EXAM PAPERS PRACTICE

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Time allowed
70 Minutes

Score /58

Percentage %

CHEMISTRY

OCR AS & A LEVEL

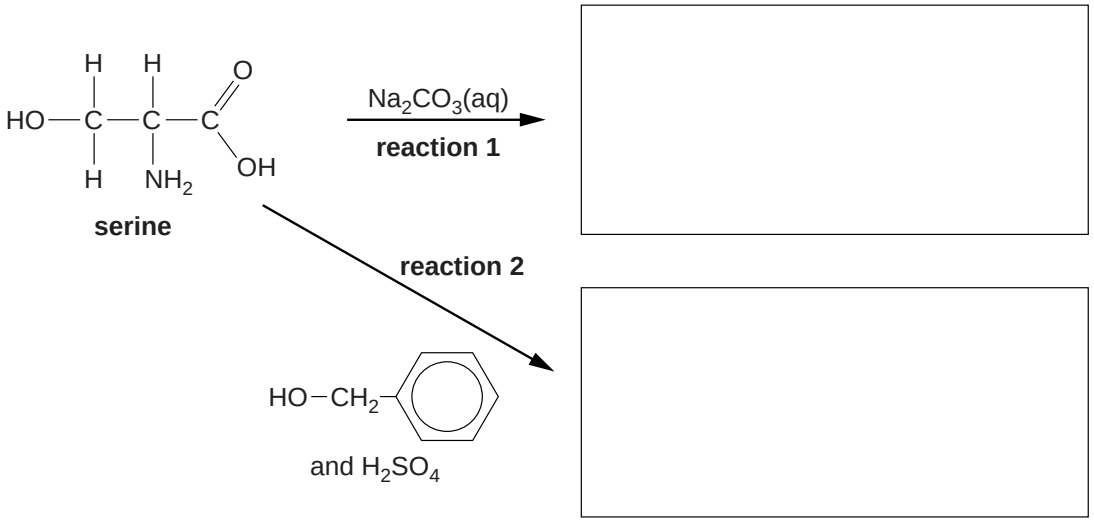
Topic Questions

Module 6: Organic chemistry and analysis

1 Many α-amino acids have several functional groups.

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

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



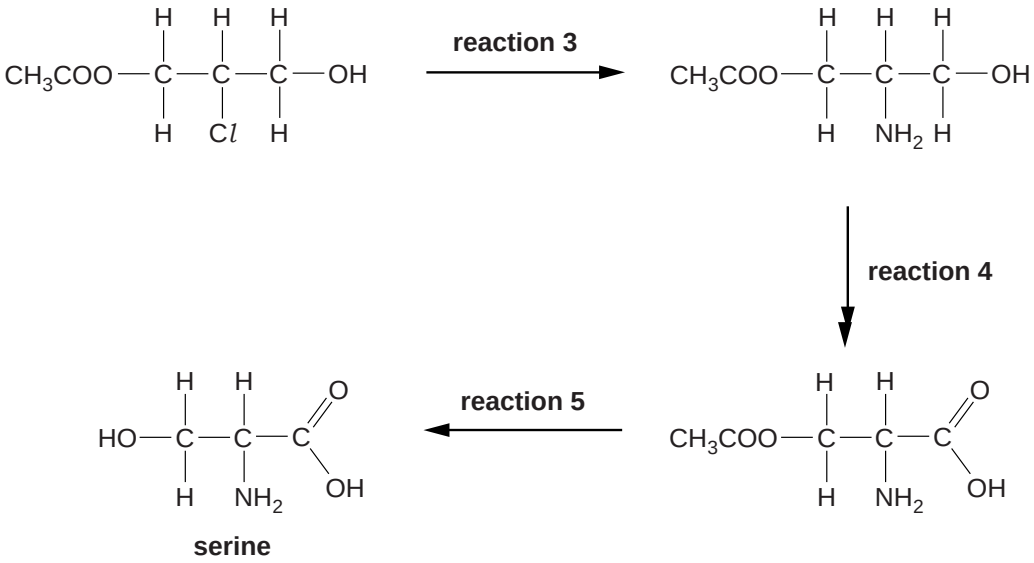
[3]

(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]

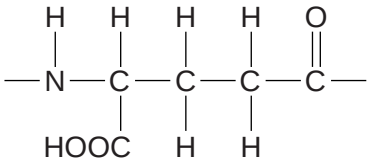
(b) Compound **E**, C_4H_7NO, is one of two optical isomers. It can be oxidised by Tollens' reagent to an α-amino acid, **F**.

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**.
- Desc ibe 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]

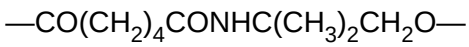
(ii) A student tried to prepare poly(glutamic acid) from glutamic acid. No polymer was found in the product mixture.

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.

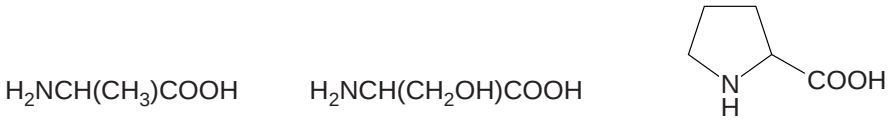
Suggest why polymer **J** is able to be washed away easily with hot water.

.....

..... **[1]**

[Total: 20]

2 Alanine, serine and proline are α-amino acids.



alanine **serine** **proline**

(a) **(i)** Alanine and serine react together to form two different dipeptides.

Draw the structures of the **two** dipeptides that can form when alanine and serine react together.

[2]

(ii) The isoelectric points of alanine and serine are shown below.

alanine, pH = 6.0

serine, pH = 5.6

Draw the structures of the ions formed at the following pH values.

structure of **alanine** ion at **pH 6.0**

structure of **serine** ion at **pH 10.0**

[2]

(iii) Proline can polymerise to form poly(proline).

Draw the structure of the repeat unit in poly(proline).

[1]

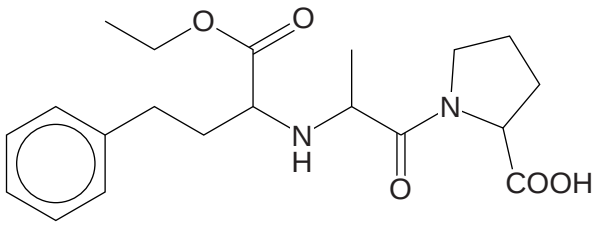
(b) A solution of serine was shaken with a few drops of D_2O. The solution was then analysed using ^1H NMR spectroscopy.

Complete the table to predict the ^1H NMR spectrum of serine after the addition of D_2O.

^1H NMR spectrum for serine		
Chemical shift, δ / ppm	**Relative peak area**	**Splitting pattern**

[2]

(c) Enalapril is a drug used in the treatment of high blood pressure.



enalapril

(i) **On the structure above**, mark each chiral centre with an asterisk (*). **[1]**

(ii) Suggest **two** benefits of using single stereoisomers in the synthesis of drugs such as enalapril.

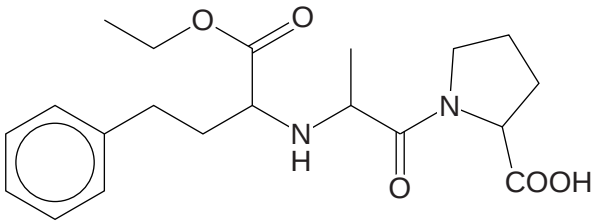
.....

.....

.....

..... **[2]**

(iii) Enalapril is broken down in the body by acid hydrolysis.



enalapril

Draw the structures of the **three** organic products of the **acid hydrolysis** of enalapril.

[4]

(iv) A scientist hydrolysed enalapril in the laboratory. The scientist then analysed the mixture of products using GC–MS.

Explain how GC–MS enables the products to be identified.

.....

.....

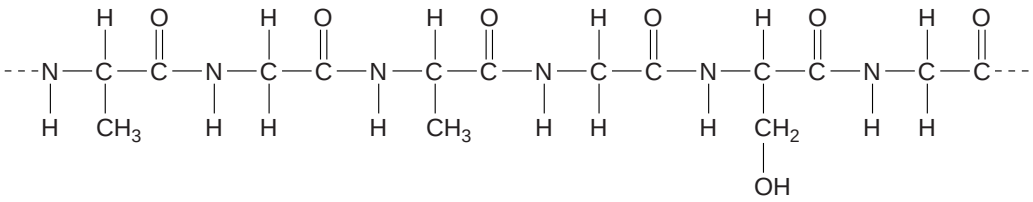
..... **[1]**

[Total: 15]

3 Many modern textiles are created using a mixture of natural and synthetic polymers.

(a) Silk is a natural fibre. It is made up of two main proteins, fibroin and sericin.

A section of a **fibroin** strand is shown below.



(i) Proteins are natural condensation polymers.

State what is meant by a *condensation polymer*.

.....

..... **[1]**

(ii) A student hydrolysed a sample of fibroin protein. She analysed the amino acids that were formed from the hydrolysis. She found that fibroin contained the amino acid glycine, H_2NCH_2COOH.

Draw the structures of the **two** other amino acids that make up the section of fibroin shown in the diagram above.

[2]

(iii) The isoelectric point of glycine is 5.8.

Define the term *isoelectric point* and draw the structure of glycine at its isoelectric point.

isoelectric point .....

.....

[2]

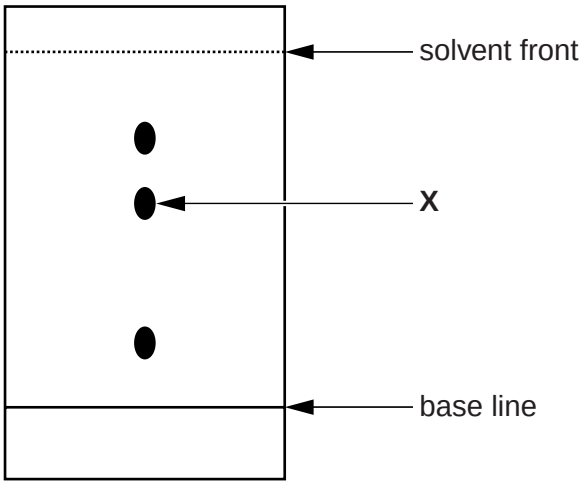
(b) The student then hydrolysed a section of sericin protein. She analysed the amino acids formed using Thin-Layer Chromatography (TLC).

(i) Name the process by which TLC separates amino acids.

..... **[1]**

(ii) The chromatogram the student obtained, and a table of R_f values for amino acids, are shown below.

Estimate the R_f value for the amino acid found at **X**. Hence identify the amino acid found at **X**.



Amino acid	R_f value
alanine	0.38
aspartic acid	0.15
glycine	0.26
leucine	0.75
methionine	0.58
threonine	0.35

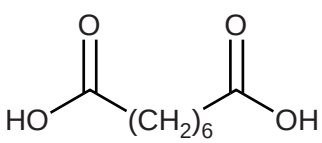
.....

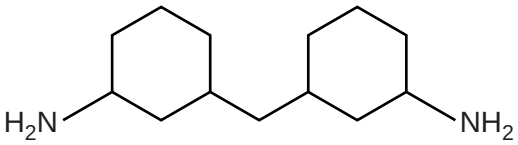
.....

..... **[2]**

(c) *Quiana* is a synthetic polymer that can be spun into a soft, silky fabric.

The monomers used to make *Quiana* are shown below.

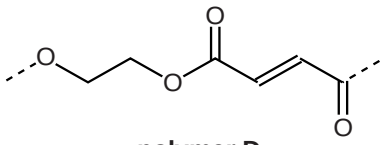




Draw the repeat unit of the polymer formed from these two monomers.

[2]

(d) Polymer **D** has been developed by the textile industry. The repeat unit of polymer **D** is shown below.



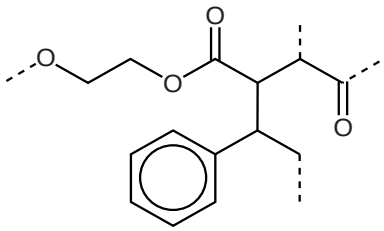
polymer D

(i) Polymer **D** is a condensation polymer.

Draw the structure of each of the monomers that make up polymer **D**.

[2]

(ii) Polymer **D** reacts with a third monomer to form an addition polymer. The repeat unit of this polymer is shown below.



addition polymer

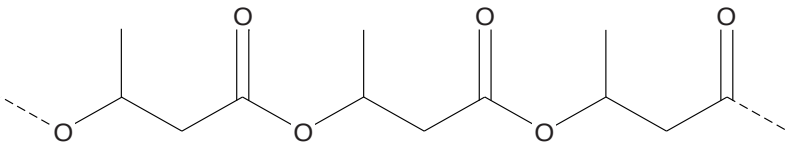
Draw the structure of the third monomer.

[1]

[Total: 13]

4 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.

explanation .....

.....

formula of salt ..... **[2]**

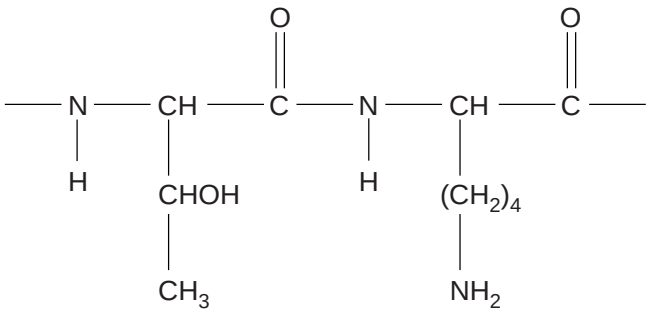
(iii) Draw the repeat unit of nylon-4,6.

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]