Nitrogen Compounds Amino Acids, Amides Polyamides & Chirality AS & A Level

Question Paper 1

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Organic Chemistry & Analysis
Topic	Nitrogen Compounds Amino Acids, Amides polyamides & Chirality
Paper	AS & A Level
Booklet	Question Paper 1

Time allowed: **41 minutes**

Score: **/30**

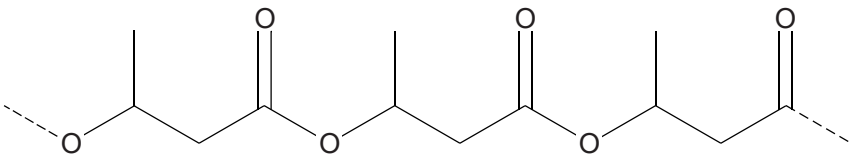
Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

This question looks at different types of condensation polymers: polyesters, polyamides and proteins.

(a) Polyester **A**, shown below, is a degradable polymer prepared by bacterial fermentation of sugars.



polyester **A**

One reason that polyester **A** is degradable is that it can be hydrolysed.

(i) State another way that a polyester may be degraded. [1]

(ii) When polyester **A** is hydrolysed with aqueous acid, compound **B** is formed.

Draw the skeletal formula of compound **B**. [1]

(b) Nylon-4,6 is a polyamide that can be prepared by reacting butane-1,4-diamine, $H_2N(CH_2)_4NH_2$, with hexanedioic acid, $HOOC(CH_2)_4COOH$.

(i) $H_2N(CH_2)_4NH_2$ can be synthesised from 1,4-dichlorobutane, $Cl(CH_2)_4Cl$.

State the reagents and conditions required for this synthesis. [1]

(ii) $H_2N(CH_2)_4NH_2$ can act as a base and forms salts with dilute acids.

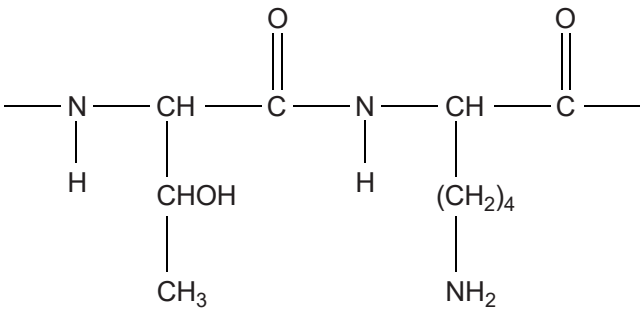
- Explain how an amine can act as a base.
- Write the formula of the salt formed when $H_2N(CH_2)_4NH_2$ reacts with an **excess** of dilute hydrochloric acid. [2]

(iii) Draw the repeat unit of nylon-4,6.

Clearly display the bonding that links the two monomers. [2]

(c) A sample of a protein is hydrolysed. The organic products are separated by chromatography. Each organic product has its pH adjusted to its isoelectric point to form a zwitterion.

A section of the protein is shown below.



(i) In the boxes below, draw the structures of the zwitterions formed from this section of the protein.

[2]

(ii) The isoelectric points of the zwitterions in **(i)** are at pH 5.60 and pH 9.60.

Explain why these isoelectric points are at different pH values. [1]

[Total 10 Marks]

The general formula of an α-amino acid is $RCH(NH_2)COOH$.

(a) Draw 3-D diagrams for the two optical isomers of the α-amino acid serine, where R is CH_2OH.

[2]

(b) Compound **F**, $C_4H_7O_2Br$, is one of two optical isomers.

Compound **F** reacts with excess ethanolic ammonia to form the α-amino acid **G**.

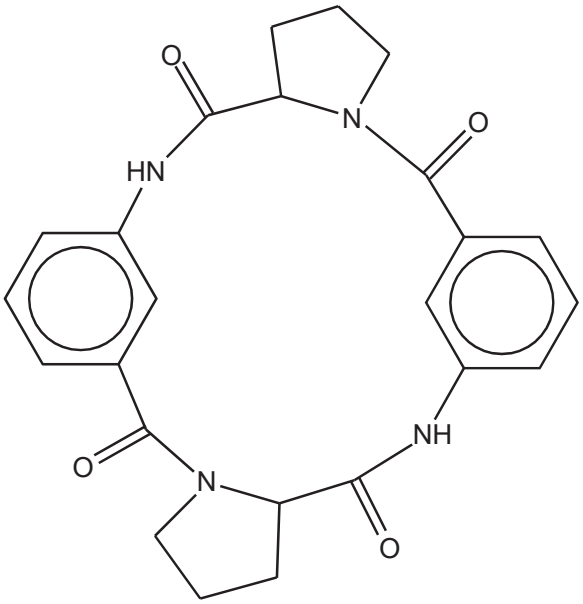
Compound **H** has *E/Z* isomers and can be converted into compound **F** by addition of HBr.

Compound **H** forms polymer **I**, which has the empirical formula C_2H_3O.

- Suggest structures for compound **F**, compound **G** and compound **H**.
- Draw a repeat unit of polymer **I**.
- State the type of reaction for the formation of **F** and for the formation of **G**.

[6]

(c) A cyclic tetrapeptide has been synthesised from 3-aminobenzoic acid and an amino acid.



cyclic tetrapeptide

The cyclic tetrapeptide is hydrolysed by heating under reflux with aqueous sodium hydroxide.

Draw the structures of **two** organic products formed by the complete alkaline hydrolysis of the cyclic tetrapeptide.

[3]

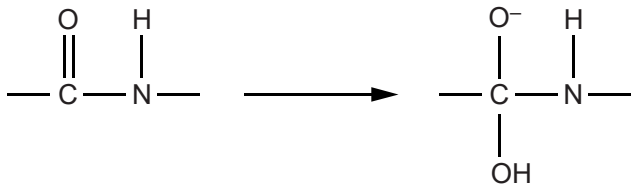
[Total: 11 marks]

The building blocks of peptides and proteins are α-amino acids.

A tripeptide is hydrolysed to form a mixture of three different α-amino acids.

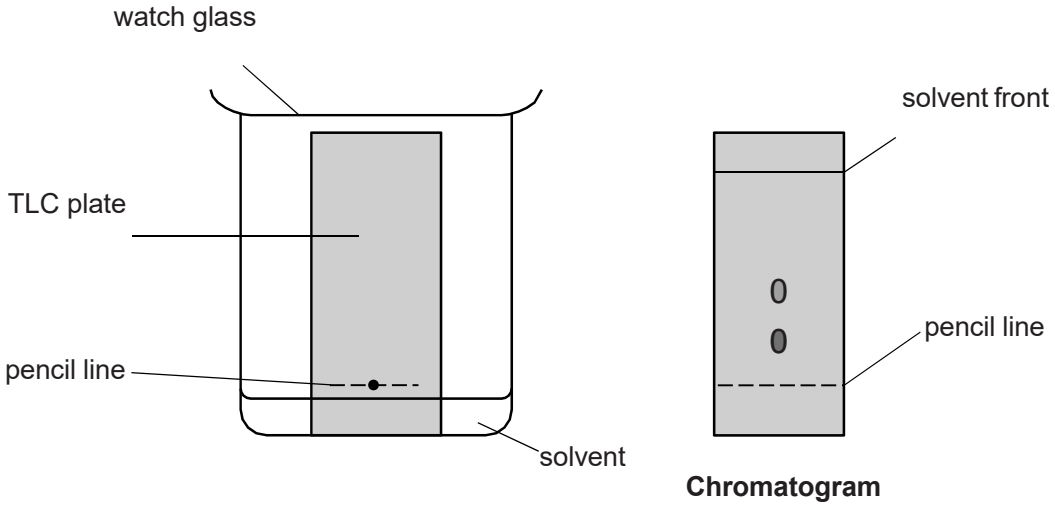
(a) The first step of an incomplete mechanism for the alkaline hydrolysis of the tripeptide is shown below.

Add curly arrows and relevant dipoles to the diagram to suggest how the hydroxide ion takes part in the first step of this mechanism.



[2]

(b) The tripeptide is hydrolysed and the resulting mixture containing the three amino acids is neutralised.
A student tries to separate and identify the three amino acids in the mixture using thin-layer chromatography (TLC). The diagram below shows the apparatus for the experiment and the chromatogram produced.



Explain how the chromatogram can be used to identify amino acids.
The student thinks that there should be three spots on the chromatogram.

Suggest why there are only two spots. [3]

(c) The three α-amino acids in the tripeptide are aspartic acid, glycine and isoleucine.

The general formula for an α-amino acid is $RCH(NH_2)COOH$.

α-amino acid	**R-group**
aspartic acid	$–CH_2COOH$
glycine	–H
isoleucine	$–CH(CH_3)CH_2CH_3$

(i) Aspartic acid has an isoelectric point of 2.77.

What is meant by the term *isoelectric point*?

In your answer you should use the appropriate technical terms spelled correctly. [1]

(ii) Draw the structure of aspartic acid when it is dissolved in a solution with a high pH. [1]

(iii) Suggest a structure for the tripeptide.

On your structure, mark each chiral centre with an asterisk (*). [2]

[Total 9 Marks]