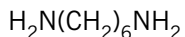
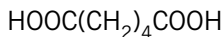


'DESIGNER POLYMERS' TEST**60 marks (1 hour)**

- 1 Nylon was invented in 1935 by Wallace Carothers. His invention resulted from a planned research project in which he was trying to make a polymer in which the molecular chains were built up in a similar way to the protein chains in silk.

He allowed pairs of compounds (e.g. compound **A** and compound **B**) to react together under suitable conditions.

Compound **A**Compound **B**

- a Say, with reasons, whether nylon was discovered by accident or design. (2 marks)
- b Suggest a *raw material* that can be used as a starting material for the manufacture of both compounds **A** and **B**. (1 mark)
- c i To which class of compound does compound **A** belong? (1 mark)
 ii Give a systematic name for compound **A**. (1 mark)
 iii Draw the structure of the compound that is produced when compound **A** reacts with hydrochloric acid. (2 marks)
- d i To which class of compound does compound **B** belong? (1 mark)
 ii Draw the full structural formula of compound **B**. (2 marks)
 iii Draw the structure of the salt formed when compound **B** reacts with aqueous sodium hydroxide. (2 marks)
- e Draw a skeletal formula for the repeating unit in the resulting nylon, showing one unit of **A** linked to one unit of **B**. (2 marks)
- f Name this nylon by putting the correct numbers in the brackets: nylon (__,__). (2 marks)
- g Nylon is a *condensation polymer*. Explain what these words mean. (2 marks)

You can make the same nylon by reacting compound **A** with compound **C**, $\text{ClOC}(\text{CH}_2)_4\text{COCl}$.

- h To which class of compound does compound **C** belong? (1 mark)
- i Apart from the nylon, what other product forms when compound **A** reacts with compound **C**? (1 mark)
- j Choose from the following list the term that best describes the reaction of compound **A** with compound **C**.
esterification hydrolysis acylation addition redox (1 mark)
- k Suggest **two** reasons why industrial companies do not use compound **C** to make nylon on a large scale. (2 marks)

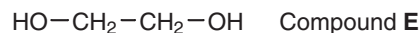
Polymer chains of nylon need only be half the length of chains of high-density poly(ethene) (hdpe) for the polymer materials to show the same strength. This is because of the stronger intermolecular forces between the nylon chains.

- l Name the **type** of intermolecular forces in hdpe. (1 mark)
- m Name the strongest **type** of intermolecular force present in nylon and draw a diagram to show how these attractive forces form between two adjacent chains. (3 marks)

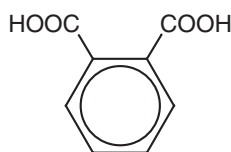
[TOTAL: 27 MARKS]

(Adapted from OCR Chemistry (Salters), Module 2, question 1, June 1998)

- 2 Polyesters are widely used as fibres, films and packaging materials. The most common polyester is made by reacting compound **D** with compound **E**.

Compound **D**

- a Name the functional group in compound **E**. (1 mark)
- b Draw the structural formula of part of the polyester molecule, showing how one molecule of compound **D** links to one molecule of compound **E**. (2 marks)
- c i Name the strongest **type** of intermolecular forces between the polyester chains. (1 mark)
 ii Draw a diagram of two sections of adjacent polyester chains, and show how these intermolecular forces arise. (2 marks)
- d i Draw the structures of the compounds that would be formed when this polyester is hydrolysed using moderately concentrated sodium hydroxide solution. (2 marks)
 ii State one other condition necessary for this hydrolysis to occur. (1 mark)
- e Compound **F** also reacts with compound **E** to give a polyester.

Compound **F**

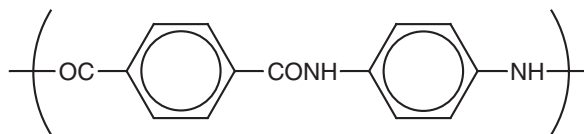
- i How would you expect the flexibility of this polyester **F/E** (produced from compounds **F** and **E**) to compare with that of the original polyester **D/E** (produced from compounds **D** and **E**)? (1 mark)
 ii Explain your answer to i. (2 marks)
 iii How would you expect the glass transition temperature of polyester **F/E** to compare with that of polyester **D/E**? (1 mark)
 iv Explain your answer to iii. (2 marks)
- f i Suggest **two** methods of disposing of objects made from polyesters. (2 marks)
 ii Give **two** reasons why the recycling of plastics is a good idea. (2 marks)

[TOTAL: 19 MARKS]

(Adapted from OCR Chemistry (Salters), Module 2, question 3, Jan 1998)

- 3 The polymer *Kevlar* is used to make bullet-proof vests and cords to reinforce the walls of car tyres. The diagram below shows the structure of the repeating unit in *Kevlar*.

- a i *Kevlar* is a condensation polymer. Draw the structures of the two monomers from which it is made. (2 marks)
 ii What name is given to the $-\text{CONH}-$ group? (1 mark)



- b *Kevlar* molecules can crystallise into long fibres in which the polymer chains are attracted to each other by hydrogen bonding. *Kevlar* is insoluble in most solvents but dissolves in concentrated sulphuric acid. Explain how this happens. (2 marks)
- c i What reagents and conditions would you use to hydrolyse *Kevlar* into its monomers in the laboratory? (2 marks)
 ii One of the hydrolysis products is a white crystalline solid. Describe how you would obtain a pure sample of this product. (3 marks)
 iii How would you show that the sample you had obtained was pure? (1 mark)
- d The structure of *Kevlar* gives it useful properties such that it can be used in many applications. Suggest **three** useful properties of *Kevlar* and relate them to features of its structure. (3 marks)

[TOTAL: 14 MARKS]

(Adapted from OCR Chemistry (Salters), Module 2, question 4, June 1999)