OCR
RECOGNISING ACHIEVEMENT

Tuesday 19 June 2012 – Afternoon

A2 GCE CHEMISTRY A

F324 Rings, Polymers and Analysis

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry A* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour 15 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **16** pages. Any blank pages are indicated.

Answer **all** the questions.

1 Alkenes and benzene both react with bromine but alkenes are much more reactive.

(a) Explain the relative resistance to bromination of benzene compared with alkenes.

In your answer, you should use appropriate technical terms, spelled correctly.

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..... **[4]**

(b) A student investigates two reactions of bromine with phenylethene, $C_6H_5CH=CH_2$.

Reaction 1
The student first mixes phenylethene with excess bromine at room temperature.
An organic compound forms with the molecular formula $C_8H_8Br_2$.

Reaction 2
The student then adds a halogen carrier to the mixture obtained from **reaction 1**.
A mixture of isomers forms. Each isomer has the molecular formula $C_8H_7Br_3$.

(i) Draw the structure of the organic compound formed in **reaction 1**.

[1]

(ii) Predict the number of peaks in the carbon-13 NMR spectrum of the organic compound formed in **reaction 1**.

..... **[1]**

(iii) Draw the structures of two of the isomers of $C_8H_7Br_3$ formed in **reaction 2**.

isomer 1	**isomer 2**

[2]

(iv) State the types of mechanism that take place in **reaction 1** and **reaction 2**.

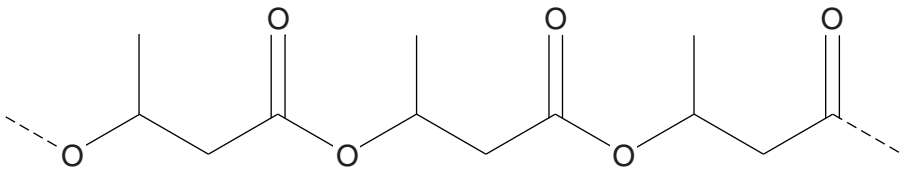
reaction 1 .....

reaction 2 ..... **[2]**

[Total: 10]

2 This question looks at different types of condensation polymers: polyesters, polyamides and proteins.

(a) Polyester **A**, shown below, is a degradable polymer prepared by bacterial fermentation of sugars.



polyester **A**

One reason that polyester **A** is degradable is that it can be hydrolysed.

(i) State another way that a polyester may be degraded.

..... **[1]**

(ii) When polyester **A** is hydrolysed with aqueous acid, compound **B** is formed.

Draw the skeletal formula of compound **B**.

[1]

(b) Nylon-4,6 is a polyamide that can be prepared by reacting butane-1,4-diamine, $H_2N(CH_2)_4NH_2$, with hexanedioic acid, $HOOC(CH_2)_4COOH$.

(i) $H_2N(CH_2)_4NH_2$ can be synthesised from 1,4-dichlorobutane, $Cl(CH_2)_4Cl$.

State the reagents and conditions required for this synthesis.

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..... **[1]**

(ii) $H_2N(CH_2)_4NH_2$ can act as a base and forms salts with dilute acids.

- Explain how an amine can act as a base.
- Write the formula of the salt formed when $H_2N(CH_2)_4NH_2$ reacts with an **excess** of dilute hydrochloric acid.

explanation .....

.....

formula of salt ..... **[2]**

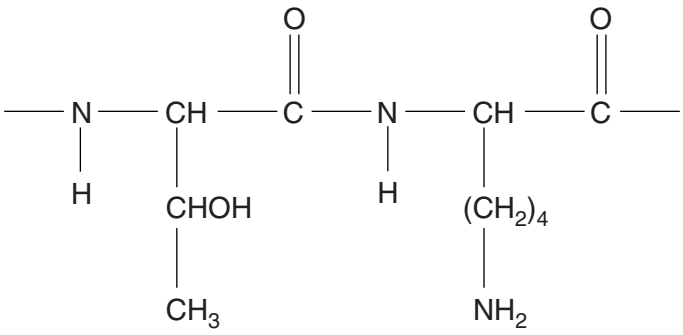
(iii) Draw the repeat unit of nylon-4,6.

Clearly display the bonding that links the two monomers.

[2]

(c) A sample of a protein is hydrolysed. The organic products are separated by chromatography. Each organic product has its pH adjusted to its isoelectric point to form a zwitterion.

A section of the protein is shown below.



(i) In the boxes below, draw the structures of the zwitterions formed from this section of the protein.

[2]

(ii) The isoelectric points of the zwitterions in **(i)** are at pH 5.60 and pH 9.60.

Explain why these isoelectric points are at different pH values.

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..... **[1]**

[Total: 10]

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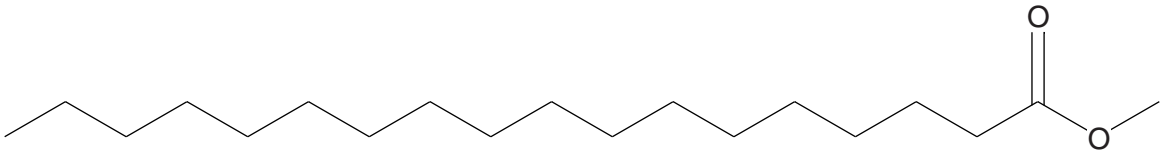
3 Fats and oils are mixtures of organic compounds. Some fats contain glycerides and steroids.

(a) Some processed foods contain *trans* oils which have been linked to health risks.

(i) The incomplete structure below shows an octadeca-12-enoate section of a *trans* oil.

- Add the double bond to the structure
- State how the *trans*-isomer is different from the *cis*-isomer.



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..... **[2]**

(ii) State **one** possible health risk of a diet that is high in *trans* oils.

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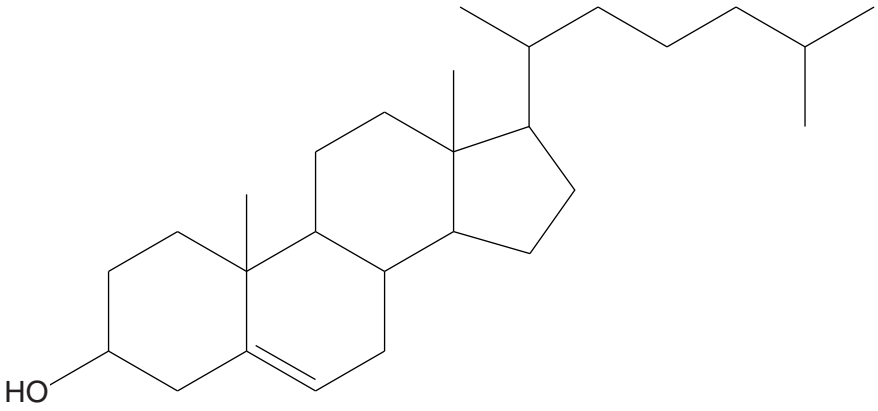
..... **[1]**

(b) Cholesterol is part of a family of compounds called steroids.

The structure of cholesterol is shown below.



(i) How many carbon atoms are there in a molecule of cholesterol?

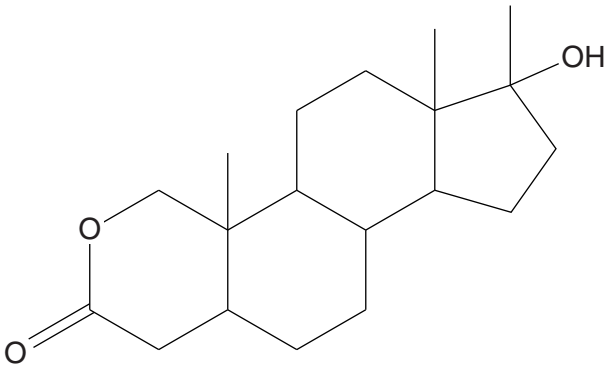
..... **[1]**

(ii) How many chiral centres are there in a molecule of cholesterol?

..... **[1]**

(c) Oxandrolone is a type of synthetic drug called an 'anabolic steroid', prescribed to promote muscle growth.

The structure of oxandrolone is shown below.



(i) What are the functional groups in oxandrolone?

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..... **[2]**

(ii) Oxandrolone is synthesised from naturally occurring steroids.

Suggest an advantage of developing a synthetic route to oxandrolone starting from a natural steroid.

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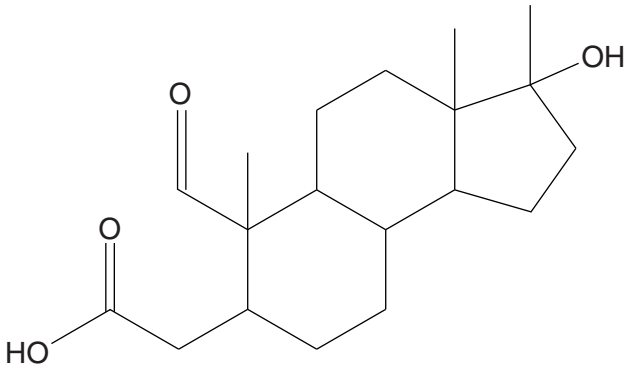
..... **[1]**

(iii) Compound **C** below is an intermediate formed during the synthesis of oxandrolone.



compound C

Suggest a two-step synthesis of oxandrolone from compound **C**.

For each step of the synthesis,

- state the reagents and any conditions
- state the functional groups that would react and those that would form.

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..... **[4]**

[Total: 12]

4 Benzaldehyde, C_6H_5CHO, is the simplest aromatic aldehyde and has a characteristic smell of almonds.

(a) Benzaldehyde can be nitrated with a mixture of concentrated nitric acid and concentrated sulfuric acid to form 3-nitrobenzaldehyde.

Explain, with the aid of curly arrows, the mechanism for the formation of 3-nitrobenzaldehyde.

Your answer should clearly show the role of sulfuric acid as a catalyst.

[6]

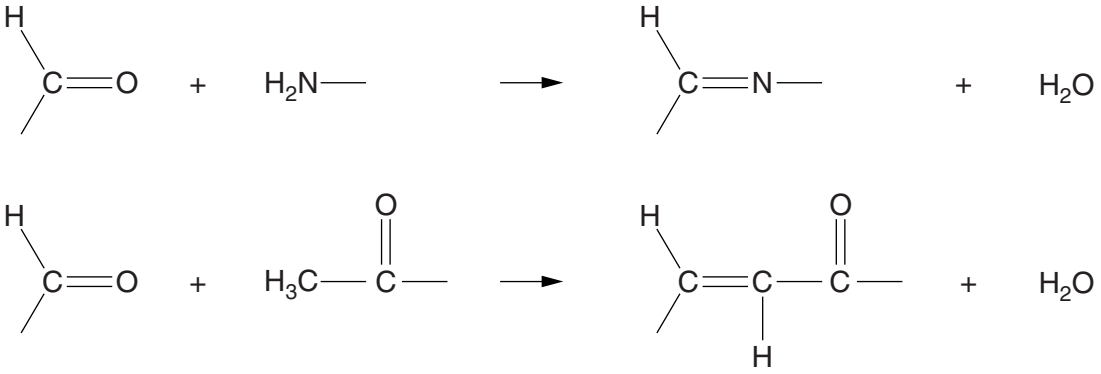
(b) Benzaldehyde reacts with a solution of potassium hydroxide. In this reaction, benzaldehyde is both oxidised and reduced to form two organic products.

Suggest an equation for this reaction, showing clearly the structures of the two organic products.

[3]

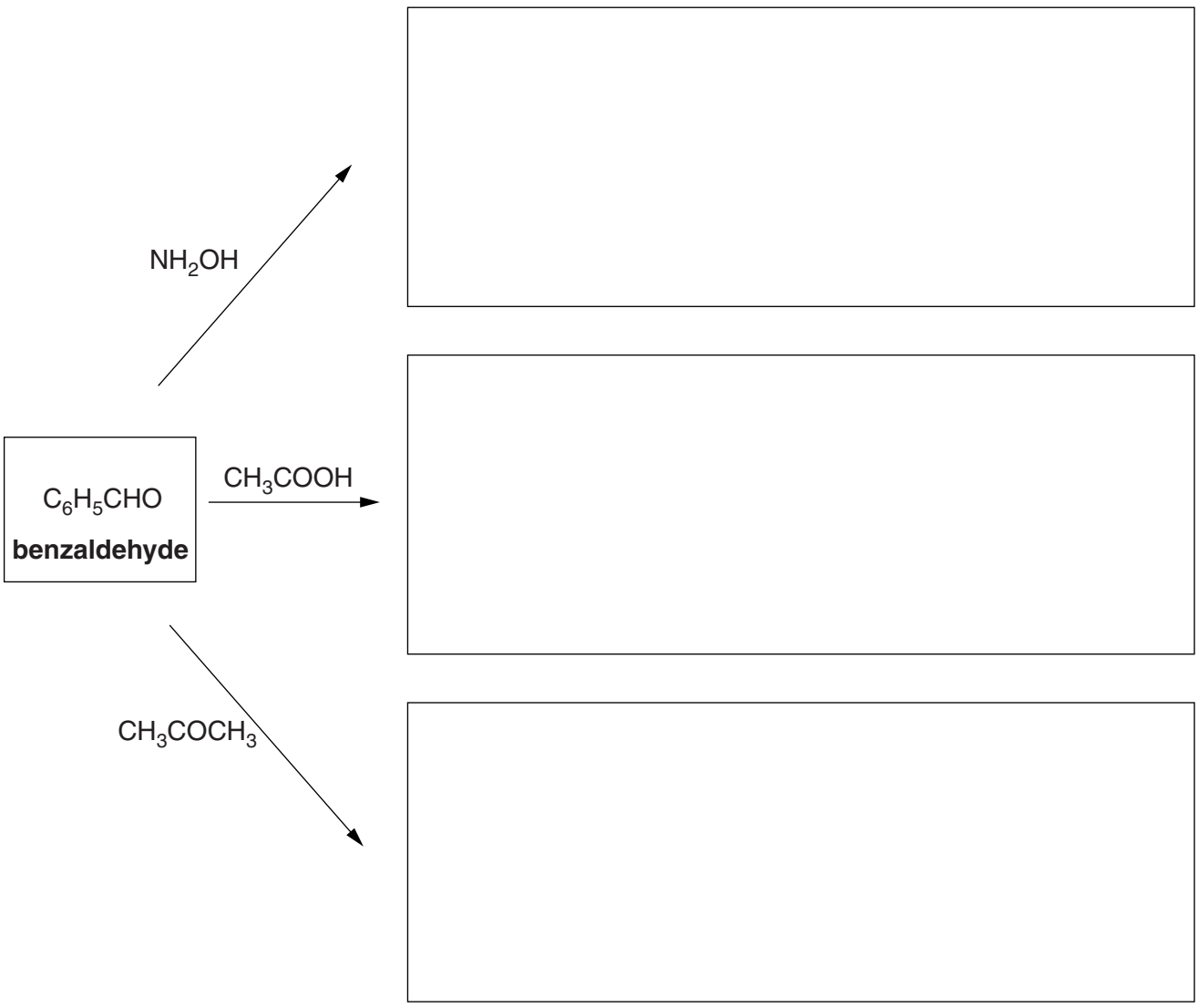
(c) The aldehyde group takes part in 'condensation' reactions with many compounds containing an amine group or a methyl group adjacent to a C=O.

In these reactions, water is formed as a product. Two examples are shown below.



Predict the organic products formed in the following condensation reactions of benzaldehyde. In each reaction, an excess of benzaldehyde is used.

Draw the structure of each organic product in the boxes.



[3]

(d) Alkyllithium compounds, RLi, can be used to increase the number of carbon atoms in an organic compound. Different alkyl groups, R, add carbon chains with different chain lengths.

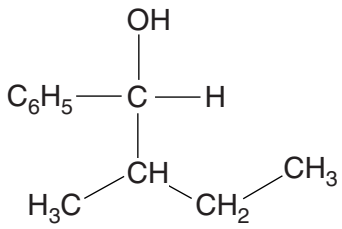
RLi provides a source of R^- ions, which act as a nucleophile.

(i) The diagram below shows an incomplete mechanism for the reaction of RLi with benzaldehyde, followed by reaction with aqueous acid.

- Complete, using curly arrows and relevant dipoles, the mechanism for **stage 1**.
- Give the structure of the intermediate and the organic product.

[4]

(ii) A chemist needs to prepare the organic compound below from benzaldehyde.



Draw the structure of the alkyllithium compound needed for this synthesis.

[1]

[Total: 17]

5 A chemist uses gas chromatography, GC, to separate the esters in a mixture. The esters are then analysed using different spectroscopic techniques.

(a) (i) How could the chemist use the results from GC to predict the number of esters in the mixture and their relative proportions?

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..... **[1]**

(ii) Why would there be some uncertainty about using GC alone to predict the number of esters in a mixture?

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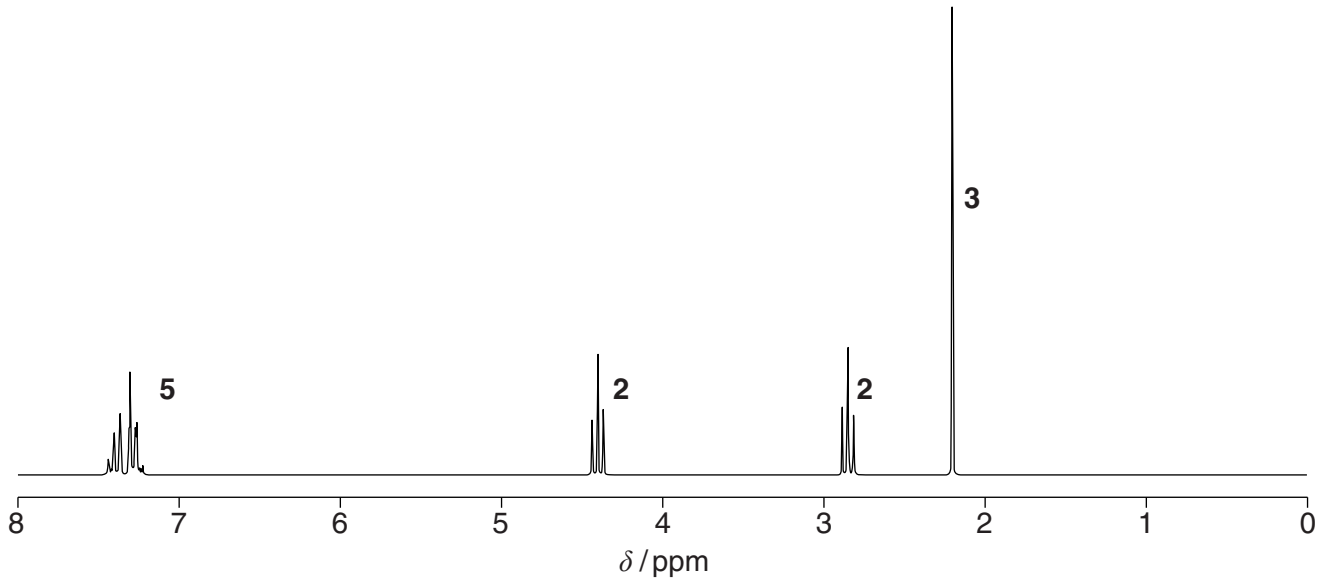
..... **[1]**

TURN OVER FOR QUESTION 5(b)

(b) The chemist obtains a mass spectrum and a proton NMR spectrum of one of the esters separated by GC.

- The mass spectrum has a molecular ion peak at $m/z = 164$.
- The proton NMR spectrum is shown below.
  The numbers on the NMR spectrum represent the relative peak areas.



Analyse this information to identify the ester.

Include full details of your analysis of the proton NMR spectrum.

In your answer, you should use appropriate technical terms, spelled correctly.

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[Total: 11]

END OF QUESTION PAPER

ADDITIONAL PAGE

If additional space is required, you should use the lined page below. The question number(s) must be clearly shown.