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

Question Paper 1

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

Time allowed: **68 minutes**

Score: **/50**

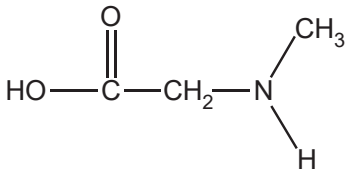
Percentage: **/100**

Grade Boundaries:

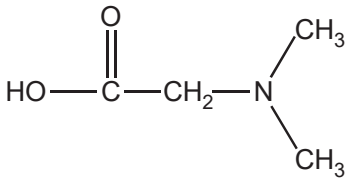
A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

Which compound is a secondary amide?

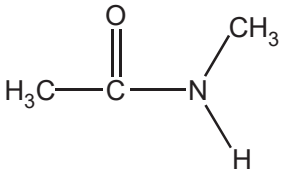
A



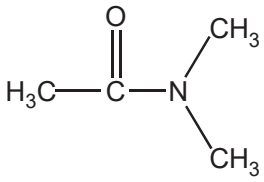
B



C



D



[1]

Question 2

How many straight-chain structural isomers of $C_7H_{15}Cl$ contain a chiral carbon atom?

A. 1

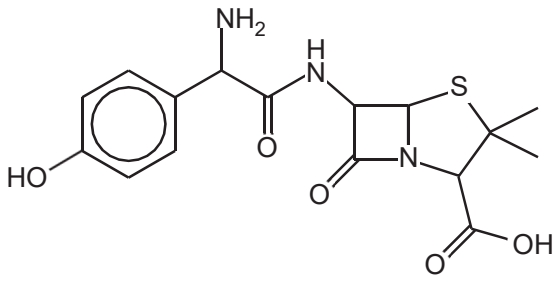
B. 2

C. 3

D. 4 **[1]**

Question 3

What is the number of chiral centres in the molecule below?



A. 2

B. 3

C. 4

D. 5 **[1]**

Which reagents could be used to prepare $CH_3CH_2CONHCH_3$?

A. $CH_3CH_2COCl + CH_3NH_2$

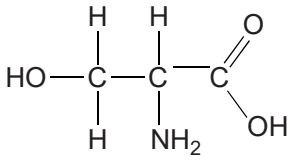
B. $CH_3CH_2CONH_2 + CH_3Br$

C. $CH_3CH_2COONa + CH_3NH_2$

D. $CH_3CH_2COCH_3 + NH_3$ **[1]**

Many α-amino acids have several functional groups.

(a) Serine, shown below, is a naturally occurring α-amino acid.



serine

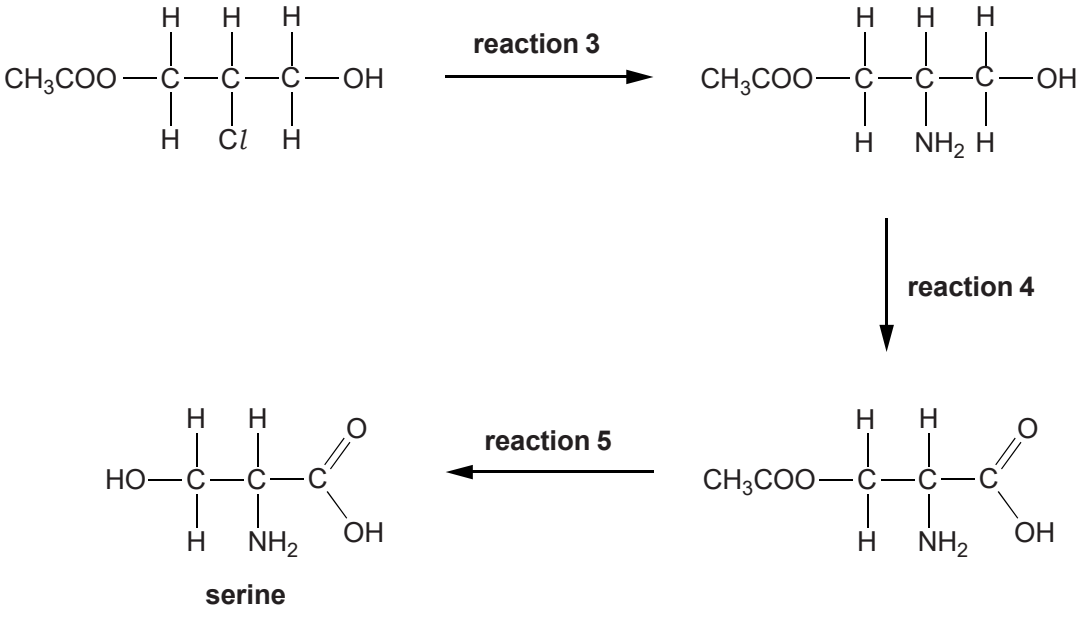
(i) In the boxes below, draw the structure of the organic compounds formed by each reaction.

[3]

(ii) Suggest a use for the organic compound formed by **reaction 2**. [1]

(iii) Serine is commonly used in organic synthesis.

One possible method of synthesising serine is shown below.



Complete the following:

Reagent and conditions used for **reaction 3**.

Type of reaction for:

reaction 4

reaction 5

[3]

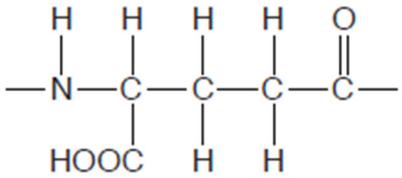
(b) Compound **E**, C_4H_7NO, is one of two optical isomers. It can be oxidised by Tollens' reagent to an α-amino acid, **F**.

The α-amino acid **F** forms two different polymers, **G** and **H**.
Polymer **G** has the empirical formula $C_4H_7NO_2$.
Polymer **H** has the empirical formula C_4H_5NO.

- Suggest structures for compound **E** and compound **F**.
- Draw repeat units of polymer **G** and polymer **H**.
- Describe how **F** forms **G** and **H**.

[6]

(c) Poly(glutamic acid) is a polymer of the amino acid, glutamic acid.



repeat unit of poly(glutamic acid)

(i) Draw the structure of glutamic acid. [1]

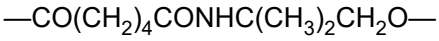
(ii) A student tried to prepare poly(glutamic acid) from glutamic acid. No polymer was found in the product mixture.

The student isolated the two major compounds in the mixture. The mass spectra of these two compounds showed molecular ion (M^+) peaks at m/z = 129 and m/z = 258.

Suggest structures for these two compounds.

[2]

(d) Polymer **J** has been recently developed by scientists. The repeat unit of polymer **J** is shown below.



polymer J

(i) What are the functional groups in polymer **J**? [1]

(ii) Two different monomers react to form polymer **J**.

Draw the structures of the two monomers in the boxes below.

Display the functional groups in each monomer.

[2]

(iii) Polymer **J** is used in hair spray. It can be washed away easily with hot water.

Suggest why polymer **J** is able to be washed away easily with hot water. [1]

[Total 20 Marks]

This question looks at the properties and chemistry of some α-amino acids. The general formula of an α-amino acid is $RCH(NH_2)COOH$.

(a) In the α-amino acid alanine, $CH_3CH(NH_2)COOH$, R is CH_3.
The isoelectric point of alanine is at pH 6.0.

(i) What is meant by the term *isoelectric point?* [1]

(ii) Draw the structures of the ions formed by alanine at pH 6.0 and at pH 1.5.

ion formed at pH 6.0	**ion formed at pH 1.5**

[2]

(iii) Different R groups in α-amino acids result in different isoelectric points.

Suggest the functional group, in the R group, that results in the isoelectric point being lower than pH 3 and higher than pH 10. [2]

(b) The α-amino acid serine, where R is CH_2OH, readily forms a condensation polymer containing peptide links.

Draw a section of poly(serine), showing **two** repeat units.

Display the peptide linkage.

[2]

(c) Apart from glycine, where R is H, all α-amino acids show optical isomerism.

(i) Why does glycine **not** show optical isomerism? [1]

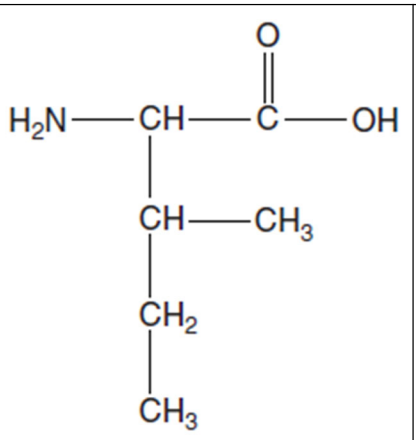
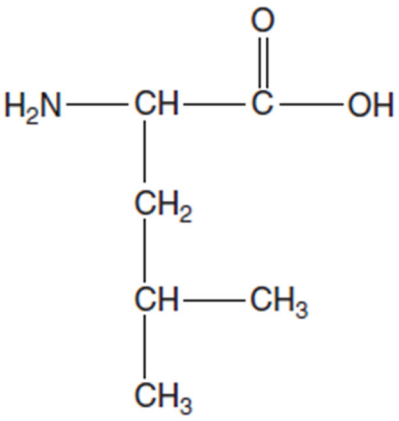
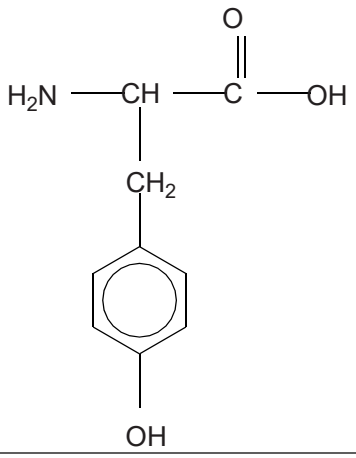
(ii) Draw 3-D diagrams for the two optical isomers of the α-amino acid cysteine, where R is CH_2SH. [2]

(iii) α-Amino acids are being used in the development of peptide-based pharmaceuticals. Optical isomerism has been found to be significant in the action of some pharmaceuticals.

- State **two** possible disadvantages of synthesising a peptide-based pharmaceutical that contains a mixture of optical isomers.
- State **two** methods that are used by manufacturers to synthesise pharmaceuticals containing just the required optical isomer.

In your answer, you should use appropriate technical terms, spelled correctly. [4]

(d) The structures of the α-amino acids isoleucine, leucine and tyrosine are shown below.

		
isoleucine	**leucine**	**tyrosine**

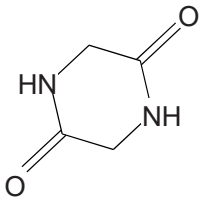
Predict the number of peaks in the carbon-13 spectrum of each of these α-amino acids.

α-amino acid	**isoleucine**	**leucine**	**tyrosine**
number of peaks			

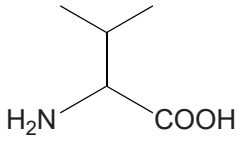
[3]

(e) When strongly heated, an α-amino acid can form a cyclic 'dimer' in a condensation reaction.

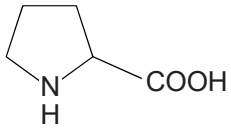
For example, glycine, where R is H, forms the cyclic dimer shown below.



Draw the structures of the cyclic dimers that could be formed from the α-amino acids valine and proline, shown below.



valine



proline

cyclic dimer formed from valine	**cyclic dimer formed from proline**

[2]

[Total 19 Marks]

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

(a) The α-amino acid cysteine ($R = CH_2SH$) shows optical isomerism.

Draw 3-D diagrams to show the optical isomers of cysteine. **[2]**

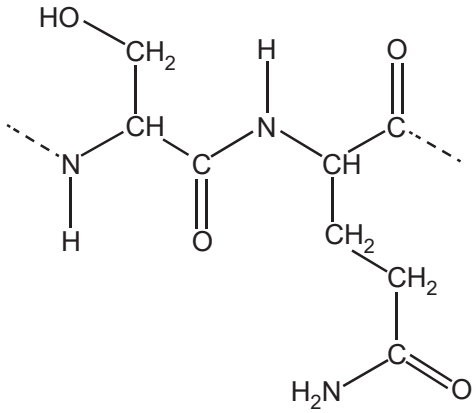
(b) The α-amino acid lysine ($R = (CH_2)_4NH_2$) reacts with an excess of dilute hydrochloric acid to form a salt.

Draw the structure of the salt formed in this reaction.

[2]

(c) α-Amino acids can react to form proteins.

A short section of a protein chain is shown below.



A student hydrolyses the protein with hot NaOH(aq).

Draw the structures of the organic products formed from this section of the protein. **[3]**

(Total 7 marks)