

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

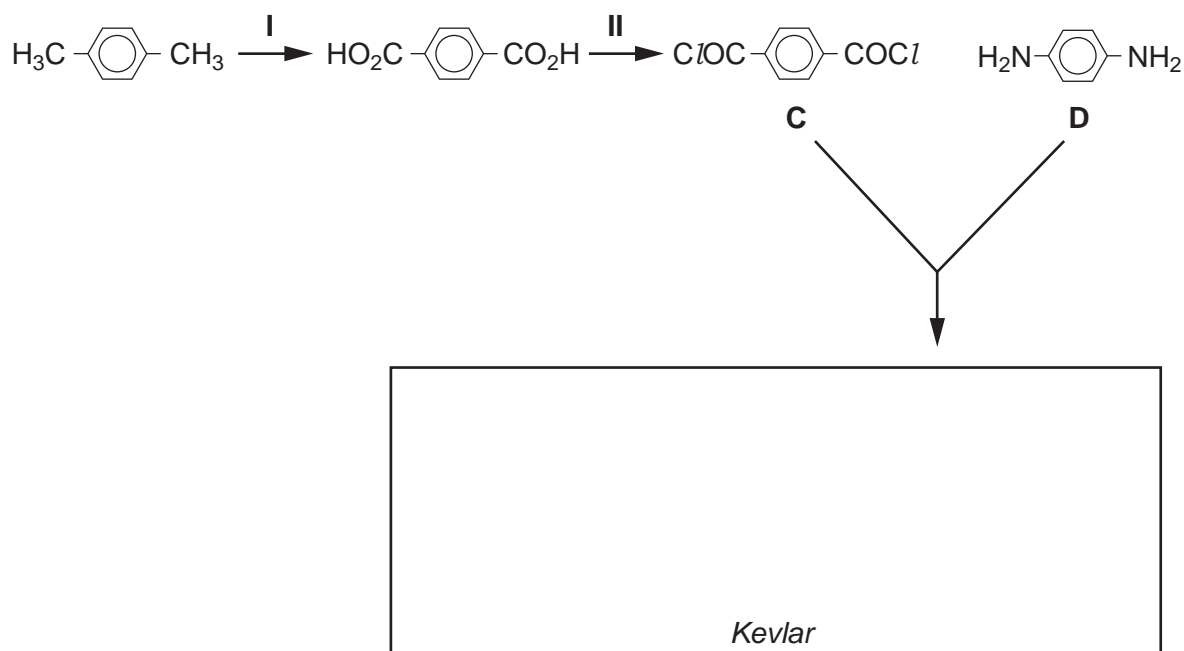
Score: /59

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	77.5%	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) $\text{HOCH}_2\text{CH}_2\text{OH}$.

[3]

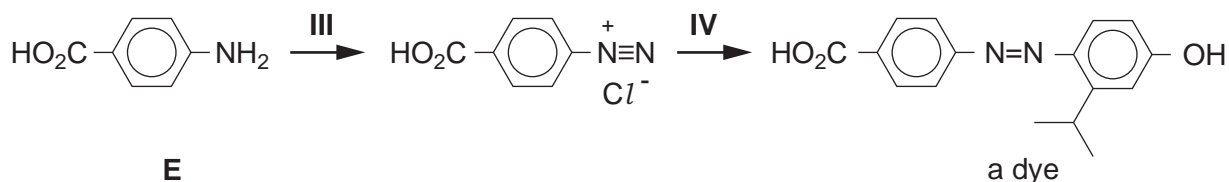
(c) The diamine **D** also reacts with a variety of reagents. Suggest the structural formulae of the products of the reaction of **D** with

(i) $\text{HCl}(\text{aq})$,

(ii) $\text{Br}_2(\text{aq})$.

[3]

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



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

.....

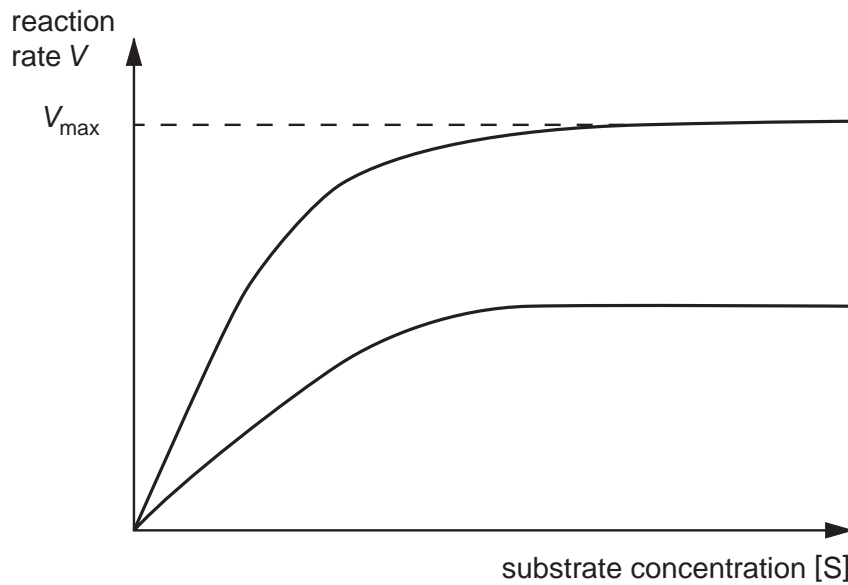
.....

..... [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]

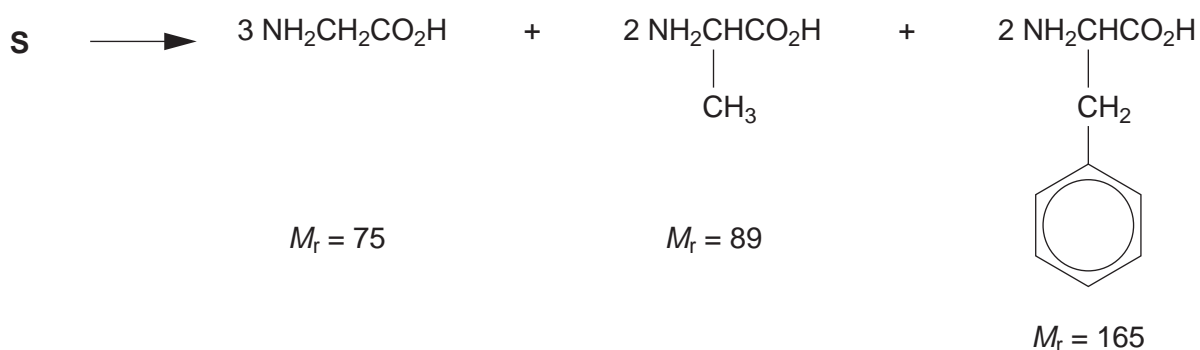
- (b) Describe how peptide bonds are formed between amino acids during the formation of a tripeptide. Include diagrams and displayed formulae in your answer.

..... [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]

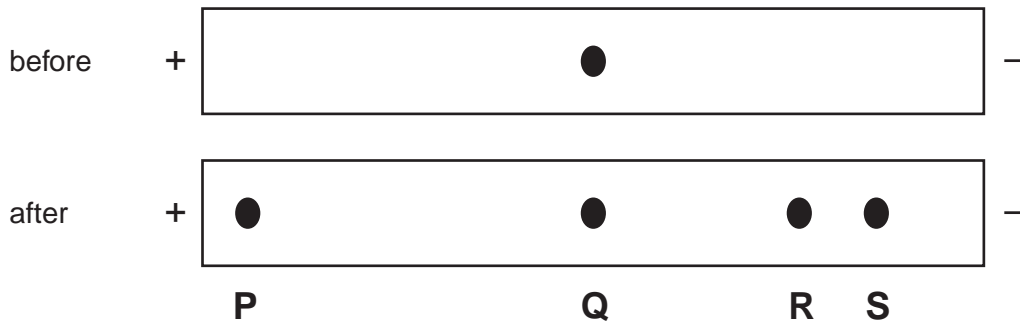
- 4(a) Electrophoresis can be used to separate amino acids which are produced by the hydrolysis of a polypeptide.

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.

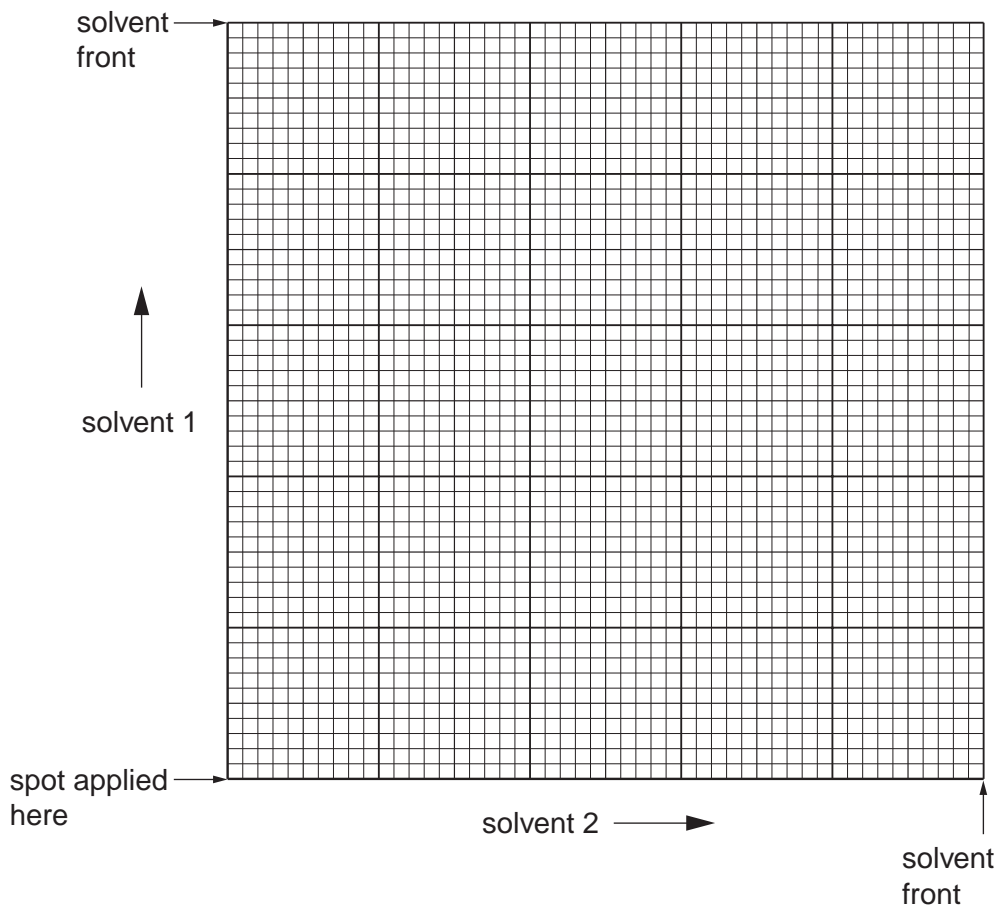
- (i) Paper chromatography relies on partition between the solvent applied and another phase.

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.

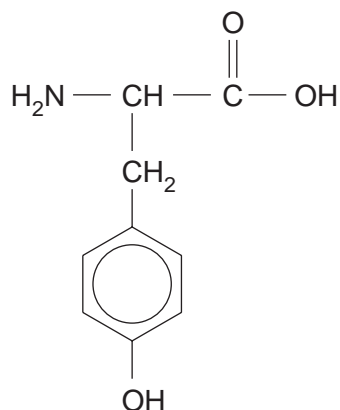


- (iii) Which amino acid travelled fastest in **both** solvents?
- (iv) Which amino acid did not move at all in solvent 2?

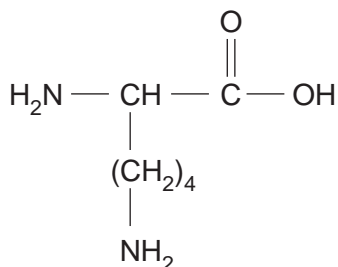
[5]

[Total: 10]

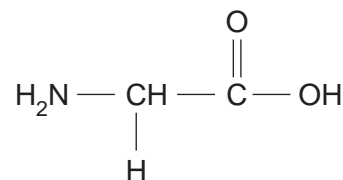
- 5 The amino acids tyrosine, lysine and glycine are constituents of many proteins.



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 HCl (aq)

.....

(iv) tyrosine + excess Br₂(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.



(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]