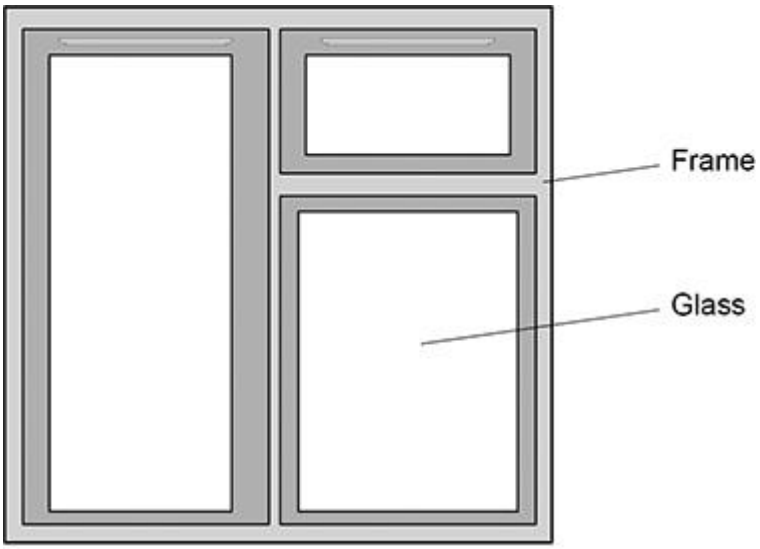
All questions are for separate science students only

Q1.

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

Figure 1 shows a window.

Figure 1



(a) Glass is made by heating sand with **two** other materials.

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

Tick (✓) **two** boxes.

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

(2)

Window frames need to be:
- easy to install
- resistant to damage.

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

Table 1 shows information about poly(chloroethene) and HDPE.

Table 1

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

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

Give **one** reason for your answer.

Use **Table 1**.

Advantage _____

_____

Reason _____

_____

(2)

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

Give **one** reason for your answer.

Use **Table 1**.

Advantage _____

_____

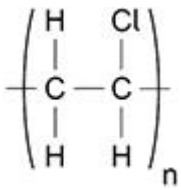
Reason _____

_____

(2)

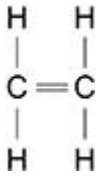
(d) **Figure 2** shows the displayed structural formula of poly(chloroethene).

Figure 2



Which monomer is used to make poly(chloroethene)?

Tick (✓) **one** box.



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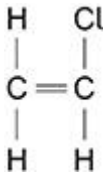

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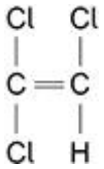

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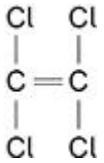


☐

(1)

(e) Chlorine gas is used to produce poly(chloroethene).

Describe a test to identify chlorine gas.

Give the result of the test.

Test _____

_____

Result _____

_____

(2)

(f) 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.

Advantage of polymers _____

_____

Advantage of wood _____

_____

(2)

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

(g) 6.00 kg of the alloy is used to make a window frame.

Table 2 shows the mass of each element in 6.00 kg of the alloy.

Table 2

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.

_____

_____

Percentage of aluminium = _____%

(2)

(h) Why is an alloy used instead of pure aluminium to make window frames?

_____

_____

(1)

(Total 14 marks)

Q2.

This question is about organic compounds.

(a) Butane is an alkane with small molecules.

Complete the sentence.

Choose the answer from the box.

fertiliser	formulation	fuel

Butane can be used as a _____.

(1)

(b) Poly(propene) is a polymer.

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

Tick (✓) **one** box.

Propane ☐

Propanoic acid ☐

Propanol ☐

Propene ☐

(1)

Ethene and steam react to produce ethanol.

The equation for the reversible reaction is:

ethene + steam ⇌ ethanol

(c) 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:

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

_____

_____

Percentage yield = _____ %

(2)

(d) What are **two** possible reasons why the percentage yield of ethanol is less than 100%?

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.	☐

(2)

(e) Ethanol burns in oxygen.

Balance the equation for the reaction.

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

(1)

(f) Two processes for producing ethanol are:

- fermentation
- hydration (reacting ethene with steam).

The table below shows information about the processes.

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.

Advantage of fermentation 1 _____

_____

Advantage of fermentation 2 _____

_____

Disadvantage of fermentation 1 _____

_____

Disadvantage of fermentation 2 _____

_____

(4)

(Total 11 marks)

Q3.

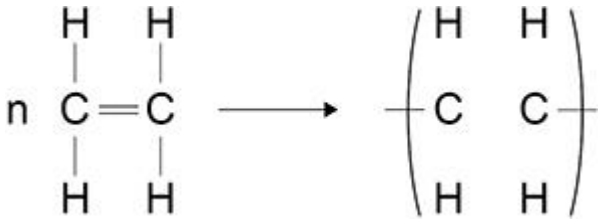
This question is about poly(ethene) and polyesters.

(a) Poly(ethene) is produced from ethene.

Figure 1 shows part of the displayed structural formula equation for the reaction.

Complete **Figure 1**.

Figure 1



(2)

(b) Poly(ethene) is a thermosoftening polymer.

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

_____

_____

_____

_____

(2)

(c) Ethene produces different forms of poly(ethene).

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

_____

_____

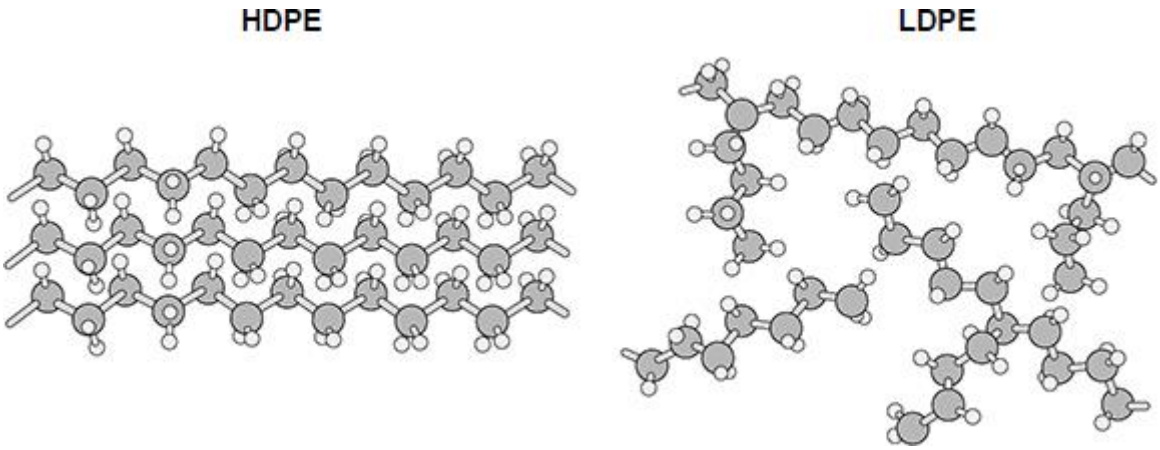
(1)

(d) Two different forms of poly(ethene) are:

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

Figure 2 represents part of the structures of HDPE and LDPE.

Figure 2



Explain why HDPE has a higher density than LDPE.

_____

_____

_____

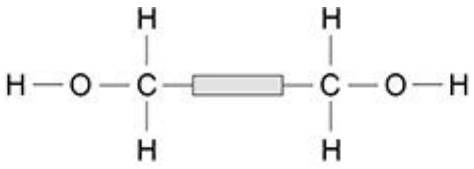
_____

(2)

Figure 3 shows three monomers, **A**, **B** and **C**.

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

Figure 3



Monomer **A**

Monomer **B**

Monomer **C**

(e) Draw a circle on **Figure 3** around an alcohol functional group.

(1)

(f) Complete the table below to show the formula of the small molecule

produced when:

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

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

(1)

(Total 9 marks)

Q4.

This question is about materials used to make plates.

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

(a) Paper plates are biodegradable and recyclable.

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

Tick (✓) **one** box.

Disposal at the end of useful life ☐

Extracting and processing raw materials ☐

Manufacturing and packaging ☐

Use and operation during lifetime ☐

(1)

(b) Which **two** processes are used to make ceramic plates?

Tick (✓) **two** boxes.

Forming a composite ☐

Galvanising with zinc ☐

Heating in a furnace ☐

Melting sand and boron trioxide ☐

Shaping wet clay ☐

(2)

Poly(propene) is produced from an alkene.

(c) Complete the sentences.

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

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

(2)

(d) The alkene needed to make poly(propene) is produced from crude oil.

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

Tick (✓) **two** boxes.

Chromatography ☐

Cracking ☐

Fermentation ☐

Fractional distillation ☐

Quarrying ☐

(2)

(e) What type of bond joins the atoms in a molecule of poly(propene)?

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

(1)

The table below shows information about two polymers used to make plates.

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

(f) What type of polymer is polymer **A**?

Use the table above.

_____

_____

(1)

(g) Why does polymer **A** behave differently to polymer **B** when heated?

You should refer to crosslinks in your answer.

_____

_____

(1)

(Total 10 marks)

Q5.

This question is about carboxylic acids.

Carboxylic acids belong to a homologous series.

The table below shows information about the first three carboxylic acids in this homologous series.

Name	Formula	pH of a 0.01 mol/dm^3 solution
Methanoic acid		2.91
Ethanoic acid	CH_3COOH	3.39
	CH_3CH_2COOH	3.44

(a) Complete the table above.

(2)

(b) Ethanoic acid ionises in water.

The equation for the reaction is:

$$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$$

Explain how the equation shows that ethanoic acid is a weak acid.

_____

_____

_____

_____

(2)

(c) A student adds a solution of ethanoic acid to zinc carbonate in an open flask on a balance.

Explain what happens to the mass of the flask and its contents during the reaction.

_____

_____

_____

_____

_____

_____

(3)

(d) The student compares the rates of the reaction of zinc carbonate with:

- 0.01 mol/dm^3 methanoic acid
- 0.01 mol/dm^3 ethanoic acid.

The rate of the reaction with methanoic acid is greater than the rate of the reaction with ethanoic acid.

Explain why.

You should refer to ions in your answer.

Use the table above.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

Ethanoic acid reacts with ethanol to produce an ester.

(e) Give the name of the ester produced when ethanoic acid reacts with ethanol.

_____

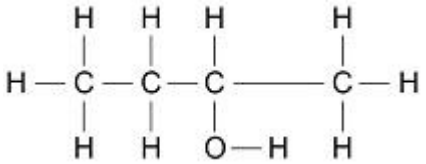
(1)

(f) Hexanedioic acid and ethanediol join together to produce a polyester.

Ethanoic acid and ethanol join together in the same way to produce an ester.

Which is the displayed structural formula of the ester produced when ethanoic acid reacts with ethanol?

Tick (✓) **one** box.



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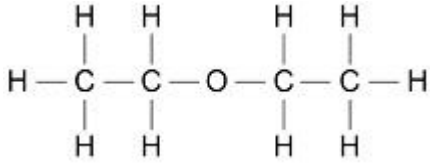

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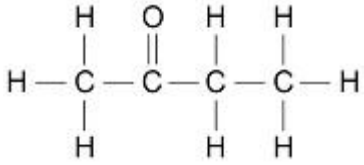

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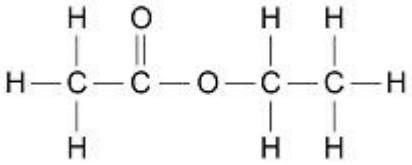


☐

(1)

(Total 12 marks)

Q6.

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.

(a) Describe a test that would identify the gas collected.

Give the result of the test.

Test _____

Result _____

_____

(2)

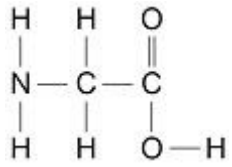
(b) Glucose is produced when algae photosynthesise.

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

_____ and _____

(2)

The diagram below shows the displayed structural formula of an amino acid called glycine.



(c) How many functional groups are there in the molecule in the diagram above ?

Tick (✓) **one** box.

1 ☐ 2 ☐ 3 ☐ 4 ☐

(1)

(d) Glycine reacts by condensation polymerisation to produce a polypeptide and one other substance.

Name the other substance produced.

_____

(1)

(e) Scientists think that algae may have used gases in Earth's early atmosphere.

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

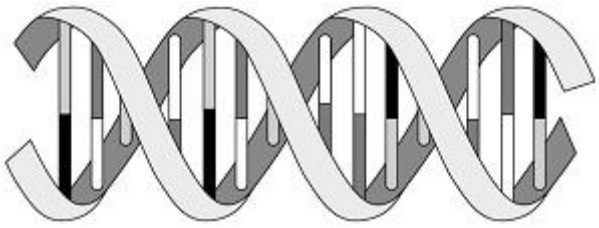
Which **two** gases from Earth's early atmosphere could have provided this element?

_____ and _____

(2)

(f) The development and function of algae are controlled by a naturally occurring polymer.

The image below represents the shape and structure of this polymer.



Describe the shape and structure of this polymer.

_____

_____

_____

_____

_____

_____

(3)

(Total 11 marks)

Q7.

Figure 1 shows a surfer on a surfboard.

Figure 1

Surfboards are made from polymers.

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

(a) **Figure 2** shows the displayed structural formula of poly(styrene).

Figure 2

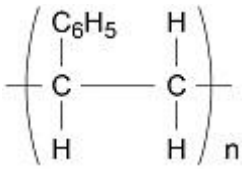
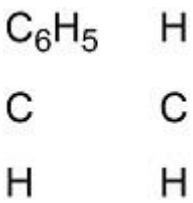


Figure 3 shows an incomplete displayed structural formula of the monomer styrene.

Complete **Figure 3**.

Figure 3



(2)

The outer skin of surfboards contains a polyester.

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

Figure 4 shows how these two monomers are represented.

Figure 4

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

(b) Name the functional group in monomer **B**.

_____

(1)

(c) Monomers **A** and **B** join together to produce a polyester and a small molecule.

Name the small molecule.

_____

(1)

(d) Why does this type of polyester melt when it is heated?

_____

_____

_____

_____

(2)

The outer skin of surfboards is a composite material.

The composite material contains glass fibres surrounded by a polyester.

(e) Draw **one** line from each material to the description of that material.

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

(2)

(f) The outer skin makes the surfboard more expensive.

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

1 _____

_____

2 _____

_____

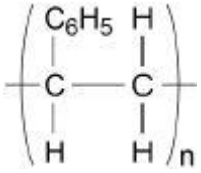
(2)

(Total 10 marks)

Q8.

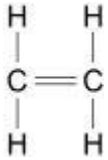
Disposable cups are made from coated paper or poly(styrene).

The diagram below represents the structure of poly(styrene).



(a) Which small molecule is used to produce poly(styrene)?

Tick **one** box.



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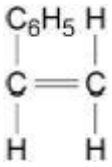

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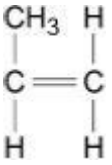

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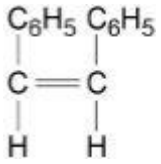


☐

(1)

(b) Which process is used to make poly(styrene) from small molecules?

Tick **one** box.

Cracking ☐

Distillation ☐

Fermentation ☐

Polymerisation ☐

(1)

(c) Complete the sentences.

Choose answers from the box.

ceramics	**composites**	**four**	**many**
monomers	**polymers**	**two**	

Poly(styrene) is produced from small molecules called

_____

When poly(styrene) is made, _____styrene molecules join to form

large molecules.

These large molecules are called _____ .

(3)

(d) The table below gives some information about disposable cups.

	Coated paper cups	**Polystyrene cups**
Source of raw materials	Wood	Crude oil
Energy to make 1 cup in arbitrary units	550	200
Biodegradable	Yes	No
Recyclable	No	Yes

Compare the advantages and disadvantages of using coated paper and poly(styrene) to make disposable cups.

Use the table above and your knowledge and understanding of life cycle assessments (LCAs).

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 9 marks)

Q9.

This question is about polymers.

(a) Polyesters are produced when monomers join together and lose a small molecule.

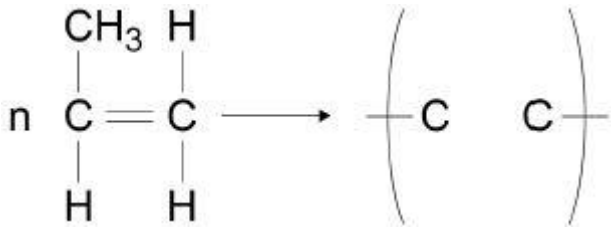
Name the small molecule lost.

_____

(1)

(b) Poly(propene) is produced from propene.

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



(3)

(c) 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)

Polymer fibres are used to make firefighter uniforms.

The table below shows some properties of two polymer fibres.

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

(d) Evaluate the suitability of poly(propene) and polyester for firefighter uniforms.

(4)

(Total 10 marks)

Q10.

This question is about polymers.

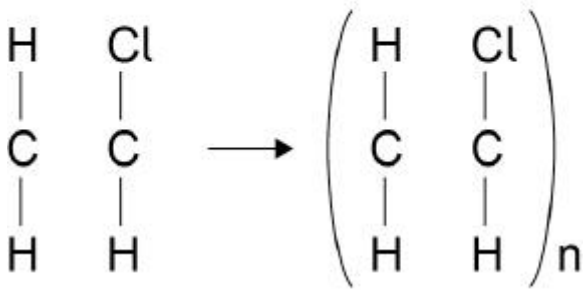
(a) Name the monomer used to form poly(chloroethene).

(1)

(b) **Figure 1** shows the equation for the formation of poly(chloroethene).

Complete **Figure 1**.

Figure 1



(3)

(c) Poly(chloroethene) is the only product.

What type of polymer is poly(chloroethene)?

_____

(1)

Ethanediol reacts with butanedioic acid to produce a polyester and a small molecule.

(d) **Figure 2** shows the structural formula of ethanediol.

Figure 2

$HO–CH_2–CH_2–OH$

Name the functional group present in ethanediol.

_____

(1)

(e) **Figure 3** shows the structural formula of butanedioic acid.

Figure 3

$HOOC–CH_2–CH_2–COOH$

Which formula represents the carboxylic acid functional group?

Tick (✓) **one** box.

$–CH_2–$ ☐

$–CH_2–CH_2–$ ☐

$–CH_2–COOH$ ☐

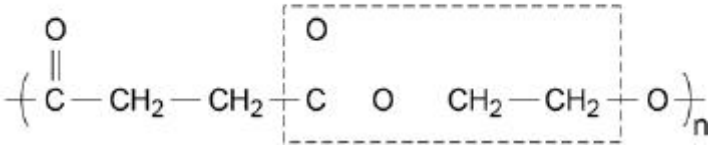
–COOH 

(1)

(f) **Figure 4** shows part of the structure of the polyester.

Complete the box in **Figure 4**.

Figure 4



(2)

(g) Name the small molecule produced when ethanediol reacts with butanedioic acid.

_____

(1)

Starch, proteins and DNA are naturally occurring polymers.

(h) Name the monomers from which starch and proteins are produced.

Starch _____

Proteins _____

(2)

(i) Describe the structure of DNA.

_____

_____

_____

_____

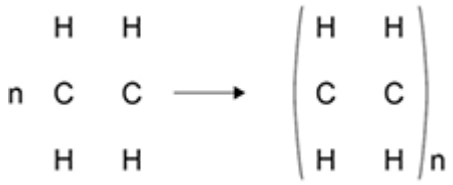
(2)

(Total 14 marks)

Q11.

Ethene is used to produce poly(ethene).

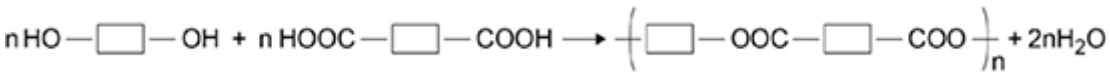
(a) Draw the bonds to complete the displayed formulae of ethene and poly(ethene) in the equation.



(2)

(b) Polyesters are made by a different method of polymerisation.

The equation for the reaction to produce a polyester can be represented as:



Compare the polymerisation reaction used to produce poly(ethene) with the polymerisation reaction used to produce a polyester.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 6 marks)