Nitrogen Compounds

Question Paper 5

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Nitrogen Compounds
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 5

Time Allowed: **71 minutes**

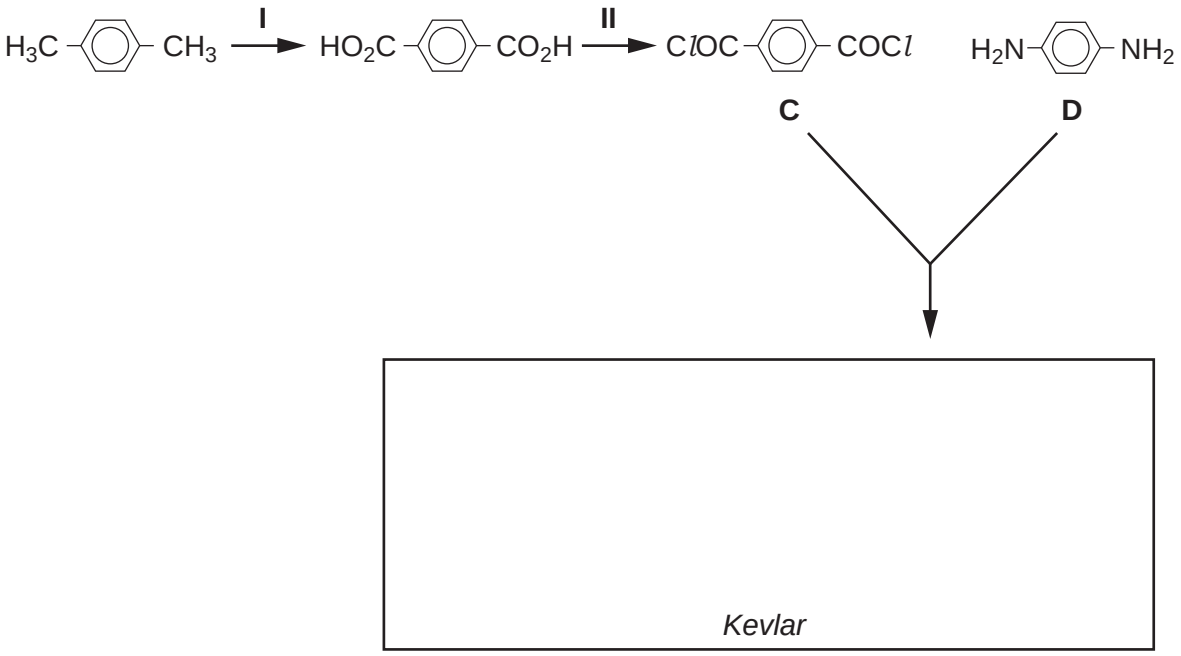
Score: **/59**

Percentage: **/100**

Grade Boundaries:

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

1 *Kevlar* is a tough polyamide used in bullet-proof vests and high-specification bicycle tyres. It can be manufactured by the following process.



(a) **(i)** Suggest reagents and conditions for

reaction **I**, ...

reaction **II**. .....

(ii) Draw the structural formula of **one** repeat unit of *Kevlar* in the box above.

[4]

(b) The di-acid chloride **C** reacts with a variety of reagents. Suggest the structural formulae of the products of the reaction of **C** with

(i) CH_3NH_2,

(ii) $HOCH_2CH_2OH$.

[3]

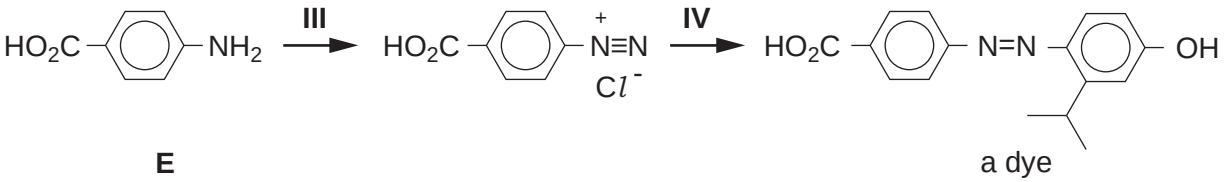
(c) The diamine **D** also reacts with a variety of reagents. Suggest the structural formulae of the products of the reaction of **D** with

(i) HC*l*(aq),

(ii) Br_2(aq).

[3]

(d) 4-aminobenzoic acid, **E**, is a useful intermediate for making dyes.



E a dye

Suggest reagents and conditions for

reaction **III**, ...

reaction **IV**. .....

[4]

(e) 4-aminobenzoic acid, **E**, forms a zwitterion.

(i) What is meant by the term *zwitterion*?

.....

.....

(ii) Draw the structural formula of the zwitterion formed from 4-aminobenzoic acid.

[2]

[Total: 16]

2 **(a)** Explain, using diagrams where appropriate, the types of interaction responsible for the primary, secondary and tertiary structure of a protein.

primary structure

.....

.....

.....

secondary structure

.....

.....

.....

tertiary structure

.....

.....

..... [6]

(b) Enzymes are particular types of protein molecule. Explain briefly how enzymes are able to help to break down molecules in the body.

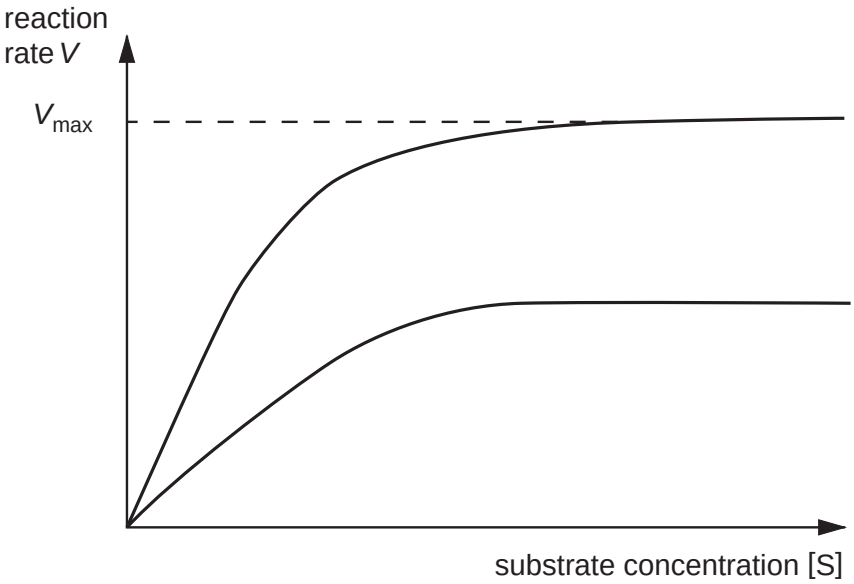
.....

.....

.....

..... [2]

(c) The graph below shows the effect of inhibition on an enzyme-catalysed reaction.



State the type of inhibition shown, giving a reason to support your answer.

type of inhibition .....

reason .....

..... [2]

[Total: 10]

3 **(a)** Explain briefly what is meant by the word *protein*.

.....

..... [1]

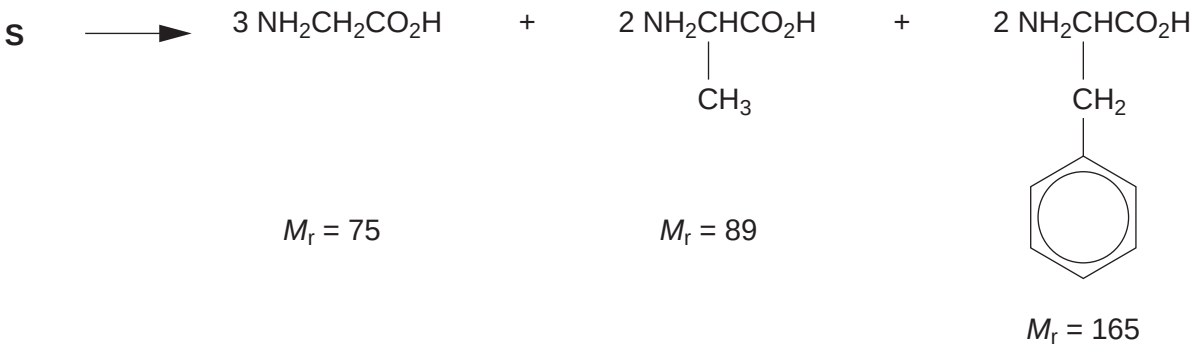
(b) Describe how peptide bonds are formed between amino acids during the formation of a tripeptide. Include diagrams and displayed formulae in your answer.

..... [3]

(c) Describe how proteins can be broken down into amino acids in the laboratory **without** the aid of enzymes.

..... [2]

(d) When a small polypeptide **S** was broken down in this way, three different amino acids were produced according to the following reaction.



(i) How many peptide bonds were broken during this reaction?

.....

(ii) Calculate the M_r of the polypeptide **S**.

M_r = ...
[3]

[Total: 9]

4(a) Electrophoresis can be used to separate amino acids which are produced by the hydrolysis of a polypeptide.

Using glycine as an example, explain why the result of electrophoresis depends on pH.

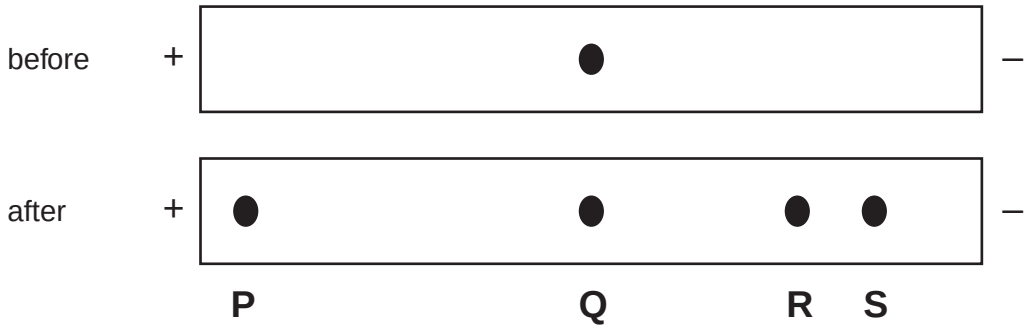
.....

.....

.....

.....[3]

(b) The diagram below shows the results of electrophoresis in neutral solution. At the start of the experiment a spot of a solution containing a mixture of amino acids **P**, **Q**, **R** and **S** was placed in the middle of the plate. Following electrophoresis the amino acids had moved to the positions shown in the lower diagram.



(i) Which amino acid existed mainly as a zwitterion in the buffer solution? Explain your answer.

.....

.....

(ii) Assuming amino acids **R** and **S** carry the same charge when in this buffer solution, which is likely to be the larger molecule? Explain your answer.

.....

.....
[2]

(c) Amino acids may also be separated by using two-dimensional paper chromatography. This involves putting a spot of the mixture on the corner of a piece of chromatography paper and allowing a solvent to soak up the paper. The paper is then dried, turned through 90° and placed in a second solvent. This method gives better separation than a one solvent method.

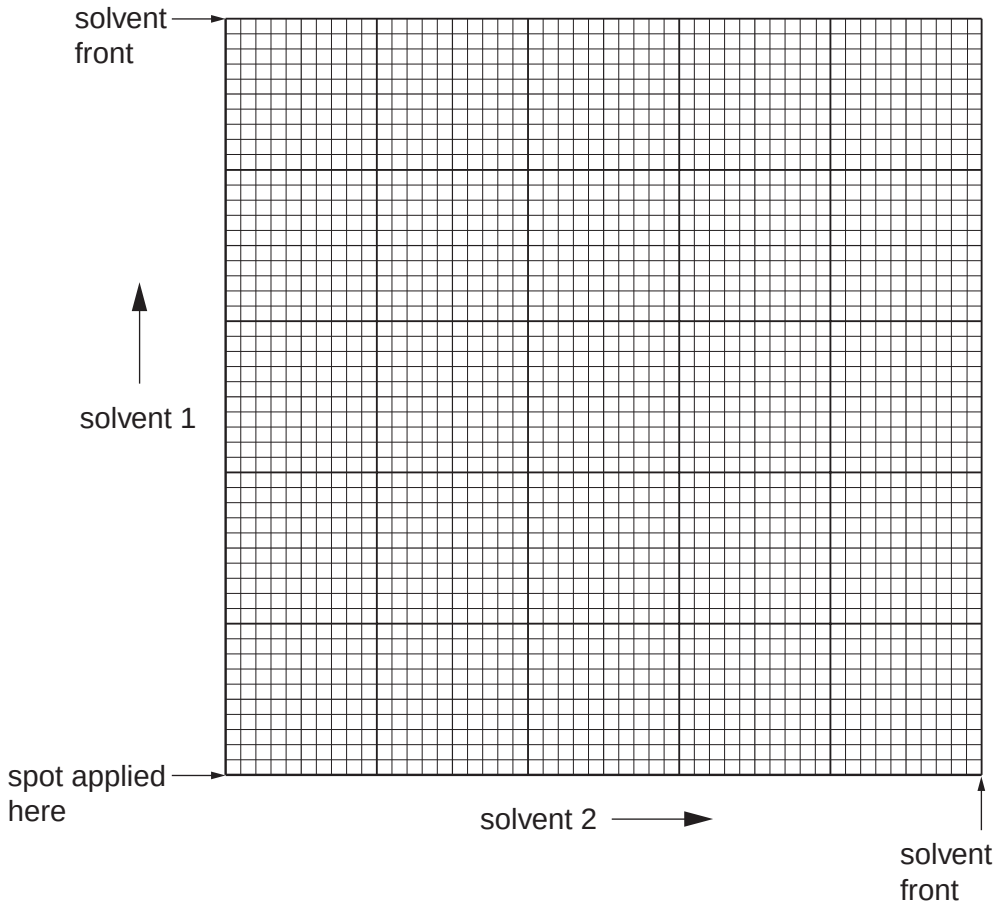
(i) Paper chromatography relies on partition between the solvent applied and another phase.

What is this second phase? .....

(ii) The table below shows the R_f values for some amino acids in two different solvents.

amino acid	R_f solvent 1	R_f solvent 2
A	0.1	0.2
B	0.0	0.4
C	0.3	0.0
D	0.8	0.9
E	0.6	0.5

Use the grid below to plot the positions of the amino acids after two-dimensional paper chromatography using solvent 1 followed by solvent 2.



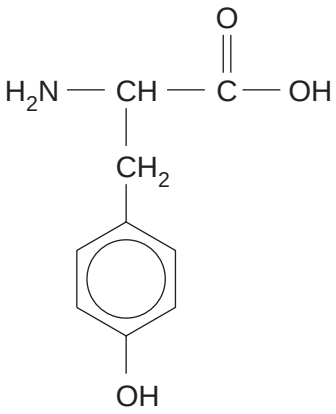
(iii) Which amino acid travelled fastest in **both** solvents? .....

(iv) Which amino acid did not move at all in solvent 2? .....

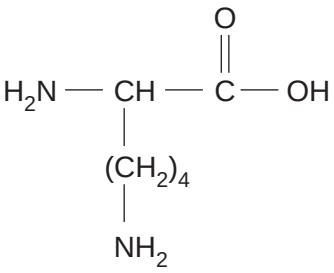
[5]

[Total: 10]

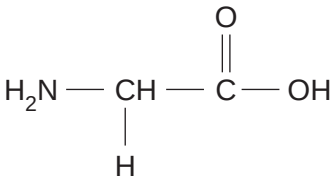
5 The amino acids tyrosine, lysine and glycine are constituents of many proteins.



tyrosine



lysine



glycine

(a) State the reagents and conditions you could use to break proteins down into amino acids.

..... [2]

(b) Draw a ring around each chiral centre in the above molecules. [1]

(c) In aqueous solution amino acids exist as zwitterions. Draw the zwitterionic structure of glycine.

..... [1]

(d) For each of the following reactions, draw the structure of the organic compound formed.

(i) glycine + excess NaOH(aq)

.....

(ii) tyrosine + excess NaOH(aq)

.....

(iii) lysine + excess HC*l* (aq)

.....

(iv) tyrosine + excess Br_2(aq)

.....
[5]

(e) Draw the structural formula of a tripeptide formed from **all three** of these amino acids, showing clearly the peptide bonds.

..... [2]

(f) The formula of part of the chain of a synthetic polyamide is shown below.

CO NH CH_2 CH_2 NH CO CO NH CH_2 CH_2 NH

(i) Identify the repeat unit of the polymer by drawing square brackets around it on the above formula.

(ii) Draw the structures of the **two** monomers from which the polymer could be made.

.....
[3]

[Total: 14]