AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.7.2.2

Reactions of alkenes

Past-paper questions

Tier	**Higher**
Question groups	**69**
Available paper years	**2007–2025**

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.

4.7.2.2 Reactions of alkenes

Question 01

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.

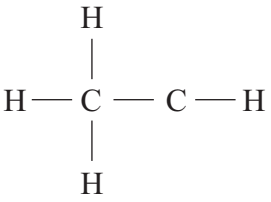
3 ethanol.

4 propene.

4.7.2.2 Reactions of alkenes

Question 01 · continued

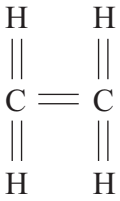
6C The hydrocarbon C_2H_4 can be represented as . . .



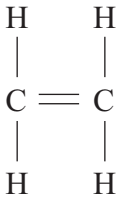
1



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 $C_{2n}H_n$

4.7.2.2 Reactions of alkenes

Question 02

June 2007 | CHY1B | Original Q1 | Legacy

QUESTION ONE

The table shows some information about four vegetable oils.

	Type of oil	Average mass of oil extracted from 100 kg of seeds in g	Energy provided by 100 g of the oil in kJ	Approximate melting point in °C	Smoke point in °C	Iodine number
A	Corn	6	3700	–15	229–268	120
B	Olive	40	3378	–12	204–210	60
C	Rapeseed	35	3696	5	230–240	100
D	Sunflower	32	3700	–18	229–252	130

A high iodine number indicates a large number of double bonds in a molecule of the oil.

The smoke point is the temperature at which the heated oil begins to give off smoke.

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

	What we can say about the oil
1	It begins to smoke only when heated to 265 °C.
2	It would be the first to solidify if the oils were cooled from 20 °C.
3	It would need the largest volume of bromine water to react completely.
4	It would provide the most energy from 100 kg of seeds.

4.7.2.2 Reactions of alkenes

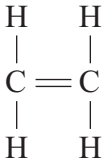
Question 03

June 2007 | CHY1B | Original Q2 | Legacy

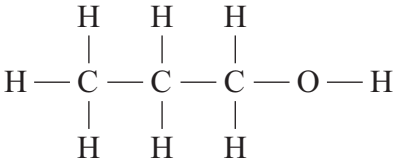
QUESTION TWO

This question is about the formulae for four compounds.

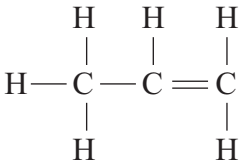
Match formulae, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.



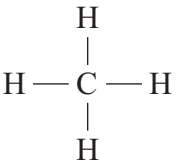
A



B



C



D

	Description
1	It is an unsaturated hydrocarbon with three carbon atoms in each molecule.
2	It is the monomer from which poly(ethene) is made.
3	It is the alkane that was present in Earth's early atmosphere.
4	It is not a hydrocarbon.

4.7.2.2 Reactions of alkenes

Question 04

June 2007 | CHY1H | Original Q5 | Legacy

5 Known crude oil reserves are being used up rapidly. Crude oil is used to produce many useful fuels, such as petrol. One way to conserve crude oil reserves would be to increase the production of bio-fuels.

(a) Ethanol can be produced for use as a bio-fuel. Cars can be powered by ethanol or ethanol–petrol mixtures.

Sugar cane can be fermented to give a mixture of water (boiling point 100 °C) and ethanol (boiling point 78 °C).

(i) How can ethanol be separated from water?

.....

.....

(1 mark)

(ii) Ethanol, C_2H_5OH, burns to release heat energy.

Complete the balanced symbol equation by writing in the formulae of the two products.

$C_2H_5OH + 3O_2 \rightarrow 2..... + 3.....$

(2 marks)

4.7.2.2 Reactions of alkenes

Question 04 · continued

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(b) The cost of producing a bio-fuel, such as ethanol, by fermentation, is at least three times higher than the production cost of petrol. It costs less to produce ethanol from alkanes. In the production, the vapour of an alkane is passed over a hot catalyst.

$$\underset{\text{hexane}}{C_6H_{14}} \xrightarrow{\text{Hot catalyst}} \underset{\text{ethane}}{C_2H_6} + \underset{\text{ethene}}{2C_2H_4}$$

Ethene is then converted into ethanol.

(i) What has happened to the hexane to produce ethene?

.....

(1 mark)

(ii) Complete the structural formula for ethene, C_2H_4.

C C

(1 mark)

(iii) Name the compound that is added to ethene to produce ethanol, C_2H_5OH.

.....

(1 mark)

(c) As explained in parts (a) and (b), ethanol can be made using either sugar or alkanes as the starting material.

Evaluate the advantages and disadvantages of using these two starting materials to produce ethanol.

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(4 marks)

10

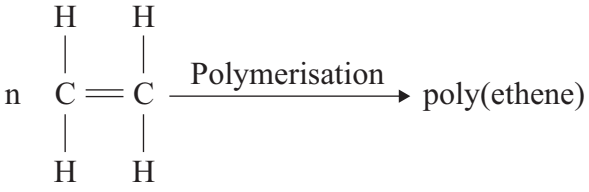
4.7.2.2 Reactions of alkenes

Question 05

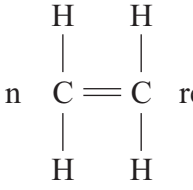
November 2007 | CHY1B | Original Q6 | Legacy

QUESTION SIX

The equation shows how poly(ethene) is made.



6A



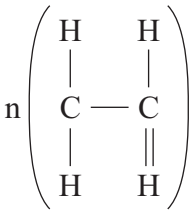
1 one molecule of poly(ethene).

2 one molecule of ethene.

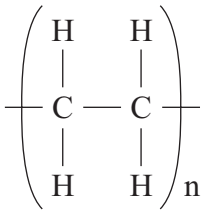
3 two molecules of ethene.

4 many molecules of ethene.

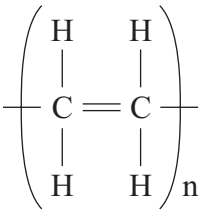
6B The formula for poly(ethene) is . . .



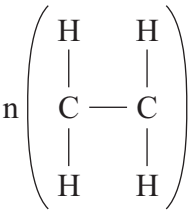
1



2



3



4

4.7.2.2 Reactions of alkenes

Question 05 · continued

6C Which row in the table correctly shows the differences between the monomer molecules and the polymer molecule formed from them in this reaction?

	Monomer molecule	Polymer molecule
1	small, saturated	large, unsaturated
2	large, saturated	small, saturated
3	small, unsaturated	large, saturated
4	large, unsaturated	small, unsaturated

6D Poly(ethene) is not used to make plastic kettles because . . .

1 it is a thermosetting polymer.

2 it is too heavy.

3 it is opaque.

4 it is a thermosoftening polymer.

4.7.2.2 Reactions of alkenes

Question 06

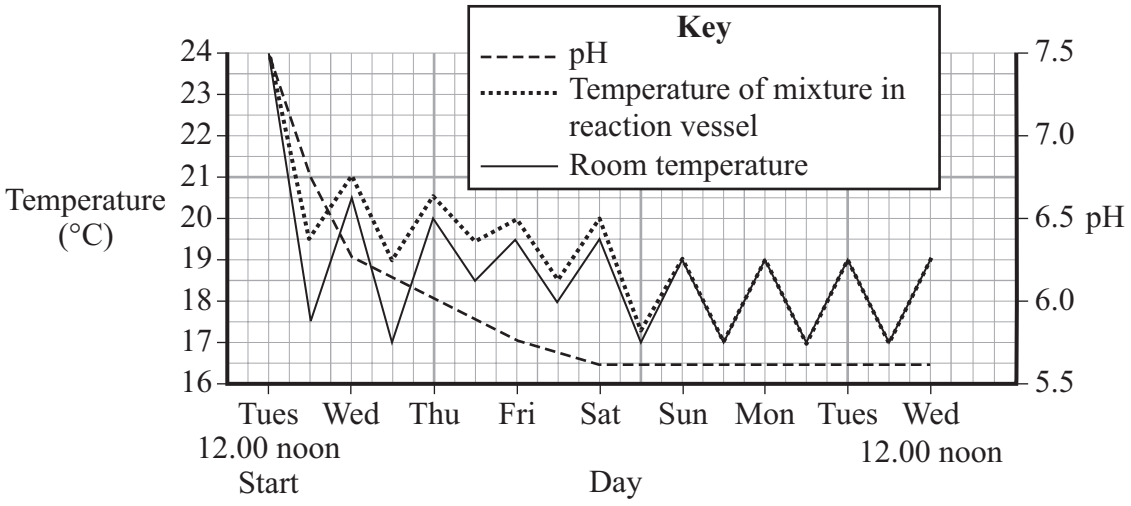
November 2007 | CHY1B | Original Q8 | Legacy

QUESTION EIGHT

Ethanol can be made by the action of yeast on a solution of sugar. This is called fermentation. The sugar is converted to ethanol and carbon dioxide. Carbon dioxide is a slightly acid gas. During fermentation, some of the energy is transferred as thermal energy.

A sugar solution and yeast were put into a reaction vessel.
The temperature of the mixture, the pH of the mixture and the room temperature were recorded over an eight-day period.

The results are shown on the graph.



8A There is a larger difference between the temperature of the mixture and the room temperature during the first few days than there is later.

The probable reason is that . . .

1 fermentation is quicker at the start.

2 the room temperature is steadily decreasing.

3 the pH value of the mixture is decreasing.

4 the room temperature fluctuates.

4.7.2.2 Reactions of alkenes

Question 06 · continued

8B From the information on the graph, . . .

1 fermentation is completed after 4 days.

2 fermentation is completed after 5 days.

3 fermentation is completed after 6 days.

4 fermentation continues after 8 days.

8C A general conclusion from the graph is that . . .

1 the yeast cannot survive for more than 8 days.

2 the acidity of the mixture increases in the first 4 days.

3 the acidity of the mixture is greater at the start than when fermentation is completed.

4 the temperature of the mixture does not fall below 18.0 °C.

8D One advantage of producing ethanol by fermentation rather than from ethene is that . . .

1 less carbon dioxide is produced in fermentation.

2 there are no waste products.

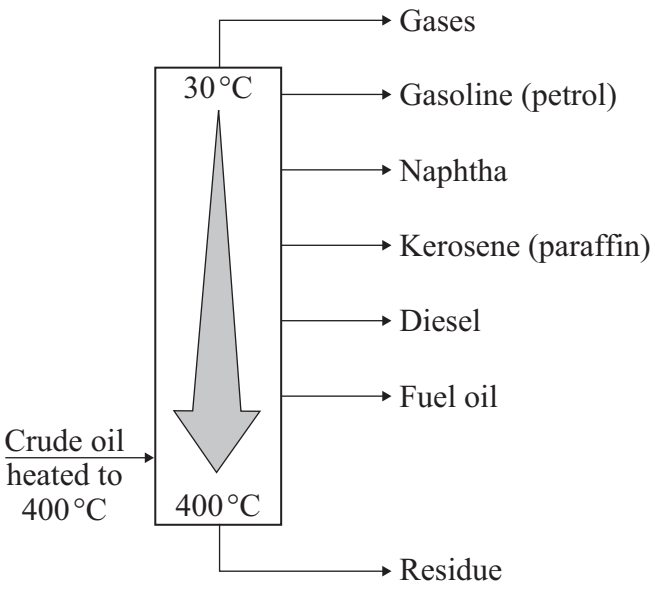
3 the raw materials are renewable.

4 the ethanol does not need further processing.

4.7.2.2 Reactions of alkenes

Question 07

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.

.....

.....

.....

.....

(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)

4.7.2.2 Reactions of alkenes

Question 07 · 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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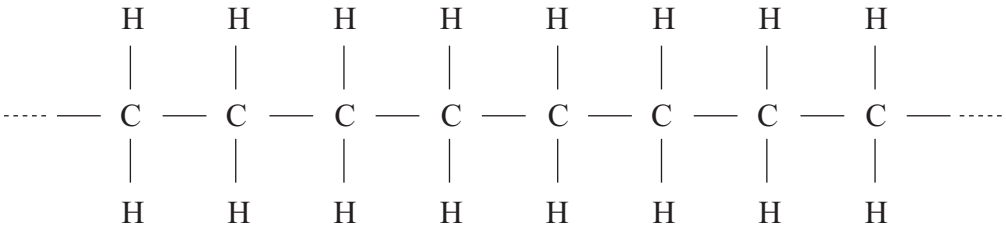
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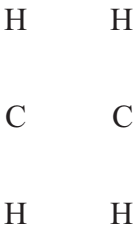
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(2 marks)

(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 07 · 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.

4.7.2.2 Reactions of alkenes

Question 07 · 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

4.7.2.2 Reactions of alkenes

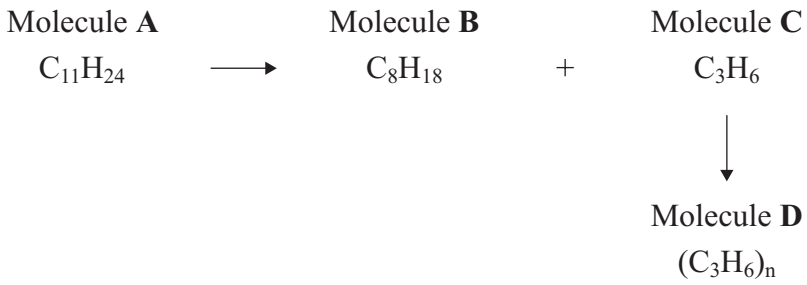
Question 08

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.

4.7.2.2 Reactions of alkenes

Question 09

March 2008 | CHY1BP | Original Q9 | Legacy

QUESTION NINE

The general equation for the complete combustion of an alkane is:

$$2C_nH_{2n+2} + (3n+1)O_2 \rightarrow 2nCO_2 + 2(n+1)H_2O$$

Use this information to help you to answer the following questions.

9A Why are alkanes with few carbon atoms likely to be better fuels?

1 They require less oxygen so are less likely to be completely burned.

2 They require less oxygen so are more likely to be completely burned.

3 They require more oxygen so are less likely to be completely burned.

4 They require more oxygen so are more likely to be completely burned.

9B The formula of hexane is C_6H_{14}

How many molecules of oxygen are needed to burn one molecule of hexane?

1 $9\frac{1}{2}$

2 19

3 $21\frac{1}{2}$

4 43

9C What is the general equation for the combustion of an alkene (C_nH_{2n})?

1 $C_nH_{2n} + 1\frac{1}{2}nO_2 \rightarrow nCO_2 + nH_2O$

2 $C_nH_{2n} + 1\frac{1}{2}nO_2 \rightarrow nCO_2 + 2nH_2O$

3 $C_nH_{2n} + 3nO_2 \rightarrow nCO_2 + nH_2O$

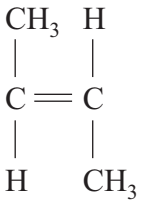
4 $C_nH_{2n} + 3nO_2 \rightarrow nCO_2 + 2nH_2O$

4.7.2.2 Reactions of alkenes

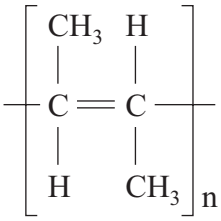
Question 09 · continued

9D Alkene molecules can be bonded together to form polymers.

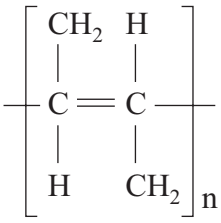
Which polymer would be produced from this alkene?



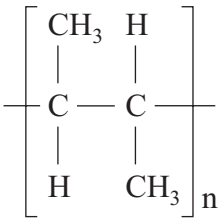
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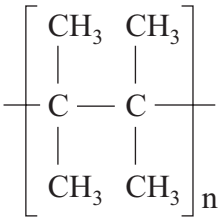
2



3



4



END OF TEST

4.7.2.2 Reactions of alkenes

Question 10

June 2008 | CHY1BP | Original Q1 | Legacy

QUESTION ONE

This question is about unsaturated hydrocarbons.

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

A catalysis

B polymerisation

C combustion

D thermal decomposition

Heating large hydrocarbon molecules so that they break down into smaller molecules, such as ethene, is an example of . . . **1** . . . .

Ethanol is formed when ethene reacts with steam. The reaction is speeded up using phosphoric acid. This reaction is an example of . . . **2** . . . .

Individual ethene molecules can be made to link together to form very long chains in a process called . . . **3** . . . .

Ethene reacts with oxygen to produce carbon dioxide and water. This reaction is an example of . . . **4** . . . .

4.7.2.2 Reactions of alkenes

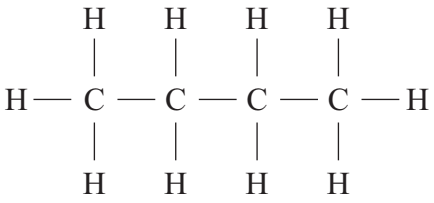
Question 11

June 2008 | CHY1BP | Original Q2 | Legacy

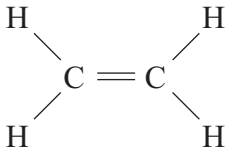
QUESTION TWO

This question is about carbon compounds.

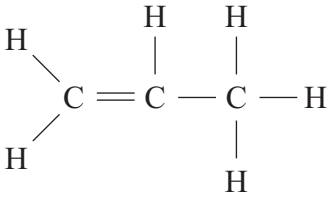
A



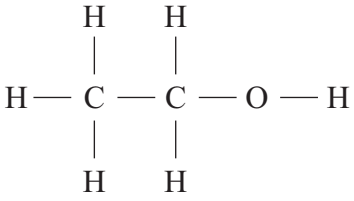
B



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.

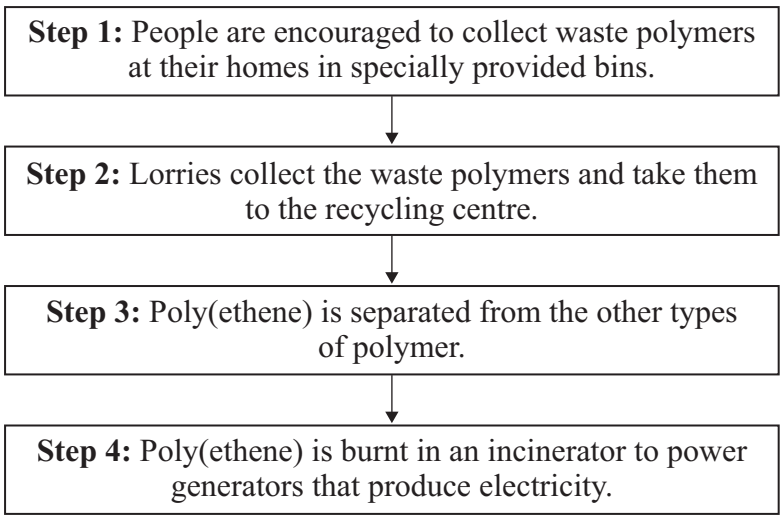
4.7.2.2 Reactions of alkenes

Question 12

June 2008 | CHY1BP | Original Q3 | Legacy

QUESTION THREE

The flow chart shows how the waste poly(ethene) from our homes can be used.



3A One problem associated with **Step 1** is that . . .

1 some people do **not** put their waste polymers in the special bins.

2 people prefer to burn their waste polymers.

3 poly(ethene) is toxic.

4 waste polymers rot and begin to smell.

3B One problem associated with **Step 2** is that . . .

1 burning diesel fuel in lorries can increase global warming.

2 people do **not** know where the recycling centres are.

3 the bins of waste polymers are very heavy.

4 the lorries are hard to recognise.

Question 12 · continued

3C One problem associated with **Step 3** is that . . .

1 all polymers are the same colour.

2 polymers **cannot** be melted down.

3 polymers are magnetic.

4 separating polymers costs money.

3D One reason why all waste polymers are **not** burned in **Step 4** is that . . .

1 burning polymers can produce toxic gases.

2 polymers are poor conductors of electricity.

3 some polymers melt before burning.

4 burning polymers produces too much heat.

Turn over for the next question

4.7.2.2 Reactions of alkenes

Question 13

June 2008 | CHY1BP | Original Q7 | Legacy

QUESTION SEVEN

This question is about polymers.

Poly(propene) is made from the alkene, propene.

7A Which one of the following statements about the formation of poly(propene) from propene is correct?

1 The product will readily react with bromine.

2 The reaction involves thermal decomposition.

3 The reaction involves cracking.

4 The product is a saturated hydrocarbon.

7B The term thermosoftening is used to describe how poly(propene) behaves on heating.

This means that poly(propene) must therefore . . .

1 **not** be used for packaging in warm countries because it will soften.

2 contain only short chain molecules which move around easily on heating.

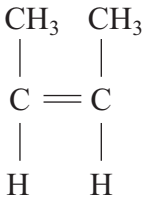
3 have chemical bonds between the chains which break on heating.

4 be capable of being shaped on heating.

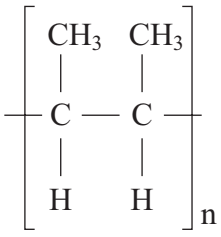
4.7.2.2 Reactions of alkenes

Question 13 · continued

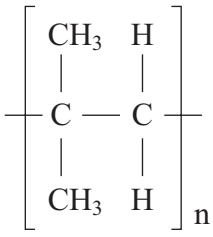
7C Which one of the following polymers can be formed by polymerising the alkene with this formula?



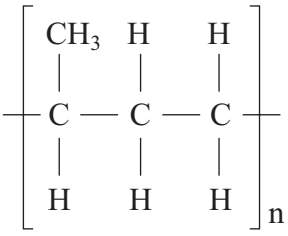
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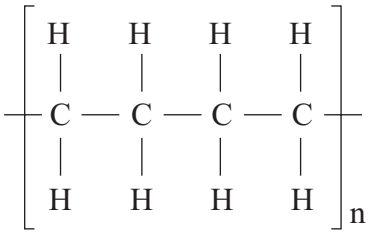
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7D Which one of the following statements about polymer waste is correct?

All polymer waste . . .

1 can be easily recycled.

2 will biodegrade when placed in landfill sites.

3 will contribute to global warming if burned.

4 is easily removed from other waste by adding water because the polymer waste will sink to the bottom.

4.7.2.2 Reactions of alkenes

Question 14

June 2008 | CHY1H | Original Q7 | Legacy

7 Scientists study the atmosphere on planets and moons in the Solar System to understand how the Earth's atmosphere has changed.

7 (a) Millions of years ago the Earth's atmosphere was probably just like that of Mars today.

The table shows data about the atmospheres of Mars and Earth as they are now.

Mars		Earth	
nitrogen	3 %	nitrogen	78 %
oxygen	trace	oxygen	21 %
water	trace	water	trace
carbon dioxide	95 %	carbon dioxide	trace
Average surface temperature –23 °C		Average surface temperature 15 °C	

Suggest what has caused the main gases in the Earth's atmosphere of millions of years ago to change to the present-day atmosphere.

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(2 marks)

7 (b) Titan is the largest moon of the planet Saturn. It has an atmosphere that, like the Earth's, contains mainly nitrogen. Methane is the other main gas.

Main gases in Titan's atmosphere	Percentage (%)	Boiling point in °C
Nitrogen	95	–196
Methane	5	–164
Average surface temperature –178 °C		

When it rains on Titan, it rains methane! Explain why.

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.....

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(2 marks)

4.7.2.2 Reactions of alkenes

Question 14 · continued

for mark

7 (c) Ultraviolet radiation from the Sun produces simple alkenes, such as ethene and propene, from methane in Titan's atmosphere.

7 (c) (i) Draw the structure of propene, C_3H_6, to show the covalent bonds.

(1 mark)

7 (c) (ii) Explain how propene molecules form a polymer. You should name the polymer formed.

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(3 marks)

8

4.7.2.2 Reactions of alkenes

Question 15

June 2008 | CHY2H | Original Q8 | Legacy

8 Epoxyethane has the formula C_2H_4O. It is used to make antifreeze and some types of plastic.

When choosing a method of making a chemical, it is important to consider:

- the percentage yield
- the atom economy.

Epoxyethane can be made from ethene by two different methods. The overall equation for each method is shown below.

Method 1

$$\underset{\text{ethene}}{C_2H_4} + Cl_2 + Ca(OH)_2 \rightarrow \underset{\text{epoxyethane}}{C_2H_4O} + CaCl_2 + H_2O$$

Method 2

$$\underset{\text{ethene}}{2C_2H_4(g)} + O_2(g) \overset{\text{catalyst}}{\rightleftharpoons} \underset{\text{epoxyethane}}{2C_2H_4O(g)}$$

8 (a) The table gives the relative formula masses (M_r) of the reactants and products for **Method 1**.

Formula of reactant or product	Relative formula mass (*M*r)
H_2O	18
C_2H_4	28
C_2H_4O	44
Cl_2	71
$Ca(OH)_2$	74
$CaCl_2$	111

The percentage atom economy can be calculated using:

$$\text{Percentage atom economy} = \frac{M_r \text{ of useful product}}{\text{Total } M_r \text{ of all reactants added together}} \times 100\%$$

The percentage atom economy for **Method 2** is 100%.

4.7.2.2 Reactions of alkenes

Question 15 · continued

for mark

8 (a) Calculate the percentage atom economy for **Method 1**.

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(2 marks)

8 (b) **Method 2** has the higher atom economy.

Suggest why this is an advantage.

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(2 marks)

8 (c) State and explain how an increase in pressure would affect the equilibrium yield of epoxyethane using **Method 2**.

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(2 marks)

8 (d) One problem with **Method 2** is that ethene can also react with oxygen to make carbon dioxide and water.

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

How might this reaction affect the percentage yield of epoxyethane?

.....

.....

(1 mark)

7

4.7.2.2 Reactions of alkenes

Question 16

March 2009 | CHY1BP | Original Q4 | Legacy

QUESTION FOUR

Scientists have developed a process to convert plastics such as nylon back to their original monomers.

4A What is the monomer used to make the polymer called poly(chloroethene)?

1 ethene

2 ethane

3 chloroethene

4 chloroethane

4B Which of the following is **not** an advantage of returning a polymer back to its monomer?

1 reduces the amount of plastic going into landfill sites

2 oil reserves will last longer

3 uses up excess supplies of monomers

4 avoids recycling of plastics

4C Plastics that can be broken down by microorganisms are described as . . .

1 unsaturated.

2 thermosetting.

3 thermoplastic.

4 biodegradable.

4D At a supermarket, customers can get vouchers for school equipment when they use their own bags for shopping.

The advantage of this scheme is that . . .

1 the supermarket can order more bags.

2 less plastic has to be manufactured.

3 queues will be shorter.

4 the plastic will be easier to recycle.

4.7.2.2 Reactions of alkenes

Question 17

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

4.7.2.2 Reactions of alkenes

Question 17 · 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

4.7.2.2 Reactions of alkenes

Question 18

March 2009 | CHY1BP | Original Q7 | Legacy

QUESTION SEVEN

This question is about materials used for carrier bags.

7A Plastic bags are made from poly(ethene).

What is the best description of the manufacture of poly(ethene)?

1 Ethene molecules join together, keeping their double bonds.

2 Unsaturated ethene molecules join together to make long saturated molecules.

3 Ethane molecules line up and join 'end to end'.

4 Ethane molecules are made into poly(ethene) using high pressure and a catalyst.

7B Which row in the table correctly identifies an advantage and a disadvantage of using poly(ethene) to make bags?

	Advantage	Disadvantage
1	easily coloured and printed	very expensive to make
2	airtight	high melting point
3	lightweight	not biodegradable
4	easy to produce	made from renewable sources

Supermarkets sell bags made of jute to customers. These bags can be re-used many times.

Jute is made from plant material, but jute bags are more expensive to make than plastic bags.

7C What is the best description of the benefits of using jute as a replacement for poly(ethene) in bags?

1 It is made from renewable sources and it will not rot.

2 It is made from non-renewable sources that remove carbon dioxide from the atmosphere.

3 It saves on the use of oil and helps to reduce the waste that goes to landfill.

4 It saves the customer money and it is biodegradable.

4.7.2.2 Reactions of alkenes

Question 18 · continued

7D Which of the following questions is unsuitable for scientific investigation?

1 Can plastics be made that are easily biodegradable?

2 Should there be laws to make supermarkets give up using plastic bags?

3 Can plastics be made that biodegrade as easily as jute?

4 Are there better materials than plastic and jute to use for making carrier bags?

Turn over for the next question

4.7.2.2 Reactions of alkenes

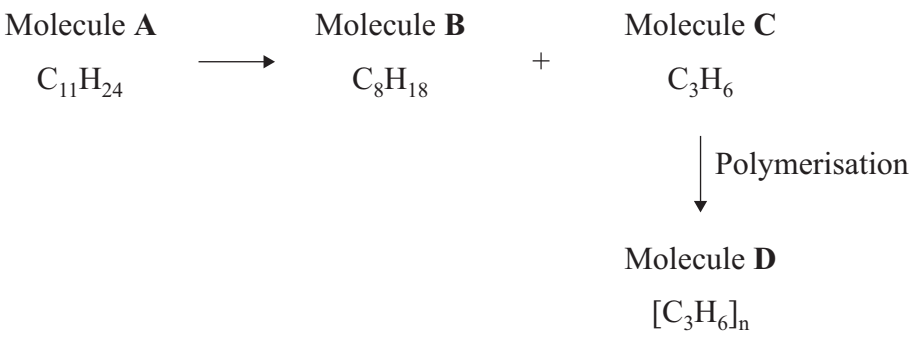
Question 19

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** . . . .

4.7.2.2 Reactions of alkenes

Question 20

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** . . . .

4.7.2.2 Reactions of alkenes

Question 21

June 2009 | CHY1BP | Original Q5 | Legacy

QUESTION FIVE

Alkenes that have one or more hydrogen atoms replaced by fluorine can be polymerised to make thermosoftening polymers. Replacing hydrogen atoms with fluorine is a very expensive process.

Increasing the number of fluorine atoms in the polymers makes them very unreactive. Polymers with more fluorine atoms in their molecules are more resistant to heat damage. However, if they are subjected to intense heat, they can burn and release some very toxic fumes.

5A Which one of the following monomers would result in the least reactive polymer?

1 $CHF=CH_2$

2 CHF=CHF

3 $CH_2=CF_2$

4 $CF_2=CF_2$

5B The monomer CHF=CHF . . .

1 is saturated.

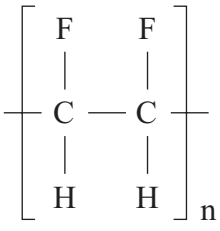
2 does **not** react with bromine.

3 reacts with hydrogen in the presence of a catalyst.

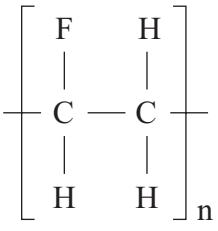
4 can be produced by cracking alkanes.

5C Which polymer would result from polymerisation of CHF=CHF?

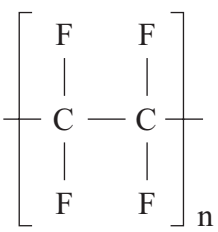
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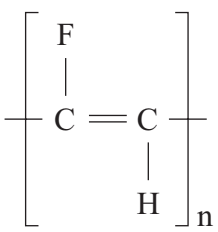
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4.7.2.2 Reactions of alkenes

Question 21 · continued

5D Which statement would **not** apply to objects made from polymers containing a lot of fluorine?

1 They can be disposed of safely in an incinerator.

2 They are resistant to breakdown by microorganisms.

3 They are expensive to manufacture.

4 They can be used to make kitchen utensils.

Turn over for the next question

4.7.2.2 Reactions of alkenes

Question 22

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)

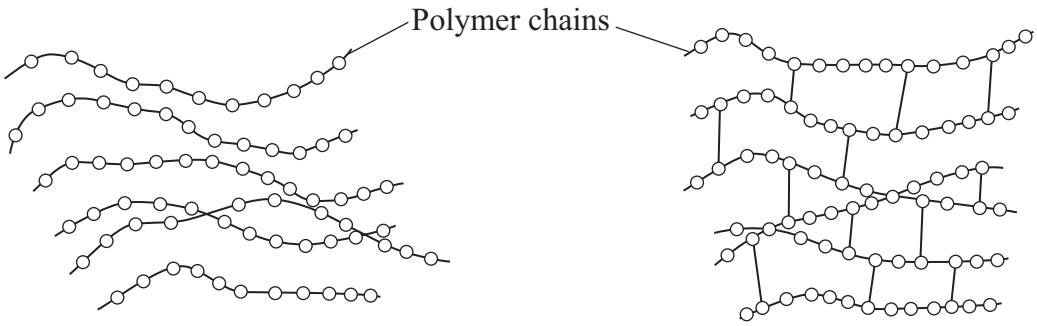
6 (a) (ii) PEX is a shape memory polymer. What property does a shape memory polymer have?

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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)

4.7.2.2 Reactions of alkenes

Question 22 · 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

4.7.2.2 Reactions of alkenes

Question 23

November 2009 | CHY1BP | Original Q5 | Legacy

QUESTION FIVE

AQA-Dri is a material with a polymer coating. The polymer called poly(tetrafluoroethene) is produced from the monomer tetrafluoroethene, C_2F_4. AQA-Dri is useful for making outdoor clothing because it prevents rain droplets from passing through the pores of the material, but allows water vapour formed during sweating to escape.

5A Which of the following statements explains the useful properties of AQA-Dri?

1 The pores in AQA-Dri are smaller than the molecules in sweat.

2 Water molecules are small enough to pass through AQA-Dri.

3 The pores in AQA-Dri are smaller than water molecules.

4 Water droplets are smaller than the pores in AQA-Dri.

5B Old documents become dry and brittle. AQA-Dri is used to help to flatten old documents, rather than wetting them with a fine water sprayer.

This is because . . .

1 AQA-Dri will let the documents absorb water more quickly.

2 water droplets will not moisten the documents enough to let them flatten.

3 water sprayers make the documents too wet, so they become even more fragile.

4 water sprayers are a low technology, out-of-date solution to the problem.

5C In the 1950s, the inventors of AQA-Dri intended to use poly(tetrafluoroethene) as an electrical insulator. Today, it has many uses.

This is because . . .

1 scientists are constantly discovering new electrical insulators.

2 chemical companies are always trying to find new applications for their products.

3 chemical companies are trying to find alternative ways of waterproofing fabrics.

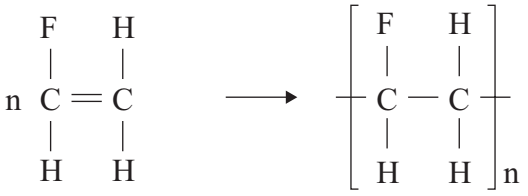
4 scientists stop testing the properties of materials once they are discovered.

4.7.2.2 Reactions of alkenes

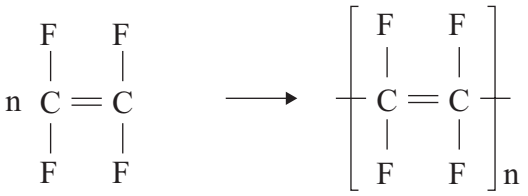
Question 23 · continued

5D Which of the following is the correct equation for the formation of poly(tetrafluoroethene) from tetrafluoroethene?

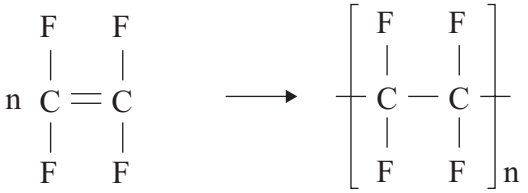
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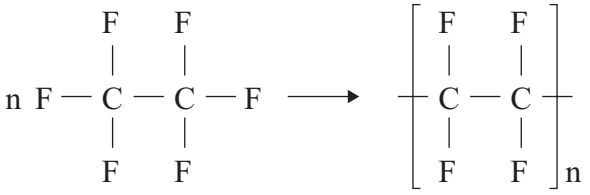
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4.7.2.2 Reactions of alkenes

Question 24

November 2009 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

This question is about ethanol. Some ethanol is used as a fuel to replace petrol.

The table compares two different industrial processes for making ethanol.

Process	Raw material	Type of process	Purity of product	Rate of ethanol production
Fermentation using yeast	Sugar	Batch – one tank of sugar solution is fermented at a time	Dilute solution of ethanol	Slow
Hydration using steam	Ethene	Continuous – ethene and steam flow steadily into the reaction vessel and ethanol flows steadily out	Almost pure ethanol	Fast

8A Ethene is obtained from the hydrocarbons in crude oil by . . .

1 thermal decomposition.

2 hydration.

3 fractional distillation.

4 polymerisation.

8B In some countries, very little ethanol for fuel is produced by fermentation because . . .

1 ethene is obtained from a non-renewable resource.

2 they have a hot climate suitable for growing sugar cane.

3 they are wealthy enough to import oil from abroad.

4 the ethanol from fermentation produces more carbon dioxide when burnt.

8C Which of the following is **not** a reason why an ethanol factory using sugar takes longer to produce ethanol than a factory using ethene?

1 A fermentation tank has to be emptied and cleaned after each batch.

2 After fermentation, the ethanol needs to be separated from water.

3 Sugar cane plants take a long time to grow.

4 Yeast takes several days to convert sugar into ethanol.

4.7.2.2 Reactions of alkenes

Question 24 · continued

8D Who would benefit economically if ethanol was made by hydration of ethene rather than by fermentation?

1 investors in the fermentation industry

2 oil companies

3 environmental pressure groups

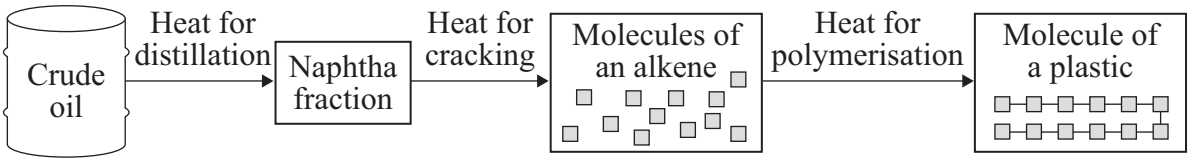
4 sugar cane farmers

Turn over for the next question

4.7.2.2 Reactions of alkenes

Question 25

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)

4.7.2.2 Reactions of alkenes

Question 25 · 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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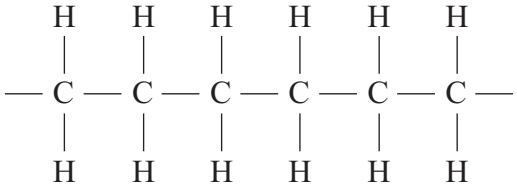
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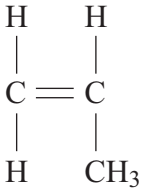
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(2 marks)

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

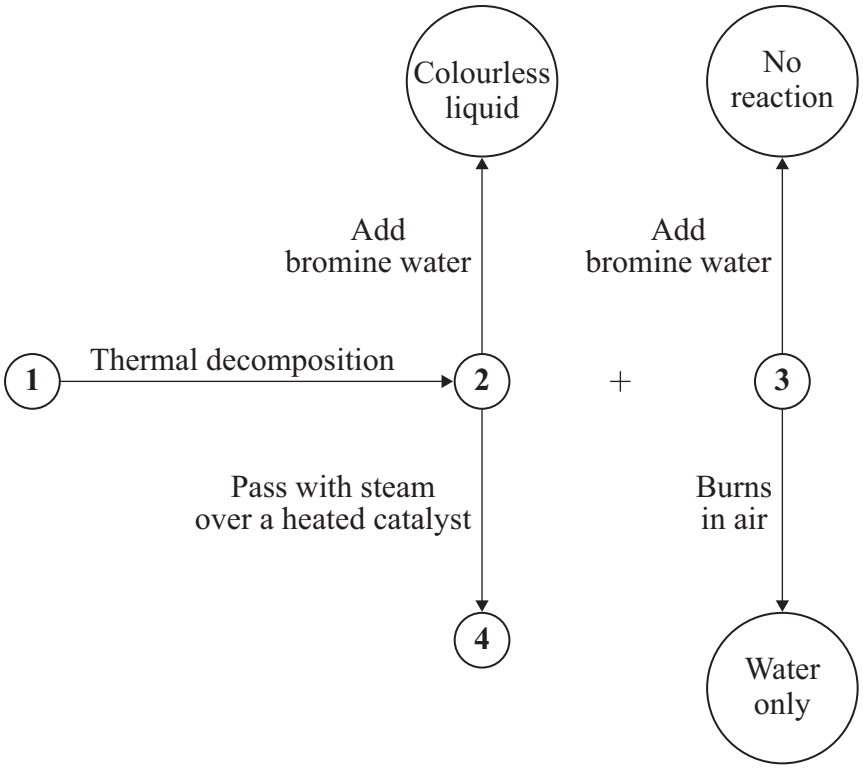
4.7.2.2 Reactions of alkenes

Question 26

March 2010 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

The flow chart shows a series of chemical reactions.



Match chemicals, **A**, **B**, **C** and **D**, with the numbers **1–4** in the flow chart.

A Ethane

B Ethene

C Ethanol

D Hydrogen

4.7.2.2 Reactions of alkenes

Question 27

March 2010 | CHY1BP | Original Q3 | Legacy

QUESTION THREE

The two equations below show reactions involving hydrocarbons.

$$C_{11}H_{24} \rightarrow C_2H_4 + C_4H_8 + C_5H_{12}$$

$$C_4H_{10} \rightarrow 2C_2H_4 + H_2$$

3A The reactions are examples of . . .

1 condensation.

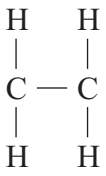
2 polymerisation.

3 cracking.

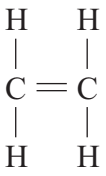
4 hydrogenation.

3B The hydrocarbon C_2H_4 can be represented by . . .

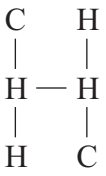
1



2



3



4



3C In the equations, the two hydrocarbons that are alkenes are . . .

1 C_2H_4 and C_4H_8

2 C_2H_4 and C_4H_{10}

3 C_2H_4 and C_5H_{12}

4 $C_{11}H_{24}$ and C_4H_{10}

4.7.2.2 Reactions of alkenes

Question 27 · continued

3D Which of the hydrocarbons is used to make poly(ethene)?

1 C_2H_4

2 C_4H_8

3 C_4H_{10}

4 C_5H_{12}

Turn over for the next question

4.7.2.2 Reactions of alkenes

Question 28

March 2010 | CHY1BP | Original Q5 | Legacy

QUESTION FIVE

Some properties of two forms of poly(ethene) are shown in the table.

Polymer	Density in kg per m^3	Tensile strength in MPa
Low-density poly(ethene) – LDPE	925	16
High-density poly(ethene) – HDPE	950	28

The molecules of low-density poly(ethene) and high-density poly(ethene) are represented in the diagrams.

Low-density poly(ethene) – LDPE



High-density poly(ethene) – HDPE



5A The reason for the differences in strength and density between LDPE and HDPE is that . . .

1 they contain different elements in their structure.

2 they were made under different conditions.

3 they have different colours added.

4 different monomers are used to make the chains.

5B HDPE has a higher density than LDPE because . . .

1 it is stronger.

2 more plastic is used to make LDPE.

3 the polymer molecules pack closer together in HDPE.

4 LDPE has shorter polymer chains.

Question 28 · continued March 2010 | CHY1BP | Original Q5 | Legacy

5C Which is the most appropriate method for disposal of a non-biodegradable polymer such as poly(ethene)?

1 freeze it so that it returns to the original monomer

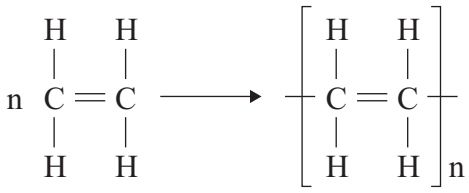
2 dispose of it at sea

3 bury it in the ground

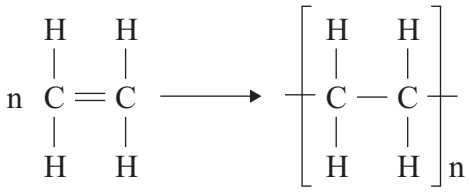
4 break it down by adding microorganisms

5D Which one of the following is the correct balanced equation for the polymerisation of ethene to form poly(ethene)?

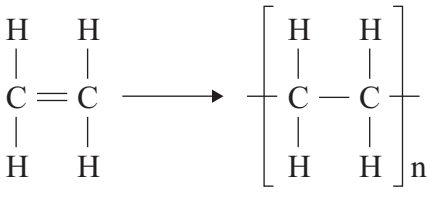
1



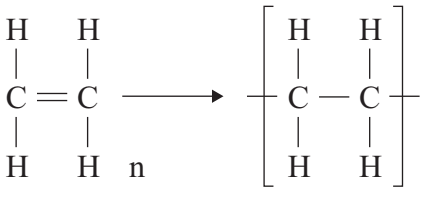
2



3



4



4.7.2.2 Reactions of alkenes

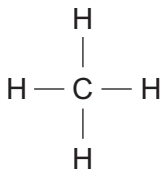
Question 29

June 2010 | CHY1BP | Original Q2 | Legacy

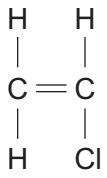
QUESTION TWO

This question is about the formulae of four carbon compounds, **A**, **B**, **C** and **D**.

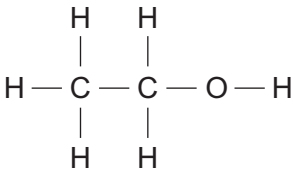
A



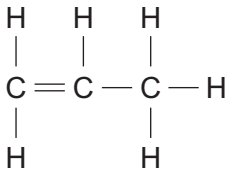
B



C



D



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

1	It is an unsaturated hydrocarbon.
2	It is the alkane that was present in Earth's early atmosphere.
3	It is made by reacting ethene with steam.
4	It is the monomer from which the polymer, poly(chloroethene) is made.

4.7.2.2 Reactions of alkenes

Question 30 June 2010 | CHY1BP | Original Q3 | Legacy

QUESTION THREE

This equation shows the thermal decomposition of a hydrocarbon.

$$C_8H_{18} \longrightarrow \text{an alkane} + \text{an alkene}$$

3A What is the name of this process?

1 polymerisation

2 cracking

3 combustion

4 hydrogenation

3B In this decomposition, . . .

1 the hydrocarbon vapour is heated with iodine.

2 the hydrocarbon is mixed with hydrogen and heated.

3 the hydrocarbon vapour is passed over a hot catalyst.

4 the hydrocarbon is liquefied, then passed over a catalyst.

3C The alkene produced . . .

1 is an unsaturated compound.

2 has molecules in which each carbon atom has two bonds.

3 is unreactive.

4 will burn to produce carbon dioxide and hydrogen.

4.7.2.2 Reactions of alkenes

Question 30 · continued

3D Poly(ethene) is a polymer that is made from an alkene.

The polymer is . . .

1 produced by thermal decomposition.

2 a thermosoftening polymer.

3 produced by cracking.

4 biodegradable.

Turn over for the next question

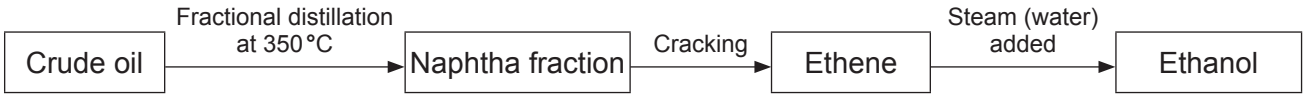
4.7.2.2 Reactions of alkenes

Question 31

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?

.....

.....

(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.

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

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

.....

.....

.....

.....

(2 marks)

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

H H

C C

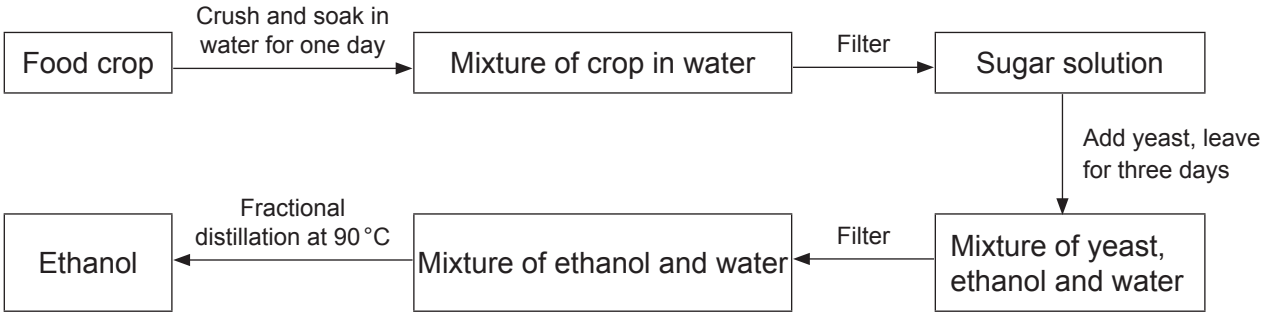
H H

(1 mark)

4.7.2.2 Reactions of alkenes

Question 31 · 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)

9

4.7.2.2 Reactions of alkenes

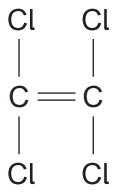
Question 32

QUESTION TWO

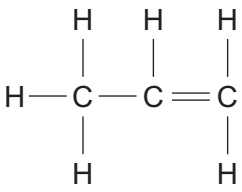
Plastic waste was taken to a recycling centre. At the recycling centre, the plastic was sorted and treated chemically. The chemical treatment broke down the plastic.

Breaking down the plastic produced new substances. The formulae for some of the substances produced are shown below.

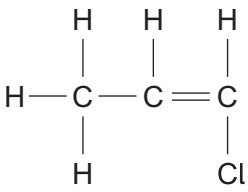
A



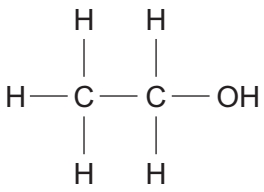
B



C



D



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

1	It is a hydrocarbon.
2	It could be made from propene, C_3H_6
3	It is formed by reacting ethene with steam, H_2O
4	It would not produce water vapour if burnt in air.

4.7.2.2 Reactions of alkenes

Question 33

November 2010 | CHY1BP | Original Q4 | Legacy

QUESTION FOUR

The equation shows the thermal decomposition of a hydrocarbon.

$$C_6H_{14} \longrightarrow \underset{\text{Ethene}}{C_2H_4} + \text{Substance } \mathbf{K}$$

4A What is the formula for substance **K**?

1 CH_4

2 C_2H_6

3 C_4H_{10}

4 C_8H_{18}

4B Ethene, C_2H_4 is . . .

1 an alkane.

2 an alkene.

3 a saturated hydrocarbon.

4 a polymer.

4C Ethene, C_2H_4 can form polymers because . . .

1 it contains both carbon atoms and hydrogen atoms.

2 it contains twice as many carbon atoms as hydrogen atoms.

3 the carbon atoms and hydrogen atoms are linked by single bonds.

4 there is a double bond between the carbon atoms.

4D Poly(ethene) is used to make shopping bags.

A problem with poly(ethene) is that . . .

1 it is not waterproof.

2 it cannot be coloured.

3 it is not broken down by microorganisms.

4 it is a thermosetting polymer.

4.7.2.2 Reactions of alkenes

Question 34

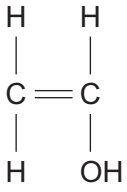
November 2010 | CHY1BP | Original Q7 | Legacy

QUESTION SEVEN

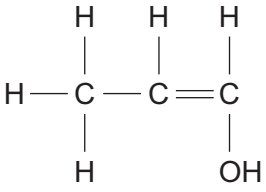
This question is about compounds that contain a double carbon carbon bond.

7A The structures of ethenol and propenol are shown below.

Ethenol



Propenol



Ethenol and propenol belong to a family of compounds with the general formula . . .

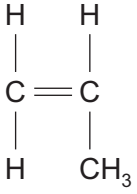
1 C_nH_nOH

2 $C_nH_{2n}OH$

3 $C_nH_{2n-1}OH$

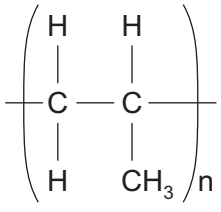
4 $C_nH_{2n+1}OH$

The formula for propene can be shown as:

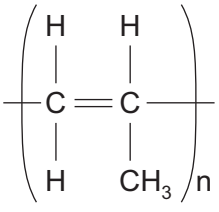


7B The polymer, poly(propene), will have the formula:

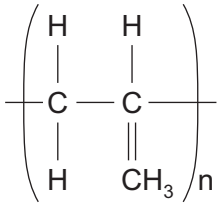
1



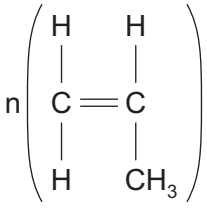
2



3



4



4.7.2.2 Reactions of alkenes

Question 34 · continued

7C Which statement about propene and poly(propene) is correct?

1 Both compounds are unsaturated.

2 Only poly(propene) reacts with bromine.

3 Only poly(propene) could be produced by cracking oil fractions.

4 Only propene reacts with hydrogen.

7D Poly(propene) is a thermosoftening polymer.

This means that . . .

1 it can be moulded into many shapes.

2 it softens when heated and hardens when it cools.

3 it hardens when it is heated to give a rigid structure.

4 it is resistant to heat.

Turn over for the next question

4.7.2.2 Reactions of alkenes

Question 35

January 2011 | CHY1H | Original Q5 | Legacy

5 Supermarkets in the UK have been advised by the Government to stop giving plastic bags to customers. The Government states that this is because plastic bags use up resources that are not renewable and that the manufacture of plastic bags produces carbon dioxide.
Most of these plastic bags are made from poly(ethene). The table shows methods to deal with large numbers of used plastic bags.

Method	**Description of what happens to the plastic bag**
Reused	used again by the customer
Recycled	collected, transported, washed and melted to make new plastic items
Burned	collected, transported and burnt to release heat energy
Dumped	mixed with other household waste, collected, transported and disposed of at a landfill site

Use the information and your knowledge and understanding to briefly give **one advantage and one disadvantage** for each of these methods.

Reused .....

.....

.....

Recycled .....

.....

.....

Burned .....

.....

.....

Dumped .....

.....

.....

(4 marks)

4

4.7.2.2 Reactions of alkenes

Question 36

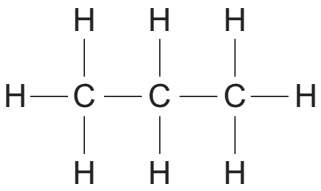
March 2011 | CHY1BP | Original Q1 | Legacy

QUESTION ONE

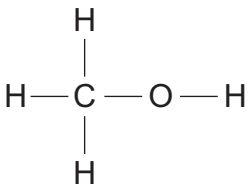
This question is about the formulae of four compounds.

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

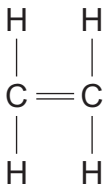
A



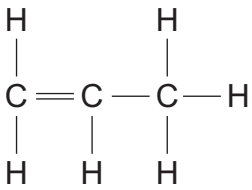
B



C



D



1	It is the alkene used to make ethanol.
2	It is a saturated hydrocarbon useful as a fuel.
3	It is not a hydrocarbon but burns to produce carbon dioxide and water vapour.
4	It belongs to the group with the general formula C_nH_{2n} where n = 3.

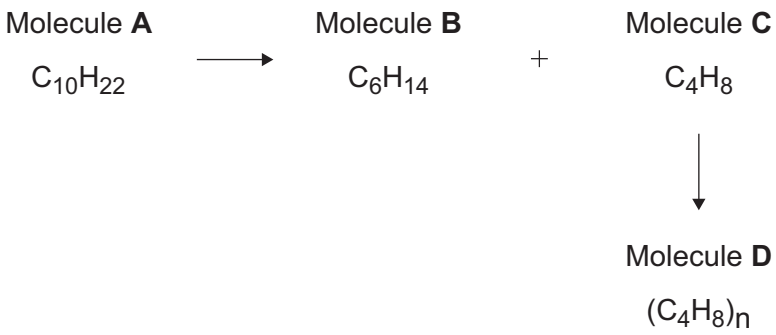
4.7.2.2 Reactions of alkenes

Question 37

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.

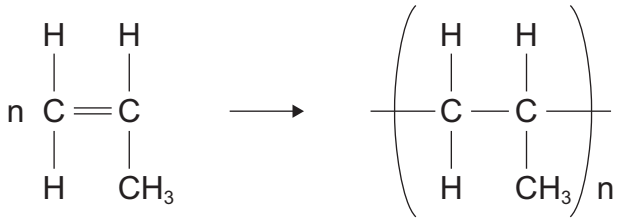
4.7.2.2 Reactions of alkenes

Question 38

March 2011 | CHY1BP | Original Q4 | Legacy

QUESTION FOUR

The equation shows a chemical reaction.



Small molecules of hydrocarbon **X**

Large molecule of hydrocarbon **Y**

4A Hydrocarbon **X** is . . .

1 an alkane.

2 a polymer.

3 an alkene.

4 a catalyst.

4B Hydrocarbon **Y** is . . .

1 an unsaturated compound.

2 a polymer.

3 an alkene.

4 a monomer.

4C Poly(propene) is a thermosoftening polymer so it **cannot** be used to make . . .

1 buckets.

2 food containers.

3 non-stick coating for frying pans.

4 washing-up bowls.

4.7.2.2 Reactions of alkenes

Question 38 · continued

4D Putting poly(propene) and other polymer waste into landfill creates a problem because this type of waste . . .

1 is very lightweight and blows about.

2 is not biodegradable.

3 does not dissolve in water.

4 is very dense and sinks deep underground.

Turn over for the next question

4.7.2.2 Reactions of alkenes

Question 39

March 2011 | CHY1BP | Original Q7 | Legacy

QUESTION SEVEN

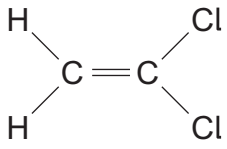
Worldwide, about 20 billion wine bottle stoppers are produced each year.

In recent years, the traditional cork stoppers have been gradually replaced by screw-top stoppers.

Cork is the bark from the cork-oak tree, which is cut off about every ten years. Tens of thousands of people in rural Portugal depend on cork for their livelihoods. Used cork can be recycled.

A screw-top stopper can be made of aluminium, inside which is a polymer sealant. The sealant is usually made of poly(ethene) or poly(vinylidene chloride). Extraction of aluminium from its ores is expensive and a lot of energy is required. It is difficult to separate the polymer from the aluminium cap to allow aluminium to be recycled.

Vinylidene chloride has the structure:



7A One difference between ethene and vinylidene chloride is that . . .

1 only ethene is an unsaturated compound.

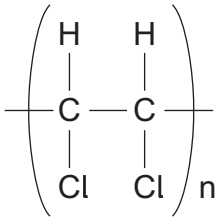
2 only vinylidene chloride will react with iodine.

3 only vinylidene chloride is obtained from crude oil.

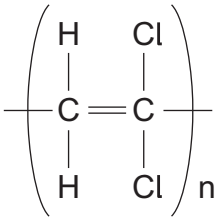
4 only ethene is a hydrocarbon.

7B The formula for poly(vinylidene chloride) is . . .

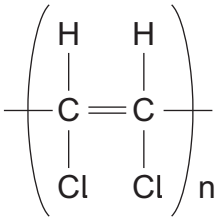
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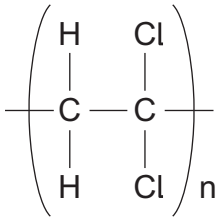
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4



Question 39 · continued

7C There are two likely consequences of wine companies using metal screw-top stoppers with polymer sealants instead of cork.

Which row in the table correctly shows the two likely consequences?

1	increased use of crude oil	loss of employment in rural Portugal
2	reduction in carbon dioxide emissions	loss of employment in rural Portugal
3	reduction in carbon dioxide emissions	loss of important forest habitat
4	increased use of crude oil	reduced amount of material to landfill

7D Scientists are researching the consequences of using screw-top stoppers with polymer sealants instead of cork.

Which row in the table below gives the correct description of an issue and its impact?

	Issue	Impact
1	ethical	effect on the price of wine
2	social	effect on the rural communities
3	environmental	effect on the quality of wine
4	economic	effect on cork forest habitat

4.7.2.2 Reactions of alkenes

Question 40

June 2011 | CHY1BP | Original Q7 | Legacy

QUESTION SEVEN

About 90 % of the world's supply of ethanol is produced by using yeast for the fermentation of sugars obtained from plants. A solution of about 8 % ethanol in water is obtained.
Ethanol can be used to produce ethene.

Reaction **P** shows carbon dioxide being removed from the atmosphere by plants to make sugar.
Reaction **Q** shows carbon dioxide being released by yeast into the atmosphere during respiration.
Reaction **R** shows the formation of ethene from ethanol.

Reaction **P** $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Reaction **Q** $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

Reaction **R** $C_2H_5OH \rightarrow C_2H_4 + H_2O$

7A In these reactions, what is the net change in the number of molecules of carbon dioxide in the atmosphere during the production of one molecule of ethene?

1 1

2 2

3 4

4 6

Ethanol can also be produced by the reaction of ethene with steam.

This is a continuous process because the reactants flow steadily into the reactor and the ethanol flows out.

7B How is the ethene for this process obtained?

1 by fractional distillation of crude oil

2 by cracking fractions from crude oil

3 by polymerisation of crude oil

4 by vaporisation of crude oil

4.7.2.2 Reactions of alkenes

Question 40 · continued June 2011 | CHY1BP | Original Q7 | Legacy

7C An advantage of producing ethanol from ethene rather than by fermentation is that . . .

1 higher temperatures are required.

2 catalysts are used.

3 the ethanol is purer.

4 the reaction is slower.

7D It may be better to obtain ethene from biologically-produced ethanol rather than from crude oil.

One reason for this is that . . .

1 ethene can be produced in unlimited quantities.

2 crude oil is a non-renewable resource.

3 poly(ethene) made from biologically produced ethanol will be biodegradable.

4 the fermentation of sugar is done in batches, whereas production of ethene from crude oil is continuous.

4.7.2.2 Reactions of alkenes

Question 41

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

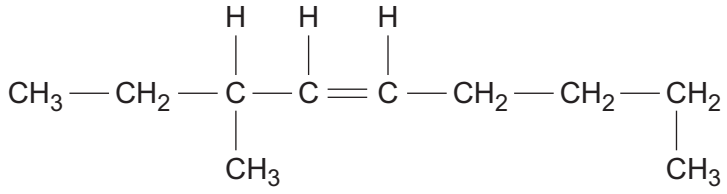
2 $C_{15}H_{32} \rightarrow 2CH_4 + C_3H_6 + C_4H_{10} + C_6H_{12}$

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

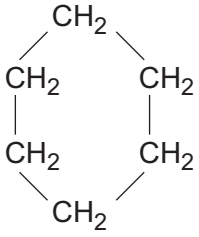
4 $C_{15}H_{32} \rightarrow C_4H_{10} + C_5H_{10} + C_6H_{14}$

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?

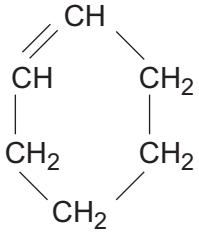
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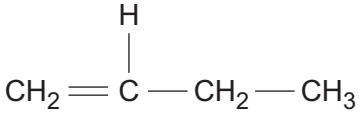
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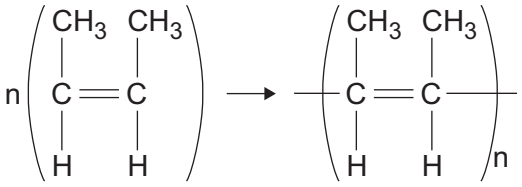


4.7.2.2 Reactions of alkenes

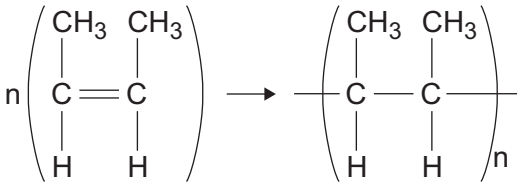
Question 41 · continued

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

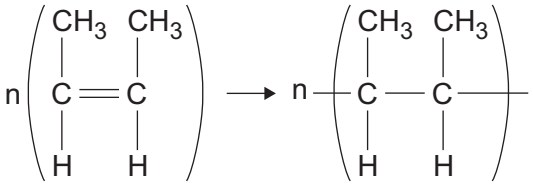
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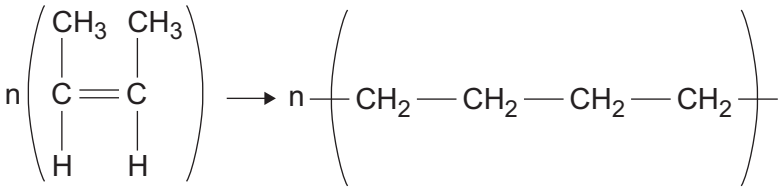
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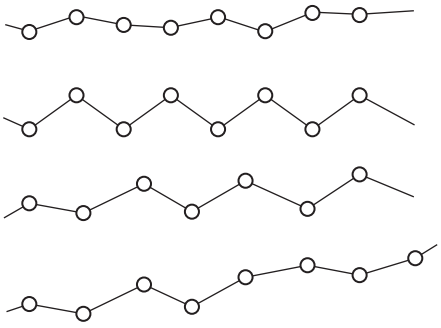
Question 8 continues on the next page

4.7.2.2 Reactions of alkenes

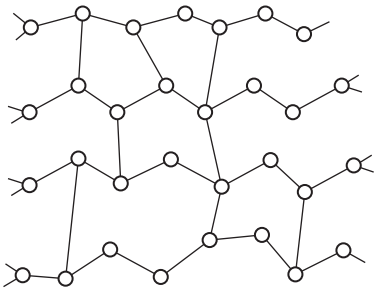
Question 41 · continued

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

4.7.2.2 Reactions of alkenes

Question 42

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.

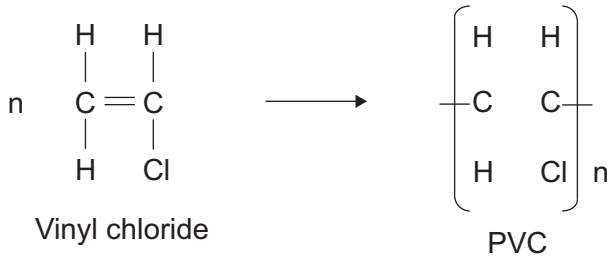
Complete the chemical equation by writing in the formula of the product vinyl chloride.

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

(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)

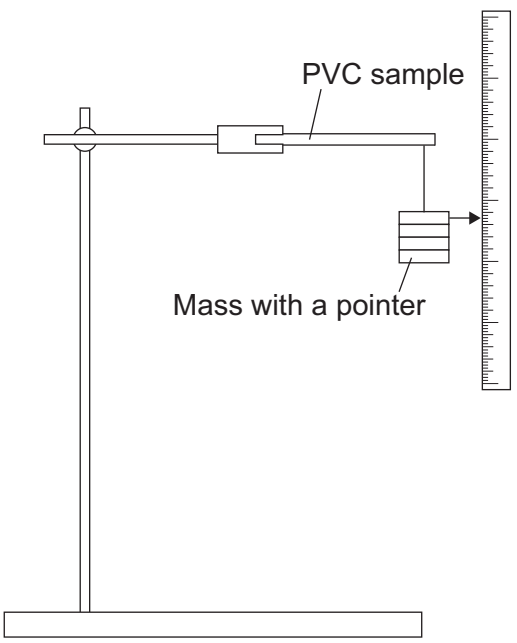
Question 2 continues on the next page

4.7.2.2 Reactions of alkenes

Question 42 · 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)

4.7.2.2 Reactions of alkenes

Question 42 · 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

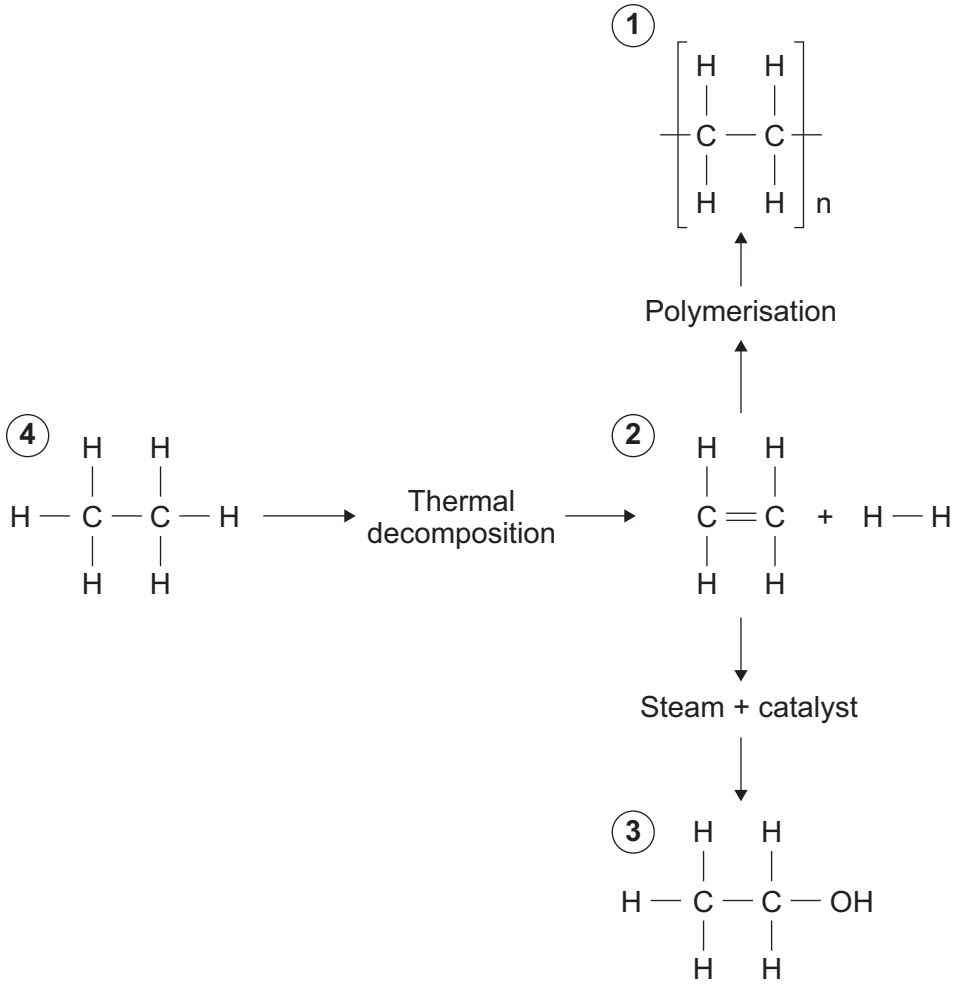
4.7.2.2 Reactions of alkenes

Question 43

November 2011 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

The flow chart shows a series of chemical reactions.



Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the flow chart.

A Ethane

B Ethanol

C Ethene

D Poly(ethene)

4.7.2.2 Reactions of alkenes

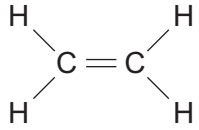
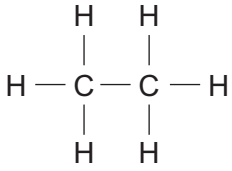
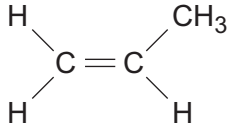
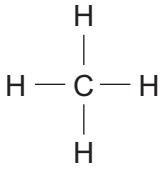
Question 44

November 2011 | CHY1BP | Original Q5 | Legacy

QUESTION FIVE

Polymers have properties that depend on what they are made from and the conditions under which they are made.

5A Which row in the table contains two molecules that are both easily made into polymers?

1	C_3H_6	
2	C_4H_{10}	
3	C_5H_{12}	
4	C_4H_8	

Poly(ethene) was first produced by heating ethene under high pressure and to high temperatures. Later, it was found that poly(ethene) could be produced at much lower temperatures and pressures if an aluminium catalyst was used.

5B An advantage of using a catalyst is that the poly(ethene) could be . . .

1 improved by including aluminium in its structure.

2 manufactured with different alkenes.

3 manufactured by polymerisation of ethane.

4 more economic to produce.

4.7.2.2 Reactions of alkenes

Question 44 · continued

5C The poly(ethene) produced using lower temperatures and pressures has a higher density.

This has enabled manufacturers to . . .

1 develop a wider range of products.

2 use different types of monomer to make poly(ethene).

3 use the polymers as fuels.

4 develop products that do not burn.

5D Many products are made using poly(ethene).

Which of the following is likely to be the most environmentally friendly way to deal with these products when they become waste?

1 allow the poly(ethene) to biodegrade

2 put the poly(ethene) in landfill sites

3 burn the poly(ethene) and use the energy released to produce electricity

4 melt the poly(ethene) and make new products

4.7.2.2 Reactions of alkenes

Question 45

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

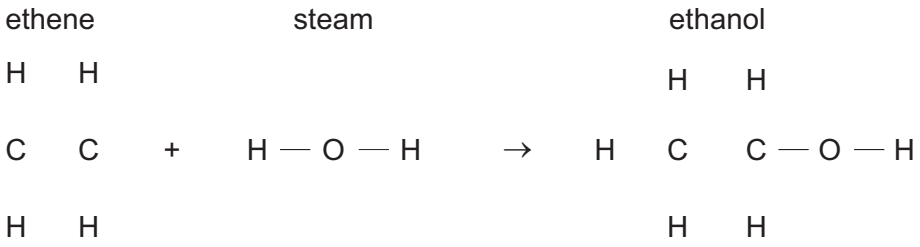
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(2 marks)

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.

4.7.2.2 Reactions of alkenes

Question 45 · 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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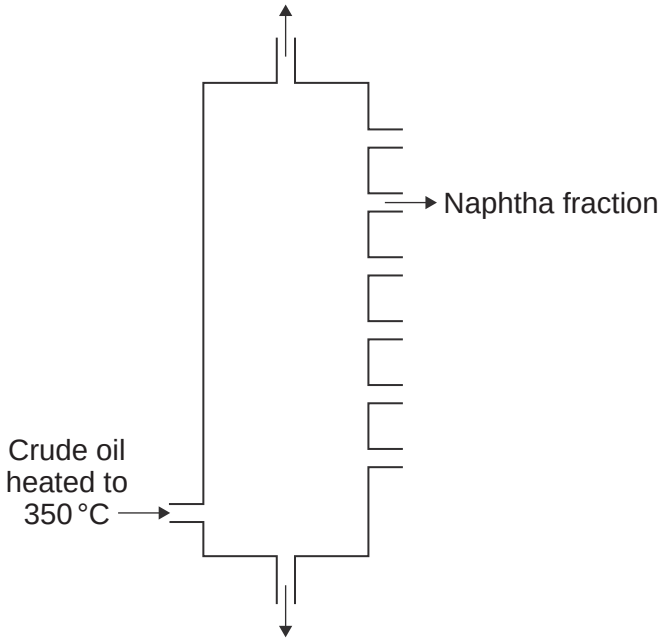
4.7.2.2 Reactions of alkenes

Question 46

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)

4.7.2.2 Reactions of alkenes

Question 46 · 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)

10

4.7.2.2 Reactions of alkenes

Question 47

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?

.....

.....

(1 mark)

4.7.2.2 Reactions of alkenes

Question 47 · 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)

8

4.7.2.2 Reactions of alkenes

Question 48

January 2013 | CH1HP | Original Q6 | Legacy

6 Most petrol used in cars contains about 5% ethanol (C_2H_5OH).

6 (a) The complete combustion of ethanol produces carbon dioxide and water.

Complete and balance the symbol equation for the complete combustion of ethanol.

C_2H_5OH + ...O_2 → ..... + ...

(2 marks)

6 (b) Ethanol can be produced from octane (C_8H_{18}).
The two chemical equations represent the production of ethanol from octane.

Equation 1: $C_8H_{18} \rightarrow C_4H_{10} + 2C_2H_4$

Equation 2: $C_2H_4 + H_2O \rightarrow C_2H_5OH$

6 (b) (i) In **Equation 1** the products are a mixture of two gases.

Describe a chemical test that would indicate the presence of ethene (C_2H_4) in the mixture.

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(2 marks)

4.7.2.2 Reactions of alkenes

Question 48 · continued

6 (b) (ii) Describe, as fully as you can, the conditions used for the two reactions to produce ethanol from octane.

Use **Equation 1** and **Equation 2** to help you with your answer.

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(4 marks)

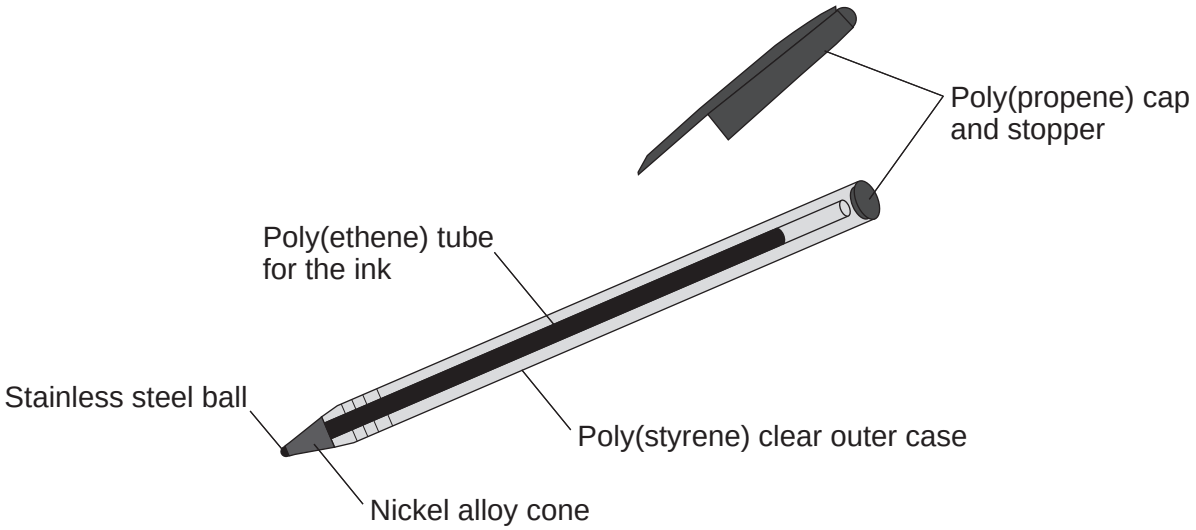
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4.7.2.2 Reactions of alkenes

Question 49

June 2013 | CH1HP | Original Q4 | Legacy

4 The diagram shows a ballpoint pen.



4 (a) Give **one** advantage and **one** disadvantage of recycling the materials from this type of ballpoint pen.

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(2 marks)

4 (b) Alloys are used to make the ballpoint pen.

Give **two** reasons why alloys are used in the ballpoint pen.

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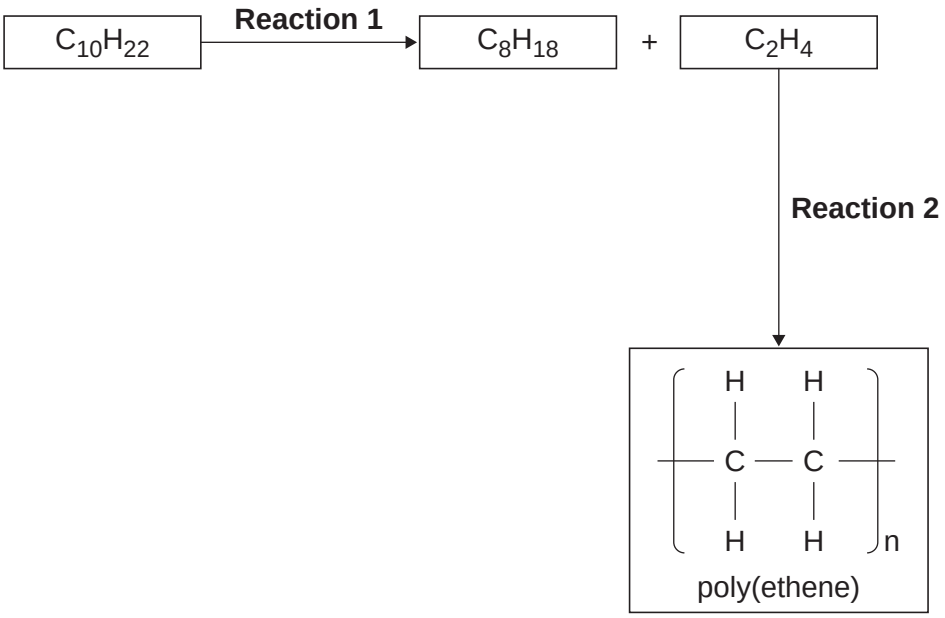
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(2 marks)

4.7.2.2 Reactions of alkenes

Question 49 · continued

4 (c) Decane ($C_{10}H_{22}$) can be used to produce poly(ethene).



4 (c) (i) Describe the conditions needed for **Reaction 1**.

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(2 marks)

4 (c) (ii) Describe, in terms of molecules, how poly(ethene) is produced in **Reaction 2.**

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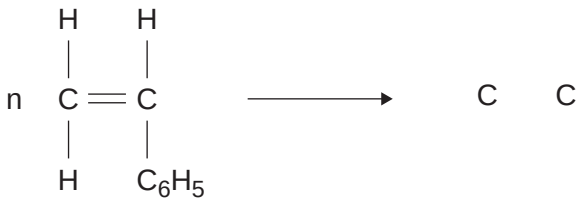
(2 marks)

Question 4 continues on the next page

4.7.2.2 Reactions of alkenes

Question 49 · continued

4 (d) Complete the displayed structure of the product in the equation.



styrene poly(styrene)

(2 marks)

10

4.7.2.2 Reactions of alkenes

Question 50

June 2014 | CH1HP | Original Q2 | Legacy

2 Ethanol and vegetable oil are used as fuels.

2 (a) There are two different ways to produce ethanol:

- using ethene from crude oil
- using sugar from plants.

2 (a) (i) Ethanol is produced from ethene by **hydration** in the presence of a catalyst.

What is **hydration**?

[1 mark]

.....

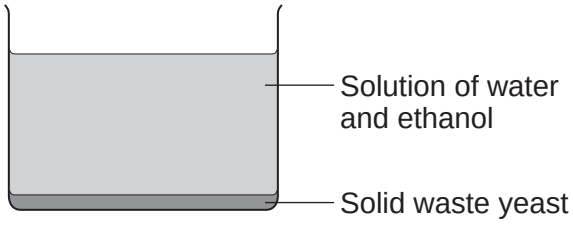
.....

2 (a) (ii) Fermentation is used to produce ethanol from sugar by:

- dissolving the sugar in water
- adding yeast to the sugar solution
- leaving the mixture for three days.

Figure 2 shows the substances after three days.

Figure 2



Suggest:

- how the solid waste yeast is removed
- how ethanol is obtained from the solution.

[2 marks]

.....

.....

.....

.....

Question 50 · continued

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

Crude oil is separated to produce the fraction petroleum diesel.

Worries about low supplies of crude oil have led to the growing of large areas of crops to produce vegetable oil.

Vegetable oils are used to produce biodiesel.

There are economic, ethical and environmental issues about the use of biodiesel.

Biodiesel and petroleum diesel are used as a fuel for cars. In a car engine the fuel burns and releases waste products through the car exhaust system.

Table 1 shows the amount of waste products formed by biodiesel compared with the amount of waste products formed by petroleum diesel.

(Note that ppm is parts per million.)

Table 1

	Carbon dioxide in ppm	Nitrogen oxides in ppm	Sulfur dioxide in ppm	Particulates in g per m^3
Biodiesel	20 000	760	0	0.3
Petroleum diesel	80 000	700	300	0.6

Use this information and your knowledge and understanding to give advantages and disadvantages of using biodiesel instead of petroleum diesel.

[6 marks]

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4.7.2.2 Reactions of alkenes

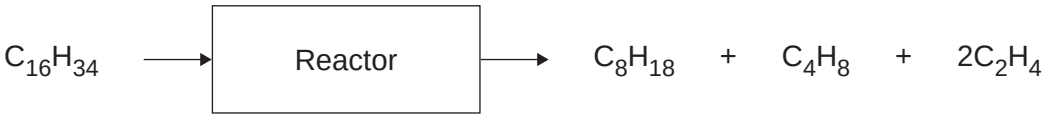
Question 51

June 2014 | CH1HP | Original Q7 | Legacy

7 Poly(butene) is a polymer made from crude oil in two stages.

7 (a) The first stage in making poly(butene) is to break down large hydrocarbon molecules from crude oil into smaller hydrocarbon molecules, as shown in **Figure 6**.

Figure 6



7 (a) (i) The products contain two types of hydrocarbon with different general formulae.

Name the two types of hydrocarbon.

[1 mark]

.....

7 (a) (ii) Describe the conditions in the reactor.

[2 marks]

.....

.....

.....

.....

7 (a) (iii) Suggest why air must **not** enter the reactor.

[1 mark]

.....

.....

7 (a) (iv) Suggest a method that can be used to separate butene (C_4H_8) from the other hydrocarbons.

[1 mark]

.....

4.7.2.2 Reactions of alkenes

Question 51 · continued

7 (b) The second stage is to use butene (C_4H_8) to produce poly(butene).

7 (b) (i) Draw the displayed structure of a butene (C_4H_8) molecule.

[1 mark]

7 (b) (ii) Describe how molecules of butene (C_4H_8) form poly(butene).

[2 marks]

.....

.....

.....

.....

8

4.7.2.2 Reactions of alkenes

Question 52

June 2015 | CH2HP | Original Q3 | Legacy

3 This question is about metals and alloys.

3 (a) Explain how electricity is conducted in a metal.

To gain full marks you must include a description of the structure and bonding of a metal.

[4 marks]

.....

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3 (b) Describe how the structure of an alloy is different from the structure of a pure metal.

[2 marks]

.....

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.....

3 (c) Alloys are used to make dental braces and coins.

3 (c) (i) Nitinol is an alloy used in dental braces.

Why is Nitinol used in dental braces?

[1 mark]

.....

.....

4.7.2.2 Reactions of alkenes

Question 52 · continued

3 (c) (ii) Suggest **one** reason why coins are not made of pure copper.

Do **not** give cost as a reason.

[1 mark]

.....

.....

3 (c) (iii) Some coins are made from an alloy of aluminium.

Complete the sentence.

[1 mark]

Aluminium is manufactured by the electrolysis of a molten mixture of

cryolite and ..... .

3 (c) (iv) Banks keep coins in poly(ethene) bags. These bags are made from low density poly(ethene).

High density poly(ethene) can also be made from the same monomer.

How can the same reaction produce two different products?

[1 mark]

.....

.....

3 (d) Give **two** reasons why instrumental methods of analysis are used to detect impurities in metals.

[1 mark]

.....

.....

.....

11

4.7.2.2 Reactions of alkenes

Question 53

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]

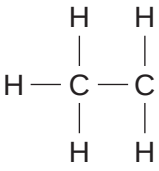
When alkenes react with bromine water the colour changes

from orange to _____ .

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

Complete the displayed structure of butane.

[1 mark]



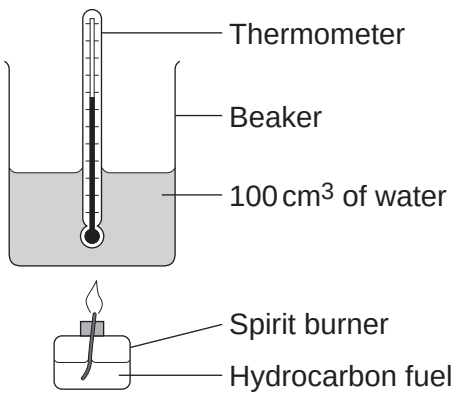
Question 2 continues on the next page

Question 53 · 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

4.7.2.2 Reactions of alkenes

Question 53 · 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 53 · 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]

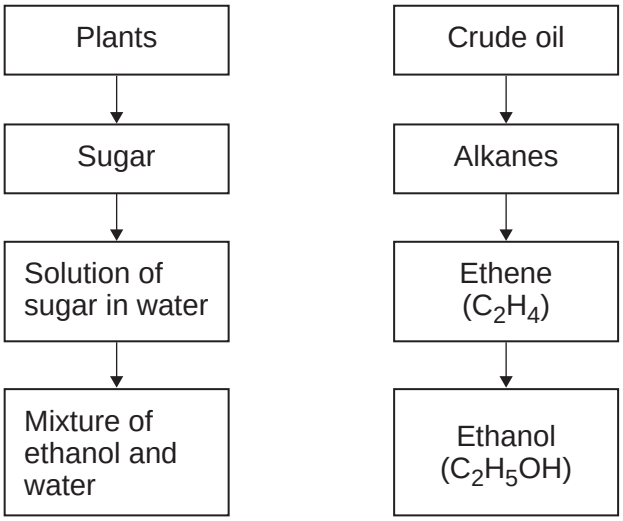
4.7.2.2 Reactions of alkenes

Question 54

June 2016 | CH1HP | Original Q4 | Legacy

4 Ethanol can be made from plants and from crude oil as shown in **Figure 6.**

Figure 6



4 (a) (i) Describe how the solution of sugar in water is used to produce the mixture of ethanol and water.

[2 marks]

4 (a) (ii) Describe how ethanol is produced from ethene.

[2 marks]

4.7.2.2 Reactions of alkenes

Question 54 · continued

4 (b) Explain **one** advantage and **one** disadvantage of using crude oil to make ethanol instead of using plants.

[4 marks]

4 (c) Ethanol has a boiling point of 78 °C.
Water has a boiling point of 100 °C.

Describe how distillation is used to separate a mixture of ethanol and water.

[3 marks]

11

4.7.2.2 Reactions of alkenes

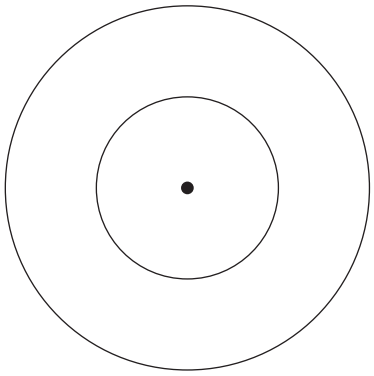
Question 55

June 2017 | CH1HP | Original Q2 | Legacy

2 This question is about compounds of carbon.

2 (a) **Figure 2** shows an atom with two energy levels (shells).

Figure 2



2 (a) (i) A carbon atom has six electrons.

Complete **Figure 2** to show the electronic structure of a carbon atom.

Use **x** to represent an electron.

[1 mark]

2 (a) (ii) Complete the following description about the central part of this carbon atom.

[3 marks]

The central part is made up of six neutrons that have no electrical charge and _____

_____

_____

_____

_____

2 (b) Crude oil is a mixture of compounds. These compounds are mainly hydrocarbons.

What does the term hydrocarbon mean?

[1 mark]

_____

_____

Question 55 · continued

2 (c) Alkanes and alkenes are hydrocarbons.

Table 2 shows the boiling points of some alkanes and alkenes.

Table 2

Alkanes

Name	Formula	Boiling point in °C
Ethane	C_2H_6	−88
Propane	C_3H_8	−42
Butane	C_4H_{10}	0
Pentane	C_5H_{12}	+36
Hexane	C_6H_{14}	+69

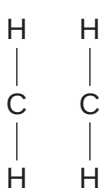
Alkenes

Name	Formula	Boiling point in °C
Ethene	C_2H_4	−104
Propene	C_3H_6	−48
Butene	C_4H_8	−6
Pentene	C_5H_{10}	+30
Hexene	C_6H_{12}	+64

2 (c) (i) Complete the displayed structure of ethane and the displayed structure of ethene.

[2 marks]

Ethane



Ethene



2 (c) (ii) Describe the relationship between the number of carbon atoms in an alkane molecule and the boiling point of the alkane molecule.

[1 mark]

4.7.2.2 Reactions of alkenes

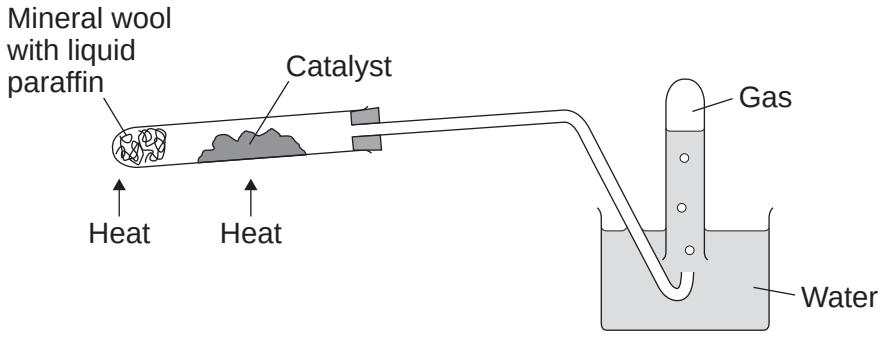
Question 55 · continued

2 (c) (iii) Use the information in **Table 2** to compare the boiling points of alkanes with the boiling points of alkenes.

[2 marks]

2 (d) A student used the apparatus in **Figure 3** to investigate what happens when liquid paraffin is heated to a high temperature.

Figure 3



Liquid paraffin contains alkanes.

Describe what happens to the alkane molecules in this investigation.

[3 marks]

13

4.7.2.2 Reactions of alkenes

Question 56

June 2017 | CH2HP | Original Q4 | Legacy

4 This question is about sulfuric acid (H_2SO_4) and ethene.

Sulfuric acid is used to produce copper sulfate ($CuSO_4$).

The equation for the reaction is:

$$CuO(s) + H_2SO_4(aq) \longrightarrow CuSO_4(aq) + H_2O(l)$$

4 (a) Describe a method for making copper sulfate crystals from copper oxide and sulfuric acid.

[4 marks]

4 (b) Calculate the mass of copper oxide required to produce 24.95 g of copper sulfate crystals ($CuSO_4.5H_2O$).

Relative formula mass (M_r) of copper sulfate crystals = 249.5

Relative atomic masses (A_r): O = 16; Cu = 63.5

[3 marks]

Mass of copper oxide = _____ g

Question 56 · continued

4 (c) Ethene and sulfuric acid are used to make many substances.

4 (c) (i) **Table 1** shows data about wealth of countries, ethene production and sulfuric acid production.

Table 1

Country	Wealth of country in billions of dollars	Ethene production in kilotonnes	Sulfuric acid production in kilotonnes
A	4000	13 900	36 000
B	1300	4 400	6 600
C	1290	2 700	26 000
D	620	3 100	2 500
E	460	1 500	4 200
F	310	650	6 700

How does the wealth of countries relate to their production of ethene and sulfuric acid?

[2 marks]

4 (c) (ii) Suggest why the use of ethene has increased in the last 50 years.

[1 mark]

10

4.7.2.2 Reactions of alkenes

Question 57

0 6 This question is about polymers.

0 6 . 1 Polyesters are produced when monomers join together and lose a small molecule.

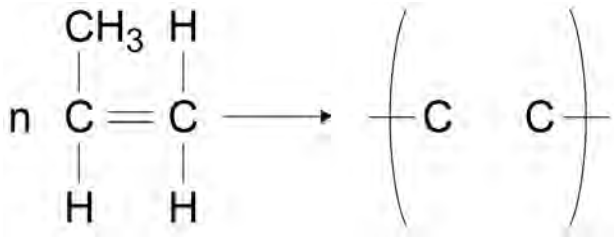
Name the small molecule lost.

[1 mark]

0 6 . 2 Poly(propene) is produced from propene.

Complete the structure of poly(propene) in the equation.

[3 marks]



0 6 . 3 Carpets are made from:

- poly(propene)
- wool
- a mixture of poly(propene) and wool.

Poly(propene) wears out more slowly than wool.

A mixture of poly(propene) and wool to make carpets is more sustainable than using just poly(propene) or just wool.

Suggest why.

[2 marks]

4.7.2.2 Reactions of alkenes

Question 57 · continued

Polymer fibres are used to make firefighter uniforms.

Table 3 shows some properties of two polymer fibres.

Table 3

	Polymer fibres	
Property	**Poly(propene)**	**Polyester**
Density in g/cm^3	0.90	1.38
Melting point in °C	165	260
Flame resistance	Poor	Good
Water absorption	Low	High

0 6 . 4 Evaluate the suitability of poly(propene) and polyester for firefighter uniforms.

[4 marks]

10

4.7.2.2 Reactions of alkenes

Question 58

June 2019 | 8462/2H | Original Q8

0 8 Titan is a moon of the planet Saturn.

Table 3 shows the percentages of the gases in the atmosphere of Titan.

Table 3

Gas	Percentage of gas in atmosphere (%)
Nitrogen	98.4
Methane	1.4
Other gases	0.2

0 8 . 1 Some scientists think that living organisms could have evolved on Titan.

Explain why these organisms could **not** have evolved in the same way that life is thought to have evolved on Earth.

Use **Table 3**.

[3 marks]

4.7.2.2 Reactions of alkenes

Question 58 · continued

0 8 . 2 Saturn has other moons.

The other moons of Saturn have no atmosphere.

Titan is warmer than the other moons of Saturn because its atmosphere contains the greenhouse gas methane.

Explain how this greenhouse gas keeps Titan warmer than the other moons of Saturn.

[3 marks]

0 8 . 3 The atmosphere of Titan contains small amounts of propene.

Describe a test to show that propene is an unsaturated hydrocarbon.

Give the result of the test.

[2 marks]

Test _____

Result _____

8

4.7.2.2 Reactions of alkenes

Question 59

November 2020 | 8462/2H | Original Q3

0 3 This question is about hydrocarbons.

Hexane and hexene are hydrocarbons containing six carbon atoms in each molecule.

Hexane is an alkane and hexene is an alkene.

0 3 . 1 Draw **one** line from each hydrocarbon to the formula of that hydrocarbon.

[2 marks]

Hydrocarbon	Formula
	C_6H_8
Hexane	C_6H_{10}
	C_6H_{12}
Hexene	C_6H_{14}
	C_6H_{16}

0 3 . 2 Bromine water is added to hexane and to hexene.

What would be observed when bromine water is added to hexane and to hexene?

[2 marks]

Hexane _____

_____

Hexene _____

_____

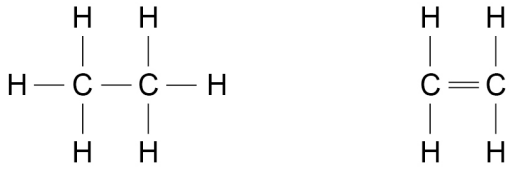
4.7.2.2 Reactions of alkenes

Question 59 · continued

0 3 . 3 Ethane is an alkane and ethene is an alkene.

Figure 1 shows the displayed structural formulae of ethane and of ethene.

Figure 1



Ethane **Ethene**

Compare ethane with ethene.

You should refer to:

- their structure and bonding
- their reactions.

[6 marks]

10

4.7.2.2 Reactions of alkenes

Question 60

November 2021 | 8462/2H | Original Q4

0 4 This question is about poly(ethene) and polyesters.

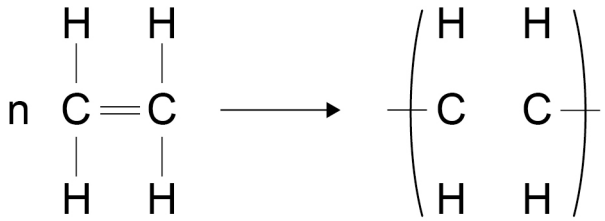
0 4 . 1 Poly(ethene) is produced from ethene.

Figure 3 shows part of the displayed structural formula equation for the reaction.

Complete **Figure 3**.

[2 marks]

Figure 3



0 4 . 2 Poly(ethene) is a thermosoftening polymer.

Suggest why poly(ethene) is easier to recycle than thermosetting polymers.

[2 marks]

0 4 . 3 Ethene produces different forms of poly(ethene).

How can different forms of poly(ethene) be produced from ethene?

[1 mark]

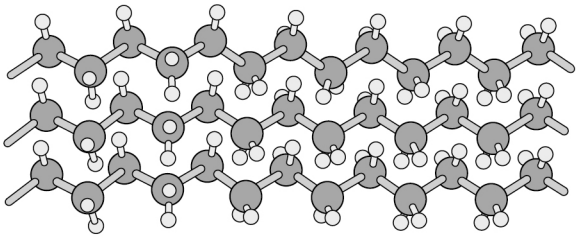
0 4 . 4 Two different forms of poly(ethene) are:

- high density poly(ethene) (HDPE)
- low density poly(ethene) (LDPE).

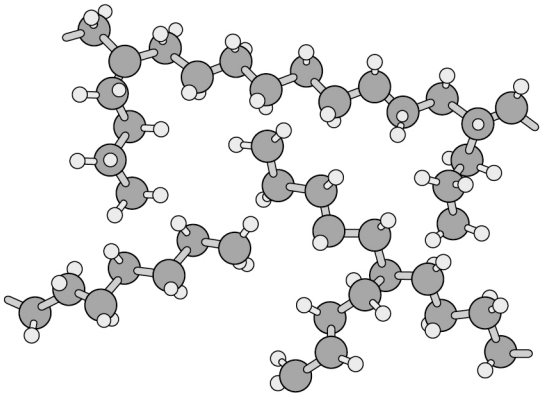
Figure 4 represents part of the structures of HDPE and LDPE.

Figure 4

HDPE



LDPE



Explain why HDPE has a higher density than LDPE.

[2 marks]

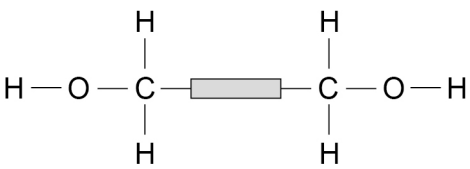
Question 4 continues on the next page.

Question 60 · continued

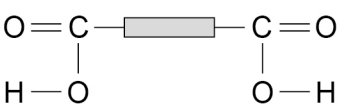
Figure 5 shows three monomers, **A**, **B** and **C**.

Monomer **A** can react with monomer **B** and with monomer **C** to produce polyesters.

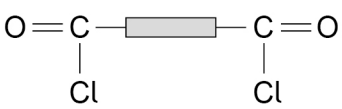
Figure 5



Monomer **A**



Monomer **B**



Monomer **C**

0 4 . 5 Draw a circle on **Figure 5** around an alcohol functional group.

[1 mark]

0 4 . 6 Complete **Table 2** to show the formula of the small molecule produced when:

- monomer **A** reacts with monomer **B**
- monomer **A** reacts with monomer **C**.

[1 mark]

Table 2

Reacting monomers	Formula of small molecule produced
A and **B**	
A and **C**	

9

4.7.2.2 Reactions of alkenes

Question 61

November 2021 | 8462/2H | Original Q6

0 6 This question is about cycloalkenes.

Cycloalkenes are ring-shaped hydrocarbon molecules containing a double carbon-carbon bond.

Cycloalkenes react in a similar way to alkenes.

0 6 . 1 Describe a test for the double carbon-carbon bond in cycloalkene molecules.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

0 6 . 2 **Table 3** shows the name and formula of three cycloalkenes.

Table 3

Name	Formula
Cyclobutene	C_4H_6
Cyclopentene	C_5H_8
Cyclohexene	C_6H_{10}

Determine the general formula for cycloalkenes.

[1 mark]

_____

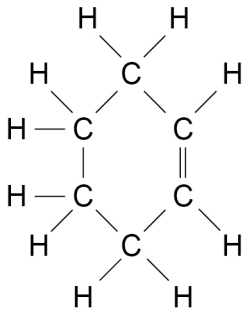
General formula = _____

4.7.2.2 Reactions of alkenes

Question 61 · continued

Figure 6 shows the displayed structural formula of cyclohexene, C_6H_{10}

Figure 6

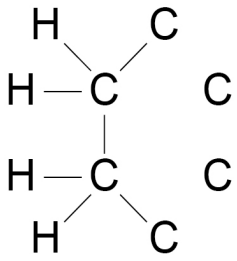


Chlorine reacts with cyclohexene to produce a compound with the formula $C_6H_{10}Cl_2$

0 6 . 3 Complete **Figure 7** to show the displayed structural formula of $C_6H_{10}Cl_2$

[2 marks]

Figure 7



0 6 . 4 Calculate the percentage by mass of chlorine in a molecule of $C_6H_{10}Cl_2$

Relative atomic masses (A_r): H = 1 C = 12 Cl = 35.5

[3 marks]

Percentage by mass = _____ %

8

4.7.2.2 Reactions of alkenes

Question 62

November 2021 | 8462/2H | Original Q10

1 0 This question is about alkenes and alcohols.

Ethene is an alkene produced from large hydrocarbon molecules.

Large hydrocarbon molecules are obtained from crude oil by fractional distillation.

1 0 . 1 Name the process used to produce ethene from large hydrocarbon molecules.

[1 mark]

1 0 . 2 Describe the conditions used to produce ethene from large hydrocarbon molecules.

[2 marks]

4.7.2.2 Reactions of alkenes

Question 62 · continued

1 0 . 3 Ethanol can be produced from ethene and steam.

The equation for the reaction is:

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

The forward reaction is exothermic.

Explain how the conditions for this reaction should be chosen to produce ethanol as economically as possible.

[6 marks]

4.7.2.2 Reactions of alkenes

Question 62 · continued

10.4 Ethanol can also be produced from sugar solution by adding yeast.

Name this process.

[1 mark]

10.5 Butanol can be produced from sugar solution by adding bacteria.

Sugar solution is broken down in similar ways by bacteria and by yeast.

Suggest the reaction conditions needed to produce butanol from sugar solution by adding bacteria.

[2 marks]

4.7.2.2 Reactions of alkenes

Question 62 · continued

Ethanol and butanol can be used as fuels for cars.

10.6 A car needs an average of 1.95 kJ of energy to travel 1 m

Ethanol has an energy content of 1300 kilojoules per mole (kJ/mol).

Calculate the number of moles of ethanol needed by the car to travel 200 km

[3 marks]

Number of moles = _____ mol

10.7 When butanol is burned in a car engine, complete combustion takes place.

Write a balanced equation for the complete combustion of butanol.

You do **not** need to include state symbols.

[2 marks]

17

4.7.2.2 Reactions of alkenes

Question 63

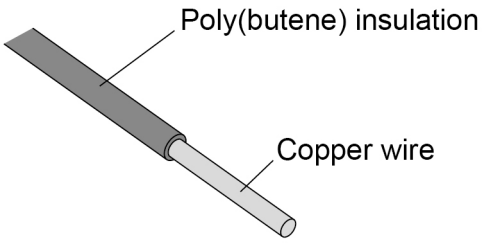
June 2022 | 8462/2H | Original Q1

0 1 This question is about copper wire and copper compounds.

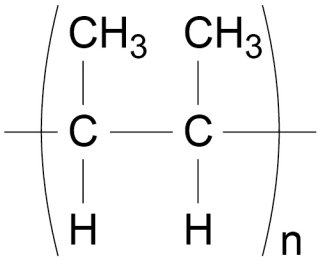
Copper is used to make electrical wires.

Figure 1 shows how copper electrical wire is insulated using an addition polymer called poly(butene).

Figure 1



0 1 . 1 The addition polymer poly(butene) has the displayed structural formula:

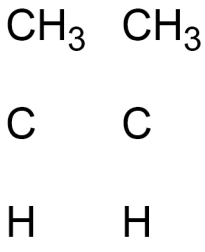


Poly(butene) is produced from the monomer butene.

Complete **Figure 2** to show the displayed structural formula of butene.

[2 marks]

Figure 2



4.7.2.2 Reactions of alkenes

Question 63 · continued

Copper can be obtained by recycling scrap copper wire.

0 1 . 2 Suggest why poly(butene) insulation must be removed from scrap copper wire before the copper is recycled.

[1 mark]

0 1 . 3 Describe how scrap copper wire can be recycled to make new copper water pipes.

[2 marks]

0 1 . 4 Suggest **two** reasons why recycling scrap copper is more sustainable than extracting copper from copper ores.

[2 marks]

1

2

Question 1 continues on the next page

Question 63 · continued

Copper sulfate is a compound of copper.

Copper sulfate solution contains copper(II) ions and sulfate ions.

0 1 . 5 A solution can be added to copper sulfate solution to show the presence of copper(II) ions.

Name the solution added.

Give the result of the test.

[2 marks]

Name of solution added _____

_____

Result _____

_____

0 1 . 6 Describe **one** test to show the presence of sulfate ions in copper sulfate solution.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

11

4.7.2.2 Reactions of alkenes

Question 64

June 2023 | 8462/1H | Original Q4

0 4 This question is about hydrogen and compounds of hydrogen.

Figure 3 shows the displayed formulae for the reaction between hydrogen and chlorine.

Figure 3

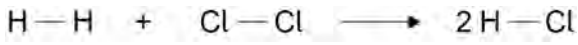


Table 4 shows the bond energies.

Table 4

Bond	H — H	Cl — Cl	H — Cl
Bond energy in kJ/mol	436	346	432

0 4 . 1 Which expression shows how to calculate the overall energy change for the reaction in **Figure 3**?

Use **Table 4**.

[1 mark]

Tick (✓) **one** box.

436 + 346 + 432 kJ/mol ☐

436 + 346 + (2 × 432) kJ/mol ☐

436 + 346 − 432 kJ/mol ☐

436 + 346 − (2 × 432) kJ/mol ☐

Question 64 · continued

The reaction between hydrogen and chlorine is exothermic.

0 4 . 2 Explain why this reaction releases energy to the surroundings.

[2 marks]

0 4 . 3 **Figure 4** shows part of a reaction profile for the reaction between hydrogen and chlorine.

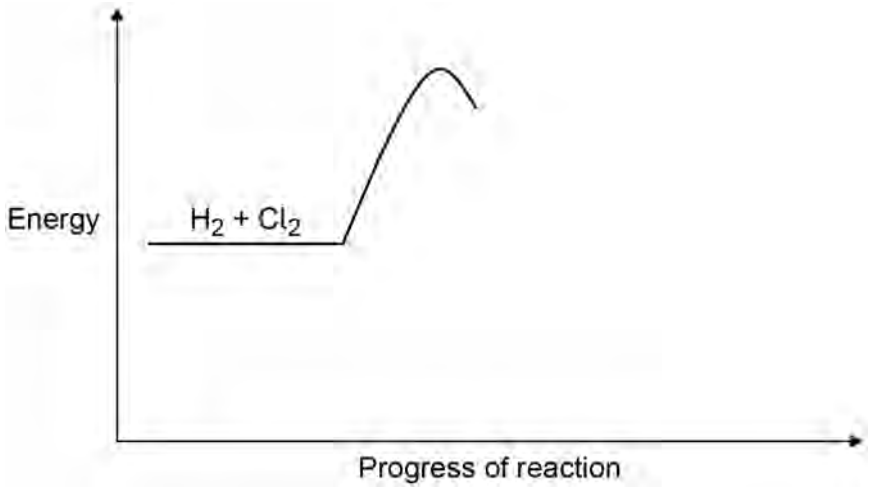
Complete the reaction profile in **Figure 4**.

You should:

- label the activation energy
- label the overall energy change.

[3 marks]

Figure 4



Question 4 continues on the next page

4.7.2.2 Reactions of alkenes

Question 64 · continued

0 4 . 4 Draw a dot and cross diagram for a molecule of hydrogen chloride (HCl).

Show the outer shell electrons only.

[2 marks]

4.7.2.2 Reactions of alkenes

Question 64 · continued

0 4 . 5 **Figure 5** represents molecules of methane and of poly(ethene).

Figure 5



Methane is a gas at room temperature but poly(ethene) is a solid at room temperature.

Explain why methane and poly(ethene) exist in different states at room temperature.

[4 marks]

12

4.7.2.2 Reactions of alkenes

Question 65

0 2 This question is about alcohols and carboxylic acids.

Alcohols are used as fuels.

A student burned 1.00 g of six alcohols and determined the energy released from each.

Table 2 shows the results.

Table 2

Alcohol	Formula of one molecule of the alcohol	Energy released in kJ/g
Ethanol	C_2H_5OH	29.6
Propanol	C_3H_7OH	33.6
Butanol	C_4H_9OH	36.1
Pentanol	$C_5H_{11}OH$	37.7
Hexanol	$C_6H_{13}OH$	38.9
Heptanol	$C_7H_{15}OH$	39.8

0 2 . 1 Calculate the mass of ethanol that must be burned to release the same amount of energy as burning 1.00 g of heptanol.

[2 marks]

Mass = _____ g

0 2 . 2 The energy released in kJ/g varies with the number of carbon atoms in one molecule of each alcohol.

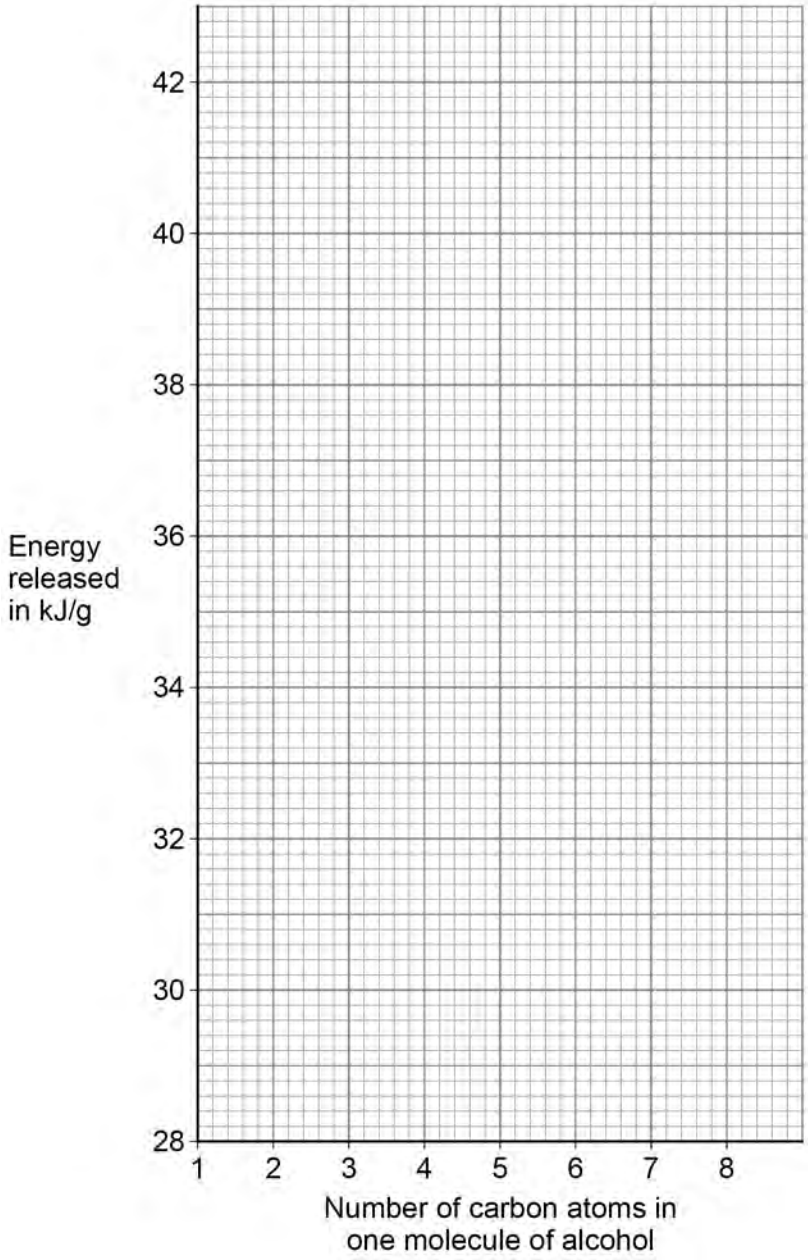
Plot the data from **Table 2** on **Figure 2**.

[2 marks]

4.7.2.2 Reactions of alkenes

Question 65 · continued

Figure 2



0 2 . 3 Estimate the energy released in kJ when 1.00 g of octanol ($C_8H_{17}OH$) is burned.

Use **Figure 2**.

[1 mark]

Energy released = _____ kJ

4.7.2.2 Reactions of alkenes

Question 65 · continued

Carbon dioxide is produced when alcohols are burned.

Carbon dioxide is identified by bubbling the gas through limewater.

0 2 . 4 Complete the sentence.

Choose the answer from the box.

[1 mark]

calcium chloride	**calcium hydroxide**	**calcium nitrate**	**calcium sulfate**

Limewater is an aqueous solution of _____.

0 2 . 5 Give the result of the test when carbon dioxide is bubbled through limewater.

[1 mark]

_____

_____

4.7.2.2 Reactions of alkenes

Question 65 · continued

Ethanoic acid can be produced from ethanol.

0 2 . 6 What is reacted with ethanol to produce ethanoic acid?

[1 mark]

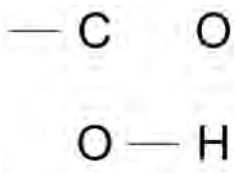
Tick (✓) **one** box.

- A halogen ☐
- An alkali metal ☐
- An oxidising agent ☐
- Water ☐

0 2 . 7 Ethanoic acid contains the functional group –COOH

Complete the displayed structural formula of this functional group.

[1 mark]



Question 2 continues on the next page

4.7.2.2 Reactions of alkenes

Question 65 · continued

0 2 . 8 Ethanoic acid reacts with different compounds.

Draw **one** line from each compound to a product of the reaction of the compound with ethanoic acid.

[2 marks]

Compound	Product of the reaction with ethanoic acid
Ethanol	Carbon dioxide
Sodium carbonate	Ethene
	Ethyl ethanoate
	Hydrogen
	Poly(ethene)

11

4.7.2.2 Reactions of alkenes

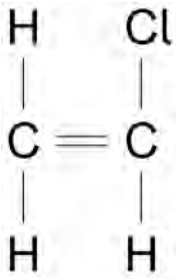
Question 66

June 2023 | 8462/2H | Original Q8

0 8 This question is about polymers.

Chloroethene can be used to produce an addition polymer called poly(chloroethene).

The displayed structural formula of chloroethene is

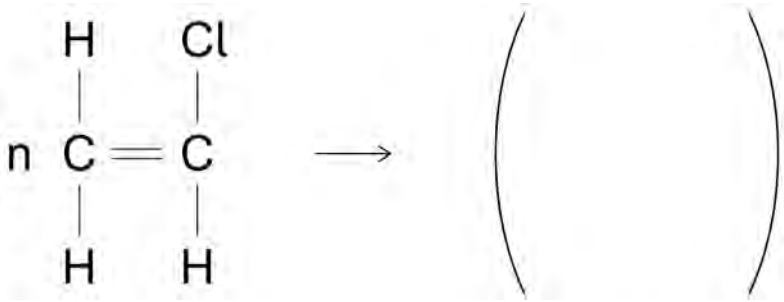


0 8 . 1 Draw a circle around the functional group on the displayed structural formula that allows chloroethene to produce an addition polymer.

[1 mark]

0 8 . 2 Complete the equation for the production of poly(chloroethene) from chloroethene.

[3 marks]



0 8 . 3 Poly(ethene) can be strengthened with wood particles to make a building material.

The building material consists of a wood particle reinforcement embedded in a poly(ethene) matrix.

What general name is given to materials like this?

[1 mark]

Question 66 · continued

0 8 . 4 The amino acid beta-alanine has the formula

$H_2NCH_2CH_2COOH$

Beta-alanine polymerises to produce a polypeptide and a small molecule.

Name the small molecule produced when beta-alanine polymerises.

[1 mark]

0 8 . 5 An amino acid can be represented as:



The relative formula mass (M_r) of this amino acid is 75

Calculate the relative formula mass of the section of this amino acid molecule represented by



Relative atomic masses (A_r): H = 1 C = 12 N = 14 O = 16

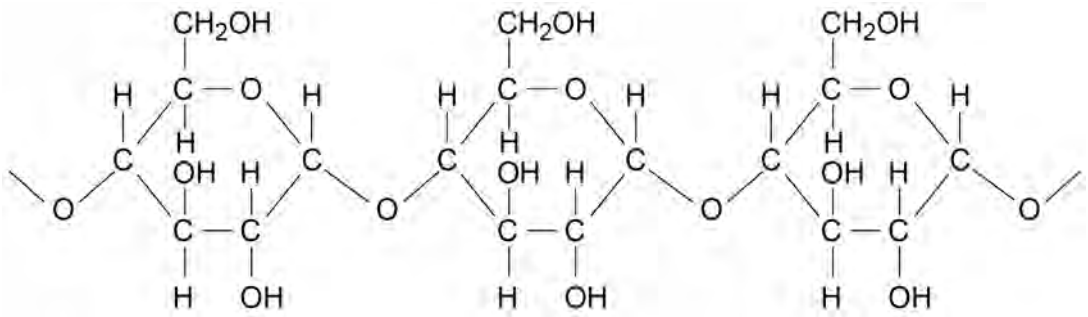
[2 marks]

Relative formula mass = _____

Question 66 · continued

Figure 6 represents part of a naturally occurring polymer molecule produced from glucose.

Figure 6



0 8 . 6 Draw a circle around the repeating unit in the polymer in **Figure 6**.

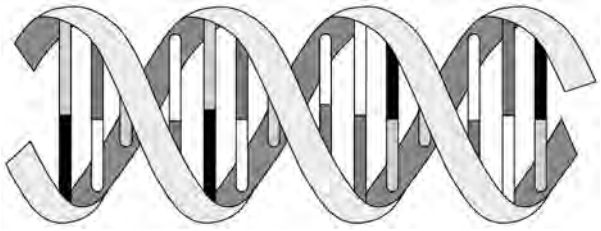
[1 mark]

0 8 . 7 Suggest the identity of this polymer.

[1 mark]

Figure 7 represents the structure of a naturally occurring polymer.

Figure 7



0 8 . 8 Give the general name for the four different monomers which make up the structure shown in **Figure 7**.

[1 mark]

0 8 . 9 Name the **shape** of the structure shown in **Figure 7**.

[1 mark]

12

4.7.2.2 Reactions of alkenes

Question 67

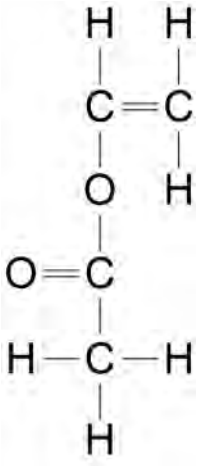
June 2024 | 8462/2H | Original Q8

0 8 This question is about monomers and polymers.

Compound **A** has an alkene functional group and an ester functional group.

Figure 8 represents a molecule of compound **A**.

Figure 8



0 8 . 1 Draw a circle around the alkene functional group on **Figure 8**.

[1 mark]

0 8 . 2 Describe what will be seen when compound **A** is shaken with bromine water.

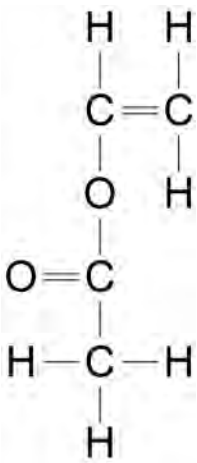
[2 marks]

Question 8 continues on the next page

4.7.2.2 Reactions of alkenes

0 8 . 3 **Figure 9** is a repeat of **Figure 8**.

Figure 9



Draw a circle around the ester functional group on **Figure 9**.

[1 mark]

0 8 . 4 Compound **A** has the formula $C_4H_6O_2$

Compound **A** is flammable.

Write a balanced equation for the complete combustion of compound **A**.

[3 marks]

_____ + _____ → _____ + _____

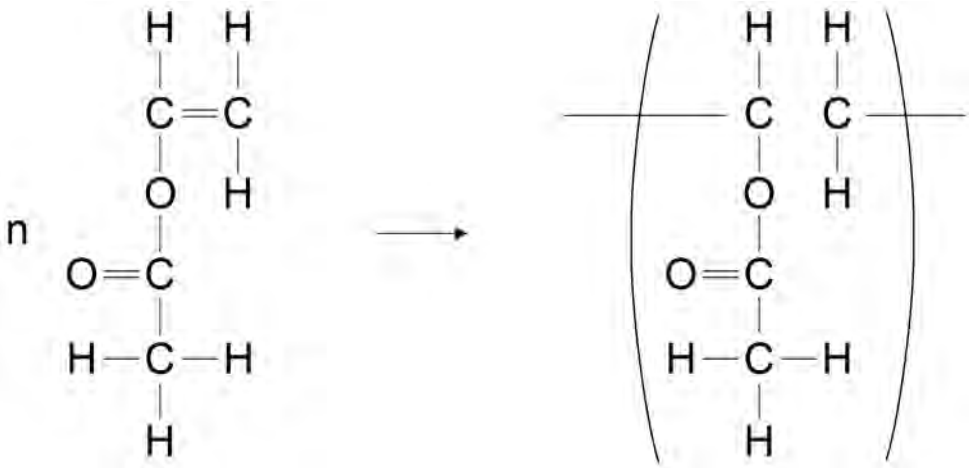
4.7.2.2 Reactions of alkenes

Question 67 · continued

0 8 . 5 Many molecules of compound **A** join together to form polymer **B**.

Complete the displayed formula equation which represents this reaction.

[2 marks]



0 8 . 6 What type of polymer is polymer **B**?

[1 mark]

Tick (✓) **one** box.

- Addition polymer ☐
- Condensation polymer ☐
- DNA ☐
- Protein ☐

Question 8 continues on the next page

4.7.2.2 Reactions of alkenes

Question 67 · continued

Polymer **B** is a polymer which melts when heated.

0 8 . 7 What word is used to describe polymers which melt when heated?

[1 mark]

0 8 . 8 Explain why some polymers do **not** melt when heated.

[2 marks]

13

4.7.2.2 Reactions of alkenes

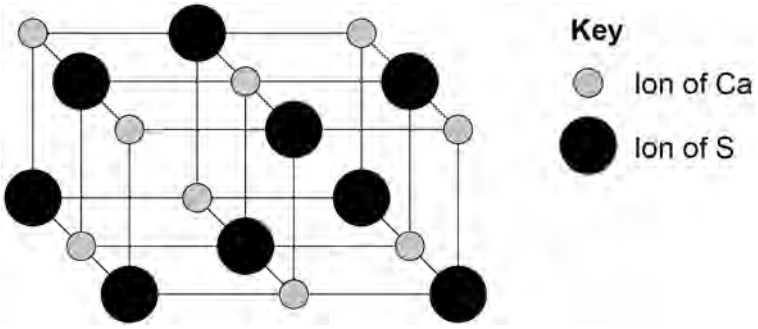
Question 68

0 2 This question is about structure and bonding.

Calcium sulfide is an ionic compound.

Figure 2 represents the structure of calcium sulfide.

Figure 2



0 2 . 1 Determine the empirical formula of calcium sulfide.

[1 mark]

Empirical formula _____

Question 2 continues on the next page

4.7.2.2 Reactions of alkenes

Question 68 · continued

0 2 . 2 Calcium is in Group 2 of the periodic table.

Sulfur is in Group 6 of the periodic table.

Describe what happens when a calcium atom reacts with a sulfur atom.

Answer in terms of electrons and ions.

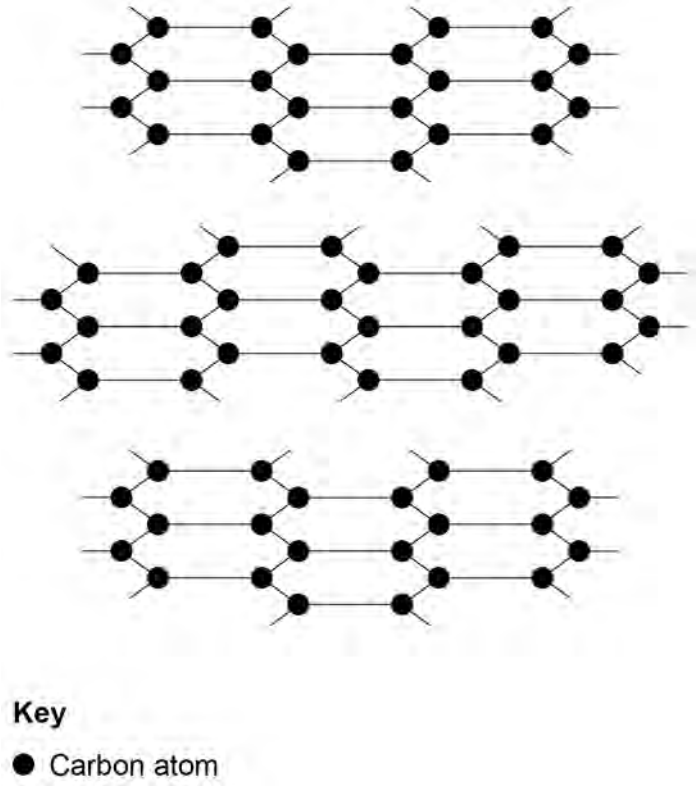
[4 marks]

4.7.2.2 Reactions of alkenes

Question 68 · continued

Figure 3 shows the structure of graphite.

Figure 3



0 2 . 3 Describe the structure and bonding of graphite.

[4 marks]

Extra space

4.7.2.2 Reactions of alkenes

Question 68 · continued

0 2 . 4 Substances that consist of small molecules do **not** conduct electricity.

Give **one** reason why.

[1 mark]

0 2 . 5 Methane consists of small molecules.

Poly(ethene) is a polymer.

Why does poly(ethene) have a higher melting point than methane?

[1 mark]

Tick (✓) **one** box.

Poly(ethene) has more covalent bonds to break than methane. ☐

Poly(ethene) has no intermolecular forces to overcome. ☐

Poly(ethene) has stronger covalent bonds to break than methane. ☐

Poly(ethene) has stronger intermolecular forces to overcome than methane. ☐

11

4.7.2.2 Reactions of alkenes

Question 69

June 2025 | 8462/2H | Original Q7

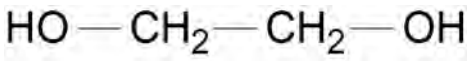
0 7 This question is about polymers.

A condensation polymer is produced from two different compounds, **A** and **B**.

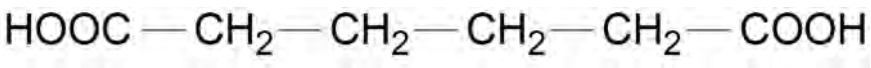
Figure 4 represents a molecule of **A** and a molecule of **B**.

Figure 4

A



B



0 7 . 1 Name compound **A** and compound **B**.

[2 marks]

A _____

B _____

0 7 . 2 Compound **A** and compound **B** react to produce a condensation polymer.

Name the type of condensation polymer produced from compound **A** and compound **B**.

[1 mark]

_____

0 7 . 3 Name the small molecule lost when molecules of compound **A** and of compound **B** react.

[1 mark]

_____

Question 69 · continued June 2025 | 8462/2H | Original Q7

Glycine is an amino acid.

Glycine can produce condensation polymers.

0 7 . 4 Name the type of condensation polymer produced when glycine polymerises.

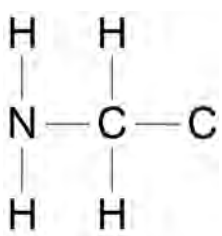
[1 mark]

_____

0 7 . 5 Complete **Figure 5** to show the displayed structural formula of glycine.

[1 mark]

Figure 5



0 7 . 6 Which polymer is produced when different amino acids are combined in the same chain?

[1 mark]

Tick (✓) **one** box.

- Cellulose ☐
- DNA ☐
- Protein ☐
- Starch ☐

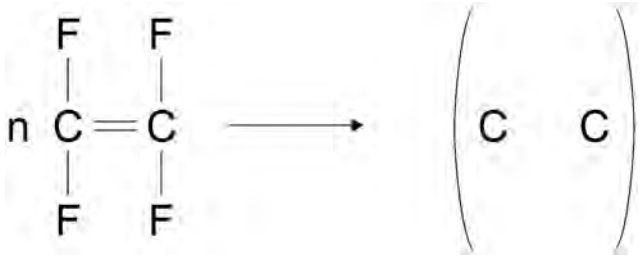
4.7.2.2 Reactions of alkenes

Question 69 · continued

The polymer poly(tetrafluoroethene) is produced from the monomer tetrafluoroethene (C_2F_4).

0 7 . 7 Complete the equation for the production of poly(tetrafluoroethene) from tetrafluoroethene.

[3 marks]



0 7 . 8 Poly(tetrafluoroethene) is a thermosoftening polymer.

Some other polymers are thermosetting polymers.

Describe the structure of a thermosetting polymer.

[2 marks]

12