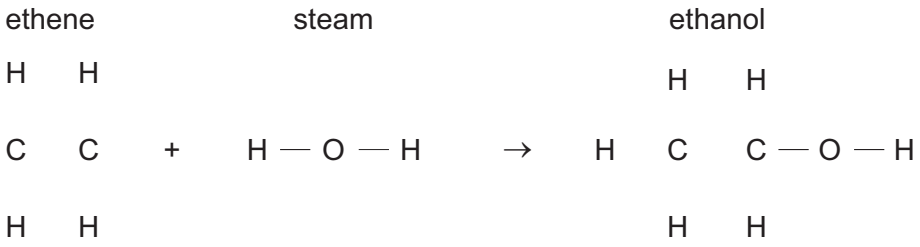
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(2 marks)

7 (a) (ii) Ethanol is produced when ethene reacts with steam in the presence of a hot catalyst.

Draw the missing bonds to complete the displayed structures in the equation.



(2 marks)

7 (b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

In 1970, the Brazilian Government had stated that all petrol must contain more than 25 % ethanol. The reasons for this statement in 1970 were:

- the oilfields in Brazil at that time only supplied 20 % of the crude oil needed to make petrol
- Brazil has a climate suitable for growing sugar cane.

To produce ethanol the sugar cane plants are crushed and soaked in water for one day. The sugar solution is separated from the plant material by filtration. Yeast is added to the sugar solution and fermented for three days. The yeast is separated from the solution of water and ethanol by filtration. Ethanol is separated from water by fractional distillation.

4.7.1.4 Cracking and alkenes

Question 20 · continued

In 2011, the Brazilian Government decided to reduce the amount of ethanol in petrol to 18%. The reasons were that in 2011:

- the demand for ethanol and the price of ethanol had greatly increased
- very large offshore oilfields had been discovered. These offshore oilfields would make Brazil one of the biggest crude oil producers in the world.

Use the information above and your own knowledge and understanding to evaluate whether Brazil should in future produce ethanol from crude oil or produce ethanol from sugar cane.

You should include environmental and economic or social factors in your evaluation.

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(6 marks)

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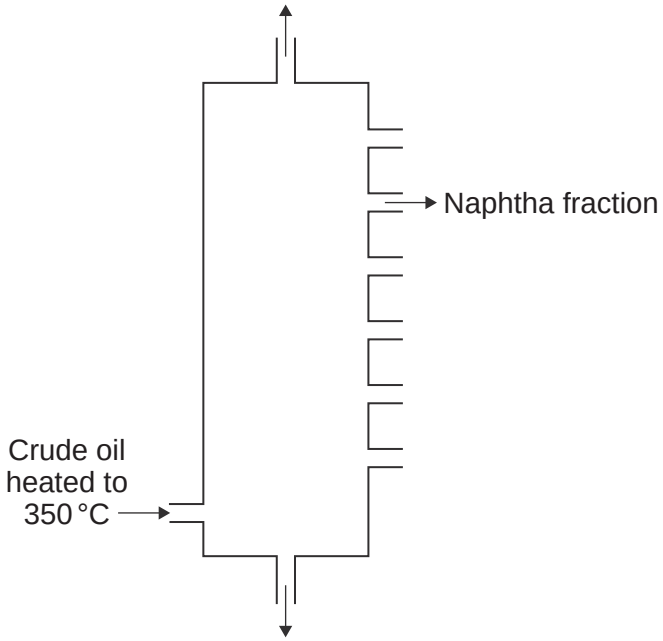
4.7.1.4 Cracking and alkenes

Question 21

June 2012 | CH1HP | Original Q3 | Legacy

3 Crude oil is used to produce poly(ethene).

3 (a) Fractional distillation is used to separate crude oil into fractions.



3 (a) (i) Write a number, **2**, **3**, **4** or **5**, next to each stage so that the description of fractional distillation is in the correct order. Numbers **1** and **6** have been done for you.

Number	Stage
1	The crude oil is heated to 350 °C.
	When a fraction in the vapours cools to its boiling point, the fraction condenses.
	Any liquids flow down to the bottom of the column and the hot vapours rise up the column.
6	The condensed fraction is separated and flows out through a pipe.
	When the hot vapours rise up the column, the vapours cool.
	Most of the compounds in the crude oil evaporate.

(2 marks)

3 (a) (ii) The naphtha fraction is cracked to produce ethene (C_2H_4).
Ethene is used to make the polymer called poly(ethene).

Name **two** substances produced when poly(ethene) burns in air.

1 .....

2 .....

(2 marks)

4.7.1.4 Cracking and alkenes

Question 21 · continued

3 (b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Each year in the UK, billions of plastic bags are given free to shoppers. These bags are made from poly(ethene) and are often used only once.
After being used many of these plastic bags are either thrown away as litter or buried in landfill sites.

In 2006 over 10 billion of these plastic bags were given free to shoppers.
In 2009 the number of plastic bags given to shoppers had decreased to 6.1 billion.
One reason for the decrease was because some supermarkets made people pay for their plastic bags.

From 2011 a new type of plastic shopping bag made mainly from poly(ethene) had a use-by date of only one year printed on the bag.

Use the information above and your knowledge and understanding to describe advantages and disadvantages of using plastic shopping bags made from poly(ethene).

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(6 marks)

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4.7.1.4 Cracking and alkenes

Question 22

June 2012 | CH1HP | Original Q7 | Legacy

7 Ethanol (C_2H_5OH) is produced from ethene or from sugar cane.

The two different methods to produce ethanol are summarised in the table.

Ethanol from sugar cane is a batch process	Ethanol from crude oil is a continuous process
Sugar cane plants are crushed and soaked in water for one day.	Crude oil is distilled to separate the naphtha fraction.
The sugar solution is separated by filtration.	The naphtha fraction is cracked when the vaporised hydrocarbons are passed over a hot catalyst.
Yeast is added to the sugar solution and fermented for three days.	The ethene produced is separated by distillation.
The solution of water and ethanol produced is separated by filtration.	Ethene is reacted with steam in the presence of a catalyst.
Distillation of this solution produces a 50% solution of ethanol.	This hydration reaction produces 100% ethanol.

7 (a) Complete and balance an equation for the cracking of the hydrocarbon C_6H_{14} to produce ethene.

C_6H_{14} ⟶ ..... + ...

(2 marks)

7 (b) What is **seen** when the sugar solution and yeast are fermented?

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(1 mark)

4.7.1.4 Cracking and alkenes

Question 22 · continued

7 (c) Evaluate the issues involved with the production of ethanol from sugar cane compared with the production of ethanol from crude oil.
You should explain why each issue you describe is important.

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(5 marks)

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4.7.1.4 Cracking and alkenes

Question 23

January 2013 | CH1HP | Original Q3 | Legacy

3 This question is about oil reserves.

3 (a) Diesel is separated from crude oil by fractional distillation.

Describe the steps involved in the fractional distillation of crude oil.

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(3 marks)

3 (b) Diesel is a mixture of lots of different *alkanes.*

What are *alkanes*?

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(2 marks)

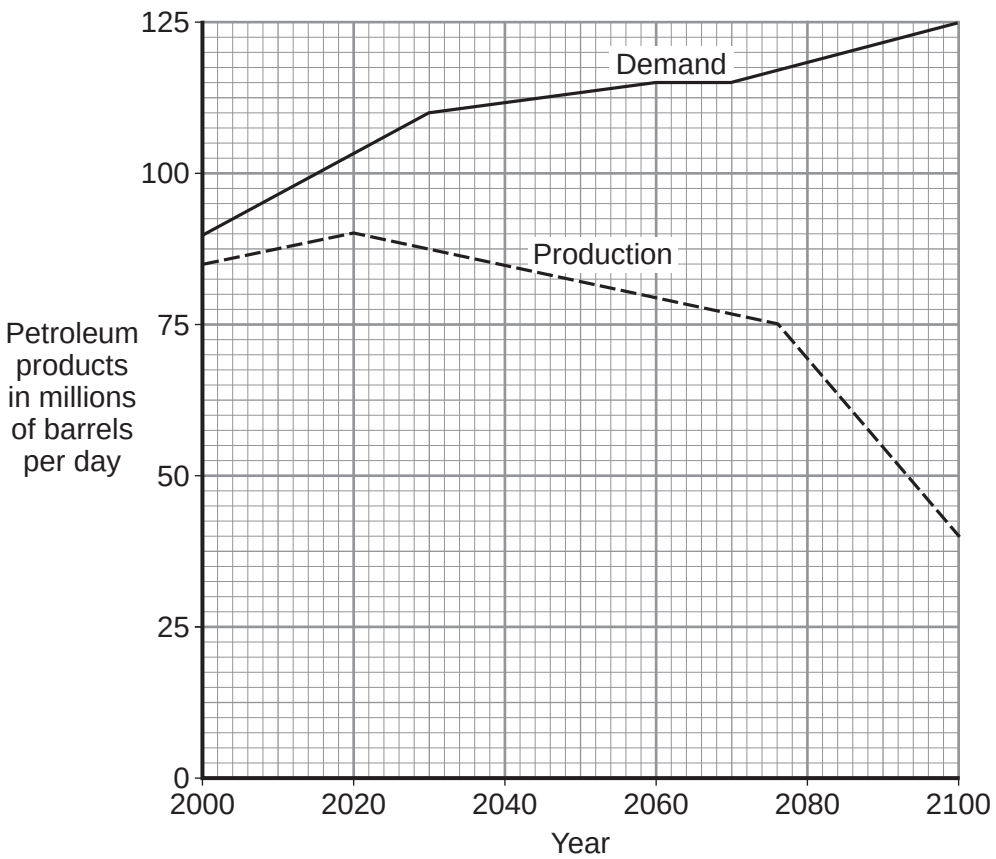
Question 3 continues on the next page

4.7.1.4 Cracking and alkenes

Question 23 · continued

3 (c) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Petroleum products, such as petrol, are produced from crude oil.
The graph shows the possible future production of petroleum products from crude oil and the expected demand for petroleum products.



Canada's oil sands hold about 20% of the world's known crude oil reserves.

The oil sands contain between 10 to 15% of crude oil. This crude oil is mainly bitumen.

In Canada the oil sands are found in the ground underneath a very large area of forest. The trees are removed. Then large diggers and trucks remove 30 metres depth of soil and rock to reach the oil sands. The oil sands are quarried. Boiling water is mixed with the quarried oil sands to separate the bitumen from the sand. Methane (natural gas) is burned to heat the water.

The mixture can be separated because bitumen floats on water and the sand sinks to the bottom of the water. The bitumen is cracked and the products are separated by fractional distillation.

4.7.1.4 Cracking and alkenes

Question 23 · continued

Use the information on page 8 and your knowledge and understanding to suggest the advantages and disadvantages of extracting petroleum products from oil sands.

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(6 marks)

11

4.7.1.4 Cracking and alkenes

Question 24

June 2015 | CH1HP | Original Q5 | Legacy

5 Crude oil is a fossil fuel.

5 (a) Describe how crude oil is separated into fractions.

[4 marks]

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5 (b) Fuel oil is one of the fractions from crude oil.

Power stations burn fuel oil to generate electricity. The waste gases from the combustion of fuel oil contain carbon dioxide, water vapour, sulfur dioxide and oxides of nitrogen.

The waste gases are passed through a suspension of limestone in water. Limestone is mainly calcium carbonate.

Suggest how the use of a suspension of limestone decreases one of the environmental impacts that the waste gases would cause.

[3 marks]

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4.7.1.4 Cracking and alkenes

Question 24 · continued

5 (c) Some fractions from crude oil contain large hydrocarbon molecules.

5 (c) (i) Hydrocarbon molecules, such as decane, can be cracked to produce smaller, more useful molecules.

Write the correct formula of the third product to complete the chemical equation.

You do not need to give the name of this product.

[1 mark]

$C_{10}H_{22} \longrightarrow C_5H_{10} + C_3H_8 +$ .....

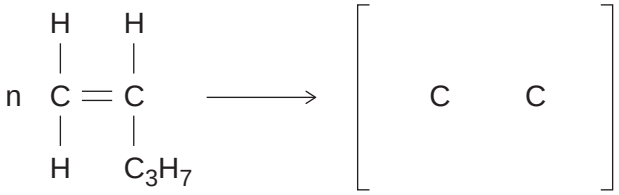
decane pentene propane

5 (c) (ii) Pentene is used to produce poly(pentene).

Complete the equation and the displayed structure of poly(pentene).

[3 marks]

Pentene **Poly(pentene)**



5 (c) (iii) Some polymers are described as smart polymers.

Suggest **one** property of a smart polymer that is different to that of an ordinary polymer.

[1 mark]

.....

.....

12

4.7.1.4 Cracking and alkenes

Question 25

June 2016 | CH1HP | Original Q2 | Legacy

2 This question is about hydrocarbons.

2 (a) Most of the hydrocarbons in crude oil are alkanes.

2 (a) (i) Large alkane molecules can be cracked to produce more useful molecules.

The equation shows the cracking of dodecane.

$$\underset{\text{dodecane}}{C_{12}H_{26}} \longrightarrow \underset{\text{butane}}{C_4H_{10}} + \underset{\text{hexene}}{C_6H_{12}} + \underset{\text{ethene}}{C_2H_4}$$

Give **two** conditions used to crack large alkane molecules.

[2 marks]

1 _____

2 _____

2 (a) (ii) The products hexene and ethene are alkenes.

Complete the sentence.

[1 mark]

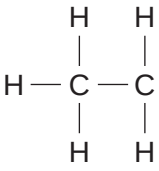
When alkenes react with bromine water the colour changes

from orange to _____ .

2 (a) (iii) Butane (C_4H_{10}) is an alkane.

Complete the displayed structure of butane.

[1 mark]



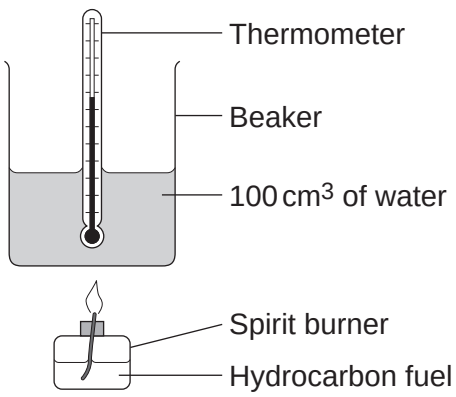
Question 2 continues on the next page

Question 25 · continued

2 (b) A group of students investigated the energy released by the combustion of four hydrocarbon fuels.

Figure 3 shows the apparatus used.

Figure 3



Each hydrocarbon fuel was burned for two minutes.

Table 1 shows the students' results.

Table 1

	After two minutes				
Name and formula of hydrocarbon fuel	**Mass of fuel used in g**	**Temperature increase of water in °C**	**Energy released by fuel in kJ**	**Energy released by 1.0 g of fuel in kJ**	**Relative amount of smoke in the flame**
Hexane, C_6H_{14}	0.81	40	16.80	20.74	very little smoke
Octane, C_8H_{18}	1.10	54	22.68	20.62	some smoke
Decane, $C_{10}H_{22}$	1.20	58	24.36		smoky
Dodecane, $C_{12}H_{26}$	1.41	67	28.14	19.96	very smoky

4.7.1.4 Cracking and alkenes

Question 25 · continued

2 (b) (i) Calculate the energy released by 1.0 g of decane in kJ.

[2 marks]

Energy released = _____ kJ

2 (b) (ii) Suggest **one** improvement to the apparatus, or the use of the apparatus, that would make the temperature increase of the water for each fuel more accurate.

Give a reason why this is an improvement.

[2 marks]

2 (b) (iii) The students noticed that the bottom of the beaker became covered in a black substance when burning these fuels.

Name this black substance.

Suggest why it is produced.

[2 marks]

2 (b) (iv) A student concluded that hexane is the best of the four fuels.

Give **two** reasons why the results in **Table 1** support this conclusion.

[2 marks]

1 _____

2 _____

Question 2 continues on the next page

Question 25 · continued

2 (c) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Most car engines use petrol as a fuel.

- Petrol is produced from the fractional distillation of crude oil.
- Crude oil is a mixture of hydrocarbons.
- Sulfur is an impurity in crude oil.

Car engines could be developed to burn hydrogen as a fuel.

- Hydrogen is produced from natural gas.
- Natural gas is mainly methane.

Table 2 shows information about petrol and hydrogen.

Table 2

	Petrol	**Hydrogen**
State of fuel at room temperature	Liquid	Gas
Word equation for combustion of the fuel	petrol + oxygen ⟶ carbon dioxide + water	hydrogen + oxygen ⟶ water
Energy released from combustion of 1 g of the fuel	47 kJ	142 kJ

Describe the **advantages** and **disadvantages** of using hydrogen instead of petrol in car engines.

Use the information given and your knowledge and understanding to answer this question.

[6 marks]

4.7.1.4 Cracking and alkenes

Question 26

June 2019 | 8462/2H | Original Q1

0 1 This question is about crude oil and hydrocarbons.

Figure 1 shows a fractionating column used to separate crude oil into fractions.

Figure 1

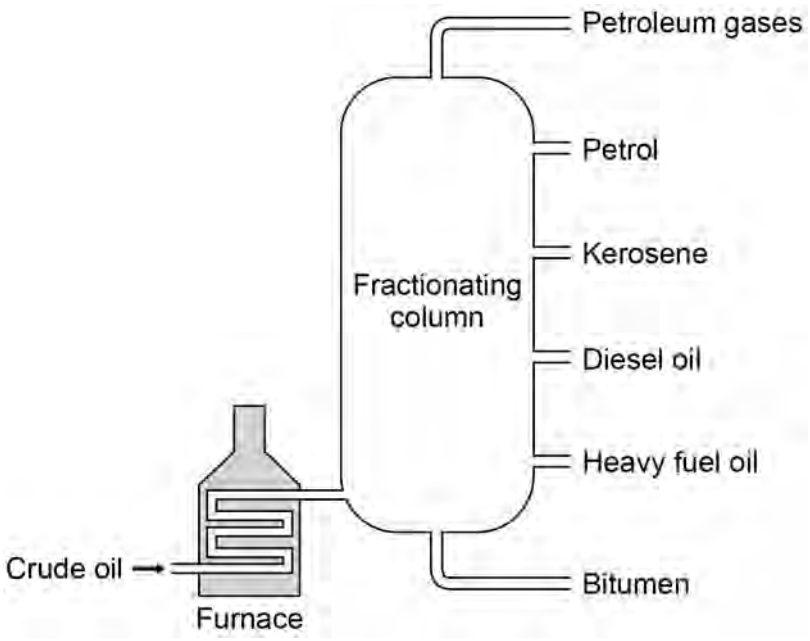


Table 1 gives information about some of the fractions.

Table 1

Fraction	Boiling point range in °C
Petroleum gases	Below 30
Petrol	40–110
Kerosene	180–260
Diesel oil	260–320
Heavy fuel oil	320–400
Bitumen	400–450

4.7.1.4 Cracking and alkenes

Question 26 · continued

0 1 . 1 Suggest a suitable temperature for the furnace in **Figure 1**.

[1 mark]

_____ °C

0 1 . 2 Explain why diesel oil collects above heavy fuel oil but below kerosene in the fractionating column.

Use **Table 1**.

[2 marks]

_____

_____

_____

_____

0 1 . 3 Suggest **two** reasons why bitumen is **not** used as a fuel.

[2 marks]

1 _____

_____

2 _____

_____

Question 1 continues on the next page

4.7.1.4 Cracking and alkenes

Question 26 · continued

0 1 . 4 Petrol contains mainly alkanes.

Which of the following compounds is an alkane?

[1 mark]

Tick (✓) **one** box.

C_2H_4 ☐

C_4H_8 ☐

C_6H_{14} ☐

C_8H_{16} ☐

Large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules.

0 1 . 5 Describe the conditions needed to crack hydrocarbon molecules from the diesel oil fraction.

[2 marks]

4.7.1.4 Cracking and alkenes

Question 26 · continued

0 1 . 6 Explain why large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules.

[2 marks]

0 1 . 7 Complete the equation for the cracking of $C_{15}H_{32}$

[1 mark]

$$C_{15}H_{32} \rightarrow C_{12}H_{26} + _____$$

11

Turn over for the next question