

Polymerisation

Question Paper 5

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Polymerisation
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 5

Time Allowed: 74 minutes

Score: /61

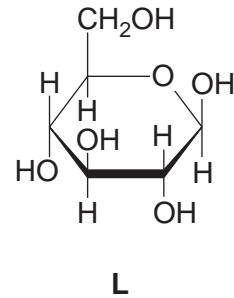
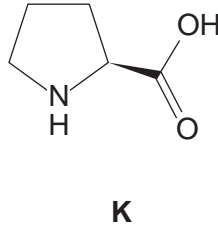
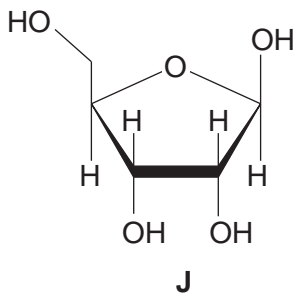
Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	70%	62.5%	57.5%	45%	<45%

1 The formation of proteins is a key process in the growth and repair of tissues in living organisms.

(a) (i) Study the structures of the three molecules below. One of the molecules could be a building block for a protein while the other two could be building blocks for other biological polymers.



Which of the three could be a building block for a protein? Explain your answer.

.....

(ii) For which biological polymer could **one** of the other molecules form a building block?

molecule **polymer**

[2]

(b) Protein molecules have four levels of structure as the long molecules fold and take shape.

(i) The primary structure is the sequence of amino acids in the protein chain. What type of bonding exists between the amino acids in this chain?

.....

(ii) What type of bonding can exist in **all** of the other types of structure?

.....

(iii) Name one type of bonding that does **not** occur in the primary or secondary structure of the protein.

.....

[3]

(c) Many proteins play an important role in catalysing chemical reactions in living organisms.

(i) What name is given to these catalysts?

.....

(ii) Give **two** changes in conditions under which these catalysts may be inactivated, explaining the chemical reason for this in each case.

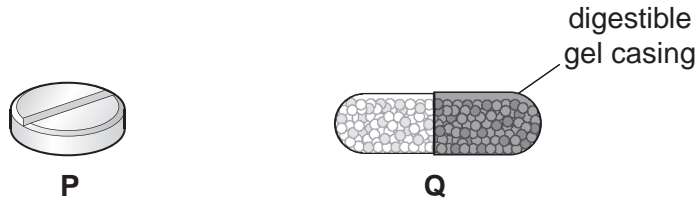
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[4]

[Total: 9]

2 Drugs can be delivered in a number of ways. The method chosen depends both on the nature of the drug, and the problem it is being used to treat.

(a) Many common drugs are taken by mouth in forms similar to those shown.



(i) Some drugs are available in solution. How would the speed of action of this form compare with **P** and **Q**? Explain your answer.

.....
.....

(ii) Explain which of the two forms, **P** or **Q**, would act the most rapidly when taken by mouth.

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(iii) Some drugs are broken down before they can be absorbed by the intestine. Suggest how the design of **Q** prevents this.

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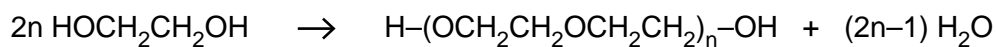
[3]

(b) After an abdominal operation drugs are often delivered by means of a 'drip' inserted into a blood vessel in the patient's arm. Explain why this is more effective than taking painkillers by mouth.

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.....
.....

[2]

- (c) One of the molecules that has found a variety of uses in drug delivery is poly(ethylene glycol) or PEG. It is formed from dihydroxyethane, HOCH₂CH₂OH.



- (i) What type of reaction is this?

.....

Attaching a PEG molecule to a drug increases the time that it takes for the drug to be broken down and flushed from the body. There are thought to be two major reasons for this: firstly the PEG can form bonds to slow the passage of the drug around the body; secondly it may reduce the efficiency of breakdown of the drug by enzymes.

- (ii) What type of bonds would the PEG part of the molecule form with molecules in the body?

.....

- (iii) Suggest why attaching a PEG molecule to a drug molecule would reduce the rate of the drug's decomposition by enzymes.

.....

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.....

- (iv) Drugs are often protein or polypeptide molecules. What type of reaction might occur in the breakdown of such a drug?

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[5]

[Total: 10]

3 Acyl chlorides are useful intermediates in organic syntheses.

(a) (i) State a suitable reagent for converting carboxylic acids into acyl chlorides.

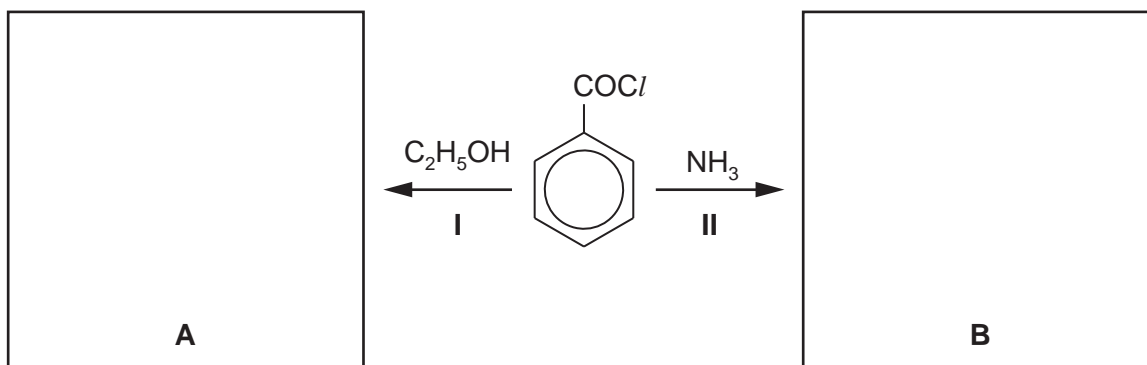
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(ii) Construct an equation for the reaction between ethanoic acid, $\text{CH}_3\text{CO}_2\text{H}$, and the reagent you have stated in (i).

.....

[2]

(b) (i) In the boxes provided draw the structures of the compounds formed when benzoyl chloride undergoes the following reactions.



(ii) Name the functional group in

• compound **A**

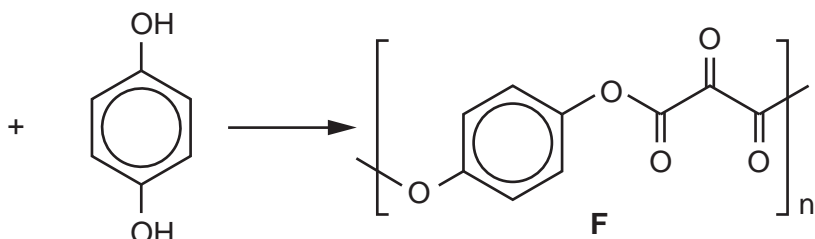
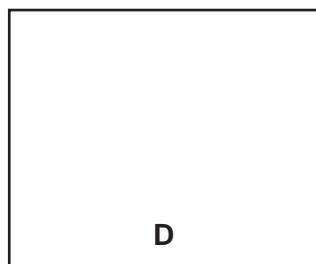
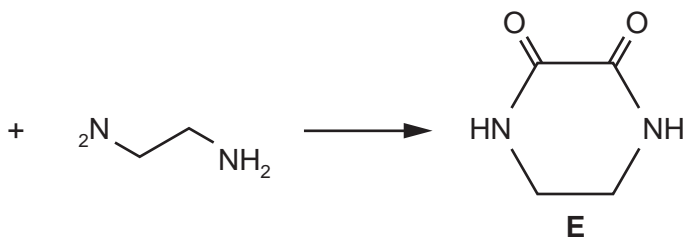
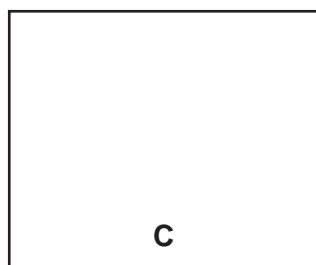
• compound **B**

(iii) What *type of reaction* is reaction **II**?

.....

[5]

- (c) (i) Suggest suitable acyl chlorides to use in the following reaction. Draw their structures in the boxes provided.



Compound **E** dissolves in, but does not react with, cold water.

- (ii) Suggest the major type of intermolecular interaction that occurs between **E** and water.

.....

- (iii) A solution of the diamine $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$ in water has $\text{pH} = 11$ but a solution of **E** in water has $\text{pH} = 7$. Suggest why this is the case.

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- (iv) What type of polymer is compound **F**?

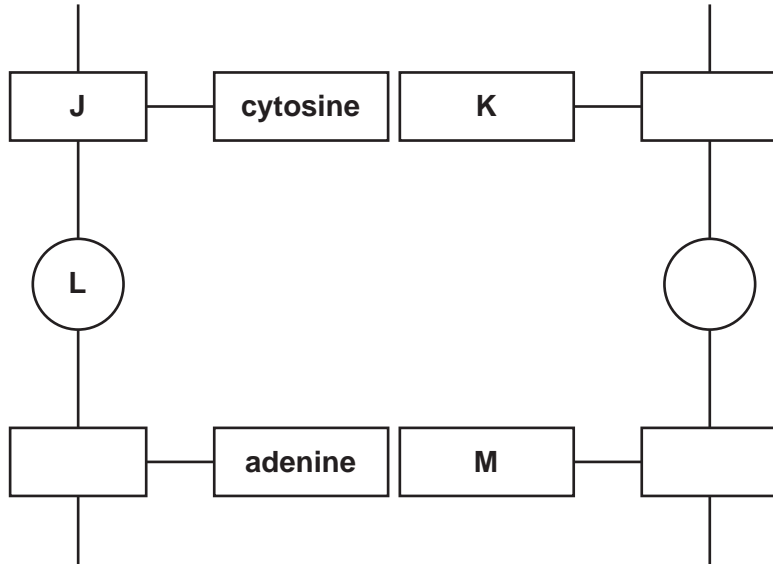
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[5]

[Total: 12]

4 The molecule that contains the genetic information for an individual organism is called deoxyribonucleic acid, DNA.

(a) The diagram shows part of a DNA molecule. Study the diagram and identify the blocks labelled J, K, L and M as accurately as you can.



block letter	identity
J	
K	
L	
M	

[3]

(b) The DNA molecule is formed from two polymer strands. What stops these strands from separating from each other?

.....
 [2]

(c) List **three** differences between the structures of DNA and RNA.

- 1.
.....
.....
- 2.
.....
.....
- 3.
.....
.....

[3]

(d) Outline the different **roles** of mRNA and tRNA in the processes of transcription and translation.

- mRNA
-
-
- tRNA
-
-

[2]

[Total: 10]

5 Human hair and silk both consist of proteins. Proteins are described as having three major levels of structure: primary, secondary and tertiary.

(a) Outline what is meant by the terms *primary structure* and *tertiary structure* of a protein.

primary structure

.....

.....

tertiary structure

.....

.....

[2]

(b) In hair, the secondary structure consists of α -helices which are cross-linked by disulfide bonds. The amino acid responsible for this cross-linking is cysteine, $\text{H}_2\text{NCH}(\text{CH}_2\text{SH})\text{CO}_2\text{H}$.

(i) Show by means of a diagram how the disulfide cross-links are formed.

(ii) What type of reaction is this?

.....

(iii) State **three** other interactions that stabilise the tertiary structure of proteins.

.....

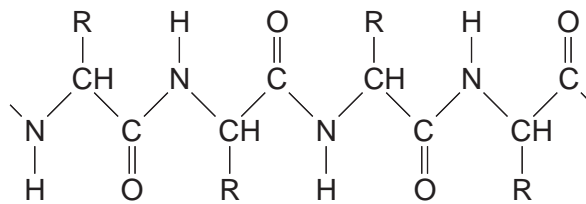
[4]

(c) The β -pleated sheet is a different form of secondary structure found in proteins, such as those in silk.

(i) What type of bonding is responsible for stabilising the β -pleated sheet in silk?

.....

(ii) On the diagram below, draw a second polypeptide strand and show how bonds would be formed that stabilise this β -pleated sheet.



[3]

(d) The cysteine-containing protein in hair is called α -keratin. A similar sequence of amino acids can produce β -keratin proteins found in the scales, claws and shells of reptiles such as tortoises. In β -keratin the secondary structure of the protein is in the form of a β -pleated sheet.

Suggest what makes the β -pleated sheet in β -keratin so much less flexible than the β -pleated sheet in silk.

.....

 [1]

[Total: 10]

6 One of the greatest challenges facing scientists today is the development of effective drugs to treat different forms of cancer.

(a) Drugs can be introduced into the body by injection or by mouth. Taking drugs by injection avoids the drug being broken down in the digestive system. State **two** other advantages of giving drugs by injection.

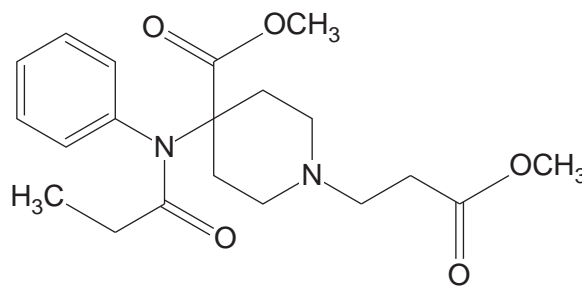
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..... [2]

(b) The drug *Ultiva* has been developed to treat ovarian cancer, and is usually given by injection.



Ultiva

Study the structure of *Ultiva* and draw a **circle** around **two different** functional groups that could be broken down in the digestive system. [2]

(c) One way of avoiding the breakdown of drugs in the body is to use a specially designed nanoparticle which encloses the drug. If the nanoparticles are made of a particular sort of polymer, they absorb water at the slightly acidic pH inside some cells, increasing their diameter from around 100 nm to around 1000 nm. This spreads out the polymer chains allowing release of the drug.

(i) Other than absorbing water, suggest a property this polymer would need to possess for its use in drug delivery.

.....

.....

(ii) Why would this method of release **not** work if the nanoparticles were taken by mouth?

.....

[2]

- (d) Polymers may be formed by two different types of chemical reaction.
Name the two types of reaction and write an equation to illustrate each reaction type.

name

equation

name

equation

[3]

- (e) The breakdown of polymers, such as carbohydrates and proteins in the body is important for digestion. What type of reaction is generally involved?

..... [1]

[Total: 10]