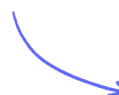


Synthetic & Natural Polymers

Addition Polymerisation / Condensation Polymerisation / Amino Acids / DNA & Natural Polymers

Easy (5 questions)	/37
Medium (8 questions)	/31
Hard (5 questions)	/40
Total Marks	/108

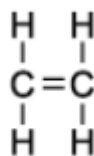
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Easy Questions

1 (a) This question is about ethene, the structure of which is shown in **Figure 1**.

Figure 1



Why is this molecule described as **unsaturated**?

..... (1 mark)

(b) Ethene can undergo a polymerisation reaction.

Complete the sentences using the words in the box.

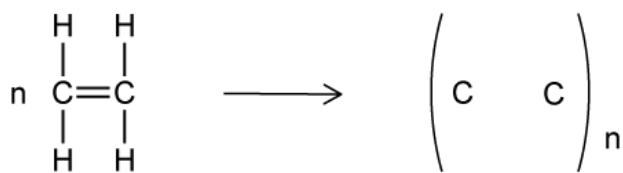
high	poly(ethene)	polymers	poly(ethane)
ten	monomers	a few	many

During polymerisation, _____ ethene molecules join together to form the large molecule, _____.

These large molecules are called _____

(3 marks)

(c) Complete the repeating unit of the polymer formed by ethene.



(2 marks)

(d) What type of polymer does ethene form?

Tick (✓) **one** box.

Condensation	☐	Addition	☐	Substitution	☐
--------------	--------------------------	----------	--------------------------	--------------	--------------------------

..... (1 mark)

2 (a) This question is about naturally occurring polymers.

Sugars such as glucose can form naturally occurring polymers.

Name the **three** elements found in glucose.

.....

.....

..... **(3 marks)**

(b) Draw **one** line from each naturally occurring polymer to the monomer it is formed from.

You can use the monomer more than once.

Starch	Glucose
	Nucleotides
Protein	Ethene
	Amino acids
Cellulose	Maltose

(3 marks)

(c) Which statements are correct about the structure of DNA?

Tick (✓) **two** boxes.

It consists of three polymer chains	
It has bases, A, C, G, and T	
It has a double helix structure	
It's formed from the monomer glucose	

.....
..... (2 marks)

(d) What type of polymerisation are proteins formed by?

..... (1 mark)

3 (a) This question is about addition and condensation polymerisation.

Place the statements about each type of polymerisation into the correct column in **Table 1**.

- Formed from a monomer with C=C double bond
- Can be formed from two monomer types with the same functional group
- A small molecule, usually water is released
- Only one product is formed
- Can be formed from one monomer type with two different functional groups

Table 1

Addition polymerisation	Condensation polymerisation

(5 marks)

(b) Which polymers are made by condensation polymerisation?

Tick (✓) **two** box.

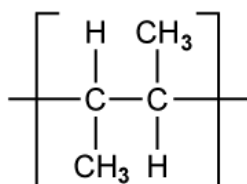
Polypeptides	
Poly(propene)	
Polyester	
Polystyrene	

(2 marks)

- (c) Poly(butene) can be formed from its monomer via addition polymerisation.

It's structure is shown in **Figure 1**.

Figure 1



Name the monomer that forms poly(butene)

(1 mark)

- (d) Which type of bonding is present in poly(butene).

Circle **one** answer.

Ionic	Covalent	Metallic
-------	----------	----------

(1 mark)

4 (a) Alkenes form polymers via addition polymerisation reactions.

What is the functional group of an alkene?

Tick (✓) **one** box.

-OH		C=C		-COOH	
-----	--	-----	--	-------	--

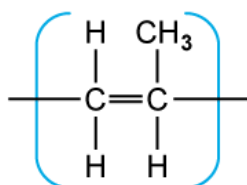
..... (1 mark)

(b) Give **two** conditions needed for addition polymerisation to take place.

..... (2 marks)

(c) Propene can form the polymer, poly(propene).

A student drew this repeating unit for the polymer.



Identify **two** errors that the student has made.

..... (2 marks)

(d) Polystyrene is a common polymer often used in packaging.

What name can be given to this type of polymer?

Circle **one** answer.

Natural	Synthetic	Condensation
---------	-----------	--------------

..... (1 mark)

5 (a) This question is about condensation polymerisation.

Condensation polymerisation produces a polymer and another small molecule.

Which small molecule is usually formed?

Tick (✓) **one** box.

carbon dioxide		water		oxygen		nitrogen
----------------	--	-------	--	--------	--	----------

(1 mark)

(b) Amino acids are formed by condensation polymerisation reactions.

Tick (✓) **two** correct statements about amino acids.

Amino acids form polypeptide chains	
An amino acid has two different functional groups	
Amino acids are saturated	
Amino acids contain an NH_3 functional group	

(2 marks)

(c) A polyester can be formed from the two monomers shown in **Figure 1**.

Figure 1

$\text{HO}-\text{CH}_2-\text{CH}_2-\text{OH}$ ethane diol	$\text{HOOC}-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{COOH}$ hexanedioic acid
--	---

Name the functional group for each monomer.

Ethane diol: _____

Hexanedioic acid: _____

.....
..... (2 marks)

- (d) Unlike condensation polymerisation, a small molecule is not released during addition polymerisation.

Give **one** other difference between condensation and addition polymerisation.

..... (1 mark)

Medium Questions

1 (a) This question is about the chemistry and applications of polymers.

When two monomers with different functional groups join together, a polyester and another small molecule are formed.

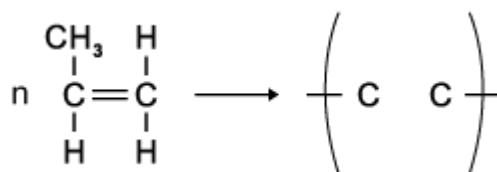
Name the small molecule that is formed.

..... (1 mark)

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

Complete the structure of poly(propene) in the equation shown in **Figure 1**.

Figure 1



(3 marks)

(c) Carpets are made from:

- wool
- poly(propene)
- a mixture of both

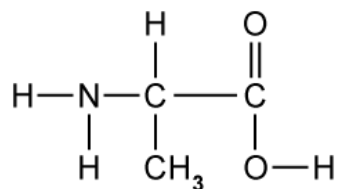
Wool is less durable than poly(propene).

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

Suggest why.

(3 marks)

(d) How many functional groups are present in the amino acid alanine?



A. 1

B. 2

C. 3

D. 4

(1 mark)

(e) Polymer fibres are used to make the fabric used to produce firefighter uniforms.

Table 1 below shows some properties of two types of polymer fibres, a poly(propene) and a polyester.

Table 1

	Polymer fibres	
Property	Poly(propene)	Polyester
Density in g/cm ³	0.88	1.40
Melting point in °C	162	263
Flame resistance	Poor	Good
Water absorption	Low	High

Evaluate the suitability of these polymers for firefighter uniforms.

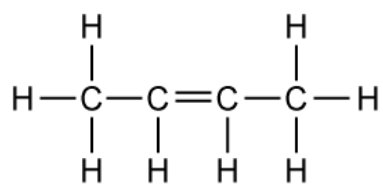
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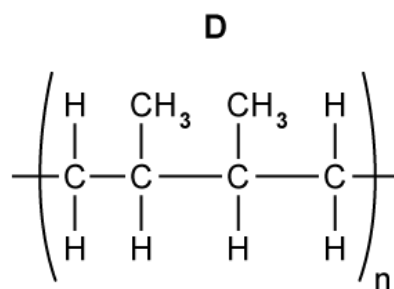
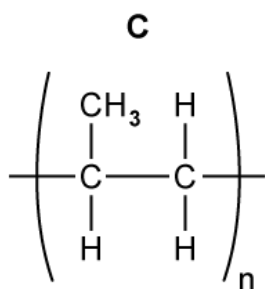
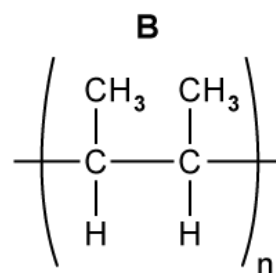
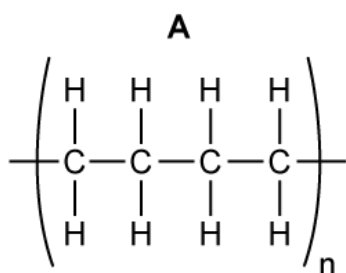
.....

..... (4 marks)

2 The following molecule can undergo addition polymerisation.



What is the correct repeat unit?



(1 mark)

3 (a) Poly(chloroethene) is an extremely versatile plastic with many different applications.

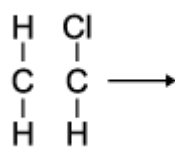
Give the monomer used to form poly(chloroethene).

..... (1 mark)

(b) **Figure 6** shows part of the equation for the formation of poly(chloroethene).

Complete **Figure 6** to show the product, correct notation and bonds in both the monomer and polymer.

Figure 6



(5 marks)

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

What type of polymer is poly(chloroethene)?

..... (1 mark)

4 (a) Proteins, starch and DNA are all naturally occurring polymers.

Give the names of the monomers from which proteins and starch are produced.

.....
..... **(2 marks)**

(b) Describe the formation of polypeptides.

.....
..... **(2 marks)**

(c) Describe the structure of DNA.

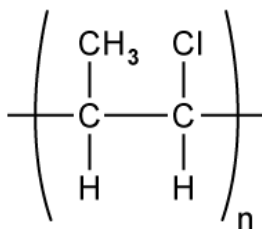
.....
.....
..... **(3 marks)**

5 Which of the following is **not** true about DNA?

- A.** The structure is a double helix
- B.** DNA is made from nucleotides
- C.** DNA is made from two polymer chains
- D.** The monomers that form DNA are amino acids

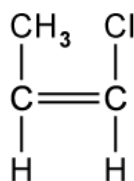
(1 mark)

6 The structure of a polymer is shown below.

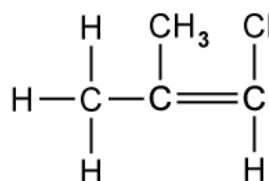


What is the correct monomer?

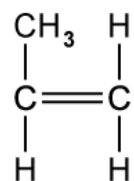
A



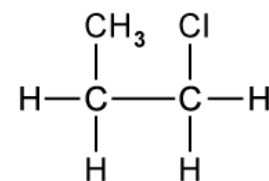
B



C

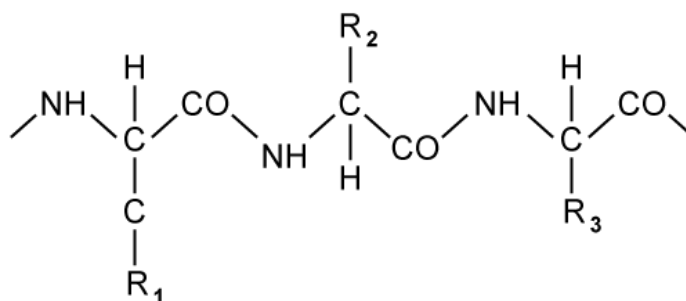


D



(1 mark)

7 Part of the chemical structure of a wool fibre is shown below.

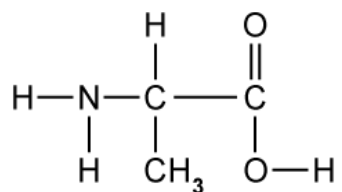


What is true about the structure?

- A.** The structure is a carbohydrate
- B.** The structure is an addition polymer
- C.** The structure is a protein
- D.** Hydrogen has two covalent bonds in the chain

(1 mark)

8 How many functional groups are present in the amino acid alanine?



- A.** 1
- B.** 2
- C.** 3
- D.** 4

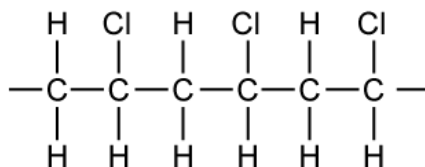
(1 mark)

Hard Questions

1 (a) This question is about polyvinyl chloride (PVC)

Figure 1 shows a short section of a PVC.

Figure 1



Draw the structure of the monomer from which it is made.

The monomer has two carbon atoms.

(2 marks)

(b) Describe how the addition polymer PVC is formed from its monomer.

.....

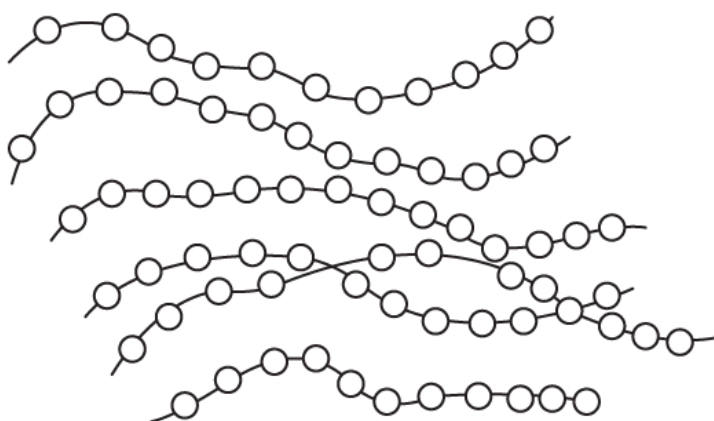
.....

.....

(3 marks)

(c) PVC molecules are shown in Figure 2.

Figure 2



When PVC is heated, it melts.

Explain why.

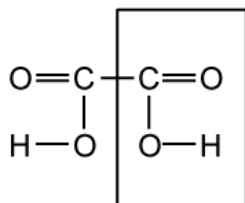
(3 marks)

(d) Polymer **C** can be formed from monomer **A** and monomer **B**.

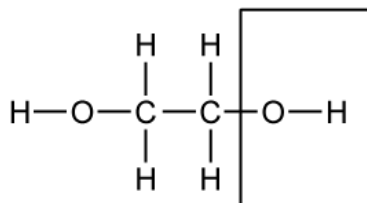
The displayed structures monomer **A** and **B** are shown in **Figure 2** with the functional group highlighted in the box.

Figure 2

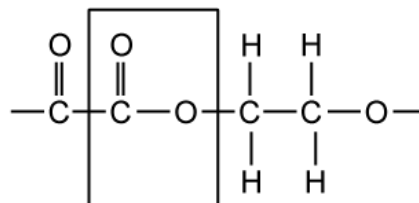
Monomer A



Monomer B



Polymer C



Name the functional group in:

Monomer **A**: _____

Monomer **B**: _____

Polymer **C**: _____

.....

.....

..... (3 marks)

2 (a) This question is about photosynthesis and naturally occurring polymers.

Plants photosynthesise to produce oxygen and glucose, $C_6H_{12}O_6$, from carbon dioxide and water.

Write the balanced symbol equation for photosynthesis.

.....

.....

..... **(3 marks)**

(b) Describe a test that could be done to identify the gas produced during this reaction.

Give the result of the test.

.....

..... **(2 marks)**

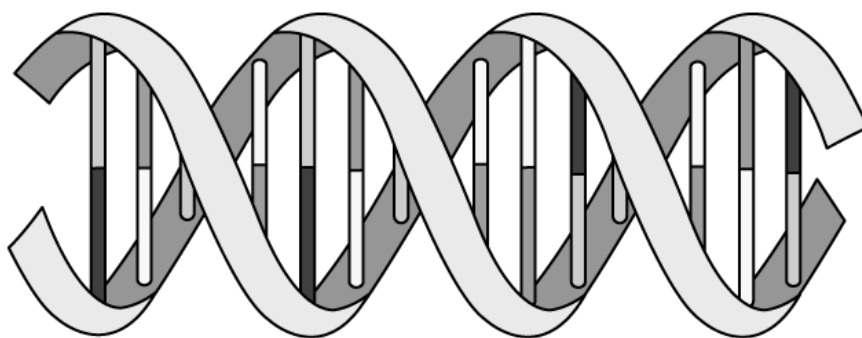
(c) Plants contain cellulose in their cell walls.

Name the monomer that forms cellulose.

..... **(1 mark)**

(d) A naturally occurring polymer found in all plants is shown in **Figure 1**.

Figure 1



Describe the shape and structure of this polymer.

.....

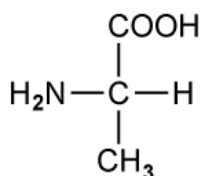
.....

.....

(3 marks)

(e) Figure 2 shows the amino acid alanine.

Figure 2



How many functional groups are there in this amino acid?

Circle **one** box.

1 2 3 4

(1 mark)

(f) Alanine will react with other amino acids to form a polypeptide and water.

Name the type of polymerisation reaction that occurs.

..... (1 mark)

3 (a) This question is about polymerisation.

Table 1 shows information about polymers and the monomers they are made from.

Complete the table.

Table 1

Monomer		Polymer	
Name	Formula	Name	Formula
ethene		poly(ethene)	$\left(\begin{array}{cc} \text{H} & \text{H} \\ & \\ -\text{C} & -\text{C}- \\ & \\ \text{H} & \text{H} \end{array} \right)_n$
styrene	$\begin{array}{ccc} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C}=\text{C} & \\ & / & \diagdown \\ \text{H} & & \text{C}_6\text{H}_5 \end{array}$	polystyrene	
		poly(chloroethene)	$\left(\begin{array}{cc} \text{H} & \text{H} \\ & \\ -\text{C} & -\text{C}- \\ & \\ \text{H} & \text{Cl} \end{array} \right)_n$

(4 marks)

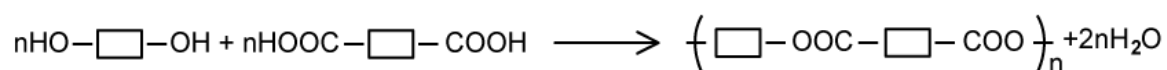
(b) State whether ethene is saturated or unsaturated.

Give **one** reason for your answer.

.....
..... (2 marks)

(c) Polyesters are not made from the same method of polymerisation as those in **Table 1**.

The equation demonstrates how a polyester is made:



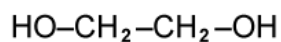
Compare the polymerisation reaction used to make poly(ethene) to the reaction used to make polyester.

.....
.....
.....
..... (4 marks)

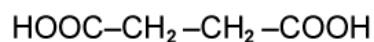
4 (a) This question is about polyesters.

A polyester is made from the monomers shown in **Figure 1**.

Figure 1



Ethanediol



Butanedioic acid

Which homologous series does ethanediol belong to?

..... (1 mark)

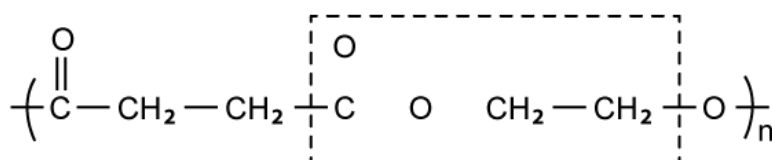
(b) Give the formula that represents the functional group of butanedioic acid.

..... (1 mark)

(c) Part of the structure formed by the polyester is shown in **Figure 2**.

Draw the remaining bonds to complete the diagram.

Figure 2



(2 marks)

(d) A small molecule is also produced during the formation of this polyester.

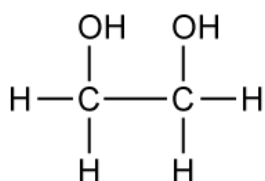
Name the small molecule.

..... (1 mark)

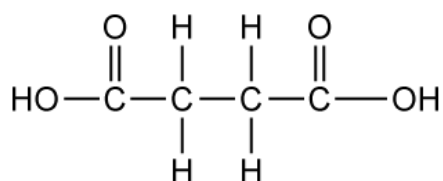
(e) Why does this polyester melt when it is heated?

(2 marks)

- 5 Polyesters can be made by condensation polymerisation. Ethanediol can react with butanedioic acid (a carboxylic acid containing two -COOH groups) to make a polymer.



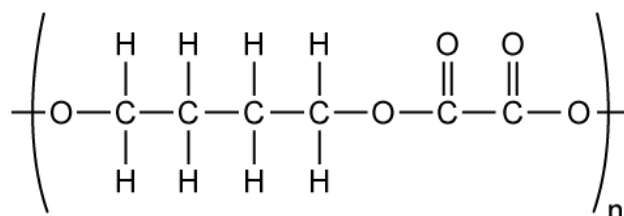
Ethanediol



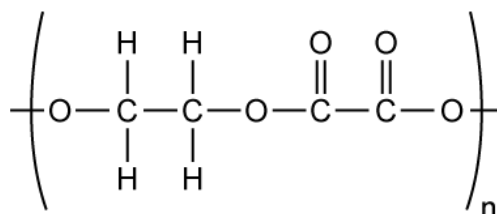
Butanedioic acid

Which of the following is a correct repeat unit for this polymer?

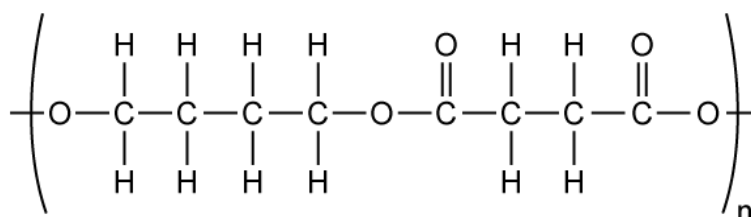
A.



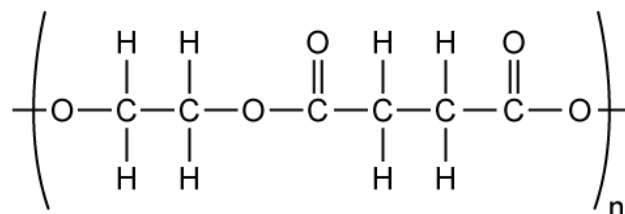
B.



C.



D.



(1 mark)