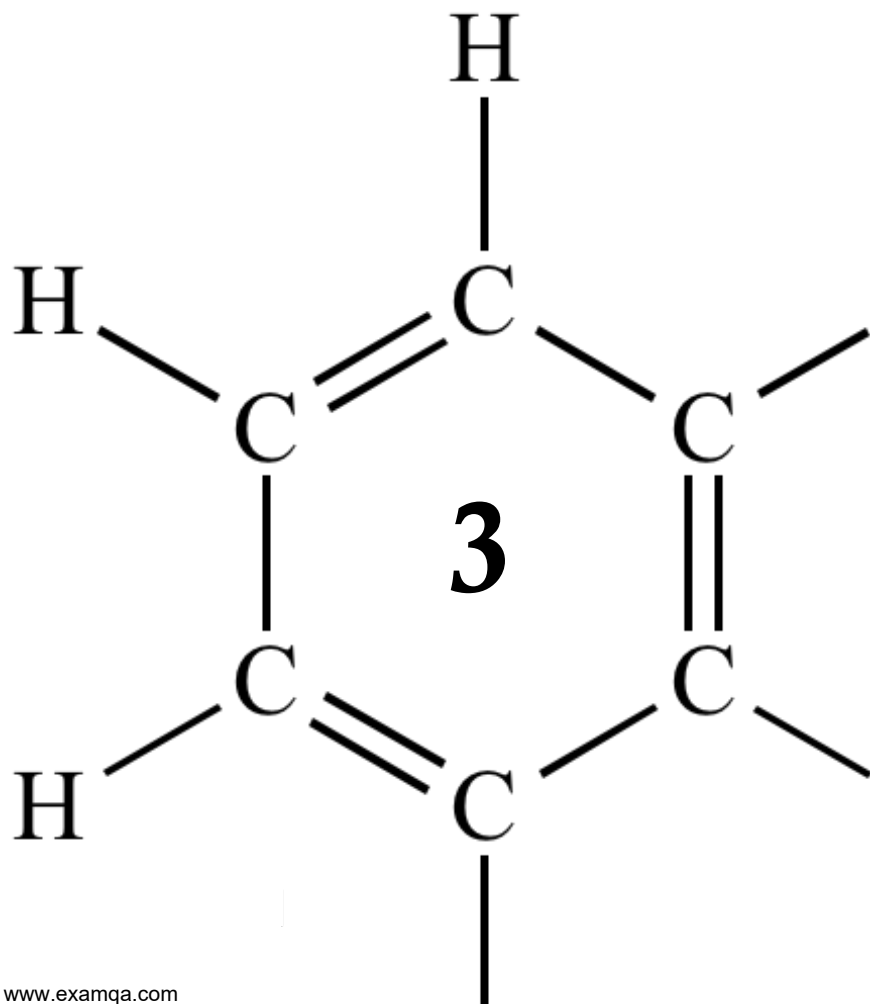


AQA A2 CHEMISTRY  
**ISOMERISM ~ CARBONYLS**

ACYLATION



1

Esters have many important commercial uses such as solvents and artificial flavourings in foods.

Esters can be prepared in several ways including the reactions of alcohols with carboxylic acids, acid anhydrides, acyl chlorides and other esters.

(a) Ethyl butanoate is used as a pineapple flavouring in sweets and cakes.

Write an equation for the preparation of ethyl butanoate from an acid and an alcohol.

Give a catalyst used for the reaction.

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(4)

(b) Butyl ethanoate is used as a solvent in the pharmaceutical industry.

Write an equation for the preparation of butyl ethanoate from an acid anhydride and an alcohol.

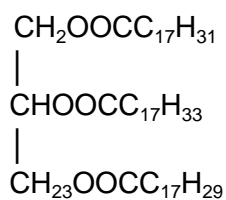
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(3)

(c) Name and outline a mechanism for the reaction of  $\text{CH}_3\text{COCl}$  with  $\text{CH}_3\text{OH}$  to form an ester.

(5)

(d) The ester shown below occurs in vegetable oils. Write an equation to show the formation of biodiesel from this ester.



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(3)

- (e) Draw the repeating unit of the polyester Terylene that is made from benzene-1,4-dicarboxylic acid and ethane-1,2-diol.

Although Terylene is biodegradeable, it is preferable to recycle objects made from Terylene.

Give **one** advantage and **one** disadvantage of recycling objects made from Terylene.

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**(4)**  
**(Total 19 marks)**

2

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

Name the amide formed.

(6)

(b) Haloalkanes such as  $\text{CH}_3\text{Cl}$  are used in organic synthesis.

Outline a three-step synthesis of  $\text{CH}_3\text{CH}_2\text{NH}_2$  starting from methane. Your first step should involve the formation of  $\text{CH}_3\text{Cl}$

In your answer, identify the product of the second step and give the reagents and conditions for each step.

Equations and mechanisms are **not** required.

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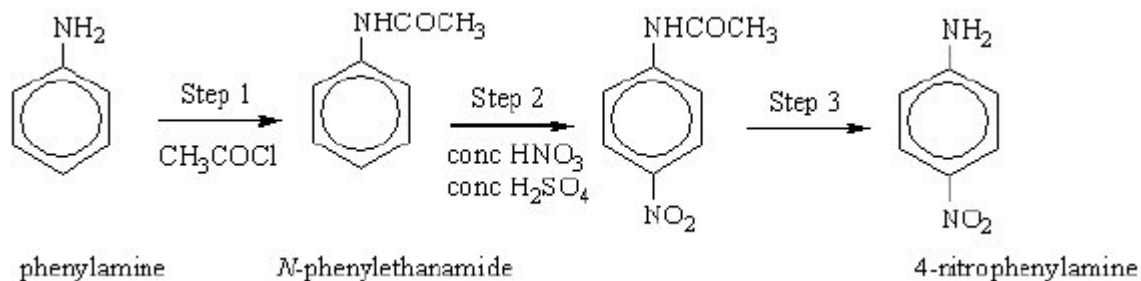
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(6)  
(Total 12 marks)

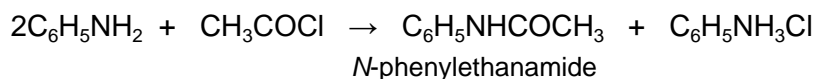
**3**

Synthetic dyes can be manufactured starting from compounds such as 4-nitrophenylamine.

A synthesis of 4-nitrophenylamine starting from phenylamine is shown below.



- (a) An equation for formation of *N*-phenylethanamide in Step 1 of the synthesis is shown below.



- (i) Calculate the % atom economy for the production of *N*-phenylethanamide ( $M_r = 135.0$ ).
- (ii) In a process where 10.0 kg of phenylamine are used, the yield of *N*-phenylethanamide obtained is 5.38 kg.
- Calculate the percentage yield of *N*-phenylethanamide.
- (iii) Comment on your answers to parts (i) and (ii) with reference to the commercial viability of the process.

**(7)**

- (b) Name and outline a mechanism for the reaction in Step 1.

**(5)**

- (c) The mechanism of Step 2 involves attack by an electrophile. Write an equation showing the formation of the electrophile. Outline a mechanism for the reaction of this electrophile with benzene.

**(4)****(Total 16 marks)****4**

- (a) Write an equation for the formation of methyl propanoate,  $\text{CH}_3\text{CH}_2\text{COOCH}_3$ , from methanol and propanoic acid.

.....

**(1)**

- (b) Name and outline a mechanism for the reaction between methanol and propanoyl chloride to form methyl propanoate.

*Name of mechanism* .....

*Mechanism*

(5)

- (c) Propanoic anhydride could be used instead of propanoyl chloride in the preparation of methyl propanoate from methanol. Draw the structure of propanoic anhydride.

(1)

- (d) (i) Give **one** advantage of the use of propanoyl chloride instead of propanoic acid in the laboratory preparation of methyl propanoate from methanol.

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- (ii) Give **one** advantage of the use of propanoic anhydride instead of propanoyl chloride in the industrial manufacture of methyl propanoate from methanol.

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(2)



(e) An ester contains a benzene ring. The mass spectrum of this ester shows a molecular ion peak at  $m/z = 136$ .

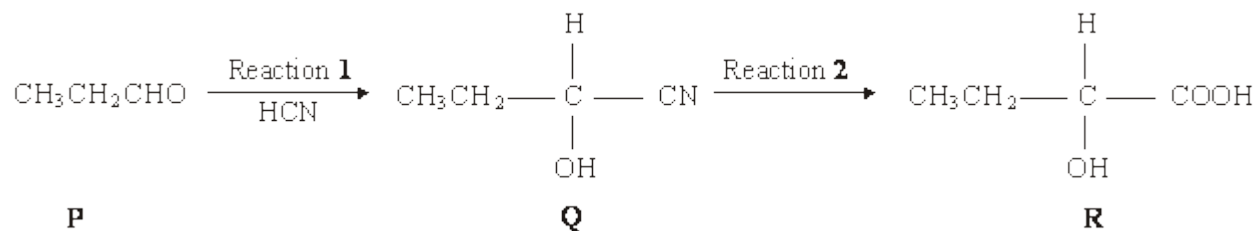
(i) Deduce the molecular formula of this ester.

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(ii) Draw **two** possible structures for this ester.

(3)  
(Total 12 marks)

**5** Consider the sequence of reactions below.



(a) Name and outline a mechanism for Reaction 1.

Name of mechanism .....

Mechanism

(5)

(b) (i) Name compound **Q**

.....

(ii) The molecular formula of **Q** is  $C_4H_7NO$ . Draw the structure of the isomer of **Q** which shows geometrical isomerism and is formed by the reaction of ammonia with an acyl chloride.

(3)

(c) Draw the structure of the main organic product formed in each case when **R** reacts separately with the following substances:

(i) methanol in the presence of a few drops of concentrated sulphuric acid;

(ii) acidified potassium dichromate(VI);

(iii) concentrated sulphuric acid in an elimination reaction.

(3)

(Total 11 marks)

6

(a) Name the compound  $(CH_3)_2NH$

.....

(1)

- (b)  $(\text{CH}_3)_2\text{NH}$  can be formed by the reaction of an excess of  $\text{CH}_3\text{NH}_2$  with  $\text{CH}_3\text{Br}$ . Name and outline a mechanism for this reaction.

Name of mechanism .....

Mechanism

(5)

- (c) Name the type of compound produced when a large excess of  $\text{CH}_3\text{Br}$  reacts with  $\text{CH}_3\text{NH}_2$ . Give a use for this type of compound.

Type of compound .....

Use .....

(2)

- (d) Draw the structures of the two compounds formed in the reaction of  $\text{CH}_3\text{NH}_2$  with ethanoic anhydride.

(2)

(Total 10 marks)

7

- (a) Name and outline a mechanism for the reaction between propanoyl chloride,  $\text{CH}_3\text{CH}_2\text{COCl}$ , and methylamine,  $\text{CH}_3\text{NH}_2$ . Draw the structure of the organic product.

(6)

- (b) Benzene reacts with propanoyl chloride in the presence of aluminium chloride. Write equations to show the role of aluminium chloride as a catalyst in this reaction. Outline a mechanism for this reaction of benzene.

(5)

- (c) Write an equation for the reaction of propanoyl chloride with water. An excess of water is added to 1.48 g of propanoyl chloride. Aqueous sodium hydroxide is then added from a burette to the resulting solution. Calculate the volume of  $0.42 \text{ mol dm}^{-3}$  aqueous sodium hydroxide needed to react exactly with the mixture formed.

**(5)**  
**(Total 16 marks)**