AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.2.2.5

Polymers

Past-paper questions

Tier	**Higher**
Question groups	**70**
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.

4.2.2.5 Polymers

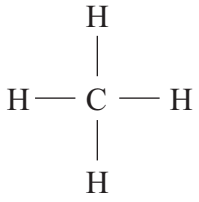
Question 01

March 2007 | CHY1B | Original Q2 | Legacy

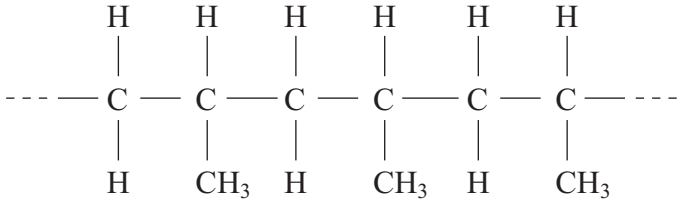
QUESTION TWO

This question is about the formulae for four hydrocarbon compounds.

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



A



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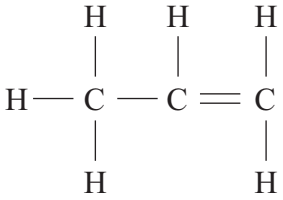
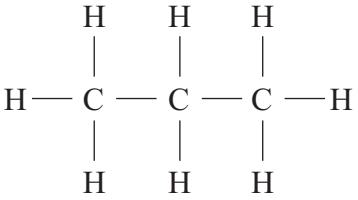


C



D

Hydrocarbon compound	Description
1	It has the molecular formula C_3H_8
2	It is the hydrocarbon with the smallest molecules.
3	It is an unsaturated hydrocarbon.
4	It is part of a polymer.

4.2.2.5 Polymers

Question 02

March 2007 | CHY1B | Original Q6 | Legacy

QUESTION SIX

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

An example of cracking is shown below:

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

large hydrocarbon molecule — small hydrocarbon molecules

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

1 C_7H_{16} and C_3H_6

2 C_7H_{16} and C_2H_4

3 C_3H_6 and C_2H_4

4 C_7H_{16} only

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

1 ethane.

2 ethene.

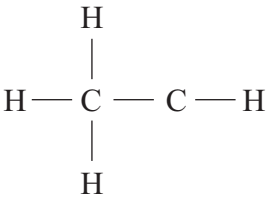
3 ethanol.

4 propene.

4.2.2.5 Polymers

Question 02 · continued

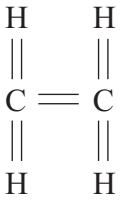
6C The hydrocarbon C_2H_4 can be represented as . . .



1



2



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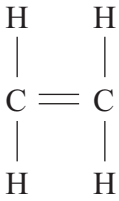


4

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

1 C_nH_n

2 C_nH_{2n}

3 C_nH_{2n+2}

4 $C_{2n}H_n$

4.2.2.5 Polymers

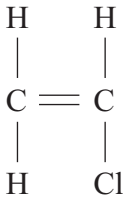
Question 03

March 2007 | CHY1B | Original Q8 | Legacy

QUESTION EIGHT

Window frames for double glazing can be made from the plastic PVC, poly(vinyl chloride).

Poly(vinyl chloride) is made from the polymerisation of vinyl chloride molecules which have the structure:



8A Vinyl chloride molecules can be described as . . .

1 alkenes.

2 polymers.

3 saturated.

4 unsaturated.

8B Vinyl chloride belongs to a family of chemicals that have the general formula . . .

1 C_nHCl

2 $C_nH_{n-1}Cl$

3 $C_nH_{n+1}Cl$

4 $C_nH_{2n-1}Cl$

8C In the polymerisation process, vinyl chloride molecules are . . .

1 catalysts.

2 monomers.

3 additives.

4 emulsifiers.

4.2.2.5 Polymers

8D PVC window frames do not need much maintenance because they are . . .

1 cheap to replace.

2 easily painted.

3 non-biodegradable.

4 rigid.

Turn over for the next question

4.2.2.5 Polymers

Question 04

June 2007 | CHY1B | Original Q7 | Legacy

QUESTION SEVEN

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

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

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

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

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

They could probably be separated and collected by . . .

1 thermal decomposition.

2 cracking.

3 condensation.

4 polymerisation.

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

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

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

4.2.2.5 Polymers

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

This is because . . .

1 it has a higher boiling point.

2 its molecule has a double carbon carbon bond.

3 its molecule is saturated.

4 it has smaller molecules.

Turn over for the next question

4.2.2.5 Polymers

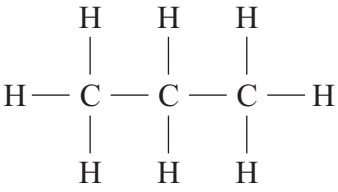
Question 05

November 2007 | CHY1B | Original Q2 | Legacy

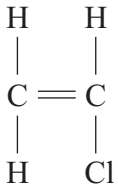
QUESTION TWO

This question is about the formulae of four organic compounds.

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



A



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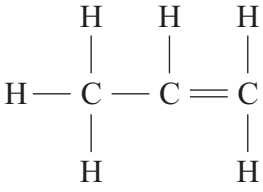

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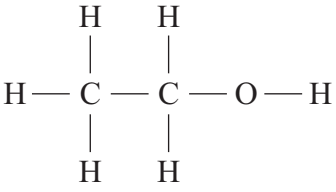


D

	What we can say about the organic compound
1	It is a saturated hydrocarbon useful as a fuel.
2	It is a monomer from which the polymer, polyvinylchloride, can be made.
3	It is the formula for ethanol.
4	It belongs to a group of hydrocarbons with the general formula C_nH_{2n}

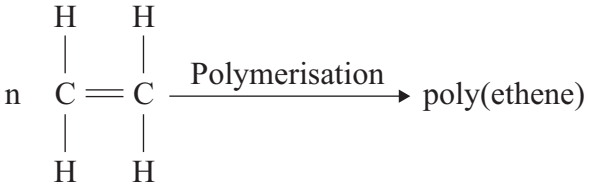
4.2.2.5 Polymers

Question 06

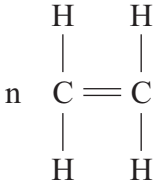
November 2007 | CHY1B | Original Q6 | Legacy

QUESTION SIX

The equation shows how poly(ethene) is made.



6A



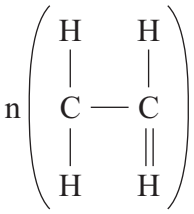
1 one molecule of poly(ethene).

2 one molecule of ethene.

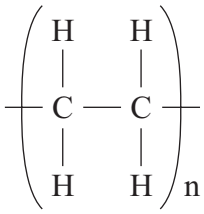
3 two molecules of ethene.

4 many molecules of ethene.

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



1



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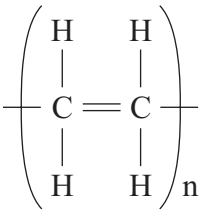

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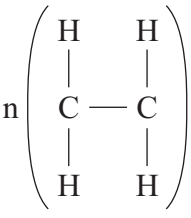

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4.2.2.5 Polymers

Question 06 · 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.

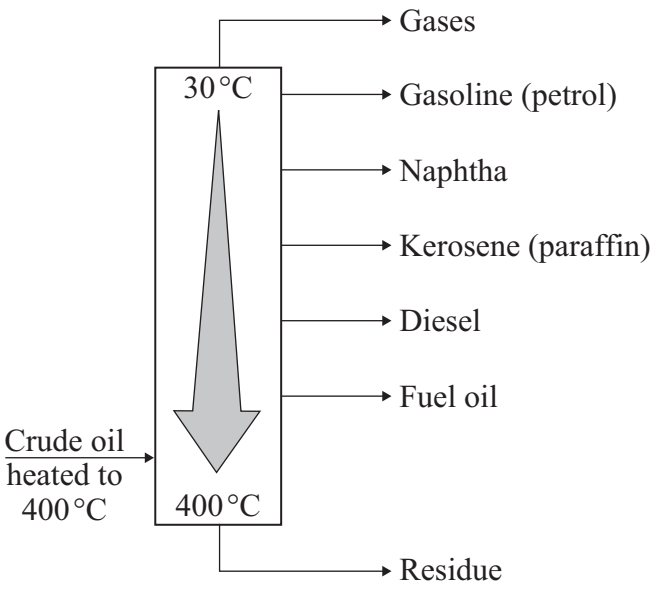
4 it is a thermosoftening polymer.

4.2.2.5 Polymers

Question 07

January 2008 | CHY1H | Original Q6 | Legacy

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



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

.....

.....

.....

.....

(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)

4.2.2.5 Polymers

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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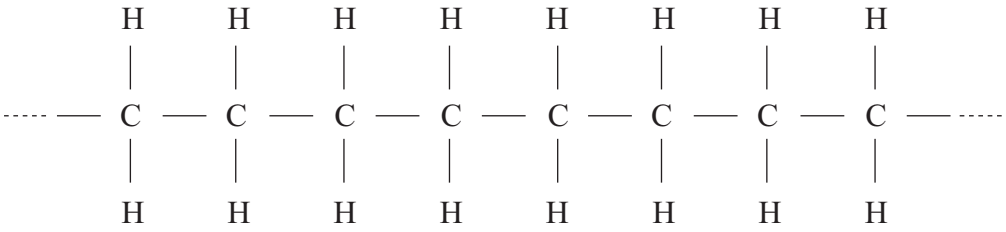
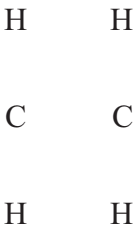
(2 marks)

(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

4.2.2.5 Polymers

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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.

4.2.2.5 Polymers

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

4.2.2.5 Polymers

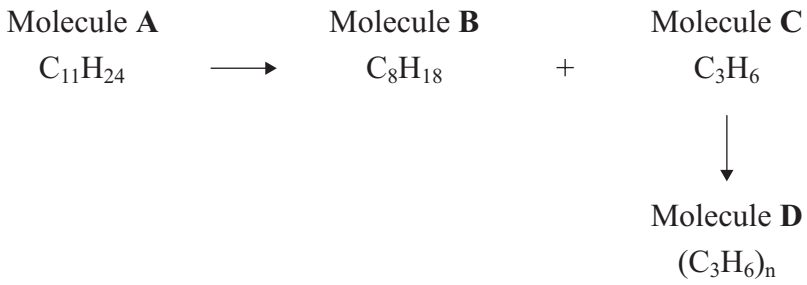
Question 08

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.

4.2.2.5 Polymers

Question 09

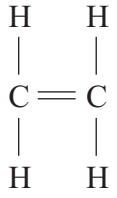
March 2008 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

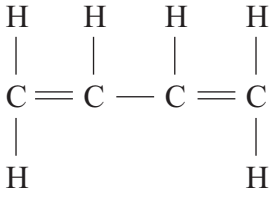
This question is about the formulae for four hydrocarbon compounds.

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

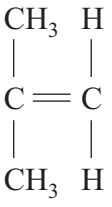
A



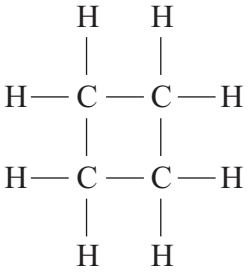
B

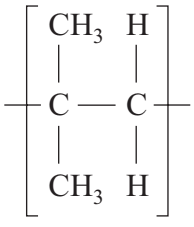


C



D



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

4.2.2.5 Polymers

Question 10

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

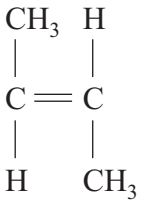
4 $C_nH_{2n} + 3nO_2 \rightarrow nCO_2 + 2nH_2O$

4.2.2.5 Polymers

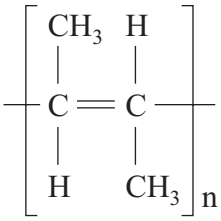
Question 10 · continued

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

Which polymer would be produced from this alkene?



1



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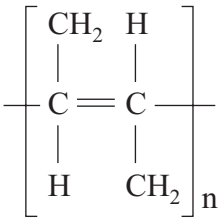

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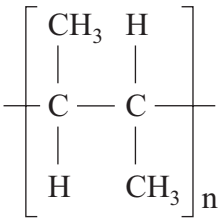
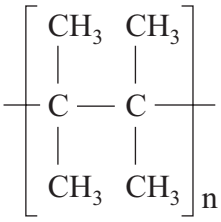


4



END OF TEST

4.2.2.5 Polymers

Question 11

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** . . . .

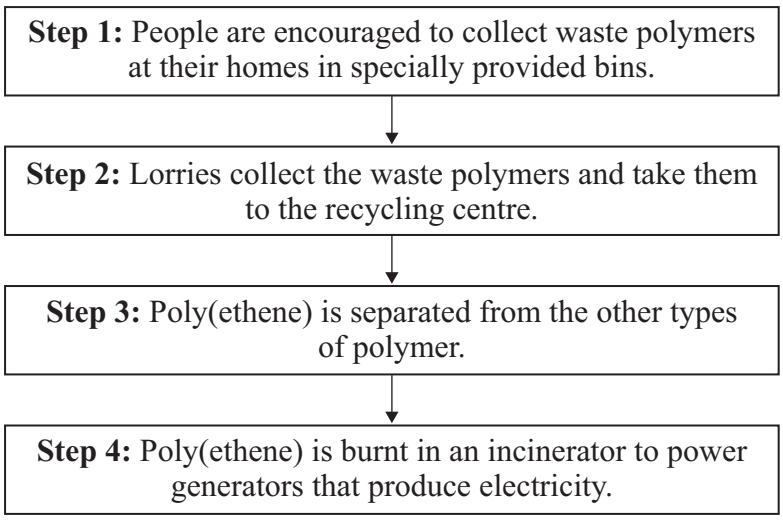
4.2.2.5 Polymers

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.

4.2.2.5 Polymers

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

4.2.2.5 Polymers

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.

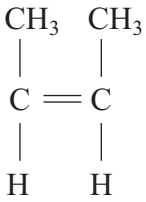
3 have chemical bonds between the chains which break on heating.

4 be capable of being shaped on heating.

4.2.2.5 Polymers

Question 13 · continued

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



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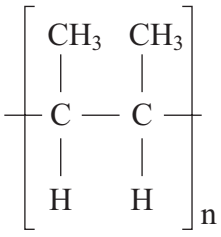

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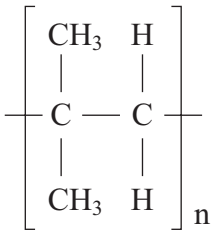

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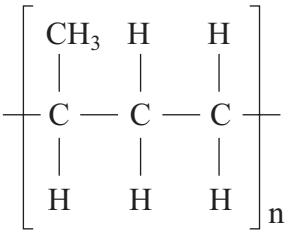

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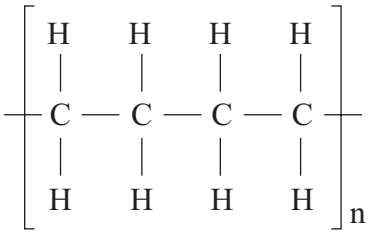

7D Which one of the following statements about polymer waste is correct?

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.

4.2.2.5 Polymers

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.

.....

.....

.....

(2 marks)

4.2.2.5 Polymers

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

4.2.2.5 Polymers

Question 15

November 2008 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

This question is about the uses of polymers.

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

A bag for frozen food

B memory polymer

C hydrogels in plant pots

D dental fillings

1	It is transparent, waterproof and flexible over a wide range of temperatures.
2	It absorbs and releases large quantities of water and can be used in horticulture.
3	It sets to form a very hard material.
4	It is placed into a collapsed human artery which is opened up as the polymer returns to its original shape.

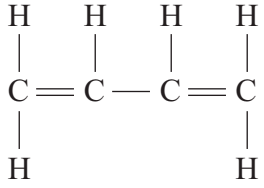
4.2.2.5 Polymers

Question 16

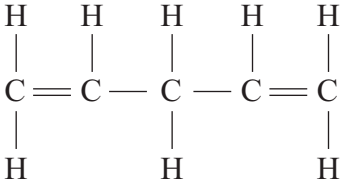
November 2008 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

Butadiene and pentadiene both contain two double carbon carbon bonds. Their structures are shown below.



Butadiene



Pentadiene

8A Butadiene and pentadiene would belong to a family of compounds having the general formula . . .

1 C_nH_{2n-2}

2 C_nH_{2n}

3 C_nH_{2n+2}

4 C_2H_{2n-4}

Butadiene can be polymerised to form a polymer, poly(butadiene) whose structure is represented by

$$\left[CH_2 - CH = CH - CH_2 \right]_n$$

8B Which one of the following statements regarding butadiene and poly(butadiene) is **not** true?

Both would . . .

1 be classed as unsaturated.

2 react with bromine and iodine.

3 be formed by cracking certain oil fractions.

4 react with hydrogen in the presence of a catalyst.

4.2.2.5 Polymers

Question 16 · continued

8C Butadiene is called the monomer in the polymerisation reaction because it . . .

1 has two double carbon carbon bonds.

2 forms the repeat unit in the polymer.

3 is an unsaturated hydrocarbon.

4 is obtained from oil.

8D Poly(butadiene) is used to make tyres for motor cars.

The most environmentally friendly way to get rid of used tyres is . . .

1 to burn them.

2 to dissolve them in a solvent and dispose of the solution.

3 to break down the long polymer chains into smaller molecules.

4 to put them in landfill sites.

4.2.2.5 Polymers

Question 17

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.

4.2.2.5 Polymers

Question 18

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

4.2.2.5 Polymers

Question 18 · 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

4.2.2.5 Polymers

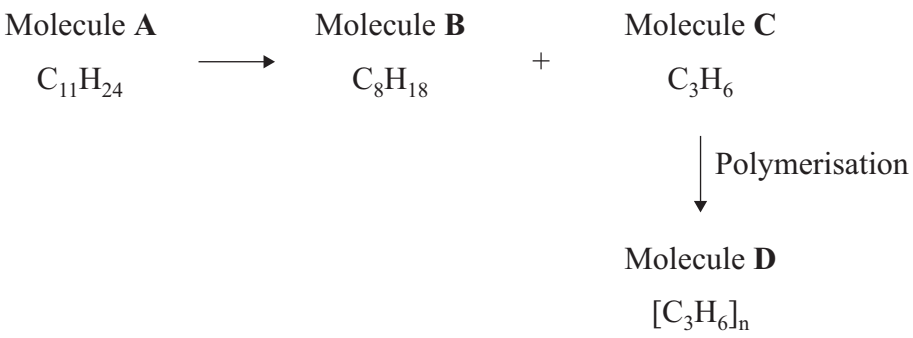
Question 19

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** . . . .

4.2.2.5 Polymers

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** . . . .

4.2.2.5 Polymers

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.

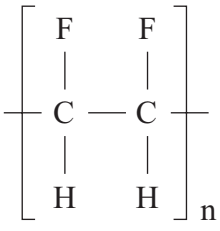
2 does **not** react with bromine.

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?

1



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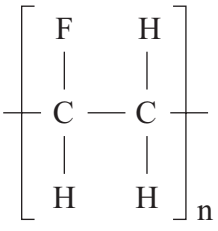

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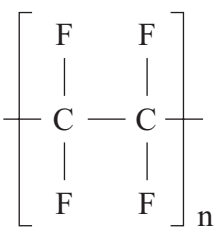

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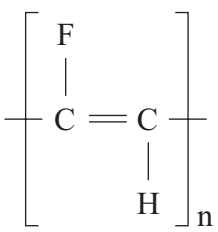

4.2.2.5 Polymers

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

4.2.2.5 Polymers

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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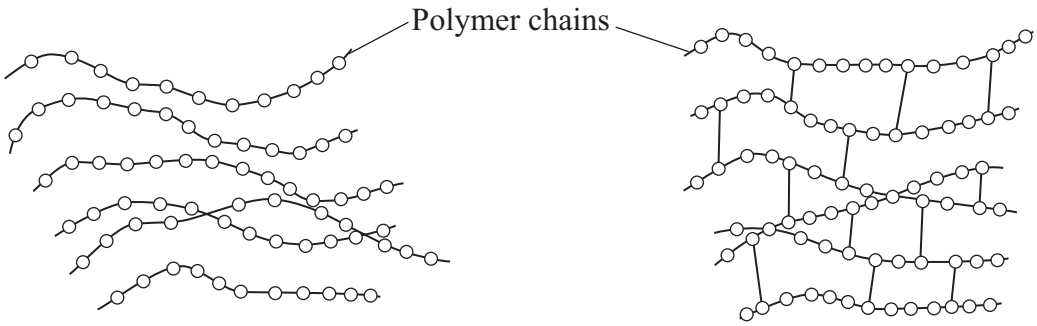
(1 mark)

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)

4.2.2.5 Polymers

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

4.2.2.5 Polymers

Question 23

November 2009 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

The equation shows a chemical reaction.

$$\underset{\text{Substance } \mathbf{K}}{C_{10}H_{22}} \longrightarrow \underset{\text{Substance } \mathbf{L}}{C_8H_{18}} + \underset{\text{Substance } \mathbf{M}}{C_2H_4}$$

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

A polymerisation

B thermal decomposition

C unsaturation

D hydration

Substances **L** and **M** are obtained from substance **K** by . . . **1** . . . .

Iodine or bromine can be used to test the products for . . . **2** . . . .

Ethanol can be made from substance **M** by . . . **3** . . . .

Molecules of substance **M** can be joined together into long chains by . . . **4** . . . .

4.2.2.5 Polymers

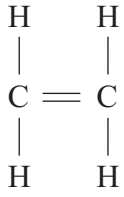
Question 24

November 2009 | CHY1BP | Original Q4 | Legacy

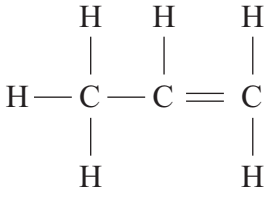
QUESTION FOUR

The diagram shows three compounds.

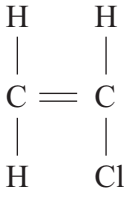
Compound W



Compound X



Compound Y



4A Which of the compounds are hydrocarbons?

1 **W** and **X**

2 **W** and **Y**

3 **X** and **Y**

4 **W**, **X** and **Y**

4B Which row in the table correctly describes the bonding in Compound **X**?

	Number of bonds to each carbon atom	Number of bonds to each hydrogen atom
1	1	1
2	1	4
3	4	1
4	4	4

4C All three compounds can form polymers because . . .

1 they have saturated molecules.

2 their molecules contain two or more carbon atoms.

3 their molecules have a double carbon carbon bond.

4 they have small molecules.

4.2.2.5 Polymers

Question 24 · continued

4D Disposal of polymer waste can be a problem.

The main reason that it causes problems in a landfill site is that . . .

1 it is very light.

2 it is not easily broken down by microorganisms.

3 it is difficult to bury.

4 it burns easily, releasing toxic gases.

Turn over for the next question

4.2.2.5 Polymers

Question 25

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.

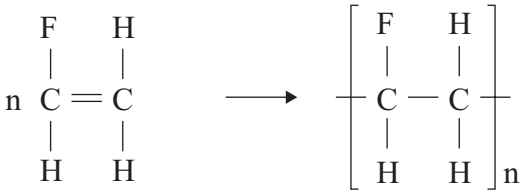
4 scientists stop testing the properties of materials once they are discovered.

4.2.2.5 Polymers

Question 25 · continued

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

1



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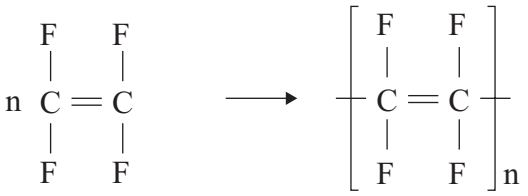

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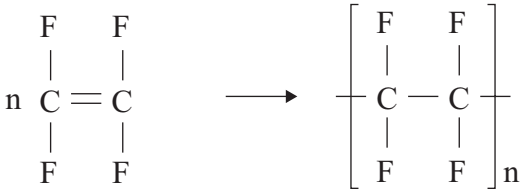

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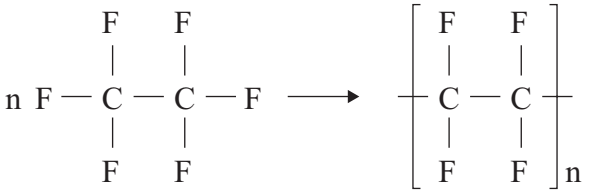
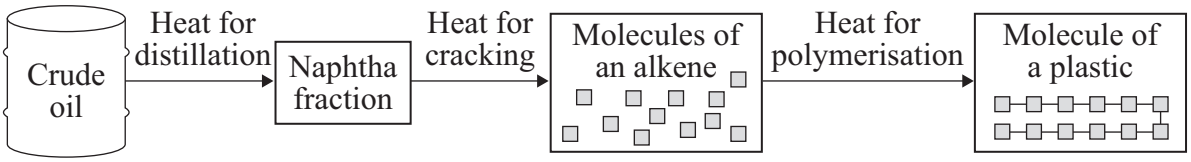


4.2.2.5 Polymers

Question 26

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)

4.2.2.5 Polymers

Question 26 · 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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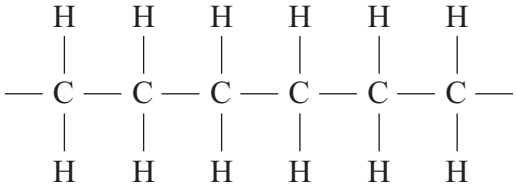
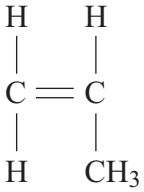
(2 marks)

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

4.2.2.5 Polymers

Question 27

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.

4.2.2.5 Polymers

Question 27 · 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

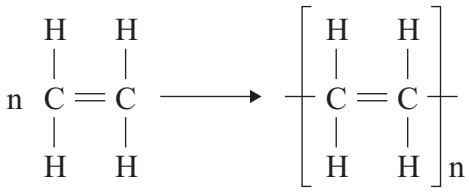
2 dispose of it at sea

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



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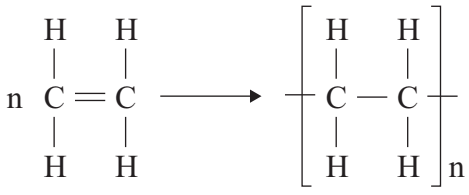

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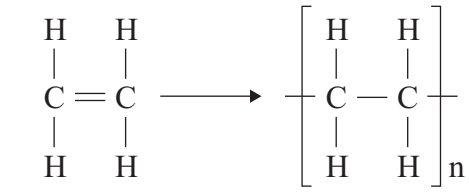

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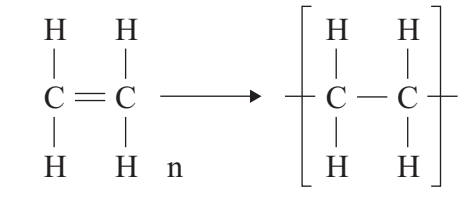


4.2.2.5 Polymers

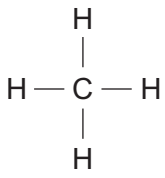
Question 28

June 2010 | CHY1BP | Original Q2 | Legacy

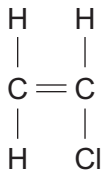
QUESTION TWO

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

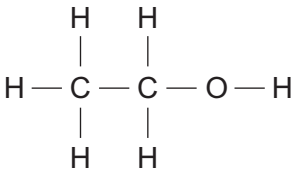
A



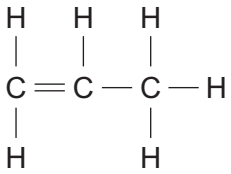
B



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.

4.2.2.5 Polymers

Question 29

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.

4.2.2.5 Polymers

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

4.2.2.5 Polymers

Question 30

June 2010 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

Four hydrocarbons, **K**, **L**, **M** and **N**, were each analysed to measure their carbon and hydrogen content.

The results are shown in the table.

	Hydrocarbon			
	K	**L**	**M**	**N**
Number of hydrogen atoms in each molecule	8	20	8	12
Number of carbon atoms in each molecule	4	10	16	5

8A From the table we can deduce that . . .

1 none of the four is an alkene.

2 **K** and **L** are alkenes.

3 only **M** is an alkene.

4 only **N** is an alkene.

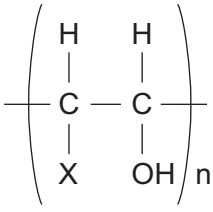
8B Hydrocarbon **N** cannot be used to make a polymer because its molecules . . .

1 are too short.

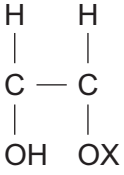
2 have an odd number of carbon atoms.

3 have fewer carbon atoms than hydrogen atoms.

4 do not have a carbon carbon double bond.

8C The polymer with the formula  where 'n' is a large number, could be made from the monomer . . .

1



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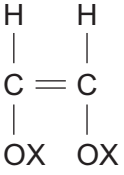

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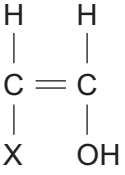

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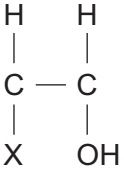
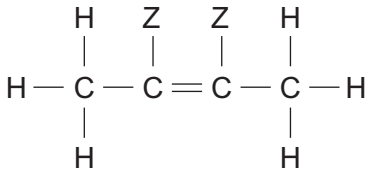


4.2.2.5 Polymers

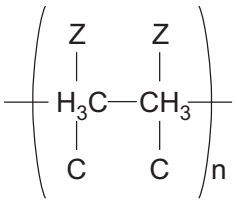
Question 30 · continued

8D The monomer  is made into a polymer.

In the formulae below, 'n' is a large number.

The polymer may be represented as . . .

1



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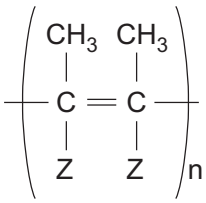

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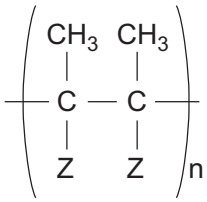

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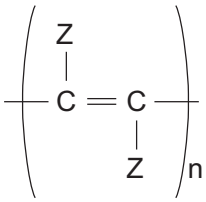


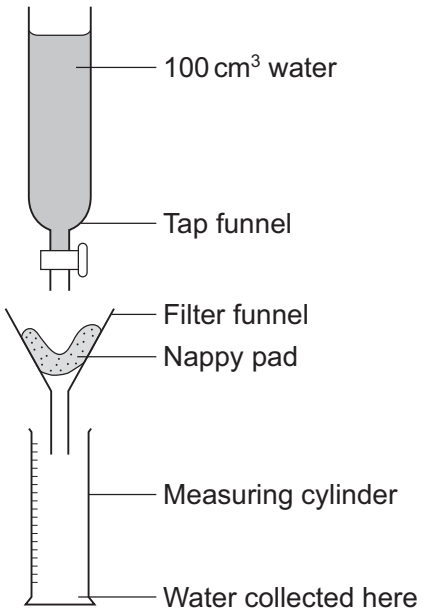
4.2.2.5 Polymers

Question 31

June 2010 | CHY1H | Original Q1 | Legacy

1 Disposable nappies for babies need to absorb as much water as possible.
Disposable nappies have a pad containing a special polymer called a hydrogel.
Hydrogels absorb water.

A company called Aqanaps compared the water absorption of its nappy pads with nappy pads made by other companies.



- A scientist from Aqanaps poured 100 cm^3 of water onto the pad of one of its nappies.
- He measured the volume of water that passed through.
- He did the test three times using a new nappy pad for each test.
- The scientist then repeated the procedure using the nappy pads from three other companies, **A**, **B** and **C**.

The results are shown in the table.

Company	Volume of water collected in cm^3		
	Pad 1	Pad 2	Pad 3
Aqanaps	55	57	55
A	47	46	39
B	65	63	64
C	38	39	38

4.2.2.5 Polymers

Question 31 · continued June 2019 | CHY1H | Original Q1 | Legacy

1 (a) (i) Choose **one** result in the table that should be tested again.

Result: Company ..... Pad .....

Explain why you chose this result.

.....

.....

.....

(2 marks)

1 (a) (ii) Suggest **one** variable that should be controlled in this investigation.

.....

.....

(1 mark)

1 (a) (iii) Suggest **one** possible cause of error in this investigation.

.....

.....

(1 mark)

1 (b) (i) The Aqanaps company studied the results. The company concluded that it should increase the amount of hydrogel used in its nappy pads.

Give **two** reasons why the company decided to increase the amount of hydrogel used in its nappy pads.

1 .....

.....

2 .....

.....

(2 marks)

1 (b) (ii) Suggest **one** disadvantage for the company if it increases the amount of hydrogel used in its nappy pads.

.....

.....

(1 mark)

7

4.2.2.5 Polymers

Question 32

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.

4.2.2.5 Polymers

Question 33

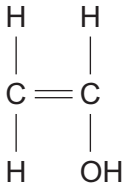
November 2010 | CHY1BP | Original Q7 | Legacy

QUESTION SEVEN

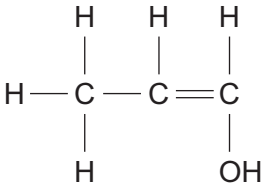
This question is about compounds that contain a double carbon carbon bond.

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 . . .

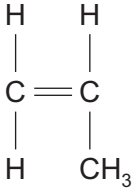
1 C_nH_nOH

2 $C_nH_{2n}OH$

3 $C_nH_{2n-1}OH$

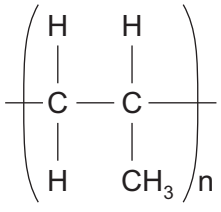
4 $C_nH_{2n+1}OH$

The formula for propene can be shown as:



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

1



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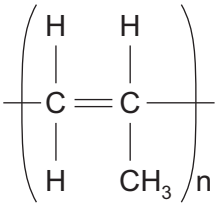

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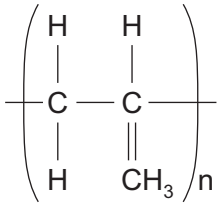

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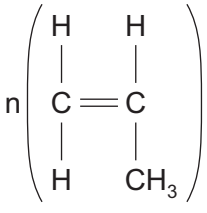


4.2.2.5 Polymers

Question 33 · 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

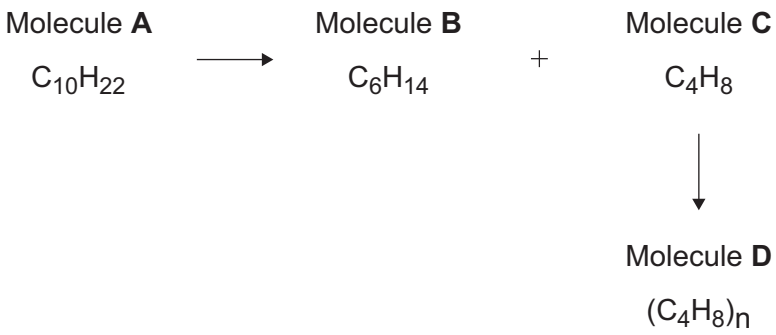
4.2.2.5 Polymers

Question 34

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.

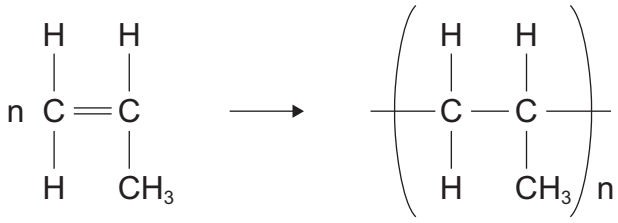
4.2.2.5 Polymers

Question 35

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.

4.2.2.5 Polymers

Question 35 · 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

4.2.2.5 Polymers

Question 36

March 2011 | CHY1BP | Original Q7 | Legacy

QUESTION SEVEN

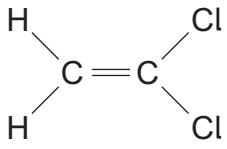
Worldwide, about 20 billion wine bottle stoppers are produced each year.

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.

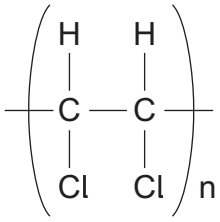
2 only vinylidene chloride will react with iodine.

3 only vinylidene chloride is obtained from crude oil.

4 only ethene is a hydrocarbon.

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

1



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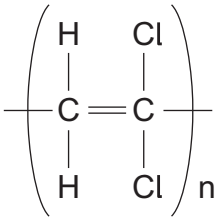

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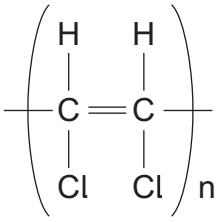

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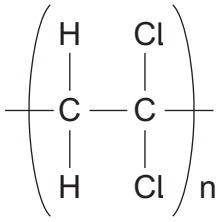


4.2.2.5 Polymers

Question 36 · 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

4.2.2.5 Polymers

Question 37

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

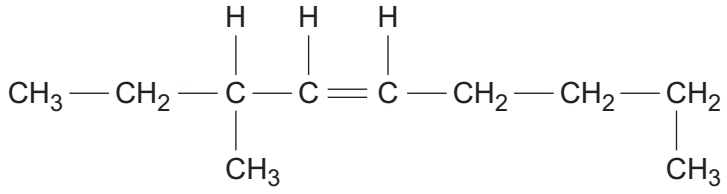
2 $C_{15}H_{32} \rightarrow 2CH_4 + C_3H_6 + C_4H_{10} + C_6H_{12}$

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?

1



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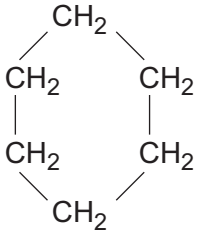

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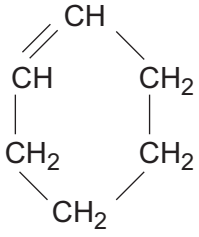

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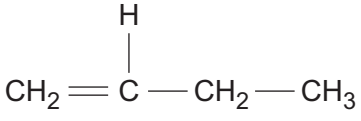
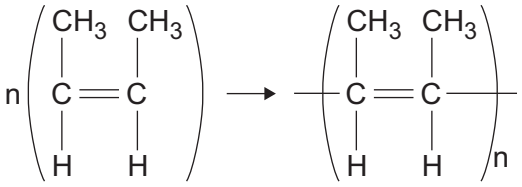


4.2.2.5 Polymers

Question 37 · continued

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

1



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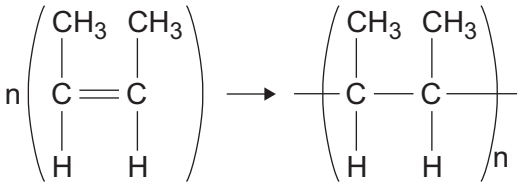

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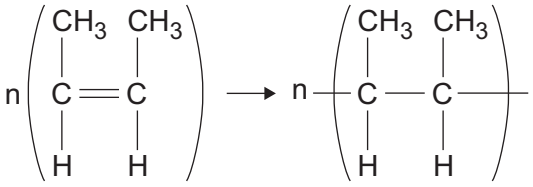

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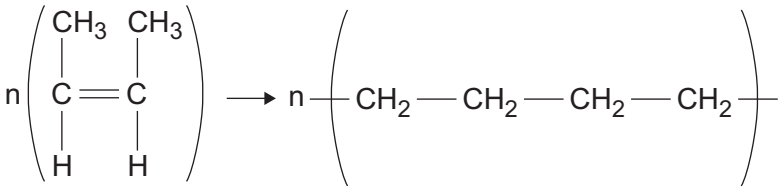


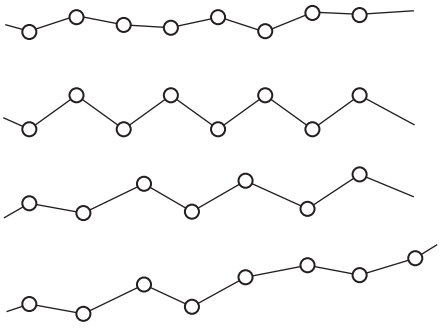
Question 8 continues on the next page

4.2.2.5 Polymers

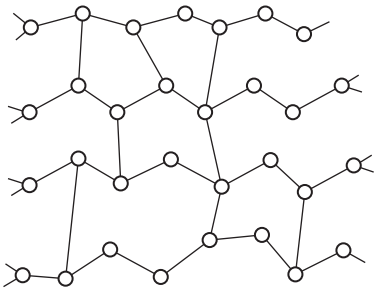
Question 37 · continued

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

4.2.2.5 Polymers

Question 38

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?

.....

.....

.....

.....

(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.

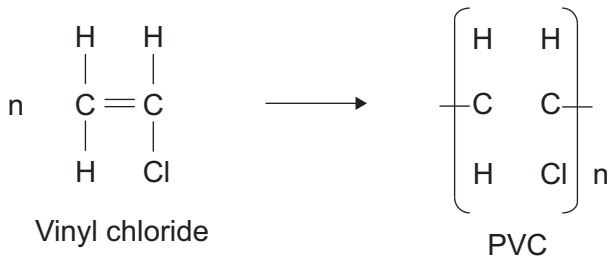
Complete the chemical equation by writing in the formula of the product vinyl chloride.

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

(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)

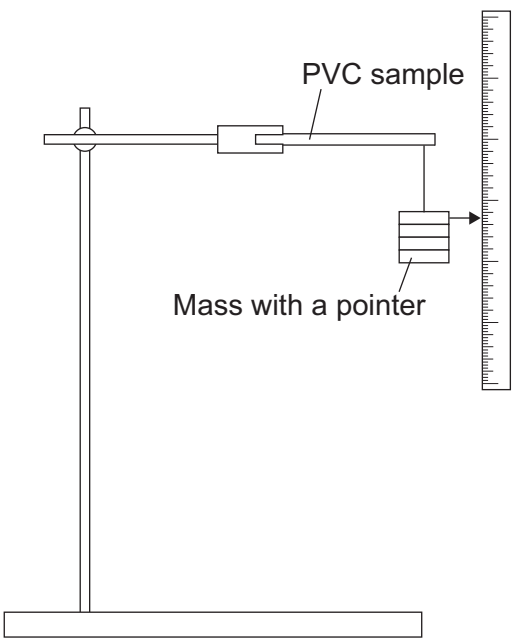
Question 2 continues on the next page

4.2.2.5 Polymers

Question 38 · 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.

.....

.....

(1 mark)

4.2.2.5 Polymers

Question 38 · continued

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

.....

.....

(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.

.....

.....

(1 mark)

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

.....

.....

(1 mark)

10

4.2.2.5 Polymers

Question 39

June 2011 | CHY3H | Original Q6 | Legacy

6 *Unsaturated* organic compounds are used to make polymers.

6 (a) (i) Describe what you would **see** when bromine water reacts with an *unsaturated* organic compound.

.....

.....

(1 mark)

6 (a) (ii) In terms of structure, what makes an organic compound *unsaturated*?

.....

.....

(1 mark)

6 (b) When 2.1 g of an unsaturated hydrocarbon were completely burned in oxygen, 6.6 g of carbon dioxide and 2.7 g of water were the only products.

Relative formula masses: CO_2 = 44; H_2O = 18.

Use this information to calculate the number of moles of carbon dioxide and of water produced in this reaction. Use your answer to calculate the empirical formula of the hydrocarbon.

You must show your working to gain full marks.

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Empirical formula = ...

(3 marks)

5

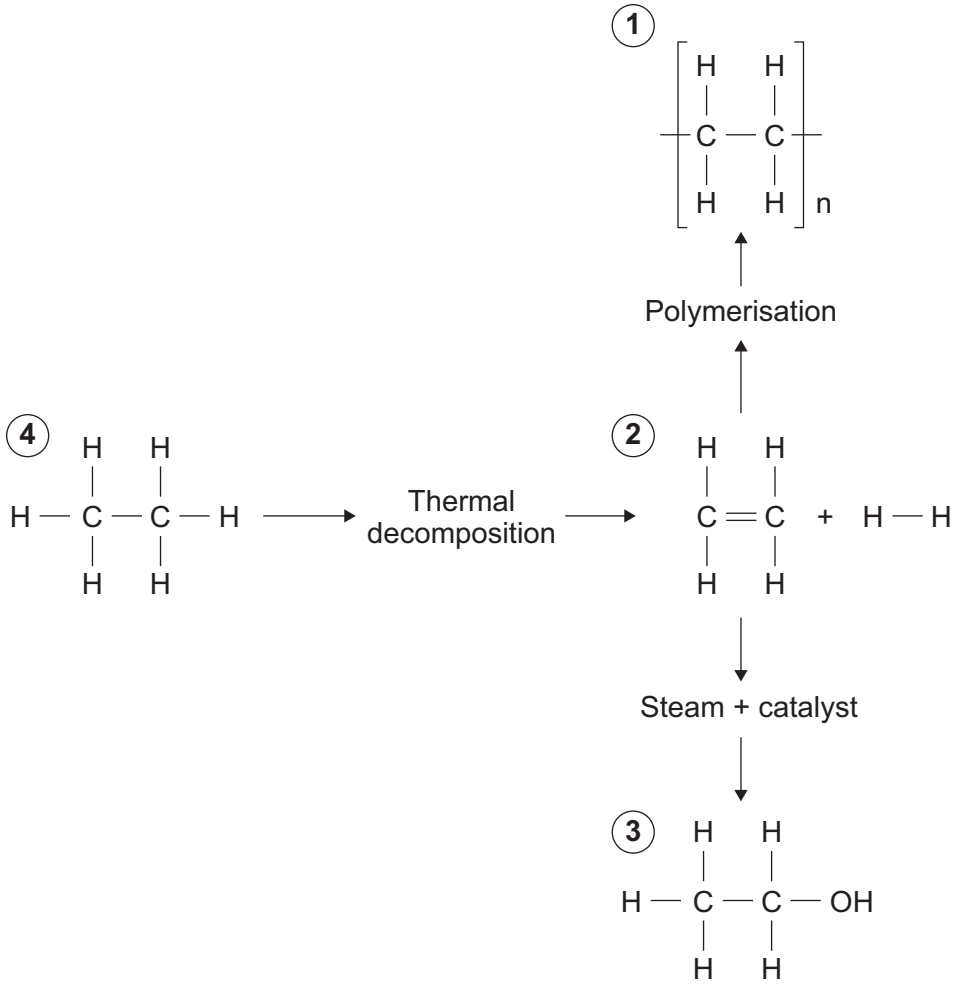
4.2.2.5 Polymers

Question 40

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)

4.2.2.5 Polymers

Question 41

November 2011 | CHY1BP | Original Q4 | Legacy

QUESTION FOUR

Large hydrocarbon molecules can be broken down to produce smaller molecules.

An example is shown below.

Hydrocarbon **K** (large molecule) $\rightarrow$ C_6H_{12} + C_3H_6 + C_3H_8

4A What are the conditions needed for this reaction to take place most successfully?

1 heat hydrocarbon **K** vapour over a hot catalyst

2 heat hydrocarbon **K** vapour with hydrogen

3 heat hydrocarbon **K** with a dilute acid

4 heat hydrocarbon **K** at 40 °C

4B The formula for hydrocarbon **K** is . . .

1 C_9H_{18}

2 $C_{12}H_{24}$

3 $C_{12}H_{26}$

4 $C_{26}H_{12}$

4C Which row in the table shows the products that react with bromine water and the colour change seen when they react?

	Product(s)	Colour change
1	C_6H_{12} and C_3H_6	from yellow-brown to colourless
2	C_3H_6 and C_3H_8	from yellow-brown to colourless
3	C_6H_{12} and C_3H_6	from colourless to yellow-brown
4	C_3H_8 only	from yellow-brown to colourless

4.2.2.5 Polymers

Question 41 · continued

4D Two of the products can form polymers because . . .

1 they are obtained from crude oil by fractional distillation.

2 they are saturated compounds.

3 their molecules have a double carbon carbon bond.

4 they vaporise at temperatures below 20 °C.

Turn over for the next question

4.2.2.5 Polymers

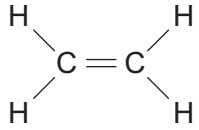
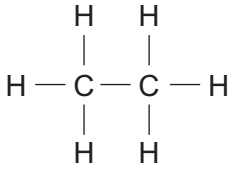
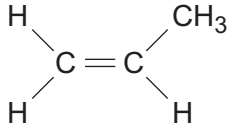
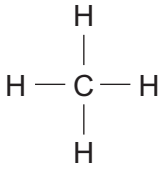
Question 42

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.

4.2.2.5 Polymers

Question 42 · 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

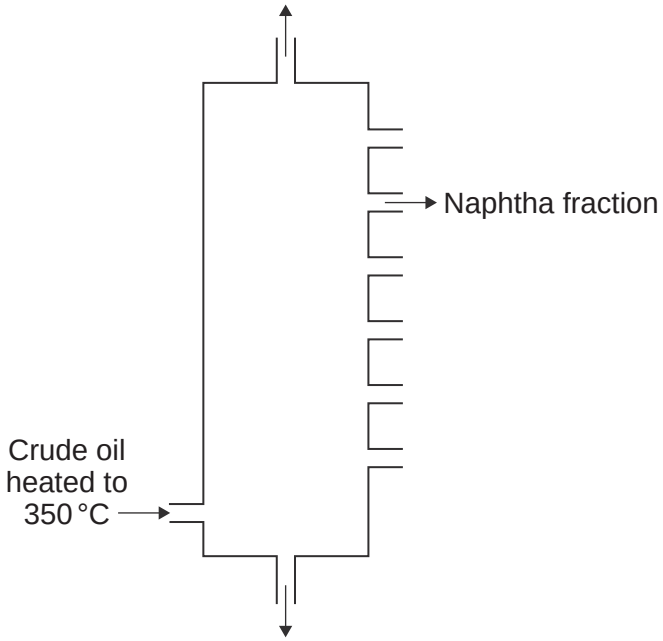
4.2.2.5 Polymers

Question 43

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)

4.2.2.5 Polymers

Question 43 · 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)

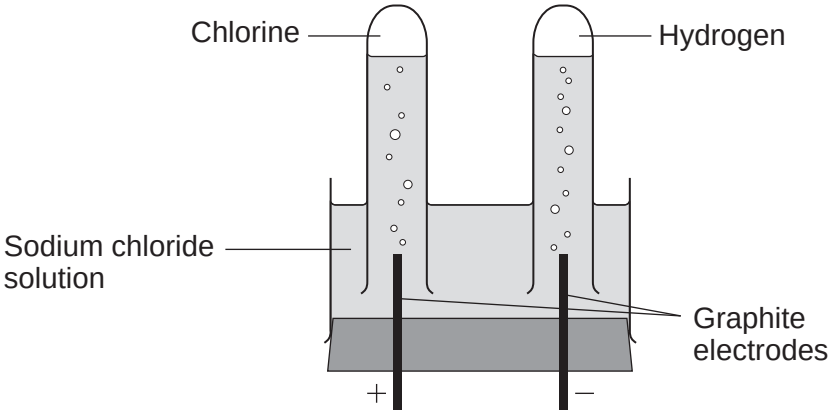
10

4.2.2.5 Polymers

Question 44

2 The electrolysis of sodium chloride solution is an industrial process.

The diagram shows the apparatus used in a school experiment.



2 (a) One of the products of the electrolysis of sodium chloride solution is hydrogen.

2 (a) (i) Why do hydrogen ions move to the negative electrode?

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(1 mark)

2 (a) (ii) How does a hydrogen ion change into a hydrogen atom?

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.....

(1 mark)

4.2.2.5 Polymers

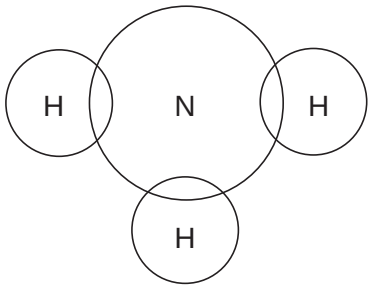
Question 44 · continued

2 (b) Hydrogen is used to make ammonia (NH_3).

Complete the diagram to show the bonding in ammonia.

Use dots (●) and crosses (x) to show electrons.

Show only outer shell electrons.



(2 marks)

2 (c) The table shows the ions in sodium chloride solution.

Positive ions	Negative ions
hydrogen	chloride
sodium	hydroxide

In industry, some of the waste from the electrolysis of sodium chloride solution is alkaline and has to be neutralised.

2 (c) (i) Which ion makes the waste alkaline?

.....

(1 mark)

2 (c) (ii) This waste must be neutralised.

Write the ionic equation for the neutralisation reaction.

.....

(1 mark)

Question 2 continues on the next page

4.2.2.5 Polymers

Question 44 · continued

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

The electrolysis of sodium chloride solution also produces chlorine and sodium hydroxide.

In industry, the electrolysis of sodium chloride solution can be done in several types of electrolysis cell.

Some information about two different types of electrolysis cell is given below.

	Mercury cell	**Membrane cell**
Cost of construction	Expensive	Relatively cheap
Additional substances used	Mercury, which is recycled. Mercury is toxic so any traces of mercury must be removed from the waste.	Membrane, which is made of a polymer. The membrane must be replaced every 3 years.
Amount of electricity used for each tonne of chlorine produced in kWh	3400	2950
Quality of chlorine produced	Pure	Needs to be liquefied and distilled to make it pure.
Quality of sodium hydroxide solution produced	50% concentration. Steam is used to concentrate the sodium hydroxide solution produced.	30% concentration. Steam is used to concentrate the sodium hydroxide solution produced.

Use the information and your knowledge and understanding to compare the environmental and economic advantages and disadvantages of these **two** types of electrolysis cell.

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4.2.2.5 Polymers

Question 45

January 2013 | CH2HP | Original Q4 | Legacy

4 Thermosoftening polymers can be used to make plastic bottles and food packaging.

4 (a) The reaction to produce polymers uses a catalyst.

Why does the catalyst work for a long time before it needs replacing?

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(1 mark)

4 (b) Thermosoftening polymers would **not** be suitable for packaging very hot food.

Explain why in terms of their properties and structure.

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(2 marks)

4.2.2.5 Polymers

Question 45 · continued

4 (c) Compounds from food packaging must not contaminate the food.

Food can be tested for contamination using gas chromatography linked to mass spectroscopy (GC-MS).

4 (c) (i) Gas chromatography can separate substances in a mixture of compounds.

Describe how, as fully as you can.

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(3 marks)

4 (c) (ii) What information does the molecular ion peak give about the molecule?

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(1 mark)

7

4.2.2.5 Polymers

Question 46

June 2013 | CH2HP | Original Q5 | Legacy

5 Oil rigs are used to drill for crude oil.



5 (a) Drill heads are made from steel. Steel is an alloy.

Explain why alloys are harder than pure metals.

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(3 marks)

4.2.2.5 Polymers

Question 46 · continued

5 (b) Drill heads also contain diamonds.

Describe, as fully as you can, the structure and bonding in diamond.

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(4 marks)

5 (c) Polymers are produced from crude oil.

Describe the structure and bonding in a thermosoftening polymer and explain why thermosoftening polymers melt when heated.

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(4 marks)

11

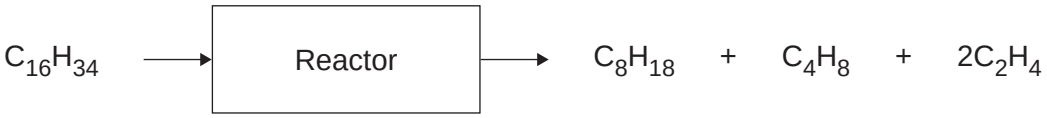
4.2.2.5 Polymers

Question 47

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]

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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]

.....

4.2.2.5 Polymers

Question 47 · 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]

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8

4.2.2.5 Polymers

Question 48

June 2015 | CH1HP | Original Q5 | Legacy

5 Crude oil is a fossil fuel.

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

[4 marks]

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

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

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

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

[3 marks]

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4.2.2.5 Polymers

Question 48 · continued

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

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

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

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

[1 mark]

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

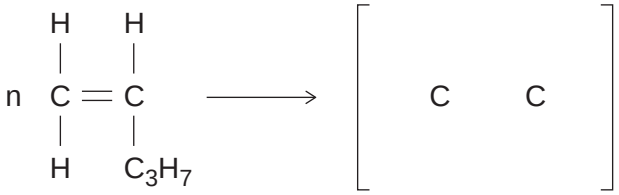
decane pentene propane

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

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

[3 marks]

Pentene **Poly(pentene)**



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

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

[1 mark]

.....

.....

12

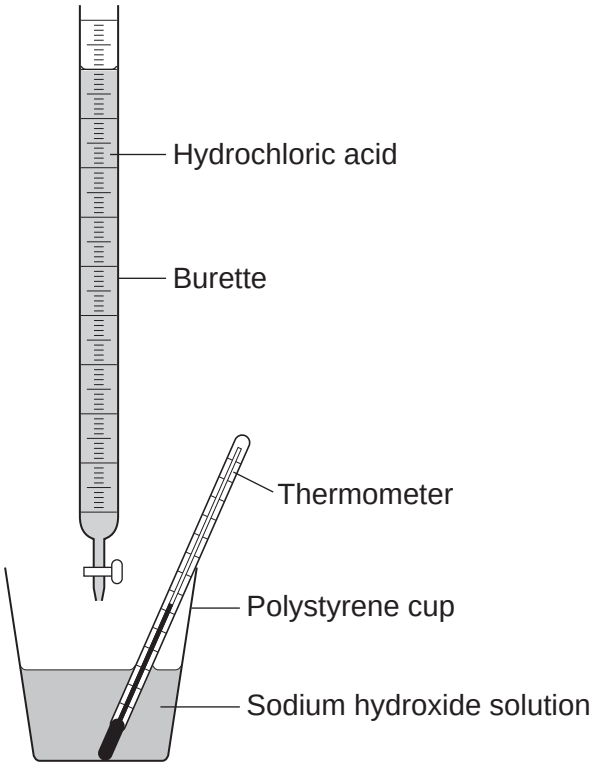
4.2.2.5 Polymers

Question 49

June 2015 | CH3HP | Original Q8 | Legacy

8 A student investigates the energy released when hydrochloric acid completely neutralises sodium hydroxide solution.
The student uses the apparatus shown in **Figure 4**.

Figure 4



The student:

- measures 25 cm^3 sodium hydroxide solution into a polystyrene cup
- fills a burette with hydrochloric acid
- measures the temperature of the sodium hydroxide solution
- adds 5 cm^3 hydrochloric acid to the sodium hydroxide solution in the polystyrene cup
- stirs the mixture and measures the highest temperature of the mixture
- continues to add 5 cm^3 portions of hydrochloric acid, stirring and measuring the highest temperature of the mixture after each addition.

Question 8 continues on the next page

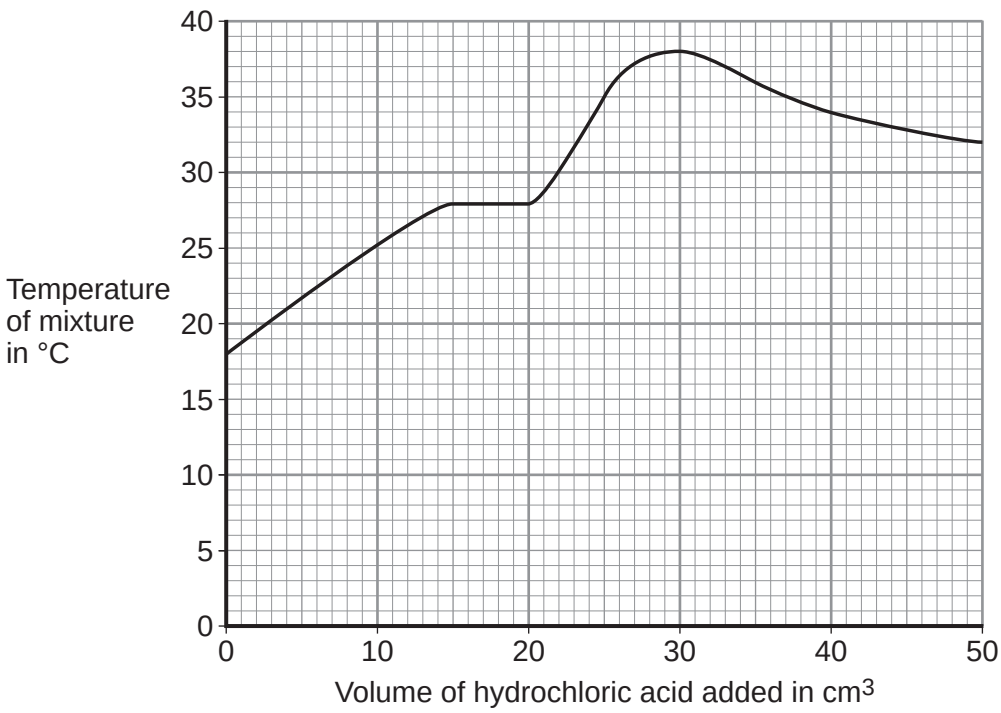
Question 49 · continued

8 (a) The student has plotted a graph of the results.

The graph line has been incorrectly drawn by including an anomalous result.

The graph is shown in **Figure 5**.

Figure 5



8 (a) (i) Suggest a cause for the anomalous result when 20 cm^3 of hydrochloric acid is added.

[1 mark]

.....

.....

8 (a) (ii) Suggest the true value of the temperature of the anomalous point.

[1 mark]

Temperature = ... °C

8 (a) (iii) What was the **total** volume of the mixture when the maximum temperature was reached?

[1 mark]

.....

Total volume of the mixture = ... cm^3

4.2.2.5 Polymers

Question 49 · continued

8 (a) (iv) Calculate the overall temperature increase in this experiment.

[1 mark]

.....

Overall temperature increase = ... °C

8 (a) (v) Use your answers to **8(a)(iii)** and **8(a)(iv)** and the equation to calculate the energy released in the reaction. Give the unit.

[2 marks]

Assume the volume in cm^3 is equivalent to the mass of solution in grams.

Equation: $Q = mc\Delta T$

where:
Q = energy released
m = mass of solution (g)
c = 4.2 (J per g per °C)
ΔT = change in temperature (°C)

.....

.....

Energy released = ... Unit = ...

8 (b) The student did the experiment on page 19 again, starting with 50 cm^3 of sodium hydroxide solution instead of 25 cm^3.

Explain why this would make no difference to the overall temperature increase.

[2 marks]

.....

.....

.....

.....

8

4.2.2.5 Polymers

Question 50

June 2016 | CH2HP | Original Q6 | Legacy

6 This question is about the properties and uses of materials.

Use your knowledge of structure and bonding to answer the questions.

6 (a) Explain how copper conducts electricity.

[2 marks]

6 (b) Explain why diamond is hard.

[2 marks]

6 (c) Explain why thermosetting polymers are better than thermosoftening polymers for saucepan handles.

[2 marks]

6

4.2.2.5 Polymers

Question 51

June 2017 | CH1HP | Original Q4 | Legacy

4 A polymer is used to make supermarket carrier bags.

4 (a) **Table 3** shows data about polymer bags used by customers of UK supermarkets.

Table 3

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014
Number of bags used in millions	12 419	11 346	9004	7570	7974	8392	8487	8759	8959
Mass of bags used in thousands of tonnes	109.8	104.7	83.4	65.6	68.3	72.3	70.4	67.3	66.1

4 (a) (i) Describe what happens in a polymerisation reaction.

[1 mark]

4 (a) (ii) Describe the trend in the number of bags used per year between 2006 and 2014.

[2 marks]

4 (a) (iii) The trend in the number of bags used does **not** match the trend of the mass of bags used between 2012 and 2014.

Suggest **two** reasons why.

[2 marks]

4.2.2.5 Polymers

Question 51 · continued

4 (b) There has been an increase in the amount of recycled polymer used to make supermarket carrier bags.

This reduces the amount of polymer put into landfill.

4 (b) (i) Give **two** reasons why the amount of polymer put into landfill **should** be reduced.

[2 marks]

4 (b) (ii) Apart from reducing the use of landfill, give **two** reasons why more recycled polymer, instead of newly manufactured polymer, should be used to make supermarket carrier bags.

[2 marks]

9

4.2.2.5 Polymers

Question 52

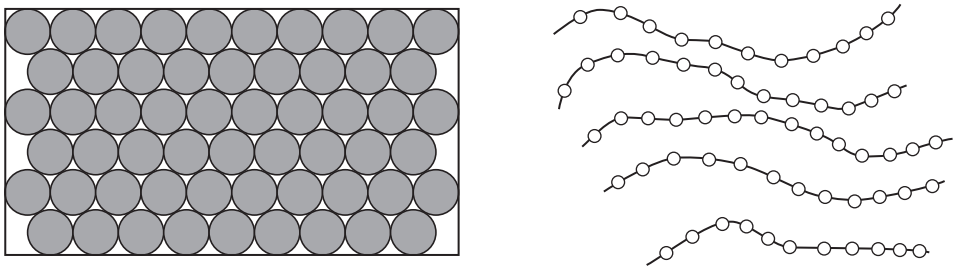
June 2017 | CH2HP | Original Q2 | Legacy

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

Metals and thermosoftening polymers have different properties.

Figure 3 shows structures of a metal and a thermosoftening polymer.

Figure 3



Explain how the properties of a metal and a thermosoftening polymer relate to their structures.

In your answer you should describe the structures of a metal and a thermosoftening polymer.

[6 marks]

4.2.2.5 Polymers

Question 53

June 2018 | 8462/2H | Original Q6

0 6 This question is about polymers.

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

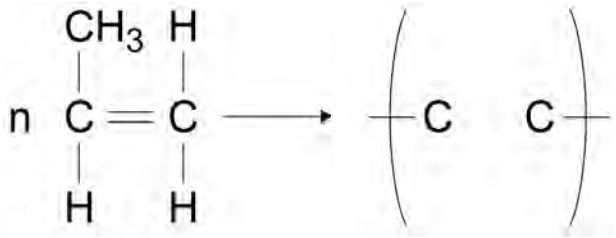
Name the small molecule lost.

[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]

4.2.2.5 Polymers

Question 53 · 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

4.2.2.5 Polymers

Question 54

June 2018 | 8462/2H | Original Q10

1 0 Disposable cups are made from coated paper or poly(styrene).

Table 6 shows information on the life cycle assessments (LCAs) of disposable cups.

Table 6

	Coated paper cups	Poly(styrene) cups
Raw materials	Wood	Crude oil
Mass of 1 cup in g	8.3	1.9
Energy to produce 1 cup in kJ	550	200
Energy released when 1 cup is burned in kJ	166	76
Biodegradable	Yes	No
Recyclable	No	Yes

1 0 . 1 Evaluate the use of coated paper compared with poly(styrene) to make disposable cups.

Use **Table 6** and your knowledge and understanding of LCAs.

[6 marks]

4.2.2.5 Polymers

Question 54 · continued

1 0 . 2 Calculate the energy needed to produce 1.00 kg of coated paper cups.

Use **Table 6**.

Give your answer in standard form.

[2 marks]

Energy = _____ kJ

1 0 . 3 Melamine is a polymer used to make non-disposable cups.

Melamine does **not** melt when it is heated.

Explain why.

[2 marks]

10

4.2.2.5 Polymers

Question 55

June 2019 | 8462/1H | Original Q9

0 9 A student investigated the temperature change in the reaction between dilute sulfuric acid and potassium hydroxide solution.

This is the method used.

1. Measure 25.0 cm^3 potassium hydroxide solution into a polystyrene cup.

2. Record the temperature of the solution.

3. Add 2.0 cm^3 dilute sulfuric acid.

4. Stir the solution.

5. Record the temperature of the solution.

6. Repeat steps 3 to 5 until a total of 20.0 cm^3 dilute sulfuric acid has been added.

0 9 . 1 Suggest why the student used a polystyrene cup rather than a glass beaker for the reaction.

[2 marks]

Question 9 continues on the next page

Question 55 · continued

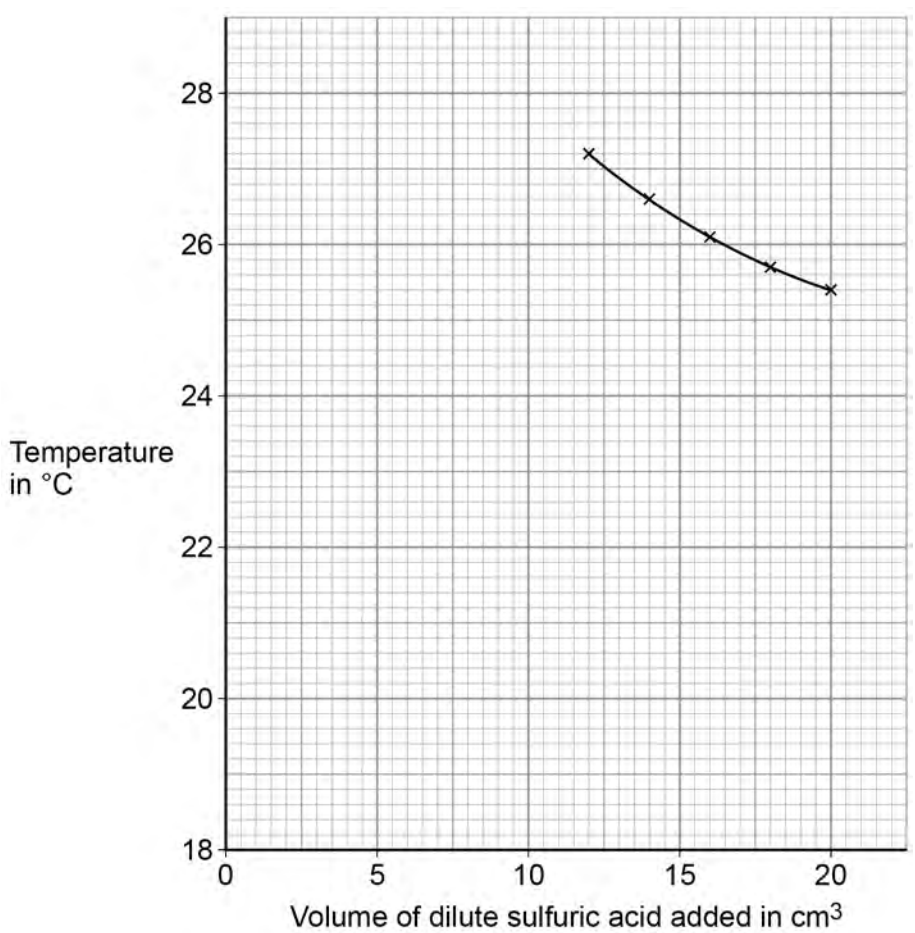
Table 6 shows some of the student's results.

Table 6

Volume of dilute sulfuric acid added in cm^3	Temperature in °C
0.0	18.9
2.0	21.7
4.0	23.6
6.0	25.0
8.0	26.1
10.0	27.1

Figure 11 shows some of the data from the investigation.

Figure 11



Question 55 · continued

0 9 . 2 Complete **Figure 11**:

- plot the data from **Table 6**
- draw a line of best fit through these points
- extend the lines of best fit until they cross.

[4 marks]

0 9 . 3 Determine the volume of dilute sulfuric acid needed to react completely with 25.0 cm^3 of the potassium hydroxide solution.

Use **Figure 11**.

[1 mark]

Volume of dilute sulfuric acid to react completely = _____ cm^3

0 9 . 4 Determine the overall temperature change when the reaction is complete.

Use **Figure 11**.

[1 mark]

_____

_____

Overall temperature change = _____ °C

Question 9 continues on the next page

4.2.2.5 Polymers

Question 55 · continued

0 9 . 5 The student repeated the investigation.

The student used solutions that had different concentrations from the first investigation.

The student found that 15.5 cm^3 of 0.500 mol/dm^3 dilute sulfuric acid completely reacted with 25.0 cm^3 of potassium hydroxide solution.

The equation for the reaction is:

$$2\,KOH + H_2SO_4 \rightarrow K_2SO_4 + 2\,H_2O$$

Calculate the concentration of the potassium hydroxide solution in mol/dm^3 and in g/dm^3

Relative atomic masses (A_r): H = 1 O = 16 K = 39

[6 marks]

Concentration in mol/dm^3 = _____ mol/dm^3

Concentration in g/dm^3 = _____ g/dm^3

14

4.2.2.5 Polymers

Question 56

June 2019 | 8462/2H | Original Q6

0 6 **Figure 5** shows a surfer on a surfboard.

Figure 5



Surfboards are made from polymers.

Surfboards have a poly(styrene) core and an outer skin.

0 6 . 1 **Figure 6** shows the displayed structural formula of poly(styrene).

Figure 6

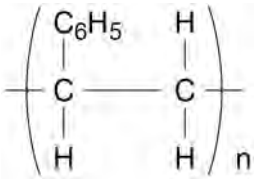
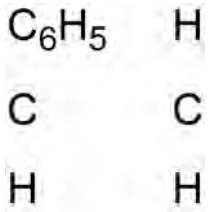


Figure 7 shows an incomplete displayed structural formula of the monomer styrene.

Complete **Figure 7**.

[2 marks]

Figure 7



4.2.2.5 Polymers

Question 56 · continued

The outer skin of surfboards contains a polyester.

Two monomers, **A** and **B**, are needed to make the polyester.

Figure 8 shows how these two monomers are represented.

Figure 8



Monomer **A** Monomer **B**

0 6 . 2 Name the functional group in monomer **B**.

[1 mark]

0 6 . 3 Monomers **A** and **B** join together to produce a polyester and a small molecule.

Name the small molecule.

[1 mark]

0 6 . 4 Why does this type of polyester melt when it is heated?

[2 marks]

4.2.2.5 Polymers

Question 56 · continued

The outer skin of surfboards is a composite material.

The composite material contains glass fibres surrounded by a polyester.

0 6 . 5 Draw **one** line from each material to the description of that material.

[2 marks]

Material	Description of the material
	Hydrocarbon
Glass fibres	Matrix
	Monomer
Polyester	Polypeptide
	Reinforcement

0 6 . 6 The outer skin makes the surfboard more expensive.

Suggest **two** reasons why an outer skin is added to the poly(styrene) core.

[2 marks]

1 _____

_____

2 _____

_____

10

4.2.2.5 Polymers

Question 57

November 2020 | 8462/1H | Original Q1

0 1 This question is about structure and bonding.

0 1 . 1 Which **two** substances have intermolecular forces between particles?

[2 marks]

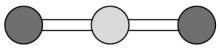
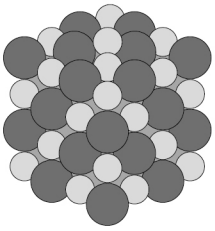
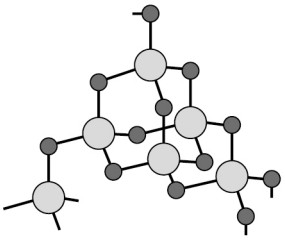
Tick (✓) **two** boxes.

- Diamond ☐
- Magnesium ☐
- Poly(ethene) ☐
- Sodium chloride ☐
- Water ☐

0 1 . 2 **Table 1** shows the structures of three compounds.

Table 1

Diagrams not to scale

Compound	Structure
Carbon dioxide	
Magnesium oxide	
Silicon dioxide	

4.2.2.5 Polymers

Question 57 · continued

Compare the structure and bonding of the three compounds:

- carbon dioxide
- magnesium oxide
- silicon dioxide.

[6 marks]

8

4.2.2.5 Polymers

Question 58

0 9 This question is about citric acid ($C_6H_8O_7$).

Citric acid is a solid.

A student investigated the temperature change during the reaction between citric acid and sodium hydrogencarbonate solution.

This is the method used.

1. Pour 25 cm^3 of sodium hydrogencarbonate solution into a polystyrene cup.

2. Measure the temperature of the sodium hydrogencarbonate solution.

3. Add 0.20 g of citric acid to the polystyrene cup.

4. Stir the solution.

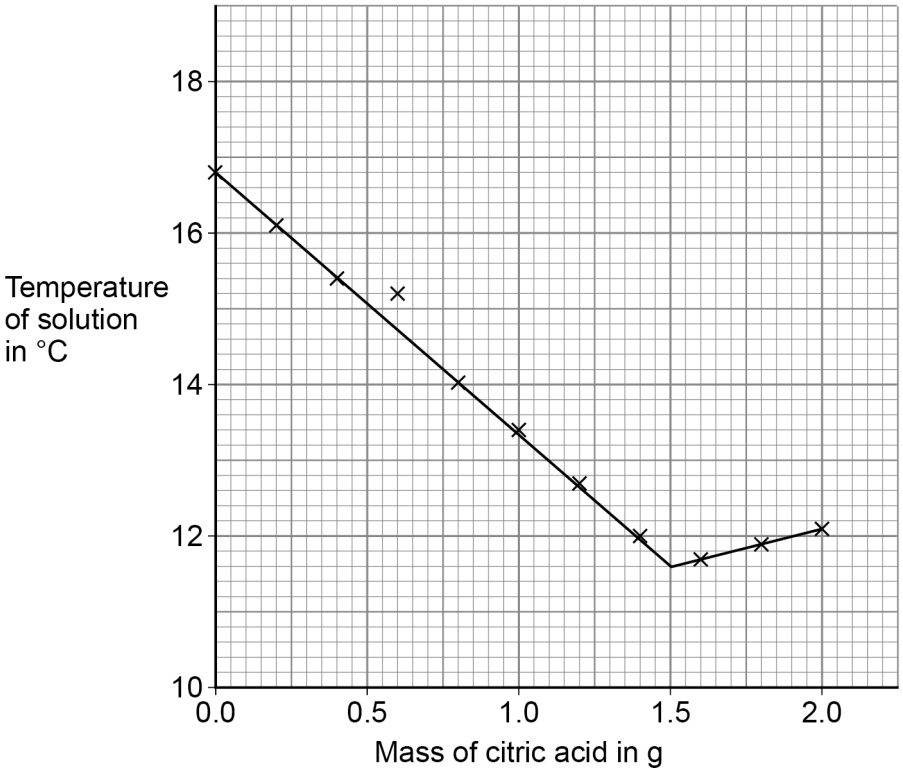
5. Measure the temperature of the solution.

6. Repeat steps 3 to 5 until a total of 2.00 g of citric acid has been added.

The student plotted the results on a graph.

Figure 6 shows the student's graph.

Figure 6



4.2.2.5 Polymers

Question 58 · continued

0 9 . 1 **Figure 6** shows an anomalous point when 0.60 g of citric acid was added. This was caused by the student making an error.

The student correctly:

- measured the mass of the citric acid
- read the thermometer
- plotted the point.

Suggest **one** reason for the anomalous point.

[1 mark]

0 9 . 2 Explain the shape of the graph in terms of the energy transfers taking place.

You should use data from **Figure 6** in your answer.

[3 marks]

0 9 . 3 A second student repeated the investigation using a metal container instead of the polystyrene cup. The container and the cup were the same size and shape.

Sketch a line on **Figure 6** to show the second student's results until 1.00 g of citric acid had been added. The starting temperature of the solution was the same.

Explain your answer.

[3 marks]

Question 58 · continued

The student used a solution of citric acid to determine the concentration of a solution of sodium hydroxide by titration.

0 9 . 4 The student made 250 cm^3 of a solution of citric acid of concentration 0.0500 mol/dm^3

Calculate the mass of citric acid ($C_6H_8O_7$) required.

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

[3 marks]

Mass = _____ g

This is part of the method the student used for the titration.

1. Measure 25.0 cm^3 of the sodium hydroxide solution into a conical flask using a pipette.
2. Add a few drops of indicator to the flask.
3. Fill a burette with citric acid solution.

0 9 . 5 Describe how the student would complete the titration.

[3 marks]

4.2.2.5 Polymers

Question 58 · continued

0 9 . 6 Give **two** reasons why a burette is used for the citric acid solution.

[2 marks]

1 _____

_____

2 _____

_____

0 9 . 7 13.3 cm^3 of 0.0500 mol/dm^3 citric acid solution was needed to neutralise 25.0 cm^3 of sodium hydroxide solution.

The equation for the reaction is:

$$3\,NaOH + C_6H_8O_7 \rightarrow C_6H_5O_7Na_3 + 3\,H_2O$$

Calculate the concentration of the sodium hydroxide solution in mol/dm^3

[3 marks]

_____

_____

_____

_____

_____

_____

Concentration = _____ mol/dm^3

18

4.2.2.5 Polymers

Question 59

November 2020 | 8462/2H | Original Q5

0 5 This question is about materials used to make food plates.

Food plates are made from paper, polymers or ceramics.

Table 2 shows information about plates of the same diameter made from each of these materials.

Table 2

	Food plate material		
	Paper	**Polymers**	**Ceramics**
Raw material	Wood	Crude oil	Mined clay
Number packaged in 10 dm^3 cardboard box	500	100	50
Average number of times used	1	400	1000
Biodegradable?	Yes	No	No
Recyclable?	Yes	Yes	No

0 5 . 1 **Table 2** does **not** show information about energy usage.

Suggest **two** pieces of information about energy usage which would help to produce a complete life cycle assessment (LCA) for the three food plate materials.

[2 marks]

1 _____

_____

2 _____

_____

4.2.2.5 Polymers

Question 59 · continued

0 5 . 2 Evaluate the use of these materials for making food plates.

You should use features of life cycle assessments (LCAs).

Use **Table 2**.

[4 marks]

0 5 . 3 Describe how ceramic food plates are produced from clay.

[2 marks]

8

4.2.2.5 Polymers

Question 60

November 2020 | 8462/2H | Original Q9

0 9 This question is about algae.

A student:

- placed algae in water containing dissolved carbon dioxide
- shone bright light on the algae.

Gas bubbles were collected as the algae photosynthesised.

0 9 . 1 Describe a test that would identify the gas collected.

Give the result of the test.

[2 marks]

Test _____

Result _____

_____

0 9 . 2 Glucose is produced when algae photosynthesise.

Name **two** naturally occurring polymers produced from glucose.

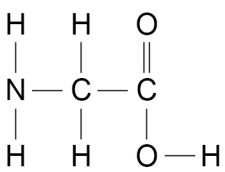
[2 marks]

_____ and _____

Question 9 continues on the next page

Figure 6 shows the displayed structural formula of an amino acid called glycine.

Figure 6



0 9 . 3 How many functional groups are there in the molecule in **Figure 6**?

[1 mark]

Tick (✓) **one** box.

1 ☐ 2 ☐ 3 ☐ 4 ☐

0 9 . 4 Glycine reacts by condensation polymerisation to produce a polypeptide and one other substance.

Name the other substance produced.

[1 mark]

_____

0 9 . 5 Scientists think that algae may have used gases in Earth's early atmosphere.

Algae need an element to produce the molecule in **Figure 6** which is **not** present in water or carbon dioxide.

Which **two** gases from Earth's early atmosphere could have provided this element?

[2 marks]

_____ and _____

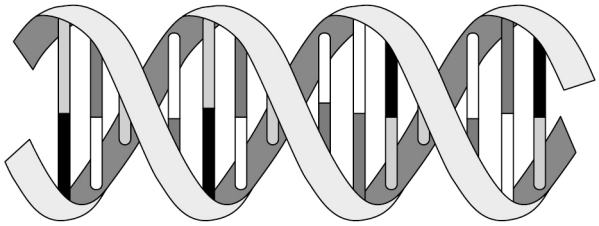
4.2.2.5 Polymers

Question 60 · continued

0 9 . 6 The development and function of algae are controlled by a naturally occurring polymer.

Figure 7 represents the shape and structure of this polymer.

Figure 7



Describe the shape and structure of this polymer.

[3 marks]

11

4.2.2.5 Polymers

Question 61

November 2021 | 8462/2H | Original Q4

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

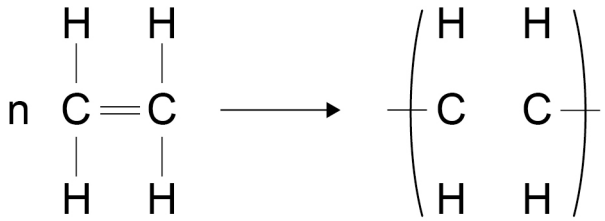
0 4 . 1 Poly(ethene) is produced from ethene.

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]

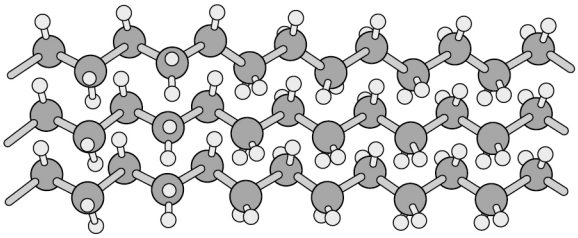
0 4 . 4 Two different forms of poly(ethene) are:

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

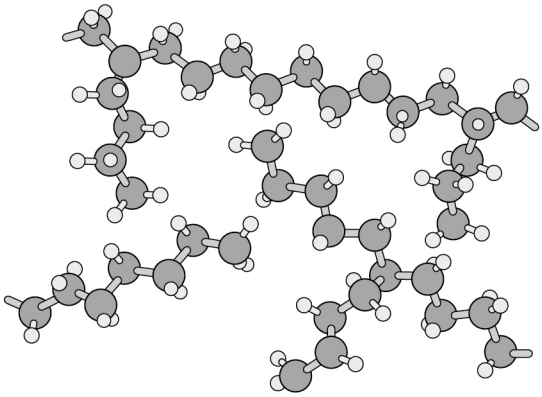
Figure 4 represents part of the structures of HDPE and LDPE.

Figure 4

HDPE



LDPE



Explain why HDPE has a higher density than LDPE.

[2 marks]

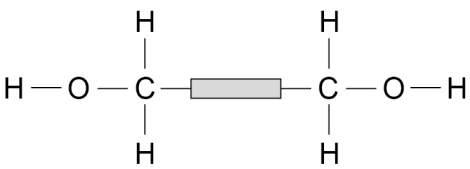
Question 4 continues on the next page.

Question 61 · continued

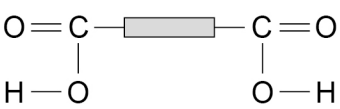
Figure 5 shows three monomers, **A**, **B** and **C**.

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

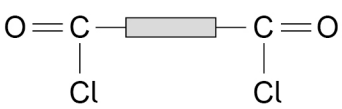
Figure 5



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

4.2.2.5 Polymers

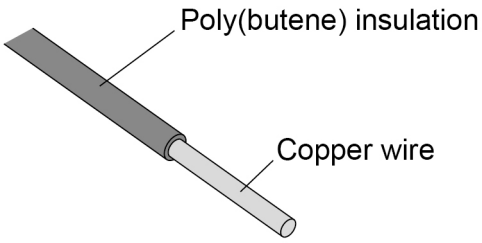
Question 62

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

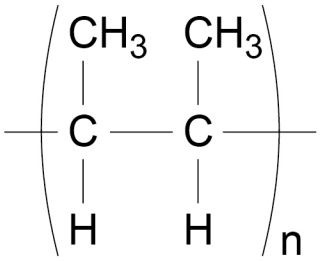
Copper is used to make electrical wires.

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:

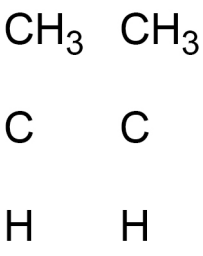


Poly(butene) is produced from the monomer butene.

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

[2 marks]

Figure 2



4.2.2.5 Polymers

Question 62 · 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

4.2.2.5 Polymers

Question 62 · 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

4.2.2.5 Polymers

Question 63

June 2022 | 8462/2H | Original Q3

0 3 This question is about life cycle assessments (LCAs).

0 3 . 1 Milk bottles can be made from glass or from a polymer.

Table 2 shows information about milk bottles of equal volume.

Table 2

	Glass	Polymer
Raw materials	Limestone Sand Sodium carbonate	Crude oil
Energy needed to process raw materials in kilojoules	6750	1710
Energy needed to manufacture bottle in kilojoules	750	90
Mass of bottle in grams	200	20
Mean number of times used during lifetime of bottle	25	1
One disposal method at end of useful life	Recycled to make different glass products	Recycled to make different polymer products

Evaluate the use of glass for milk bottles compared with the use of a polymer for milk bottles.

Use features of life cycle assessments (LCAs) in your answer.

Use **Table 2**.

[6 marks]

4.2.2.5 Polymers

Question 63 · continued

0 3 . 2 Milk is also sold in cardboard cartons.

A carton is made using 40 cm^3 of cardboard.

The density of the cardboard is 0.40 g/cm^3.

Calculate the mass of the carton.

Use the equation:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

[3 marks]

Mass = _____ g

9

4.2.2.5 Polymers

Question 64

June 2023 | 8462/1H | Original Q2

0 2 This question is about temperature changes.

A student investigated the change in temperature of a solution when different masses of ammonium nitrate were dissolved in water.

This is the method used.

1. Measure 200 cm^3 of water into a polystyrene cup.

2. Measure the temperature of the water.

3. Add 4.0 g of ammonium nitrate to the water.

4. Stir the solution until all the ammonium nitrate has dissolved.

5. Measure the lowest temperature reached by the solution.

6. Repeat steps 1 to 5 with different masses of ammonium nitrate.

0 2 . 1 Give the independent variable and the dependent variable in the investigation.

[2 marks]

Independent variable _____

Dependent variable _____

Table 2 shows the results.

Table 2

Mass of ammonium nitrate added in grams	Lowest temperature of solution in °C
4.0	18.2
8.0	16.2
12.0	15.2
16.0	13.6
20.0	12.4
24.0	10.6

4.2.2.5 Polymers

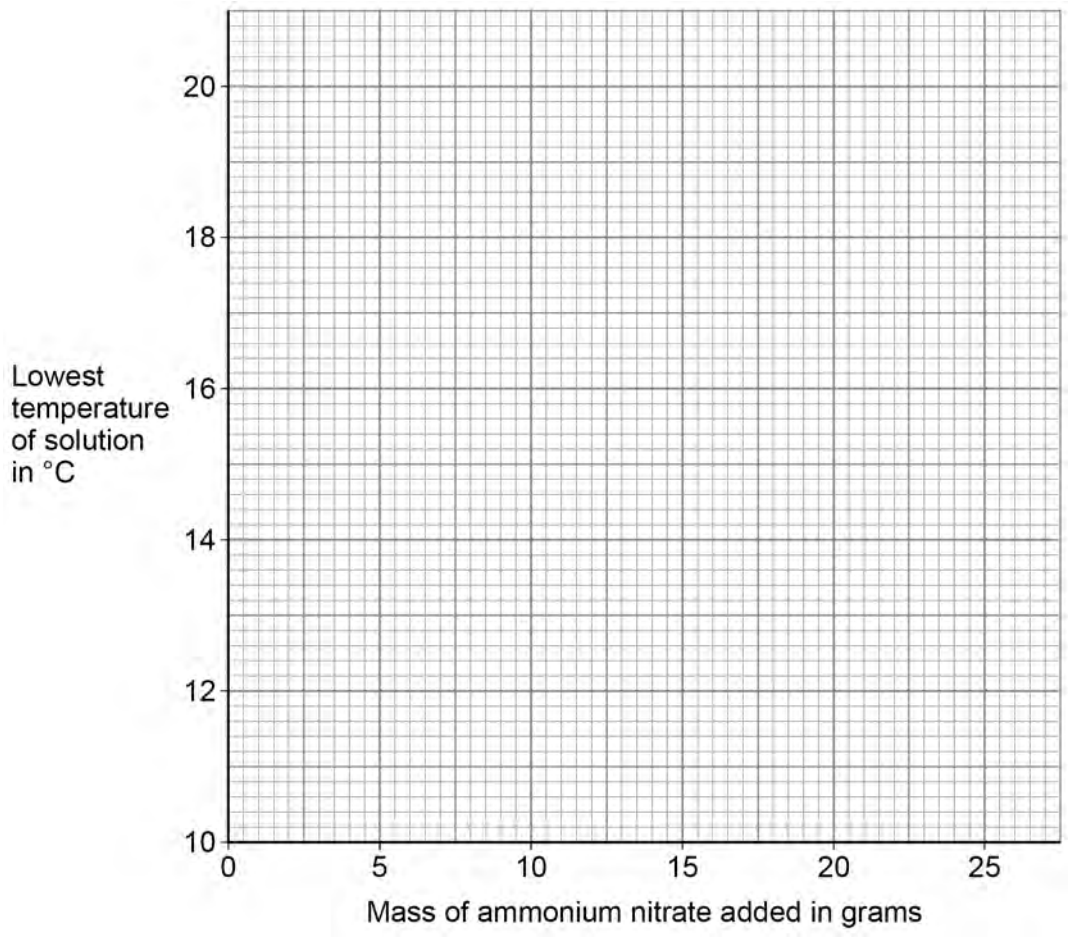
Question 64 · continued

0 2 . 2 Plot the data from **Table 2** on **Figure 2**.

Draw a line of best fit.

[3 marks]

Figure 2



0 2 . 3 Determine the initial temperature of the water.

You should extend your line of best fit on **Figure 2**.

[2 marks]

Initial temperature of the water = _____ °C

0 2 . 4 How do the results show that dissolving ammonium nitrate in water is endothermic?

[1 mark]

_____

_____

The student repeated the experiment three more times.

Table 3 shows the results for 8.0 g of ammonium nitrate.

Table 3

	Trial 1	Trial 2	Trial 3	Trial 4	Mean
Lowest temperature of solution in ºC	16.2	16.6	16.8	16.4	16.5

0 2 . 5 The student recorded the mean lowest temperature of the solution for 8.0 g of ammonium nitrate as 16.5 ± 0.3 ºC.

Explain why the student included ± 0.3 ºC after the mean lowest temperature.

[2 marks]

0 2 . 6 What type of error is shown by the results in **Table 3**?

[1 mark]

Tick (✓) **one** box.

Random error ☐

Systematic error ☐

Zero error ☐

11

4.2.2.5 Polymers

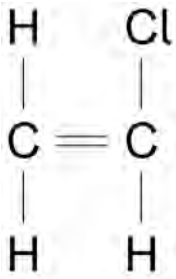
Question 65

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

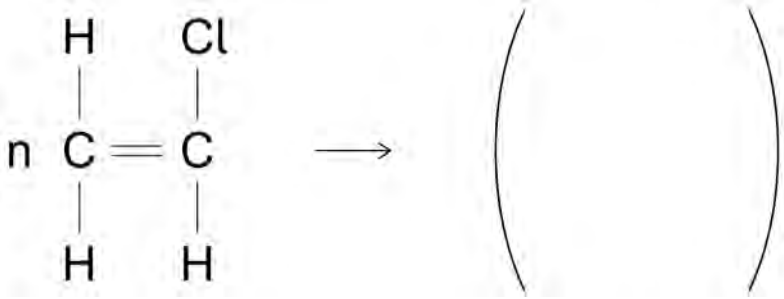


0 8 . 1 Draw a circle around the functional group on the displayed structural formula that allows chloroethene to produce an addition polymer.

[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 65 · 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]

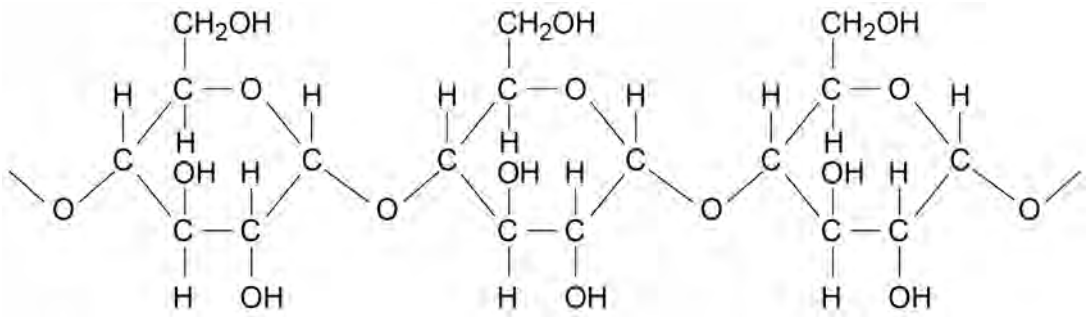
Relative formula mass = _____

4.2.2.5 Polymers

Question 65 · 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**.

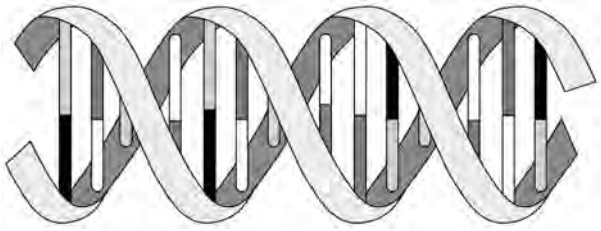
[1 mark]

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

4.2.2.5 Polymers

Question 66

June 2024 | 8462/1H | Original Q4

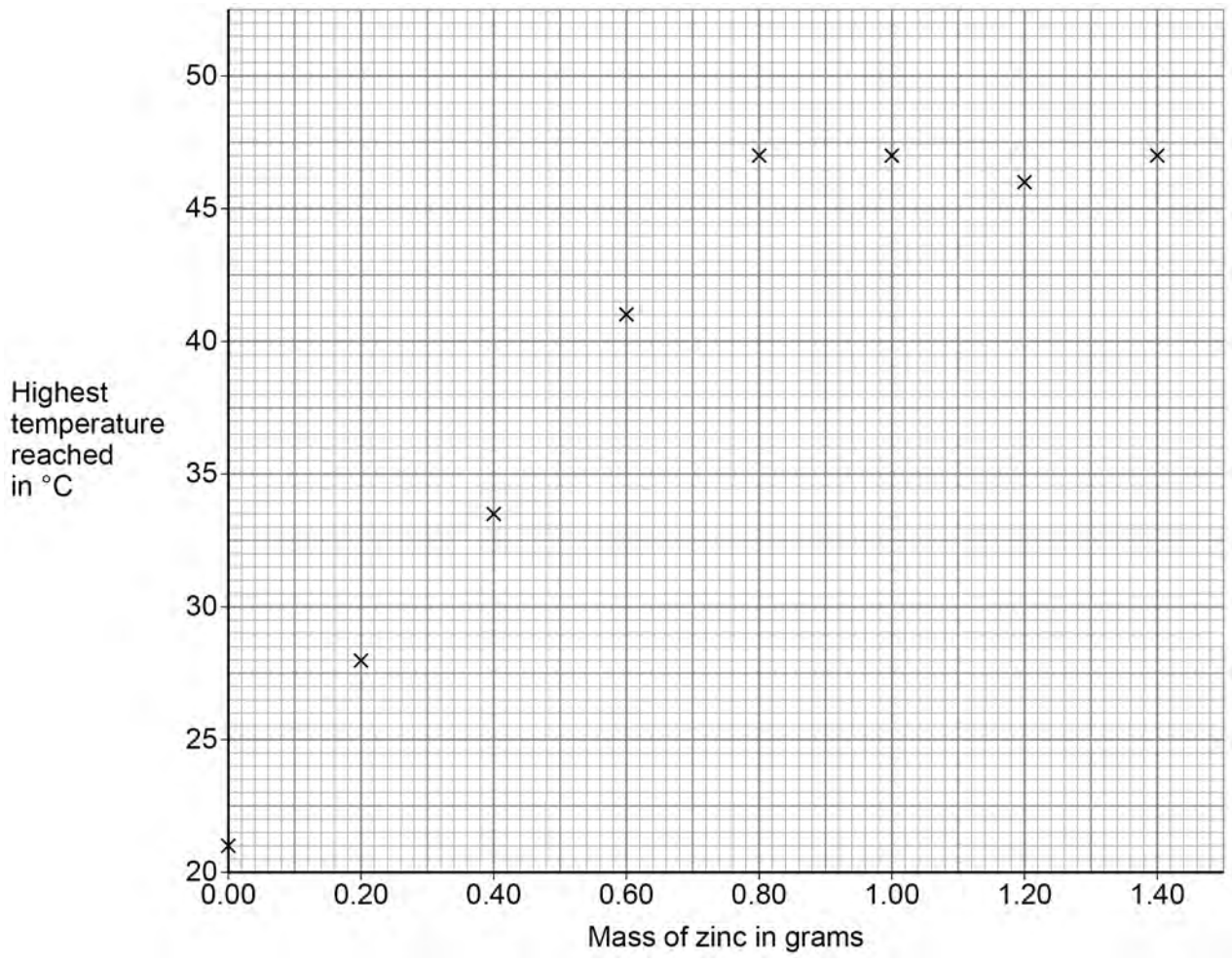
0 4 A student investigated the energy change of the reaction between zinc and copper sulfate solution.

This is the method used.

1. Measure 25 cm^3 of copper sulfate solution into a polystyrene cup.
2. Measure the temperature of the copper sulfate solution.
3. Add 0.20 g of zinc powder to the copper sulfate solution.
4. Stir the reaction mixture.
5. Record the highest temperature reached.
6. Repeat steps 1 to 5 with different masses of zinc powder.

Figure 3 shows the results.

Figure 3



Question 66 · continued

0 4 . 1 Draw **two** lines of best fit on **Figure 3**.

The lines should cross.

[2 marks]

0 4 . 2 Explain the results shown in **Figure 3**.

Do **not** refer to anomalous points.

Use data from **Figure 3**.

[4 marks]

0 4 . 3 Explain why using a polystyrene cup gives more accurate results than using a glass beaker.

[2 marks]

0 4 . 4 Complete the ionic equation for the reaction between zinc and copper sulfate solution.

Include state symbols.

[2 marks]

$$Zn(s) + Cu^{2+}(aq) \rightarrow ____(__) + ____(__)$$

Question 66 · continued

A different student repeated steps 1 to 5 of the method four times using 0.50 g of zinc powder.

Table 2 shows the results.

Table 2

	Trial 1	Trial 2	Trial 3	Trial 4
Highest temperature reached in °C	37.6	37.2	37.8	37.4

0 4 . 5 Calculate the mean highest temperature reached.

Include the uncertainty in your answer.

[3 marks]

Mean highest temperature reached = _____ ± _____ °C

0 4 . 6 The results show random errors.

The student did not make any measuring errors.

Suggest **one** reason for the random errors in this experiment.

[1 mark]

14

4.2.2.5 Polymers

Question 67

June 2024 | 8462/2H | Original Q6

0 6 This question is about materials used to make bicycles.

Figure 6 shows a bicycle.

Figure 6



Table 3 shows information about two materials used to make bicycle frames.

Table 3

	Material	
	Aluminium alloy	**Bamboo**
Raw material	aluminium ore	bamboo plant
Cost of frame in £	250	1500
Strength in arbitrary units	290	193
Mass in kilograms	1.6	2.4
Lifespan in years	6–10	10–15
One method of disposal at end of life	recycled to make new products	burned to produce heat energy

4.2.2.5 Polymers

Question 67 · continued

0 6 . 1 Evaluate the use of aluminium alloy and of bamboo for making bicycle frames.

Use **Table 3**.

[6 marks]

0 6 . 2 Explain why aluminium alloy bicycle frames do **not** need protection from corrosion.

[2 marks]

Question 6 continues on the next page

4.2.2.5 Polymers

Question 67 · continued

0 6 . 3 Bicycle chains are made from an alloy of iron.

Bicycle chains rust without protection.

Paint is **not** used to protect bicycle chains from rusting.

Suggest how bicycle chains can be protected from rusting.

[1 mark]

0 6 . 4 Bicycle frames can also be made from a composite of carbon fibres embedded in a polymer resin.

What description is given in this composite to:

- the carbon fibre component
- the polymer resin component?

[2 marks]

Carbon fibre _____

Polymer resin _____

11

4.2.2.5 Polymers

Question 68

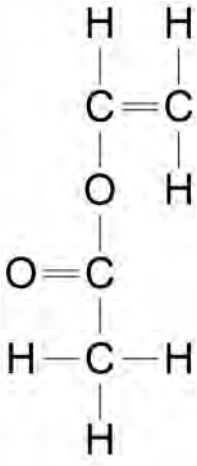
June 2024 | 8462/2H | Original Q8

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.

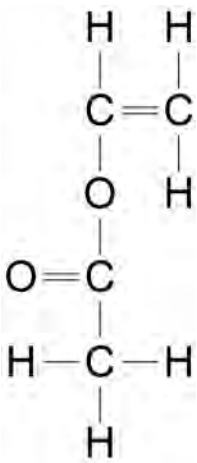
[2 marks]

Question 8 continues on the next page

4.2.2.5 Polymers

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]

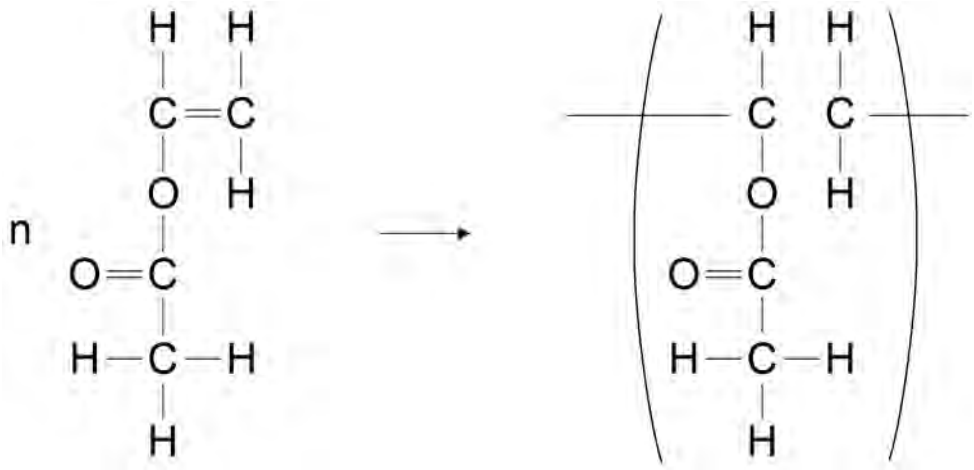
_____ + _____ → _____ + _____

Question 68 · 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

4.2.2.5 Polymers

Question 68 · 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

4.2.2.5 Polymers

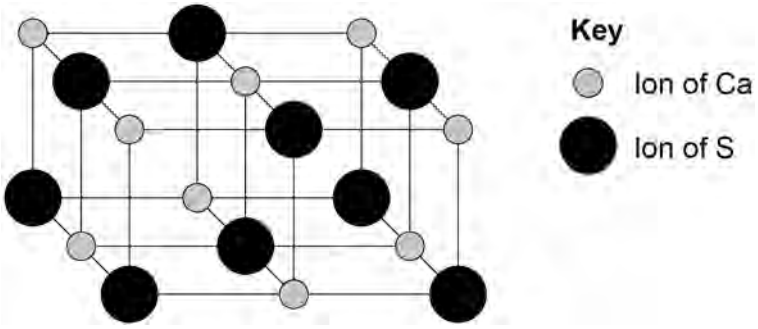
Question 69

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

4.2.2.5 Polymers

Question 69 · 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.

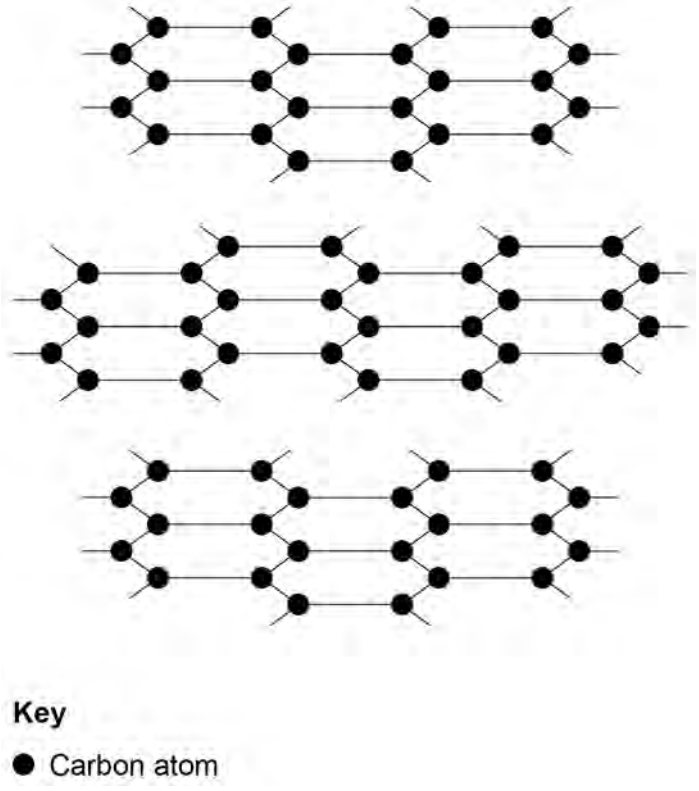
[4 marks]

4.2.2.5 Polymers

Question 69 · continued

Figure 3 shows the structure of graphite.

Figure 3



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

[4 marks]

Extra space

4.2.2.5 Polymers

Question 69 · 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

4.2.2.5 Polymers

Question 70

June 2025 | 8462/2H | Original Q7

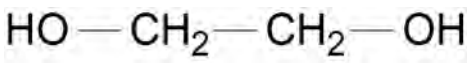
0 7 This question is about polymers.

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

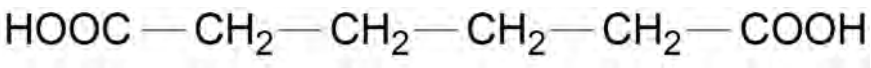
Figure 4 represents a molecule of **A** and a molecule of **B**.

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 70 · continued

Glycine is an amino acid.

Glycine can produce condensation polymers.

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

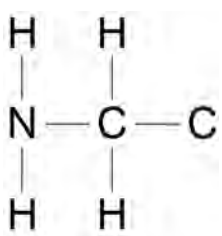
[1 mark]

_____

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 ☐

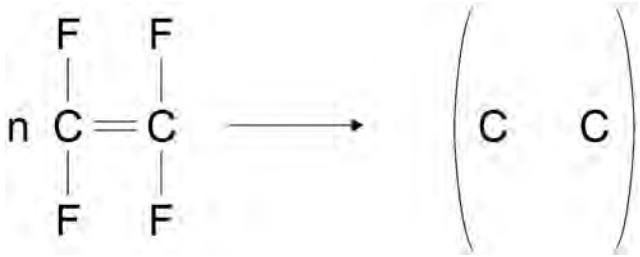
4.2.2.5 Polymers

Question 70 · 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