Nitrogen Compounds

Question Paper 7

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Nitrogen Compounds
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 7

Time Allowed: **80 minutes**

Score: **/66**

Percentage: **/100**

Grade Boundaries:

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

1 **(a)** Organohalogen compounds can undergo hydrolysis.

$$R\text{–}Cl + H_2O \rightarrow R\text{–}OH + HCl$$

State the relative rates of hydrolysis of the following compounds.

$CH_3CH_2CH_2Cl$ CH_3CH_2COCl C_6H_5Cl

Explain your answer.

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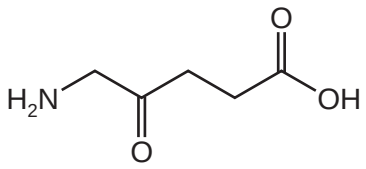
..... [3]

(b) Aminolaevulinic acid is involved in the synthesis of haemoglobin and chlorophyll.



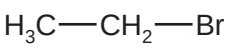
aminolaevulinic acid

Name the **three** functional groups in aminolaevulinic acid.

..... [2]

(c) Aminolaevulinic acid reacts readily with bromoethane.

(i) Show the mechanism of the **first step** of this reaction on the diagram. Include all necessary curly arrows, lone pairs and relevant dipoles.



(ii) Name the mechanism in **(c)(i)**.

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(iii) Identify the non-organic product formed in this reaction.

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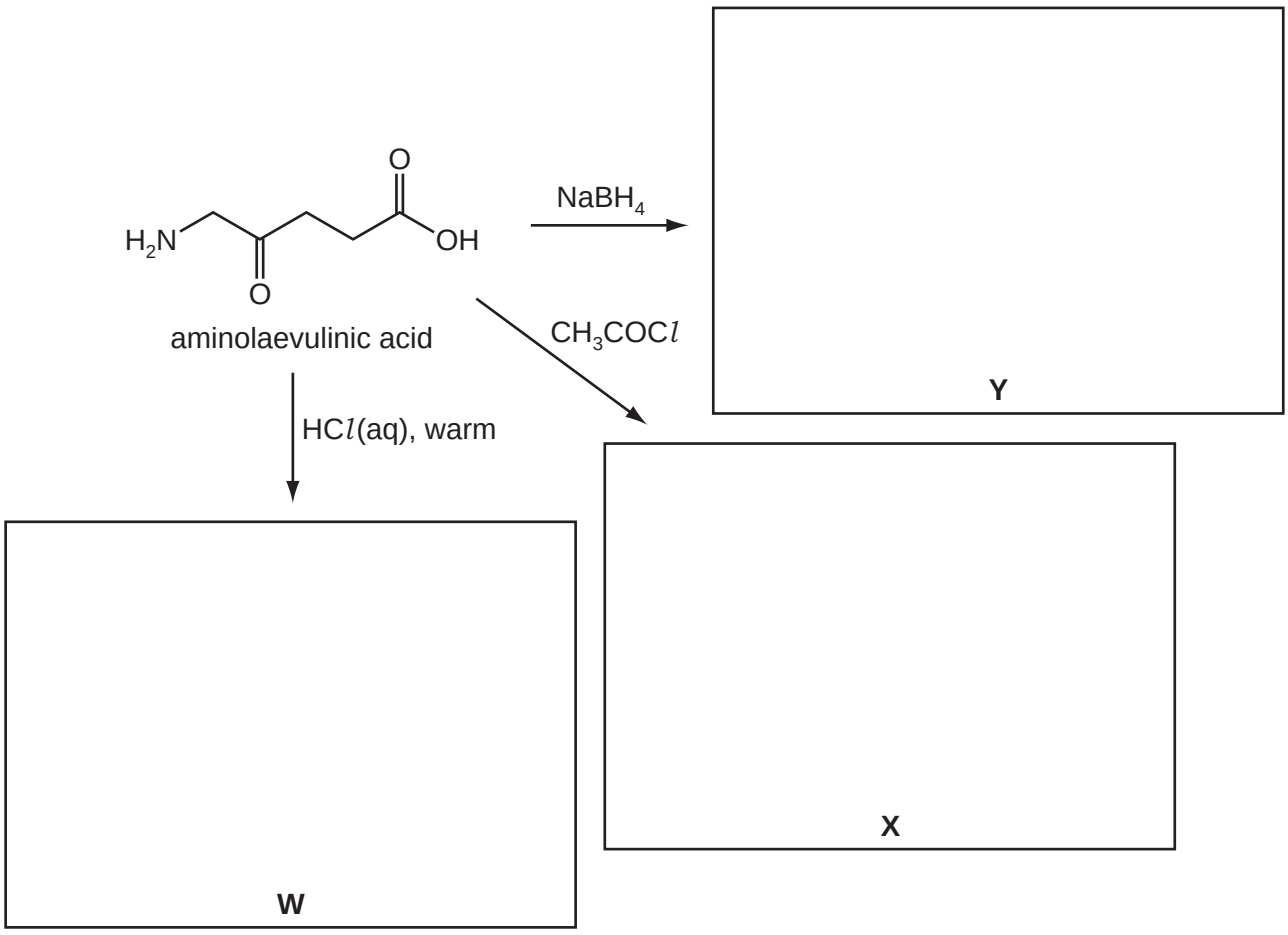
[5]

(d) Three reactions of aminolaevulinic acid are shown. Draw the structures of the products **W**, **X** and **Y** in the boxes below.



[3]

(e) Aminolaevulinic acid can undergo polymerisation.

Draw the structure of the polymer showing **two** repeat units. The linkages between the monomer units should be shown fully displayed.

[2]

[Total: 15]

2 **(a)** A mixture of amino acids can be separated by electrophoresis. During an electrophoresis experiment,

- different amino acids move in different directions,
- different amino acids move at different speeds,
- some amino acids do not move at all.

Explain these observations.

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..... [3]

(b) **(i)** A mixture of amino acids can also be separated by thin-layer chromatography. Identify the mobile and the stationary phases in this type of chromatography.

mobile phase .....

stationary phase .....

(ii) What is the process by which thin-layer chromatography can separate a mixture?

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[3]

(c) State **three** structural features of DNA.

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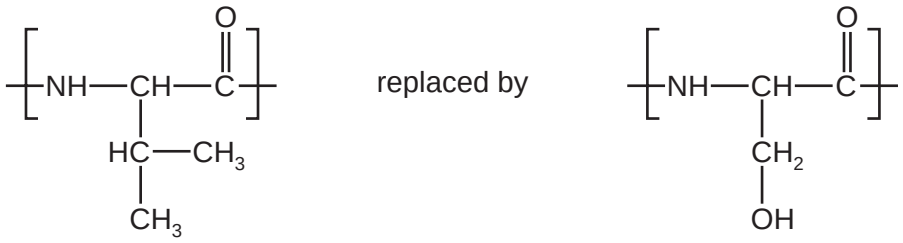
..... [3]

(d) Some diseases are caused by a mutation in the DNA base sequence which results in one amino acid being replaced by another during protein synthesis.
Suggest what changes in the interactions that form the tertiary structure would result from a mutation that replaced a valine residue with a serine residue.



val ser

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..... [2]

[Total: 11]

3 There are two important polymerisations that occur within living organisms – protein synthesis and the formation of DNA.

(a) Complete the table by placing a tick (✓) in the correct column to indicate in which process each substance could be used.

substance	protein synthesis	formation of DNA
cysteine		
cytosine		
glutamine		
guanine		

[3]

(b) DNA consists of a double helical structure.

(i) Describe the bonding between the two strands in DNA and state which part of each strand is joined by it.

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(ii) How does the strength of this bonding relate to the mechanism of the replication of DNA?

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[4]

(c) Some diseases are caused by changes in the structure of proteins. Explain the genetic basis of these changes.

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[3]

[Total: 10]

4 Ammonia, NH_3, and methane, CH_4, are the hydrides of elements which are next to one another in the Periodic Table.

(a) In the boxes below, draw the 'dot-and-cross' diagram of a molecule of **each** of these compounds. Show outer electrons only.
State the shape of **each** molecule.

NH_3	CH_4
shape	shape

[3]

(b) Ammonia is polar whereas methane is non-polar. The physical properties of the two compounds are different.

(i) Explain, using ammonia as the example, the meaning of the term *bond polarity*.

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(ii) Explain why the ammonia molecule is polar.

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(iii) State **one** physical property of ammonia which is caused by its polarity.

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[4]

(c) When ammonia gas is mixed with hydrogen chloride, white, solid ammonium chloride is formed.

State **each type** of bond that is present in one formula unit of ammonium chloride and how many of each type are present.
You may draw diagrams.

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..... [3]

[Total: 10]

5 (a) Enzymes are particular types of proteins that catalyse chemical reactions. The ef ficiency of enzymes can be reduced by the presence of other substances known as inhibitors.

(i) State **one** example of a substance that can act as a *non-competitive* inhibitor in enzyme reactions.

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(ii) For the inhibitor you have identified, explain why it is a non-competitive inhibitor.

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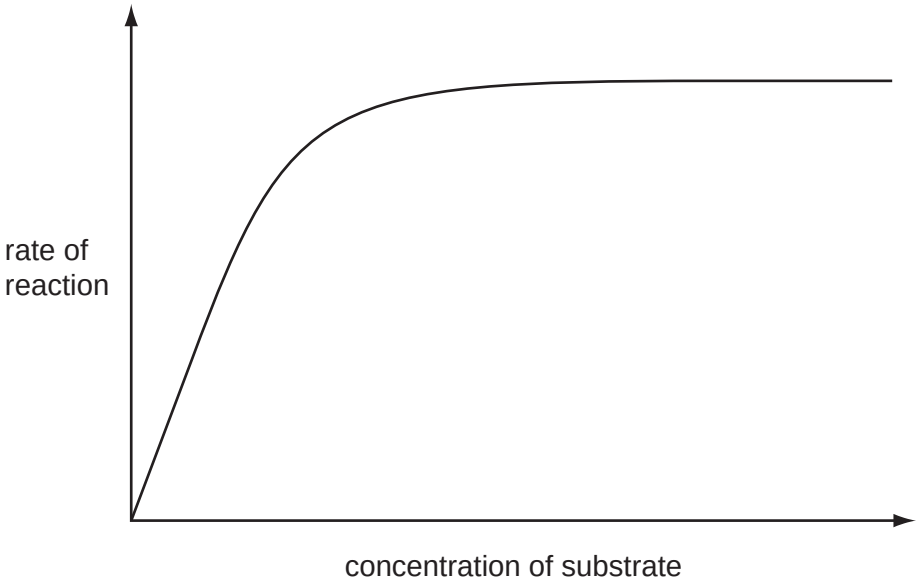
(iii) The graph shows the rate of an enzyme-catalysed reaction against the substrate concentration in the absence of an inhibitor.



On the same axes, sketch a graph showing the rate of this reaction if a *competitive inhibitor* was present.

[4]

(b) DNA is responsible for encoding the amino acid sequence to produce proteins.

Ribosome, tRNA and mRNA are all involved in the process of protein synthesis.

(i) Write ribosome, tRNA and mRNA in the boxes below to show the correct sequence in which they are involved.

(ii) Sequences of three bases code for specific amino acids. The code UGA however does not usually code for an amino acid. Suggest its use.

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[3]

(c) Much of the energy used in biochemical reactions is provided by the hydrolysis of the molecule ATP.

(i) What are the breakdown products of the hydrolysis of ATP?

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(ii) Give **two** uses for the energy released by ATP hydrolysis in cells.

1. .....

2. .....

[3]

[Total: 10]

6 In key reactions responsible for growth and repair in the human body, amino acids react together to form polymers known as proteins.

(a) What *type of reaction* is this polymerisation?

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(ii) From stocks of glycine and alanine, it is possible to make the dipeptide gly-ala.
Using the same three-letter abbreviations for the amino acids, give the structures of all other possible dipeptides that can be made from these stocks of amino acids.

[3]

(b) DNA consists of a double helix formed by two strands held together by hydrogen bonds between base pairs.
Sketch a section of DNA showing **two** base pairs, using blocks for the various components. You should label all of the components.

(ii) Suggest what the effect on DNA replication would be if the hydrogen bonds between the strands were replaced by stronger bonds, e.g. covalent bonds.

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[4]

(c) Some diseases, such as sickle-cell anaemia, are caused by mutation resulting in a change in the triplet code.

(i) Explain why some changes in the triplet code do **not** result in a change in the primary structure of a protein.

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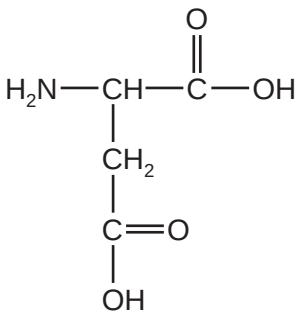
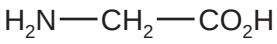
(ii) Suggest what change in the tertiary structure of a protein would result from a mutation that replaced aspartic acid with glycine.



aspartic acid



glycine

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(iii) Sometimes a mutation can result in the *deletion* of a single base in DNA (or RNA). Explain why this is likely to have more serious consequences for the protein than the *replacement* of one base by another.

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[3]

[Total: 10]