AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.7.3.1

Addition polymerisation

Past-paper questions

Tier	**Foundation**
Question groups	**14**
Available paper years	**2007–2022**

Using this booklet

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

Name: _____ **Date:** _____

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

4.7.3.1 Addition polymerisation

Question 01

January 2007 | CHY1F | Original Q5 | Legacy

5 Polymers are used to make many materials that people need.

(a) Plastic bags are used to carry, protect and store food. Plastic bags are made from polymers.



Plastic bag made from a polymer

(i) Ethene is the small molecule (the monomer) used to make the polymer for this plastic bag.

Name the polymer that is made from ethene.

.....

(1 mark)

(ii) Use the correct word from the box to complete the sentence about ethene.

condensing	corroding	cracking

Ethene is made by breaking down large hydrocarbon molecules into smaller hydrocarbon molecules by a process called ..... .

(1 mark)

(iii) The hydrocarbon ethene has the formula C_2H_4

Complete the sentence about ethene.

Ethene is a hydrocarbon made up of carbon and ..... atoms.

(1 mark)

Question 5 continues on the next page

4.7.3.1 Addition polymerisation

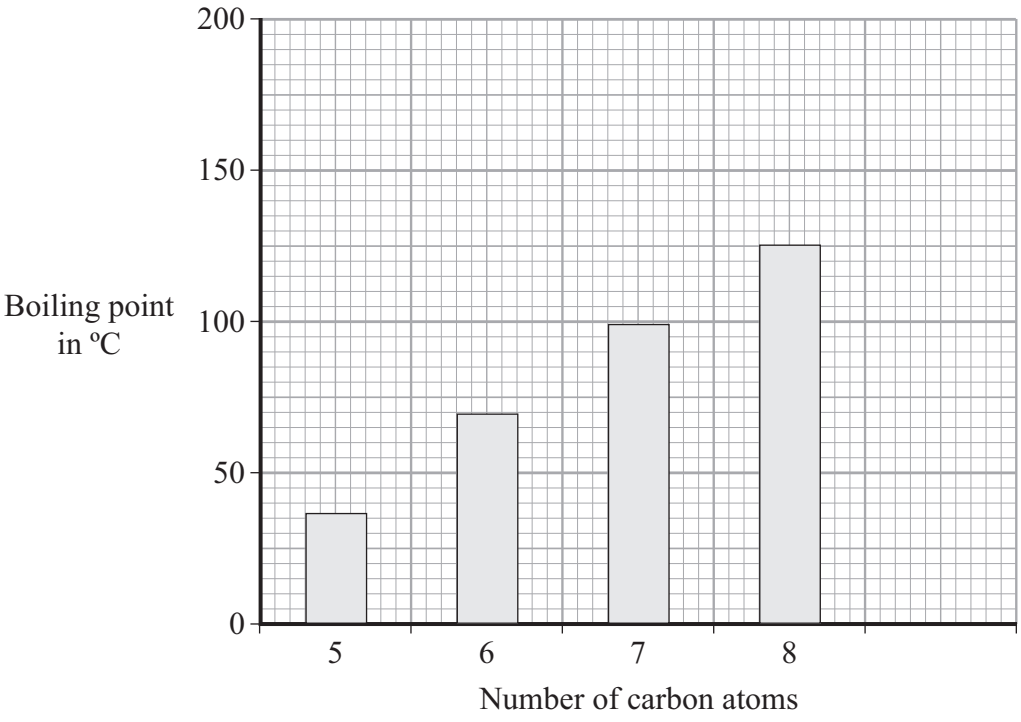
Question 01 · continued

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(b) The hydrocarbons used to make ethene come from crude oil.
The properties of hydrocarbons are linked to the number of carbon atoms in their molecules.

Number of carbon atoms	5	6	7	8	9
Boiling point in °C	36	69	99	125	151

(i) Use the data in the table to complete the bar chart.



(2 marks)

(ii) What happens to the boiling point of a hydrocarbon as the number of carbon atoms increases?

.....

(1 mark)

4.7.3.1 Addition polymerisation

Question 01 · continued

BLANK

(iii) All the hydrocarbons in the table are found in petrol. Petrol is one of the fractions separated from crude oil.

Describe how the fractions are separated from crude oil.

.....

.....

.....

.....

.....

(2 marks)

(c) Most plastic bags that are made of hydrocarbons are not biodegradable.

Used plastic bags can be:

- dumped into large holes, which is called landfill
- burned to give out heat energy, which would produce large amounts of gases.

Would burning used plastic bags be better for the environment than dumping them in landfill?

Explain your answer.

.....

.....

.....

.....

(2 marks)

10

4.7.3.1 Addition polymerisation

Question 02

March 2007 | CHY1B | Original Q1 | Legacy

QUESTION ONE

This question is about hydrocarbons.

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

A alkanes

B fuels

C monomers

D polymers

Hydrocarbons are cracked to produce smaller molecules.

Some of the products of cracking can be used in cars as . . . **1** . . . .

The products of cracking include alkenes and saturated hydrocarbons called . . . **2** . . . .

Alkenes can be used in reactions to make . . . **3** . . . such as poly(ethene) and poly(propene).

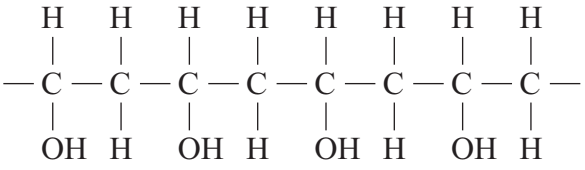
In these reactions, many small molecules known as . . . **4** . . . join together to form very large molecules.

4.7.3.1 Addition polymerisation

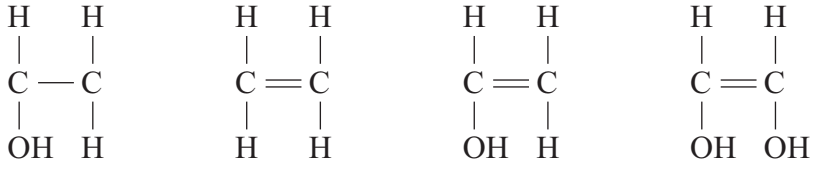
Question 03 June 2007 | CHY1B | Original Q9 | Legacy

QUESTION NINE

Poly(vinyl alcohol) has this structure:



9A The monomer from which poly(vinyl alcohol) is made can be represented by . . .



1 **2** **3** **4**

Poly(vinyl alcohol) reacts with a solution of sodium borate to form 'slime'.
Slime can be fluid or, when almost solid, it can retain its shape.

A student measured the relationship between the spread of a lump of slime and the concentration of the sodium borate solution used to make it.
She called this 'the slump test'.

The student followed this procedure:

- make a sample of slime using 50 cm^3 of 4 % poly(vinyl alcohol) solution and 5 cm^3 of a 1 % solution of sodium borate
- stir the mixture for 2 minutes
- measure out 50 cm^3 of the slime produced and make this into a disc shape
- place this disc on paper and mark its outline with a pencil line
- leave for 5 minutes
- mark the new outline of the slime with a pencil
- calculate the increase in area of the disc
- repeat, using different concentrations of sodium borate to make the slime.

9B The student would have achieved greater accuracy in the test if she had . . .

1 used a smaller piece of slime.

2 stirred the reacting mixture for more than 2 minutes.

3 allowed the slime to spread for less than 5 minutes.

4 controlled the starting area of the slime discs.

Question 03 · continued

9C One variable that she did not control was . . .

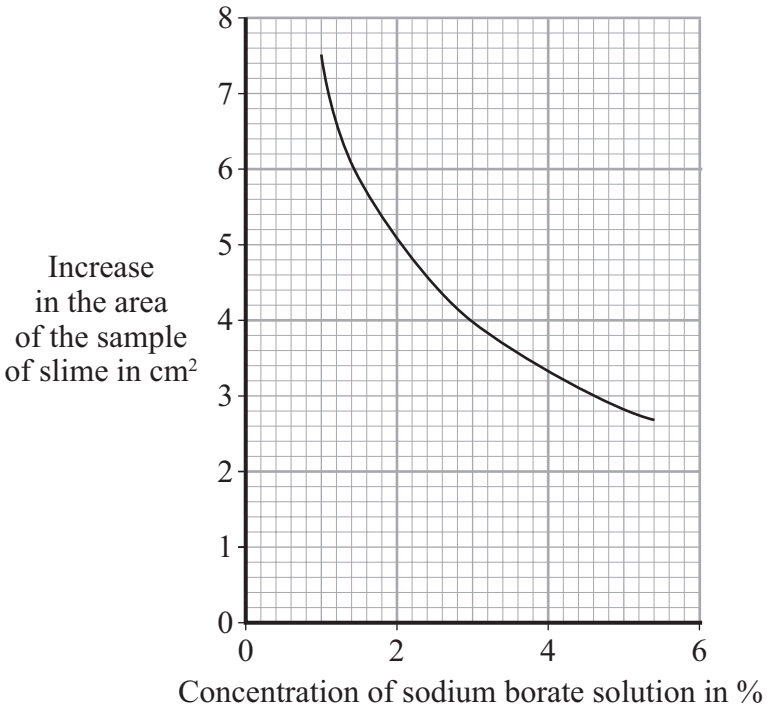
1 the concentration of the poly(vinyl alcohol).

2 the room temperature during the slump test.

3 the volume of the sodium borate solution.

4 the volume of the slime.

9D The student's results are shown on the graph.



The graph shows that . . .

1 the increase in area is directly proportional to the concentration of the sodium borate solution.

2 there is a linear relationship between the increase in area and the concentration of the sodium borate solution.

3 the increase in area is reduced as the sodium borate solution becomes more concentrated.

4 there is no relationship between the size of the disc and the concentration of the sodium borate solution.

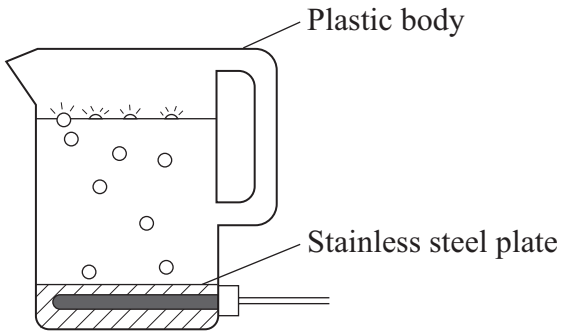
END OF TEST

4.7.3.1 Addition polymerisation

Question 04

January 2008 | CHY1F | Original Q4 | Legacy

4 Plastics are used to make many everyday items, such as the body of the kettle.



(a) Complete the sentences by drawing a ring around the correct words.

(i) The plastic is made from many small molecules called [catalysts / monomers / polymers] .

(1 mark)

(ii) Propene is produced by cracking some of the fractions that are separated from [crude oil / limestone / metal ores] .

(1 mark)

4.7.3.1 Addition polymerisation

Question 04 · continued

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(b) After a few years the kettle no longer worked.

- Some parts of the kettle are made of plastic.
- Some parts of the kettle are made of stainless steel.
- The owner of the kettle disposed of it in a landfill site.

Consider these statements.

Suggest **three** reasons why the kettle should **not** be disposed of in a landfill site.

1 .....

.....

2 .....

.....

3 .....

.....

(3 marks)

5

4.7.3.1 Addition polymerisation

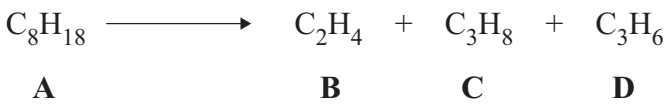
Question 05

June 2008 | CHY1BP | Original Q5 | Legacy

QUESTION FIVE

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

An example is shown below.



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

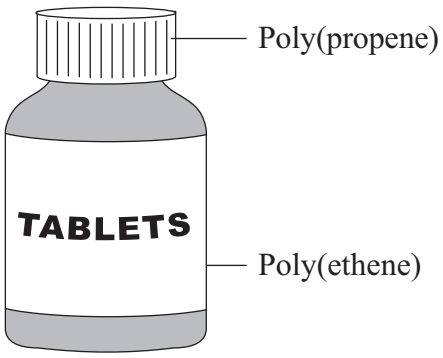
1	It is the molecule which contains 11 atoms.
2	It is ethene.
3	It is the monomer from which poly(propene) can be made.
4	It is the alkane with the largest molecules.

4.7.3.1 Addition polymerisation

Question 06

June 2008 | CHY1F | Original Q5 | Legacy

5 Tablet containers are often made from two different polymers.



5 (a) Ethene, C_2H_4, and propene, C_3H_6, can be made from crude oil.

5 (a) (i) Complete the following sentence.

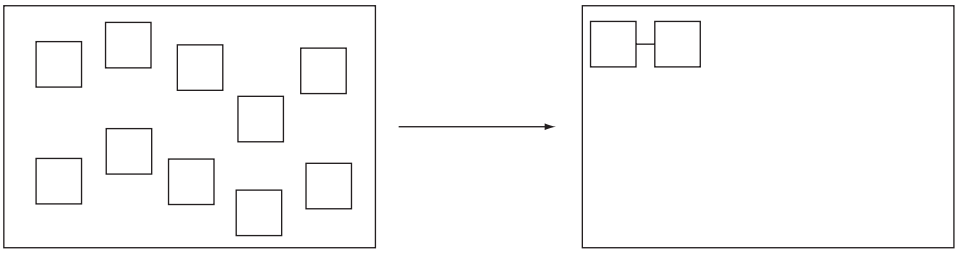
Ethene and propene are called hydrocarbons because they are made up of carbon and ..... atoms only.

(1 mark)

5 (a) (ii) Ethene molecules are used to form poly(ethene) molecules.

Complete the diagram to show the poly(ethene) molecule.

Ethene molecules **Poly(ethene) molecule**



(2 marks)

5 (b) The tablet containers could be disposed of in a landfill site or could be recycled.

5 (b) (i) Suggest **two** reasons why disposing of the tablet containers in a landfill site could cause problems.

1 .....

.....

2 .....

.....

(2 marks)

4.7.3.1 Addition polymerisation

Question 06 · continued

for mark

5 (b) (ii) Suggest **one** reason why recycling the tablet containers would be difficult.

.....

.....

(1 mark)

6

Turn over for the next question

4.7.3.1 Addition polymerisation

Question 07

March 2009 | CHY1BP | Original Q9 | Legacy

QUESTION NINE

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

9A What is the monomer used to make the polymer called poly(chloroethene)?

1 ethene

2 ethane

3 chloroethene

4 chloroethane

9B 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

9C Plastics that can be broken down by microorganisms are described as . . .

1 unsaturated.

2 thermosetting.

3 thermoplastic.

4 biodegradable.

9D 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.

END OF TEST

4.7.3.1 Addition polymerisation

Question 08

June 2011 | CHY1BP | Original Q4 | Legacy

QUESTION FOUR

This question is about hydrocarbons.

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

A alkenes

B polymers

C monomers

D alkanes

Hydrocarbons are cracked to produce both saturated and unsaturated hydrocarbons.

The saturated hydrocarbons that are used as fuels are called . . . **1** . . . .

The unsaturated hydrocarbons are called . . . **2** . . . .

Compounds, such as poly(ethene) and poly(propene), that have very long chain molecules are called . . . **3** . . . .

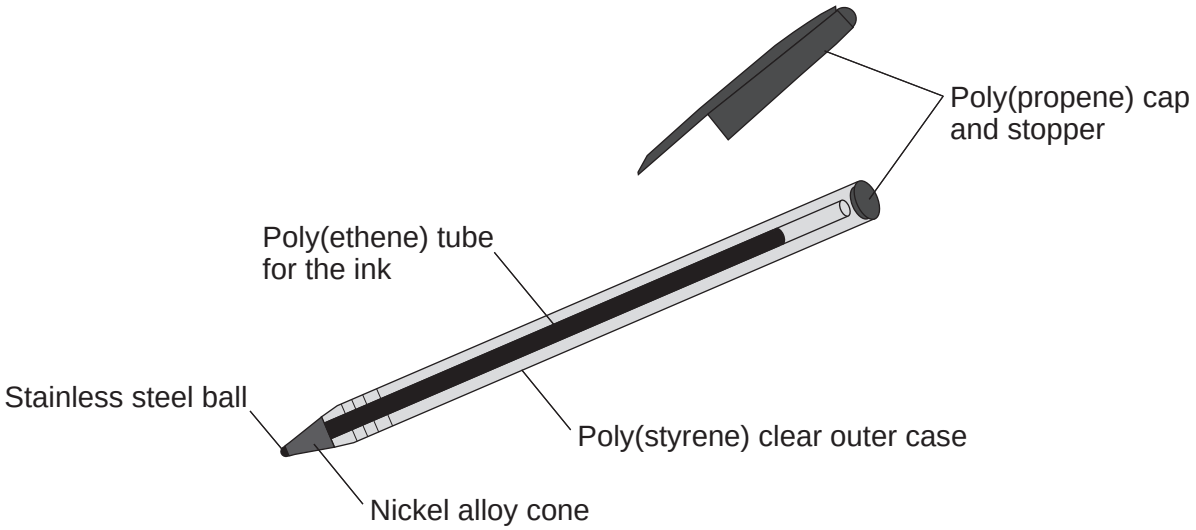
Long chain molecules are made when many small molecules join together. These small molecules are called . . . **4** . . . .

4.7.3.1 Addition polymerisation

Question 09

June 2013 | CH1FP | Original Q5 | Legacy

5 The diagram shows a ballpoint pen.



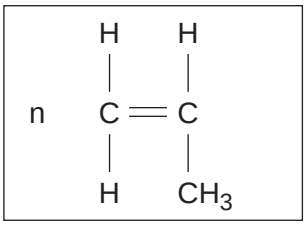
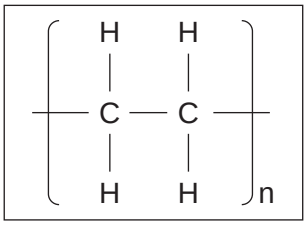
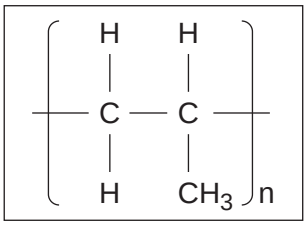
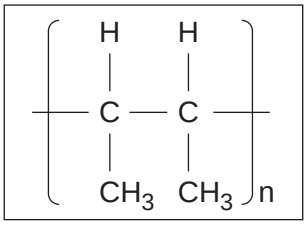
5 (a) Polymers are used to make the ballpoint pen.

5 (a) (i) Name the monomer used to make poly(ethene).

.....

(1 mark)

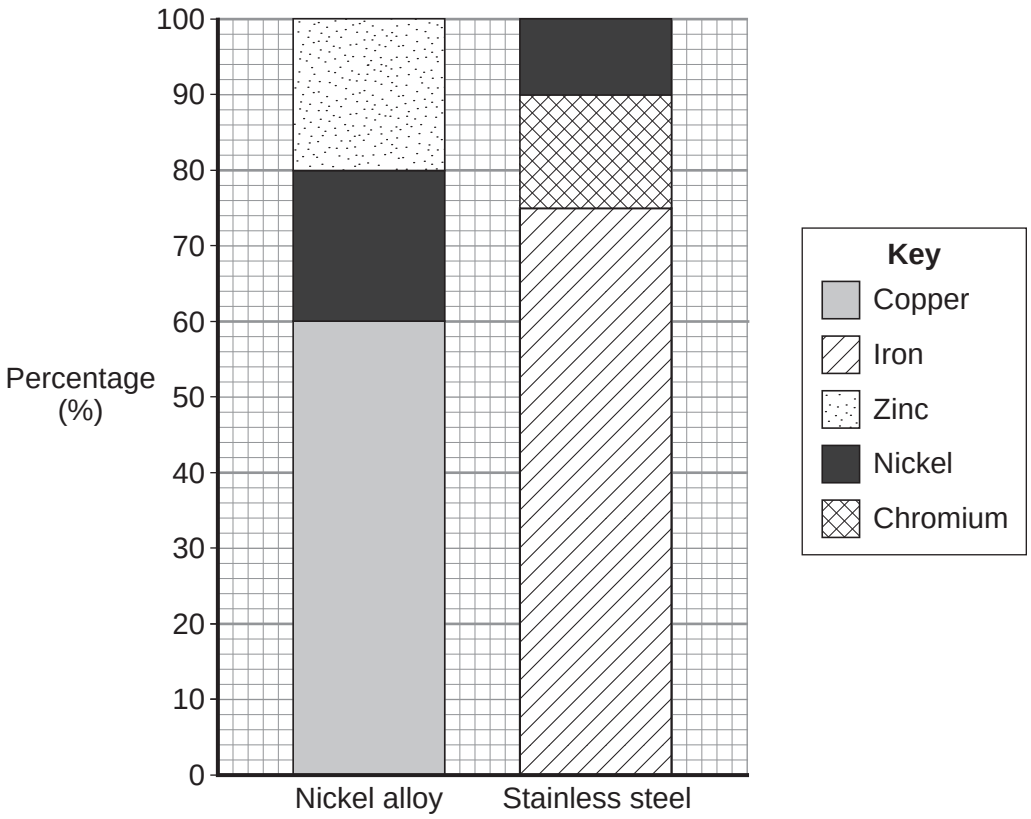
5 (a) (ii) Draw **one** line from the monomer propene to its polymer poly(propene).

Monomer	Polymer
	
	
	

(1 mark)

4.7.3.1 Addition polymerisation

5 (b) Two alloys are used to make the ballpoint pen.



Use the bar chart to answer these questions.

5 (b) (i) Which metal is in both of these alloys? .....

(1 mark)

5 (b) (ii) What is the percentage of iron in the stainless steel? ..... %

(1 mark)

4.7.3.1 Addition polymerisation

Question 09 · continued

5 (b) (iii) The alloy stainless steel is used instead of pure iron for the ball of the pen.
Give **two** reasons why.

.....

.....

.....

.....

(2 marks)

5 (c) Tick (✓) **one** advantage and tick (✓) **one** disadvantage of **recycling** this type of ballpoint pen.

	Advantage Tick (✓)	Disadvantage Tick (✓)
Can be refilled and reused		
Conserves resources of crude oil and ores		
High cost of separating materials		
Polymers and alloys are not expensive		

(2 marks)

8

4.7.3.1 Addition polymerisation

Question 10

June 2019 | 8462/2F | Original Q5

0 5 **Figure 3** shows a surfer on a surfboard.

Figure 3



Some surfboards are made from addition polymers.

Addition polymers are made from small alkene molecules.

0 5 . 1 Which type of bonding is present in small alkene molecules?

[1 mark]

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

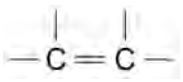
4.7.3.1 Addition polymerisation

Question 10 · continued

0 5 . 2 What is the functional group in these small alkene molecules?

[1 mark]

Tick (✓) **one** box.



☐

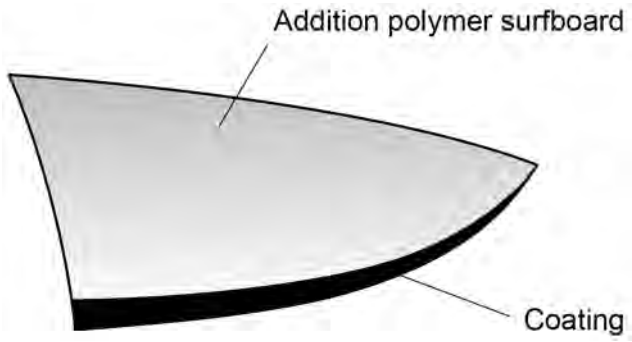
—COOH ☐

—OH ☐

Figure 4 shows the structure of part of an addition polymer surfboard.

The outer surface of the surfboard is coated.

Figure 4



The coating is made from soda-lime glass fibres surrounded by a plastic.

0 5 . 3 What type of material is the coating of the surfboard?

[1 mark]

Tick (✓) **one** box.

Alloy ☐

Ceramic ☐

Composite ☐

Nanotube ☐

4.7.3.1 Addition polymerisation

Question 10 · continued

0 5 . 4 Complete the sentence.

Choose answers from the box.

[2 marks]

air	**ammonia**	**copper**
limestone	**sand**	

The materials used to make the soda-lime glass fibres are sodium carbonate,

_____ and _____.

0 5 . 5 Suggest **two** reasons why surfboards are coated.

[2 marks]

1 _____

_____

2 _____

_____

Some surfboards are made from wood.

Table 3 contains information about the materials in an addition polymer surfboard and a wooden surfboard.

Table 3

	Addition polymer surfboard	Wooden surfboard
Relative strength	14	38
Cost (£ per m^3)	140	390
Density (kg/m^3)	50	150
Disposal at end of life	Difficult to recycle	Can be used as fuel

4.7.3.1 Addition polymerisation

Question 10 · continued

0 5 . 6 Suggest **two** advantages and **two** disadvantages of using addition polymers rather than wood to make surfboards.

Use **Table 3**.

[4 marks]

Advantages of addition polymers _____

_____

_____

_____

Disadvantages of addition polymers _____

_____

_____

_____

0 5 . 7 Calculate the volume of wood in a wooden surfboard of mass 5.25 kg

Use **Table 3** and the equation:

$$\text{Density in kg/m}^3 = \frac{\text{Mass in kg}}{\text{Volume in m}^3}$$

[3 marks]

_____

_____

_____

_____

Volume = _____ m^3

14

4.7.3.1 Addition polymerisation

Question 11

November 2020 | 8462/2F | Original Q6

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

Plates are made from ceramics, paper or poly(propene).

0 6 . 1 Paper plates are biodegradable and recyclable.

Which stage of a life cycle assessment (LCA) would contain this information?

[1 mark]

Tick (✓) **one** box.

- Disposal at the end of useful life ☐
- Extracting and processing raw materials ☐
- Manufacturing and packaging ☐
- Use and operation during lifetime ☐

0 6 . 2 Which **two** processes are used to make ceramic plates?

[2 marks]

Tick (✓) **two** boxes.

- Forming a composite ☐
- Galvanising with zinc ☐
- Heating in a furnace ☐
- Melting sand and boron trioxide ☐
- Shaping wet clay ☐

4.7.3.1 Addition polymerisation

Question 11 · continued

Poly(propene) is produced from an alkene.

0 6 . 3 Complete the sentences.

[2 marks]

The name for very large molecules such as poly(propene) is _____.

The name of the alkene used to produce poly(propene) is _____.

0 6 . 4 The alkene needed to make poly(propene) is produced from crude oil.

Which **two** processes are used to produce this alkene from crude oil?

[2 marks]

Tick (✓) **two** boxes.

- Chromatography ☐
- Cracking ☐
- Fermentation ☐
- Fractional distillation ☐
- Quarrying ☐

0 6 . 5 What type of bond joins the atoms in a molecule of poly(propene)?

[1 mark]

Tick (✓) **one** box.

- Covalent ☐
- Ionic ☐
- Metallic ☐

4.7.3.1 Addition polymerisation

Question 11 · continued

Table 4 shows information about two polymers used to make plates.

Table 4

Polymer	Effect of heating the polymer
A	does not melt
B	melts at 50 °C

0 6 . 6 What type of polymer is polymer **A**?

Use **Table 4**.

[1 mark]

0 6 . 7 Why does polymer **A** behave differently to polymer **B** when heated?

You should refer to crosslinks in your answer.

[1 mark]

10

4.7.3.1 Addition polymerisation

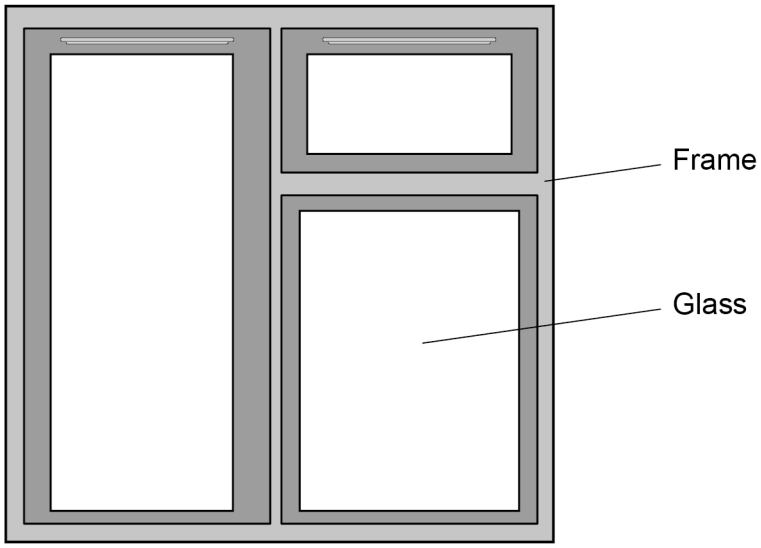
Question 12

November 2021 | 8462/2F | Original Q3

0 3 This question is about substances used to make windows and window frames.

Figure 2 shows a window.

Figure 2



0 3 . 1 Glass is made by heating sand with **two** other materials.

Which **two** other materials are used to make glass?

[2 marks]

Tick (✓) **two** boxes.

- Clay ☐
- Graphite ☐
- Limestone ☐
- Sodium carbonate ☐
- Sodium hydroxide ☐

4.7.3.1 Addition polymerisation

Question 12 · continued

Window frames need to be:

- easy to install
- resistant to damage.

The polymers poly(chloroethene) and HDPE are used to make window frames.

Table 3 shows information about poly(chloroethene) and HDPE.

Table 3

Property	Poly(chloroethene)	HDPE
Density in g/cm^3	1.4	0.92
Relative strength	72	25

0 3 . 2 Suggest **one** advantage of using poly(chloroethene) compared with HDPE to make window frames.

Give **one** reason for your answer.

Use **Table 3**.

[2 marks]

Advantage _____

_____

Reason _____

_____

0 3 . 3 Suggest **one** advantage of using HDPE compared with poly(chloroethene) to make window frames.

Give **one** reason for your answer.

Use **Table 3**.

[2 marks]

Advantage _____

_____

Reason _____

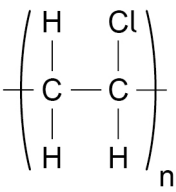
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4.7.3.1 Addition polymerisation

Question 12 · continued

0 3 . 4 **Figure 3** shows the displayed structural formula of poly(chloroethene).

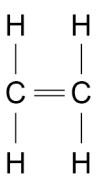
Figure 3

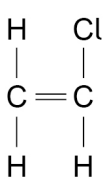


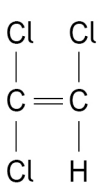
Which monomer is used to make poly(chloroethene)?

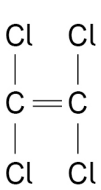
[1 mark]

Tick (✓) **one** box.

 ☐

 ☐

 ☐

 ☐

4.7.3.1 Addition polymerisation

Question 12 · continued

0 3 . 5 Chlorine gas is used to produce poly(chloroethene).

Describe a test to identify chlorine gas.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

0 3 . 6 Wood can be used instead of polymers to make window frames.

- Polymers are unreactive.
- Polymers are produced from crude oil.
- Wood breaks down in wet conditions.
- Wood is produced from trees.

Suggest **one** advantage of using polymers and **one** advantage of using wood to make window frames.

[2 marks]

Advantage of polymers _____

_____

Advantage of wood _____

_____

Question 3 continues on the next page

4.7.3.1 Addition polymerisation

Question 12 · continued

Window frames can also be made from an alloy of aluminium.

0 3 . 7 6.00 kg of the alloy is used to make a window frame.

Table 4 shows the mass of each element in 6.00 kg of the alloy.

Table 4

Element	Mass in kg
Aluminium	5.94
Magnesium	0.04
Silicon	0.02

Calculate the percentage of aluminium in 6.00 kg of the alloy.

[2 marks]

Percentage of aluminium = _____ %

0 3 . 8 Why is an alloy used instead of pure aluminium to make window frames?

[1 mark]

14

4.7.3.1 Addition polymerisation

Question 13

November 2021 | 8462/2F | Original Q7

0 7 This question is about organic compounds.

0 7 . 1 Butane is an alkane with small molecules.

Complete the sentence.

Choose the answer from the box.

[1 mark]

fertiliser	**formulation**	**fuel**

Butane can be used as a _____.

0 7 . 2 Poly(propene) is a polymer.

What is the name of the monomer used to produce poly(propene)?

[1 mark]

Tick (✓) **one** box.

- Propane ☐
- Propanoic acid ☐
- Propanol ☐
- Propene ☐

4.7.3.1 Addition polymerisation

Question 13 · continued

Ethene and steam react to produce ethanol.

The equation for the reversible reaction is:

ethene + steam ⇌ ethanol

0 7 . 3 The reaction produces a maximum theoretical mass of 400 kg of ethanol from 243 kg of ethene and 157 kg of steam.

A company produces 380 kg of ethanol from 243 kg of ethene and 157 kg of steam.

The percentage yield of ethanol is less than 100%

Calculate the percentage yield of ethanol.

Use the equation:

$$\text{percentage yield of ethanol} = \frac{\text{mass of ethanol actually made}}{\text{maximum theoretical mass of ethanol}} \times 100$$

[2 marks]

Percentage yield = _____ %

0 7 . 4 What are **two** possible reasons why the percentage yield of ethanol is less than 100%?

[2 marks]

Tick (✓) **two** boxes.

- Ethanol is the only product of the reaction. ☐
- Ethanol is very unreactive. ☐
- Some ethanol changes back into ethene and steam. ☐
- Some ethanol escapes from the apparatus. ☐
- Some ethanol reacts with steam. ☐

4.7.3.1 Addition polymerisation

Question 13 · continued

0 7 . 5 Ethanol burns in oxygen.

Balance the equation for the reaction.

[1 mark]

$$C_2H_5OH + ___ O_2 \rightarrow 3H_2O + 2CO_2$$

0 7 . 6 Two processes for producing ethanol are:

- fermentation
- hydration (reacting ethene with steam).

Table 5 shows information about the processes.

Table 5

Feature	Process	
	Fermentation	Hydration
Raw material	sugar	crude oil
Energy usage	low	high
Rate of reaction	slow	fast
Purity of ethanol	15%	98%

Give **two** advantages and **two** disadvantages of using fermentation to produce ethanol.

[4 marks]

Advantage of fermentation 1 _____

_____

Advantage of fermentation 2 _____

_____

Disadvantage of fermentation 1 _____

_____

Disadvantage of fermentation 2 _____

_____

11

4.7.3.1 Addition polymerisation

Question 14

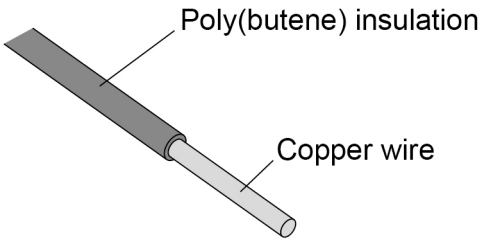
June 2022 | 8462/2F | Original Q8

0 8 This question is about copper wire and copper compounds.

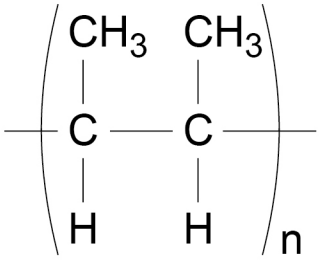
Copper is used to make electrical wires.

Figure 9 shows how copper electrical wire is insulated using an addition polymer called poly(butene).

Figure 9



0 8 . 1 The addition polymer poly(butene) has the displayed structural formula:

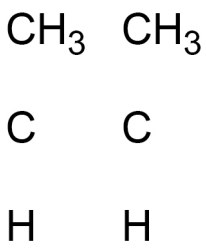


Poly(butene) is produced from the monomer butene.

Complete **Figure 10** to show the displayed structural formula of butene.

[2 marks]

Figure 10



4.7.3.1 Addition polymerisation

Question 14 · continued

Copper can be obtained by recycling scrap copper wire.

0 8 . 2 Suggest why poly(butene) insulation must be removed from scrap copper wire before the copper is recycled.

[1 mark]

0 8 . 3 Describe how scrap copper wire can be recycled to make new copper water pipes.

[2 marks]

0 8 . 4 Suggest **two** reasons why recycling scrap copper is more sustainable than extracting copper from copper ores.

[2 marks]

1

2

Question 8 continues on the next page

4.7.3.1 Addition polymerisation

Question 14 · continued

Copper sulfate is a compound of copper.

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

0 8 . 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 8 . 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