Polymerisation

Question Paper 3

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Polymerisation
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 3

Time Allowed: **64 minutes**

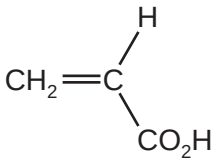
Score: **/53**

Percentage: **/100**

Grade Boundaries:

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

1 Super-absorbent polymers have the ability to absorb 200-300 times their own mass of water. They are classified as hydrogels and they are widely used in personal disposable hygiene products such as babies' nappies (diapers).
These polymers are commonly made by the polymerisation of compound **K** mixed with sodium hydroxide in the presence of an initiator.



K

(a) Explain what is meant by the term *polymerisation*.

.....

.....

(ii) What type of polymerisation is involved in the formation of hydrogels?

.....

(iii) Describe the changes in chemical bonding that occur during the polymerisation of **K**.

.....

.....
[3]

(b) *Acrylic acid* is the common name for compound **K**.
Suggest the systematic (chemical) name of **K**.

.....
[1]

(c) Draw the structure of at least **two** repeat units of the polymer formed by the above method from acrylic acid, **K**, when mixed with NaOH.

(ii) The C–C–C bond angle in compound **K** changes when the polymer is formed.
State and explain how the C–C–C bond angle differs between a molecule of **K** and the polymer.

angle changes from ..... to .....

explanation .....

.....
[4]

(d) Draw a detailed diagram of a portion of the polymer you have drawn in **(c)(i)** to explain how it can absorb a large volume of water.

(ii) A student added 0.10 g of the polymer to 10 cm^3 of aqueous copper(II) sulfate solution.
Predict, with a reason, what you expect to observe.

.....

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[4]

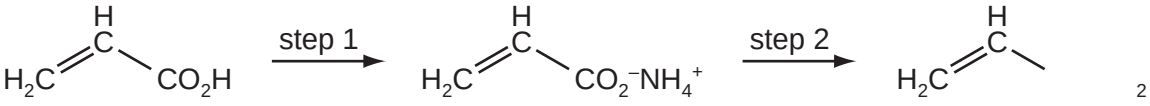
(e) Compound **L**, CH_2=$CHCONH_2$, can also be polymerised to form a super-absorbent polymer.

(i) Name the **two** functional groups in compound **L**.

.....

.....

Compound **K** can be converted into compound **L** by the following two-step route.



K **L**

2

(ii) Suggest a reagent for step 1.

.....

(iii) What other product is formed in step 2?

.....

(iv) State the reagents and conditions necessary to re-form **K** from **L**.

.....
[5]

[Total: 17]

2 In key reactions responsible for growth and repair in the human body, amino acids react together to form polymers known as proteins.

(a) What *type of reaction* is this polymerisation?

.....

(ii) From stocks of glycine and alanine, it is possible to make the dipeptide gly-ala.
Using the same three-letter abbreviations for the amino acids, give the structures of all other possible dipeptides that can be made from these stocks of amino acids.

[3]

(b) DNA consists of a double helix formed by two strands held together by hydrogen bonds between base pairs.
Sketch a section of DNA showing **two** base pairs, using blocks for the various components. You should label all of the components.

(ii) Suggest what the effect on DNA replication would be if the hydrogen bonds between the strands were replaced by stronger bonds, e.g. covalent bonds.

.....

.....

[4]

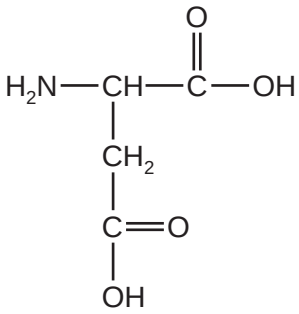
(c) Some diseases, such as sickle-cell anaemia, are caused by mutation resulting in a change in the triplet code.

(i) Explain why some changes in the triplet code do **not** result in a change in the primary structure of a protein.

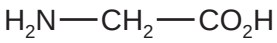
.....

.....

(ii) Suggest what change in the tertiary structure of a protein would result from a mutation that replaced aspartic acid with glycine.



aspartic acid



glycine

.....

.....

(iii) Sometimes a mutation can result in the *deletion* of a single base in DNA (or RNA). Explain why this is likely to have more serious consequences for the protein than the *replacement* of one base by another.

.....

.....

[3]

[Total: 10]

3 **(a)** Describe and explain how the acidities of $CHCl_2CO_2H$ and CH_2ClCO_2H compare to each other, and to the acidity of ethanoic acid.

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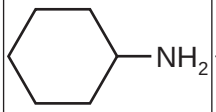
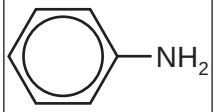
.....

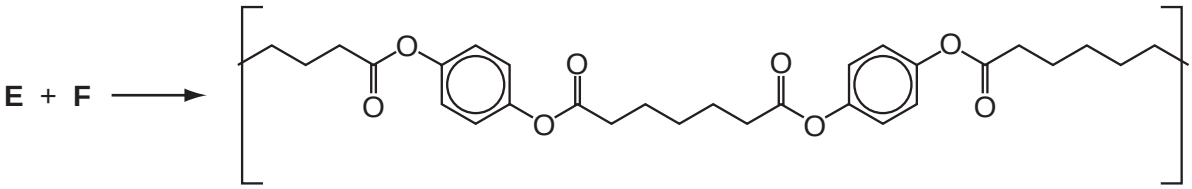
[3]

(b) For each of the following pairs of compounds, suggest one chemical test (reagents and conditions) that would distinguish between them.
State the observations you would make with each compound, writing 'none' if appropriate.

first compound	second compound	test (reagents and conditions)	observation with first compound	observation with second compound
				
CH_3CH_2COCl	CH_3COCH_2Cl			
CH_3CH_2CHO	CH_3COCH_3			

[7]

(c) The following diagram shows a section (not a repeat unit) of a polymer, **G**, that can be made from the two monomers **E** and **F**.



polymer **G**

(i) What *type of polymerisation* made this polymer?

.....

(ii) Draw the structures of the two monomers **E** and **F**.

E

F

(iii) Suggest the conditions needed to make polymer **G** from **E** and **F** in the laboratory.

.....

.....

.....

(iv) One of the monomers, **E** or **F**, could be changed to make a more rigid polymer of a similar chemical type to **G**.
Suggest which of your two monomers could be changed, and suggest a structure for the new monomer.

Monomer to be changed (**E** or **F**) .....

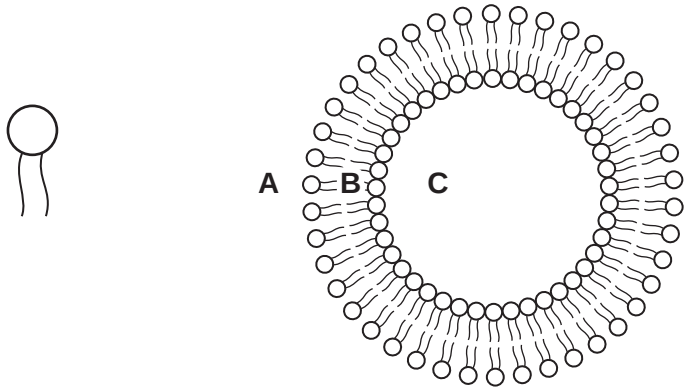
Structural formula of the new monomer

[6]

[Total: 16]

4 The developments in nanotechnology and drug delivery over the past 20 years have been wide-ranging.

(a) One of the most widespread developments for delivering a range of pharmaceutical products has been the use of liposomes. These are artificially created spheres made from phospholipids which have an ionic phosphate 'head' and two hydrocarbon 'tails'.



phospholipid liposome

Liposomes have also been used to carry pharmaceuticals such as vitamins and moisturisers used in cosmetic anti-ageing creams. Otherwise these pharmaceuticals may be oxidised or dehydrated if exposed to air.

(i) State in which area of the liposome, **A**, **B** or **C**, each of the following types of molecule would be carried.

a hydrophilic moisturiser .....

a fat-soluble vitamin .....

(ii) For one of the areas, **A**, **B** or **C**, suggest why this would **not** be an appropriate place to carry either molecule.

.....

.....

.....

[3]

(b) When liposomes are used to carry drugs, their main purpose is to prevent the drug molecules from being broken down on passage through the digestive system.

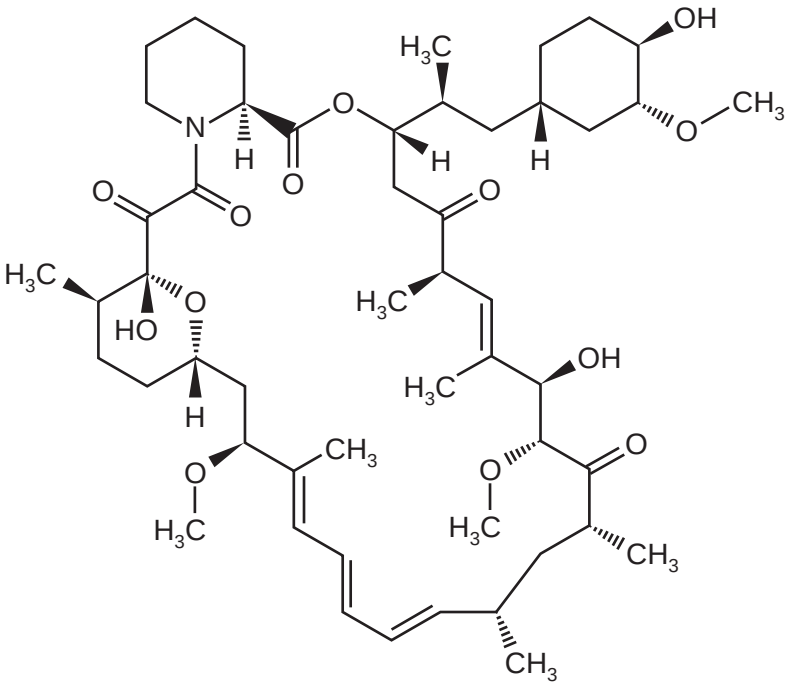
(i) Name a functional group present in drug molecules that might be broken down by acid in the stomach.

.....

(ii) Name the *type of reaction* that would cause such a breakdown.

.....

(iii) The drug *Sirolimus* is used to suppress possible rejection by the body after kidney transplants.



Sirolimus

Circle **two bonds**, each in a **different** functional group that could be broken down in the digestive system.

[4]

(c) *Sirolimus* is not very soluble in water, greatly reducing its effectiveness when given by mouth or by injection. To increase its effectiveness when taken by mouth nano-sized crystals of the drug combined with poly(ethylene glycol) or PEG (shown below) are produced.

$$HO—(CH_2—CH_2—O)_n—H$$

(i) Suggest what is meant by the term *nano-sized*.

.....

(ii) Suggest where on the molecule of PEG the drug would be attached.

.....

(iii) Why would bonding the drug to a PEG molecule improve its solubility in water?

.....

[3]

[Total: 10]