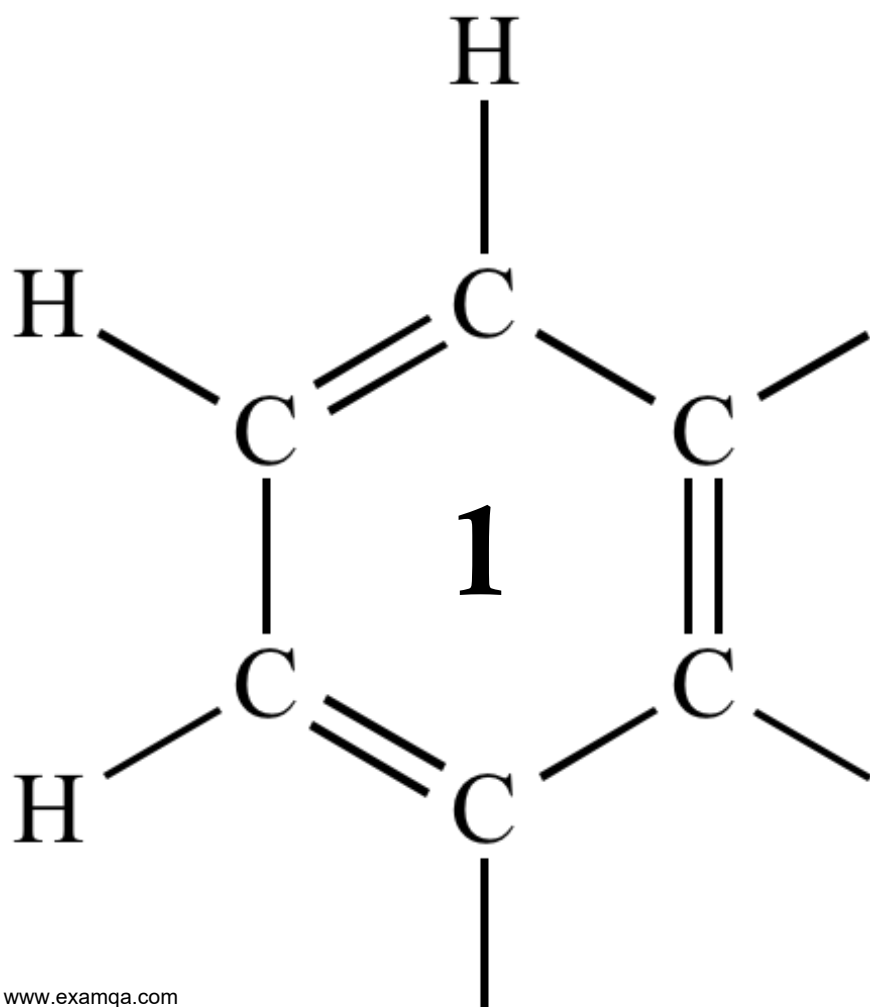


OCR A2 CHEMISTRY

# MODULE 6.2

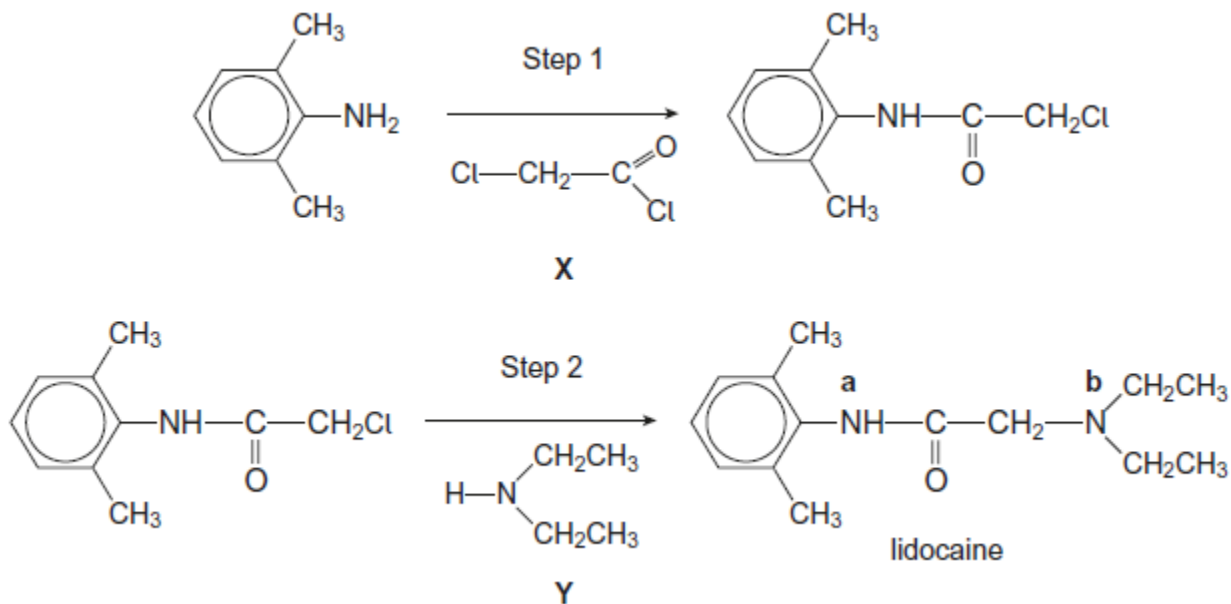
NITROGEN COMPOUNDS

POLYMERS



1

Lidocaine is a local anaesthetic used in dentistry and in minor surgical operations. The synthesis of lidocaine in 2 steps from 2,6-dimethylphenylamine is shown.



- (a) (i) Give the IUPAC name of reagent **X** in Step 1.

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(1)

- (ii) Outline a mechanism for Step 1.  
In your answer, use  $\text{RNH}_2$  to represent 2,6-dimethylphenylamine.

(4)

- (b) Name the mechanism for Step 2.

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(1)

- (c) Which of these is the total number of peaks in the  $^{13}\text{C}$  n.m.r spectrum of lidocaine?

Tick (✓) one box.

8

9

11

12

(1)

(d) Calculate the percentage by mass of hydrogen in a molecule of lidocaine.

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**(2)**

(e) Give the name, including the classification, of the functional group that contains the nitrogen atom labelled **b**.

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**(1)**

(f) Lidocaine is used medically as the salt lidocaine hydrochloride.

(i) Suggest which one of the nitrogen atoms labelled **a** or **b** is protonated in lidocaine hydrochloride. Explain your answer.

Nitrogen atom protonated .....

Explanation .....

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**(3)**

(ii) Suggest why lidocaine hydrochloride is used medically in preference to lidocaine. Explain your answer.

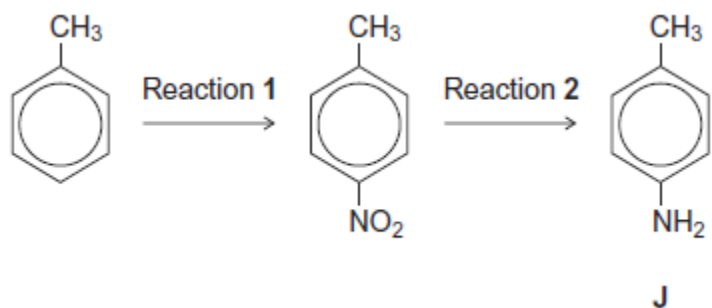
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**(2)**

**(Total 15 marks)**

**2**

Consider the following reaction sequence starting from methylbenzene.



(a) Name the type of mechanism for reaction 1.

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(1)

(b) Compound J is formed by reduction in reaction 2.

(i) Give a reducing agent for this reaction.

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(1)

(ii) Write an equation for this reaction. Use [H] to represent the reducing agent.

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(1)

(iii) Give a use for J.

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(1)

- (c) Outline a mechanism for the reaction of bromomethane with an excess of compound **J**. You should represent **J** as  $\text{RNH}_2$  in the mechanism.

(4)

- (d) Compound **K** ( $\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2$ ) is a structural isomer of **J**.

Explain why **J** is a weaker base than **K**.

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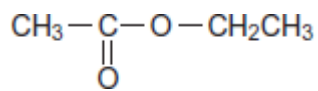
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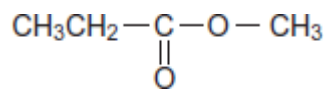
(Total 11 marks)

3

(a) Ester 1 and Ester 2 were studied by  $^1\text{H}$  n.m.r. spectroscopy.

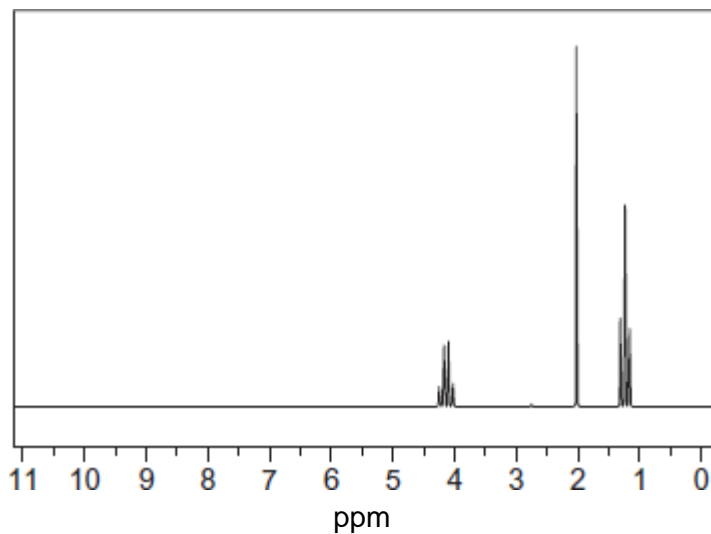


Ester 1



Ester 2

One of the two esters produced this spectrum.



Deduce which of the two esters produced the spectrum shown. In your answer, explain the position and splitting of the quartet peak at  $\delta = 4.1$  ppm in the spectrum.

Predict the  $\delta$  value of the quartet peak in the spectrum of the other ester.

Use **Table B** on the Data Sheet.

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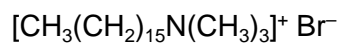
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(4)

(b) Cetrimide is used as an antiseptic.



cetrimide

Name this type of compound.

Give the reagent that must be added to  $\text{CH}_3(\text{CH}_2)_{15}\text{NH}_2$  to make cetrimide and state the reaction conditions.

Name the type of mechanism involved in this reaction.

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**(4)**

(c) Give a reagent that could be used in a test-tube reaction to distinguish between benzene and cyclohexene.

Describe what you would see when the reagent is added to each compound and the test tube is shaken.

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**(3)**

**(Total 11 marks)**

4

This question is about the primary amine  $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$

(a) The amine  $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$  reacts with  $\text{CH}_3\text{COCl}$

Name and outline a mechanism for this reaction.

Give the IUPAC name of the organic product.

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(6)

(b) Isomers of  $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$  include another primary amine, a secondary amine and a tertiary amine.

(i) Draw the structures of these **three** isomers.  
Label each structure as primary, secondary or tertiary.

(3)



- (ii) Use **Table 1** on the Data Sheet to explain how you could use infrared spectra in the range outside the fingerprint region to distinguish between the secondary amine and the tertiary amine.

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**(2)**

(c) The amine  $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$  can be prepared by two different routes.

Route **A** is a two-stage process and starts from  $\text{CH}_3\text{CH}_2\text{Br}$ .

Route **B** is a one-stage process and starts from  $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$ .

(i) Identify the intermediate compound in Route **A**.

Give the reagents and conditions for both stages in Route **A** and the single stage in Route **B**.

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(7)

(ii) Give **one** disadvantage of Route **A** and **one** disadvantage of Route **B**.

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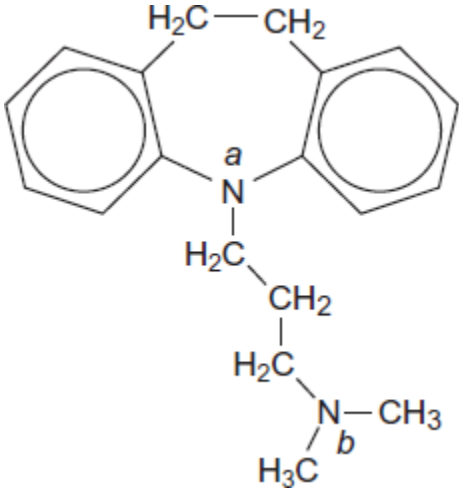
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(2)  
(Total 20 marks)

5

Imipramine has been prescribed as an antidepressant. The structure of imipramine is shown below.



- (a) The medicine is usually supplied as a salt. The salt is formed when one mole of imipramine reacts with one mole of hydrochloric acid.

Suggest why the nitrogen atom labelled *b* is more likely to be protonated than the nitrogen atom labelled *a* when the salt is formed.

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(3)

- (b) Deduce the molecular formula of imipramine and give the number of peaks in its <sup>13</sup>C n.m.r. spectrum.

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(2)

(Total 5 marks)

6

Ammonia and methylamine were dissolved in separate samples of water. The two solutions had equal molar concentrations.

State **one** simple method, other than smell, of distinguishing these solutions.  
State what you would observe.

Method .....

Observation .....

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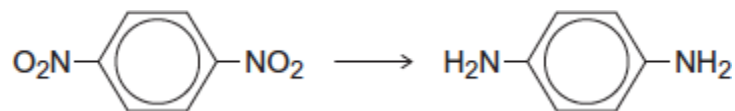
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**(Total 2 marks)**

7

Each of the following conversions involves reduction of the starting material.

(a) Consider the following conversion.



Identify a reducing agent for this conversion.

Write a balanced equation for the reaction using molecular formulae for the nitrogen-containing compounds and [H] for the reducing agent.

Draw the repeating unit of the polymer formed by the product of this reaction with benzene-1,4-dicarboxylic acid.

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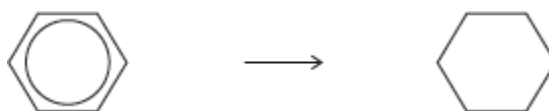
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(5)

(b) Consider the following conversion.



Identify a reducing agent for this conversion.

State the empirical formula of the product.

State the bond angle between the carbon atoms in the starting material and the bond angle between the carbon atoms in the product.

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(4)

(c) The reducing agent in the following conversion is  $\text{NaBH}_4$



(i) Name and outline a mechanism for the reaction.

Name of mechanism .....

Mechanism

(5)

- (ii) By considering the mechanism of this reaction, explain why the product formed is optically inactive.

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(3)  
(Total 17 marks)

8

The amide or peptide link is found in synthetic polyamides and also in naturally occurring proteins.

- (a) (i) Draw the repeating unit of the polyamide formed by the reaction of propanedioic acid with hexane-1,6-diamine.

(2)

- (ii) In terms of the intermolecular forces between the polymer chains, explain why polyamides can be made into fibres suitable for use in sewing and weaving, whereas polyalkenes usually produce fibres that are too weak for this purpose.

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(Extra space) .....

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**(3)**

- (b) (i) Name and outline a mechanism for the reaction of  $\text{CH}_3\text{CH}_2\text{COCl}$  with  $\text{CH}_3\text{NH}_2$

Name of mechanism.....

Mechanism

**(5)**

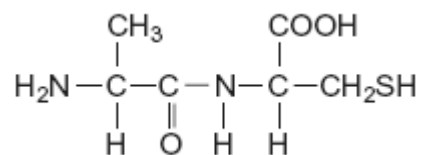
- (ii) Give the name of the product containing an amide linkage that is formed in the reaction in part (b) (i).

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**(1)**



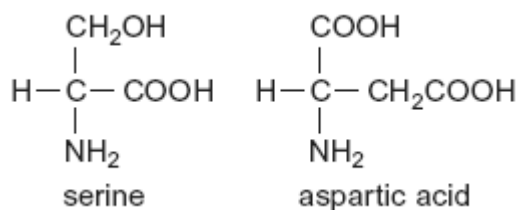
- (c) The dipeptide shown below is formed from two different amino acids.



Draw the structure of the alternative dipeptide that could be formed by these two amino acids.

(1)

- (d) The amino acids serine and aspartic acid are shown below.



- (i) Give the IUPAC name of serine.

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(1)

- (ii) Draw the structure of the species formed when aspartic acid reacts with aqueous sodium hydroxide.

(1)

(iii) Draw the structure of the species formed when serine reacts with dilute hydrochloric acid.

(1)

(iv) Draw the structure of the species formed when serine reacts with an excess of bromomethane.

(1)

(Total 16 marks)