EXAM QUESTIONS ON

4.1.4 AMINES

4.2.1 AMINO ACIDS AND CHIRALITY

4.2.2 POLYESTERS AND POLYAMIDES

4.2.3 SYNTHESIS

TOTAL 130 MARKS

Mark: /130	%	Grade:

2 Amines are commonly occurring compounds. Ethylamine, $C_2H_5NH_2$, is a primary amine responsible for the smell of decaying fish.

(a) Explain the meaning of the term *primary amine*.

.....

..... [1]

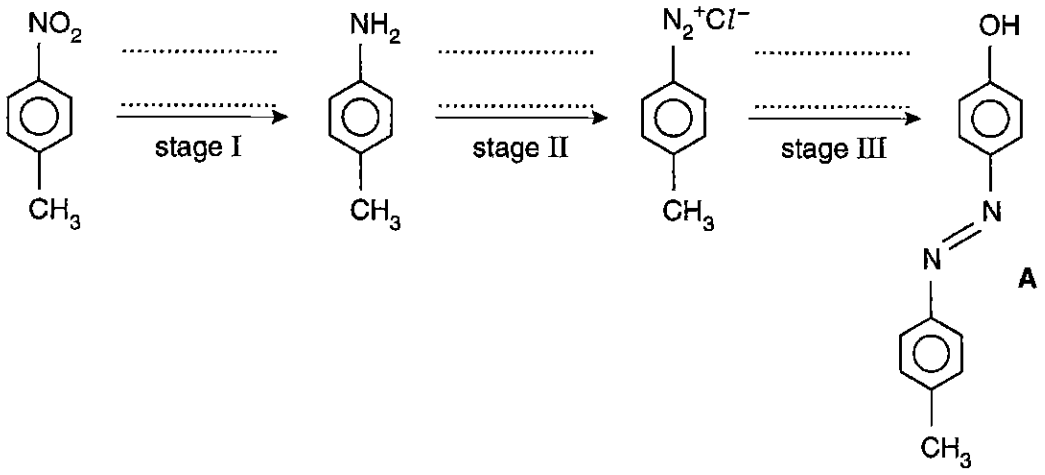
(b) Ethylamine and phenylamine are bases.

Write an equation to show ethylamine acting as a base.

..... [2]

(c) Aromatic amines such as phenylamine are intermediates in the synthesis of many other compounds such as **A** below.

(i) Complete the scheme by writing the reagents on the lines provided.



[5]

(ii) Write the equations for stages I and III.

stage I

stage III [2]

(iii) State a general use for compounds such as **A**.

..... [1]

[Total : 11]

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5 A diagram of a section of nylon-6,6 is shown below.

$$—CO(CH_2)_4CONH(CH_2)_6NHCO(CH_2)_4CONH(CH_2)_6NH—$$

(a) Identify the monomer(s) from which nylon-6,6 is obtained.

.....

..... [2]

(b) State and explain the type of polymerisation reaction which gives nylon-6,6.

.....

.....

..... [2]

(c) Proteins and polypeptides are polymers which have been described as being similar to nylon-6,6.

Suggest with the aid of diagrams and equations.

- **one** structural similarity
- **one** chemical similarity
- **one** important difference

(In this question, 1 mark is available for the quality of written communication.)

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..... [7]

[Total : 11]

Exa

7 The α-amino acid glycine, H_2NCH_2COOH, is used as a poultry feed additive and in the fertiliser industry. There are twenty naturally occurring α-amino acids.

(a) Draw the general formula for an α-amino acid.

[1]

(b) In the crystalline state, glycine contains zwitterions.

(i) Draw the structure of the zwitterion of glycine.

[1]

(ii) Explain how this zwitterion arises.

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.....

..... [2]

(iii) Crystals of glycine melt between 230 and 235°C. Explain why the melting point of glycine is higher than that of hydroxyethanoic acid, $HOCH_2COOH$ (m.p. 75–80 °C).

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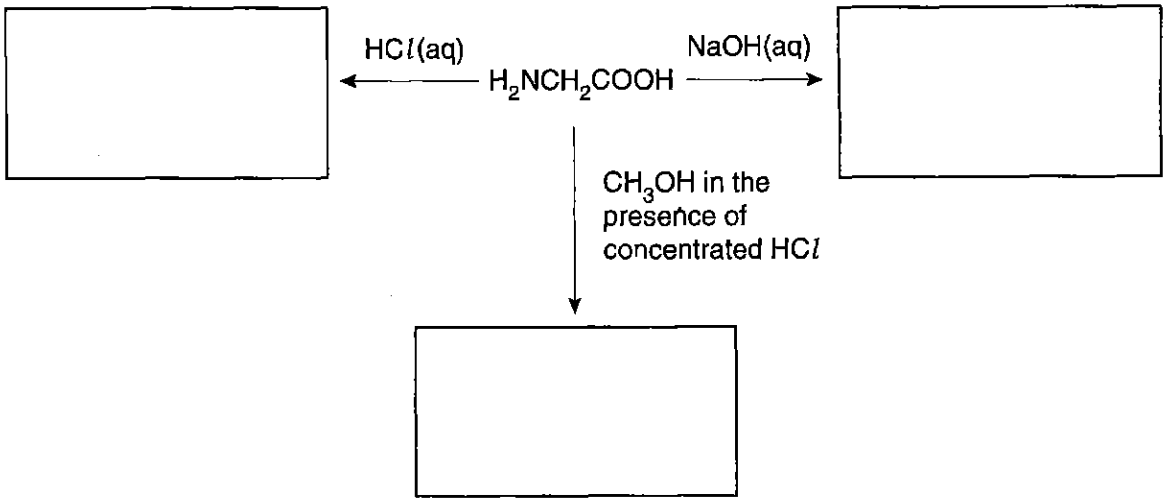
..... [3]

(c) In the boxes below, draw suggested structures for the organic products obtained from glycine.



[4]

[Total : 11]

4 Describe the synthesis of a diazonium salt from phenylamine. Explain why diazonium salts are important.

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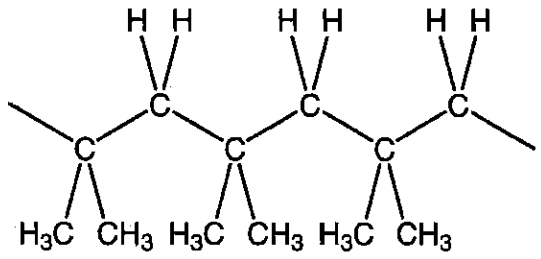
..... [6]

[Total : 6]

For Examiner Use

5 **(a)** A section of a polymer has the structure shown below.



(i) Circle a repeat unit of this polymer on the diagram above. [1]

(ii) Deduce the empirical formula of this polymer.

..... [1]

(iii) Draw a structure for a monomer from which this polymer could be made. Your structure should show any multiple bonds.

[1]

(b) Proteins are natural polymers made from α-amino acids, such as glycine, H_2NCH_2COOH.

(i) Name the functional group made during amino acid polymerisation and draw its displayed formula.

name of functional group .....

displayed formula of functional group:

[2]

(ii) Name this type of polymerisation reaction.

..... [1]

(iii) Draw a displayed and a skeletal formula for the dipeptide **H**, $C_4H_8N_2O_3$, made from glycine, H_2NCH_2COOH.

displayed formula of **H**

skeletal formula of **H**

[2]

(iv) A student made 1.10 g of dipeptide **H** starting from 1.40 g of glycine.

Calculate the percentage yield obtained. Give your answer to 3 significant figures.

Percentage yield ..... % [4]

(v) When glycine is treated with hydrochloric acid a compound **J**, $C_2H_6ClNO_2$, is formed. Draw a structure for compound **J**.

[2]

[Total : 14]

8 *In this question, two marks are available for the quality of written communication.*

Explain the different types of isomerism encountered in organic chemistry.

Outline the importance of stereoisomerism in the synthesis and use of compounds as pharmaceuticals.

In your answer use diagrams of suitable examples to illustrate both structural isomerism and stereoisomerism.

[10]

Quality of Written Communication [2]

[Total : 12]

For Examiner's Use

2 Glycine is an amino acid obtained from natural proteins by digestion.
The structure of glycine is $CH_2(NH_2)COOH$.

(a) State **in words** the three dimensional shape adopted by the **bonds** in a molecule of glycine

(i) around the nitrogen atom,

.....[1]

(ii) around the carbon atom of the CH_2 group,

.....[1]

(iii) around the carbon atom of the COOH group.

.....[1]

(b) Amino acids react both with acids and with bases.
Draw the structure you expect for glycine

(i) in acidic solution,

[1]

(ii) in alkaline solution.

[1]

(c) Proteins can also be converted into amino acids in the laboratory.

(i) State the reagents and conditions required.

.....[2]

(ii) State the type of reaction taking place.

.....[1]

For Examiner's Use

(d) Alanine, $CH_3CH(NH_2)COOH$, is another amino acid obtained from proteins. Alanine has a chiral centre but glycine does not.

(i) What is meant by the term *chiral centre*?

.....

.....[1]

(ii) Draw the two stereoisomers of alanine.

[2]

(iii) Would you expect the alanine isolated from a protein to be:

either only one stereoisomer .....

or a 1:1 mixture of both stereoisomers .....

or unequal amounts of the two stereoisomers? .....

Tick one answer and explain your choice.

.....

.....

.....

.....[2]

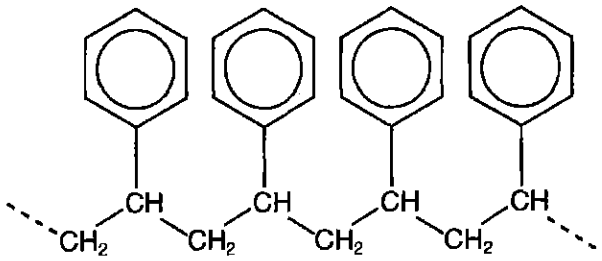
[Total: 13]

[Turn over

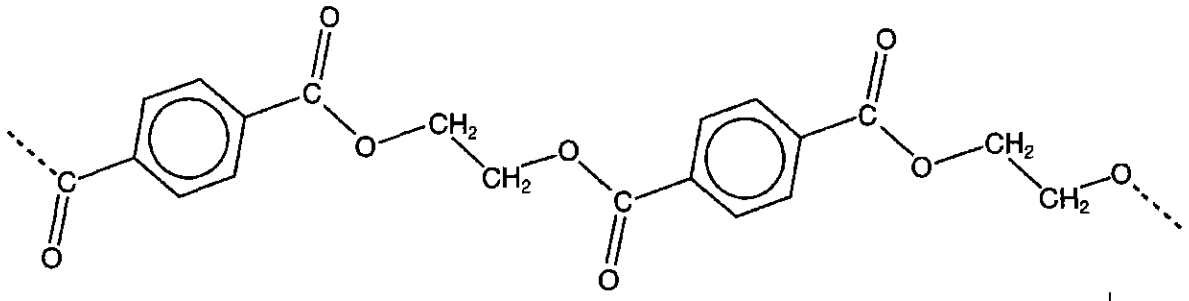
For Examiner's Use

7 Polymers can be made either from a single monomer or from more than one monomer. Two polymers, **L** and **M**, are shown below.

Polymer L



Polymer M



(a) Deduce the structures of the monomers from which **L** and **M** could be obtained.

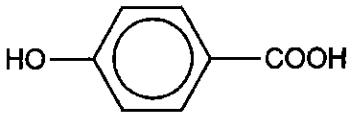
For **L:**

For **M:**

[3]

(b) Polymer **N** can be made from the monomer **P** only, shown below.

Monomer P



Suggest a structure for polymer **N**, showing three repeat units.

[2]

(c) Polymers **M** and **N** are made by the same type of polymerisation.
Name this type of polymerisation and describe its characteristic features.

.....

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.....

.....[2]

(d) State a major use for polymers such as **M**.

.....[1]

[Total: 8]

4 In aqueous solution, some organic compounds are bases and some are acids; others are neither.

(a) Identify an organic compound that acts as an acid in water, and give an equation to show this behaviour.

name or formula .....

equation .....[2]

(b) Phenylamine, $C_6H_5NH_2$, acts as a base in water.

(i) Give an equation to show this behaviour.

.....[1]

(ii) Explain why phenylamine is a weaker base than ethylamine, $C_2H_5NH_2$.

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.....[3]

(c) Identify an organic compound which can act both as an acid and as a base. Explain your answer.

name or formula .....

explanation .....

.....

.....

.....[2]

[Total: 8]

7 Diazonium salts are important reactive intermediates. They are made from aromatic amines, which themselves are usually made from aromatic nitro-compounds.

(a) (i) State the reagents required for the preparation of phenylamine from nitrobenzene.

.....[2]

(ii) A student obtained 6.80 g phenylamine starting from 10.0 g nitrobenzene. Calculate the percentage yield of phenylamine. Give your answer to three significant figures.

answer .....[4]

(b) State the reagents and conditions needed to make a diazonium salt from phenylamine.

reagents

.....

.....

conditions

.....[3]

[Total: 9]

8 There are two major types of polymerisation: addition polymerisation and condensation polymerisation.

(a) (i) Propene undergoes addition polymerisation.

Give a balanced equation for this polymerisation, using structural formulae.

[2]

(ii) Explain the differences between **addition** polymerisation and **condensation** polymerisation.

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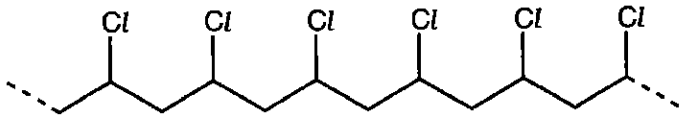
.....[2]

(b) Polymer **G** is also formed by addition polymerisation.

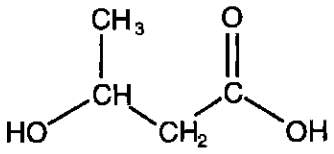
a section of polymer G



Deduce the structure of a monomer from which **G** could be made.

[1]

(c) The monomer shown below can form a condensation polymer, **H**.



(i) Suggest a structure for the polymer, showing **two** repeat units.

[2]

(ii) Concentrated aqueous NaOH solution can be transported in containers made of poly(propene) but not in containers made of polymer **H**. Suggest reasons for this difference.

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.....[3]

[Total: 10]

9 From the information given, draw the structural formula for each organic compound.

(a) This compound is made by reaction of benzene with concentrated nitric acid in the presence of concentrated sulphuric acid.

[1]

(b) These two compounds react together in the presence of concentrated sulphuric acid to make methyl ethanoate, CH_3COOCH_3.

[2]

(c) These two different compounds can be made by reaction of $C_6H_5CH(NH_2)COOH$ with $CH_3CH(NH_2)COOH$.

[2]

[Total: 5]

Acknowledgement

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3 Analysis of some samples of soy sauce recently showed the presence of the potentially harmful chemical 3-chloropropane-1,2-diol.
This could be formed from soya oil during the hydrolysis of soya.

(a) (i) Draw a displayed formula for 3-chloropropane-1,2-diol.

[2]

(ii) Does your displayed formula contain a chiral centre? Explain your answer.

.....

.....[1]

(b) In this question, one mark is available for the quality of written communication.

Explain how **two** spectroscopic techniques could be used to confirm the presence of an OH group in an organic compound such as 3-chloropropane-1,2-diol or ethanol.

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[5]

Quality of Written Communication [1]

For Examiner's Use

(c) Soya is a useful source of protein for vegetarians.
Soya protein can be hydrolysed in the laboratory.

(i) State the reagent used.

.....[1]

(ii) Draw a displayed formula for the functional group which is hydrolysed in the protein.

[1]

(iii) State the class of organic compounds produced by hydrolysis of proteins.

.....[1]

[Total: 12]

[Turn over