Polymerisation

Question Paper 2

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Polymerisation
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 2

Time Allowed:	**60 minutes**
Score:	**/50**
Percentage:	**/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	777.5%	70%	62.5%	57.5%	45%	<45%

1 Polymers consist of monomers joined by either addition or condensation reactions.

(a) Name an example of a synthetic addition polymer and a synthetic condensation polymer.

addition polymer .....

condensation polymer .....
[2]

(b) Addition polymers are long-term pollutants in the environment but condensation polymers are often biodegradable.

(i) What *type of reaction* occurs when condensation polymers biodegrade?

.....

(ii) Identify **two** functional groups that could undergo this type of reaction.

.....
[2]

(c) Petroleum is a non-renewable resource from which a wide range of useful polymers is currently produced. Current polymer research is looking at renewable plant material as a potential source of monomers.

Two monomers obtained from plants are shown.

$CH_3CH(OH)COOH$ $HOCH_2COOH$

Draw the displayed formula of the repeat unit of a polymer using **both** monomers.

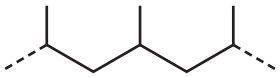
[2]

(d) Monomers obtained from plant sources do not usually form addition polymers.
Suggest why this is.

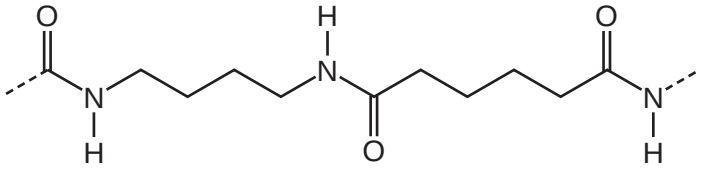
.....

..... [1]

(e) The diagrams show sections of two polymers **Y** and **Z**.



Y



Z

(i) What would be the main force between the chains in each polymer?

Y .....

Z .....

(ii) Which is likely to be the more hydrophilic of these two polymers? Explain your answer.

.....

.....

[3]

[Total: 10]

2 There are two important polymerisations that occur within living organisms – protein synthesis and the formation of DNA.

(a) Complete the table placing a tick (✓) in the correct column to indicate in which process each substance could be used.

substance	protein synthesis	formation of DNA
adenine		
alanine		
aspartate		
phosphate		

[3]

(b) Proteins and DNA form different helical structures. Briefly describe the bonding that maintains the shape of each of these helical structures.

protein .....

.....

.....

DNA .....

.....

.....

[4]

(c) Describe the differences in bonding in the *primary* and *tertiary* structures of proteins. Your answer should include reference both to the nature of the bonding and the types of amino acid causing it.

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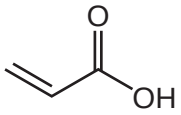
[3]

[Total: 10]

3 In recent years there has been a lot of interest in polymers in the form of gels that absorb aqueous materials. One of the largest uses of these polymers is in disposable nappies (diapers). The gel which is used in this case is a polymer of propenoic acid.



propenoic acid

(a) (i) Draw a section of the polymer of propenoic acid showing **two** repeat units.

(ii) By what type of chemical reaction is this polymer formed?

.....

(iii) By what type of bonding is water held on the polymer?

.....

[3]

(b) For some disposable nappies (diapers), the monomer is a mixture of propenoic acid and sodium propenoate. The properties of the polymer are influenced by the proportion of sodium salt in the monomer mixture.

(i) Suggest and explain how the difference in the structure of this polymer compared to one formed only from propenoic acid might affect the water absorbing properties of the polymer.

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(ii) Suggest a property the polymer should have in order to be used in disposable products.

.....

[3]

(c) A variation on the gel used for disposable nappies (diapers) containing more sodium propenoate has been used to treat soils contaminated by heavy metals such as lead (Pb^{2+}) and cadmium (Cd^{2+}). Suggest why the gel is effective.

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[2]

(d) Another variation on this type of polymer is used in hair gels. In these, the polymer chains are cross-linked by a compound known as pentaerythritol.

pentaerythritol

(i) By what type of chemical reaction are the cross-links in this polymer formed?

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(ii) It is important that the gel should be easily washed out of hair. What is it about the structure of the polymer that allows this to happen?

.....
[2]

[Total: 10]

4 There are two important polymerisations that occur within living organisms – protein synthesis and the formation of DNA.

(a) Complete the table by placing a tick (✓) in the correct column to indicate in which process each substance could be used.

substance	protein synthesis	formation of DNA
cysteine		
cytosine		
glutamine		
guanine		

[3]

(b) DNA consists of a double helical structure.

(i) Describe the bonding between the two strands in DNA and state which part of each strand is joined by it.

.....

.....

(ii) How does the strength of this bonding relate to the mechanism of the replication of DNA?

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[4]

(c) Some diseases are caused by changes in the structure of proteins. Explain the genetic basis of these changes.

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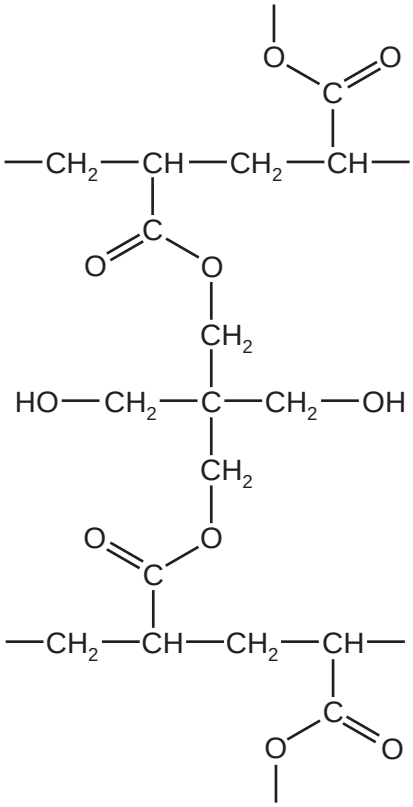
[3]

[Total: 10]

5 In recent years there has been considerable interest in a range of polymers known as 'hydrogels'. These polymers are hydrophilic and can absorb large quantities of water.

(a) The diagram shows part of the structure of a hydrogel.



The hydrogel is formed from chains of one polymer which are cross-linked using another molecule.

(i) Draw the structure of the monomer used in the polymer chains.

(ii) State the type of polymerisation used to form these chains.

.....

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(iii) Draw the structure of the molecule used to cross-link the polymer chains.

(iv) During the cross-linking, a small molecule is formed as a by-product. Identify this molecule.

.....

[5]

(b) Once a hydrogel has absorbed water, it can be dried and re-used many times. Explain why this is possible, referring to the structure on the opposite page.

.....

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[2]

(c) Not every available side chain in the polymer is cross-linked, and the amount of cross-linking affects the properties of the hydrogel.

(i) The amount of cross-linking has little effect on the ability of the gel to absorb water. Suggest why this is the case.

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(ii) Suggest **one** property of the hydrogel that will change if more cross-linking takes place. Explain how the increased cross-linking brings about this change.

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[3]

[Total: 10]