OCR
Oxford Cambridge and RSA

Tuesday 13 June 2017 – Afternoon

A2 GCE CHEMISTRY A

F324/01 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

* F 3 2 4 0 1 *

* 6 7 6 5 3 1 4 3 4 2 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found inside 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(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

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.

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Answer **all** the questions.

1 Arenes are unsaturated hydrocarbons that undergo substitution reactions.

(a) The Kekulé model and the delocalised model have been proposed for the structure and bonding of benzene.

(i) Draw diagrams showing orbital overlap for the Kekulé model and the delocalised model.

[2]

(ii) Benzene is more resistant to reaction than expected from the Kekulé model.

Describe **two** other examples of experimental evidence which led scientists to doubt the model proposed by Kekulé.

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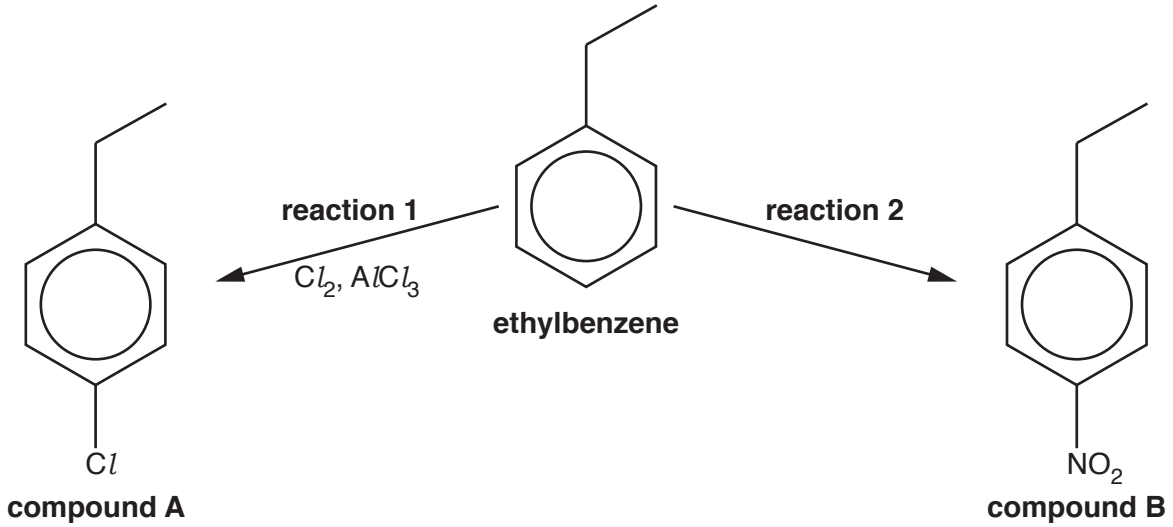
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..... **[3]**

(b) The flowchart below shows the laboratory preparation of compound **A** and compound **B** from ethylbenzene. Parts **(i)**–**(iv)** refer to structures and reactions from this flowchart.



compound A **compound B**

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(i) Predict the number of peaks in the carbon–13 NMR spectrum of compound **A**.

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

(ii) Compound **A** is formed in **reaction 1** by reacting ethylbenzene with chlorine in the presence of an $AlCl_3$ catalyst.

Explain, with the aid of curly arrows, the mechanism for the formation of compound **A** in **reaction 1**.

Your answer should show how $AlCl_3$ behaves as a catalyst.

[5]

(iii) State the reagents and conditions required for the preparation of compound **B** from ethylbenzene in **reaction 2**.

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

(iv) 2.65 g of ethylbenzene is converted into compound **B** in **reaction 2**.

2.31 g of compound **B** is formed.

Calculate the percentage yield of compound **B**.

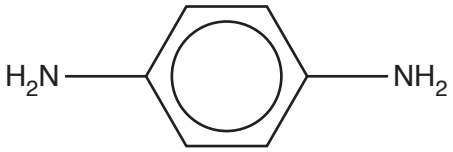
Give your answer to **three** significant figures.

percentage yield of compound **B** = ... % **[3]**

[Total: 15]

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2 Diamines such as benzene-1,4-diamine can be used to make polyamides.



benzene-1,4-diamine

(a) Benzene-1,4-diamine reacts with acids to form salts.

Explain how benzene-1,4-diamine is able to react with acids.

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

(b) Benzene-1,4-diamine can be prepared by the reduction of 1,4-dinitrobenzene.

(i) State the reagents and conditions used for this reduction.

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

(ii) Write an equation for the formation of benzene-1,4-diamine from 1,4-dinitrobenzene.

Use **[H]** to represent the reducing agent.

[1]

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(c) Kevlar™ is a polyamide that can be made by reacting benzene-1,4-diamine and benzene-1,4-dicarboxylic acid.

(i) Polyamides are condensation polymers.

State what is meant by a *condensation polymer*.

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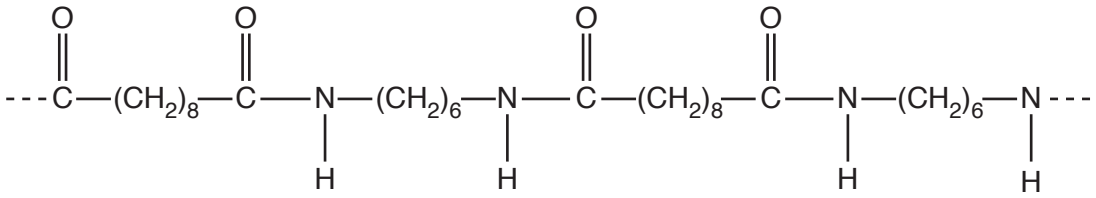
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..... **[1]**

(ii) Draw the structure of the repeat unit in Kevlar™.

[2]

(d) A short section of polyamide **C** is shown below.



polyamide C

(i) What is the empirical formula of the repeat unit in polyamide **C**?

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

(ii) Draw the structures of **two** monomers that could be used to make polyamide **C**.

[2]

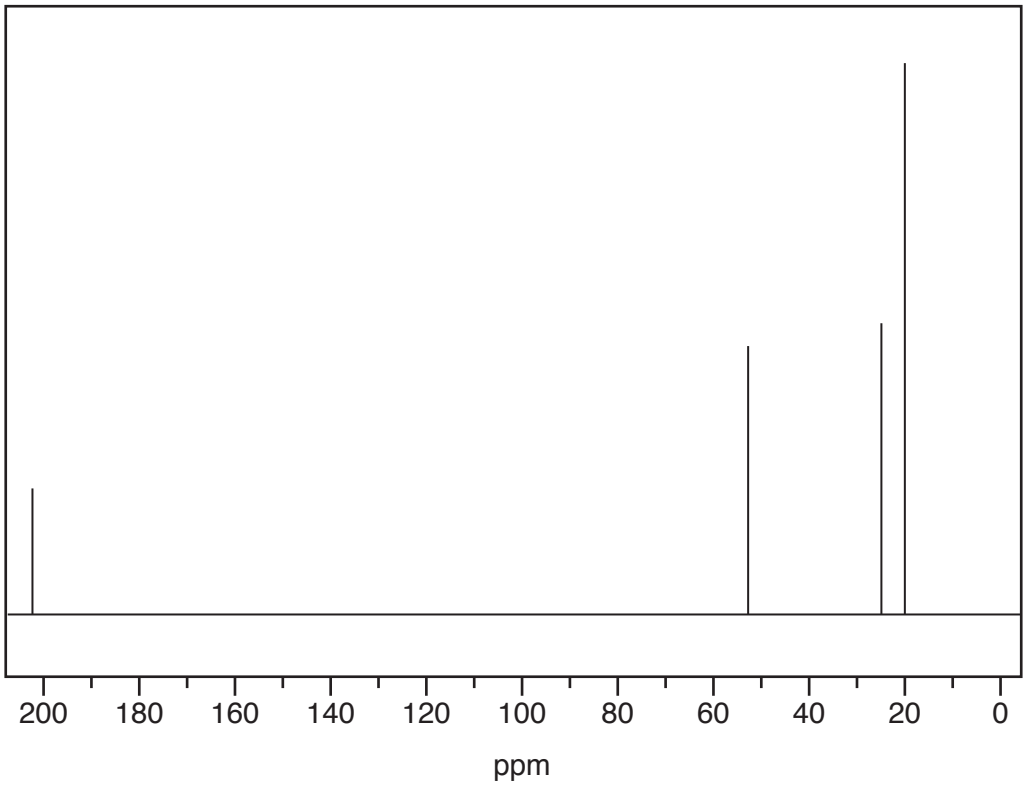
[Total: 9]

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3 Compound **D** and compound **E** are carbonyl compounds with the molecular formula $C_5H_{10}O$.

(a) Compound **D** reacts with Tollens' reagent to form a silver mirror.

The ^{13}C NMR spectrum of compound **D** is shown below.



Use this information to deduce the structure of compound **D**.

Explain your reasoning.

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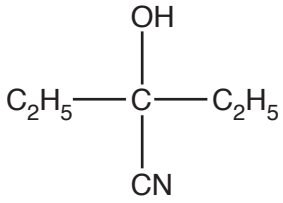
..... **[3]**

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(b) Carbonyl compounds react with cyanide ions, $^{-}$**:**CN, in the presence of dilute acid.

This is a nucleophilic addition reaction in which $^{-}$**:**CN, acts as a nucleophile.

Compound **E** reacts with $^{-}$**:**CN and H^{+} to form the organic compound shown below.



Identify compound **E** and suggest the mechanism for this reaction.

Use curly arrows and show relevant dipoles.

[4]

[Total: 7]

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4 The general formula of an α-amino acid is $RCH(NH_2)COOH$.

(a) Draw 3-D diagrams for the two optical isomers of the α-amino acid serine, where R is CH_2OH.

[2]

(b) Compound **F**, $C_4H_7O_2Br$, is one of two optical isomers.

Compound **F** reacts with excess ethanolic ammonia to form the α-amino acid **G**.

Compound **H** has *E/Z* isomers and can be converted into compound **F** by addition of HBr.

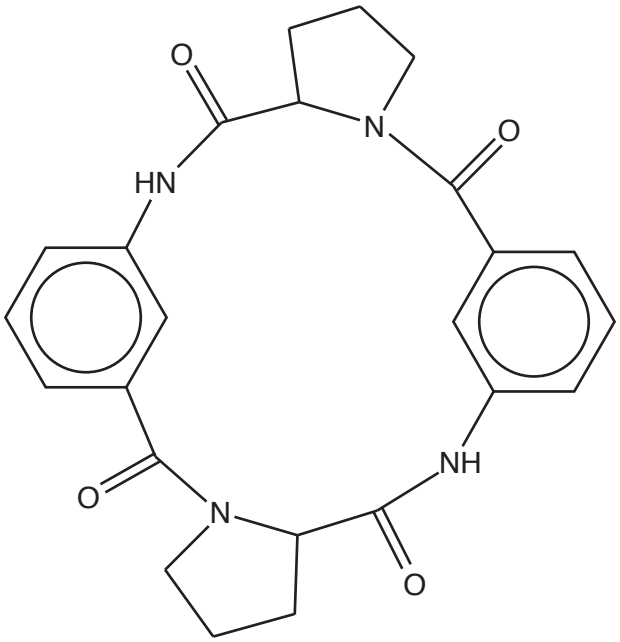
Compound **H** forms polymer **I**, which has the empirical formula C_2H_3O.

- Suggest structures for compound **F**, compound **G** and compound **H**.
- Draw a repeat unit of polymer **I**.
- State the type of reaction for the formation of **F** and for the formation of **G**.

[6]

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(c) A cyclic tetrapeptide has been synthesised from 3-aminobenzoic acid and an amino acid.



cyclic tetrapeptide

The cyclic tetrapeptide is hydrolysed by heating under reflux with aqueous sodium hydroxide.

Draw the structures of **two** organic products formed by the complete alkaline hydrolysis of the cyclic tetrapeptide.

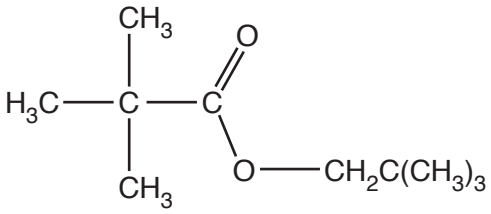
[3]

[Total: 11]

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5 A chemist prepares and analyses some esters.

(a) The chemist decides to synthesise the ester shown below.



The **only** organic compound available to the chemist is 2,2-dimethylpropanal, $(CH_3)_3CCHO$.

Explain how the chemist is able to synthesise this ester using only 2,2-dimethylpropanal and standard laboratory reagents. Include conditions and relevant equations.

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

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(b) A mixture of esters is separated and identified using gas chromatography, GC.

Explain the possible limitations of GC in both the separation and the identification of esters.

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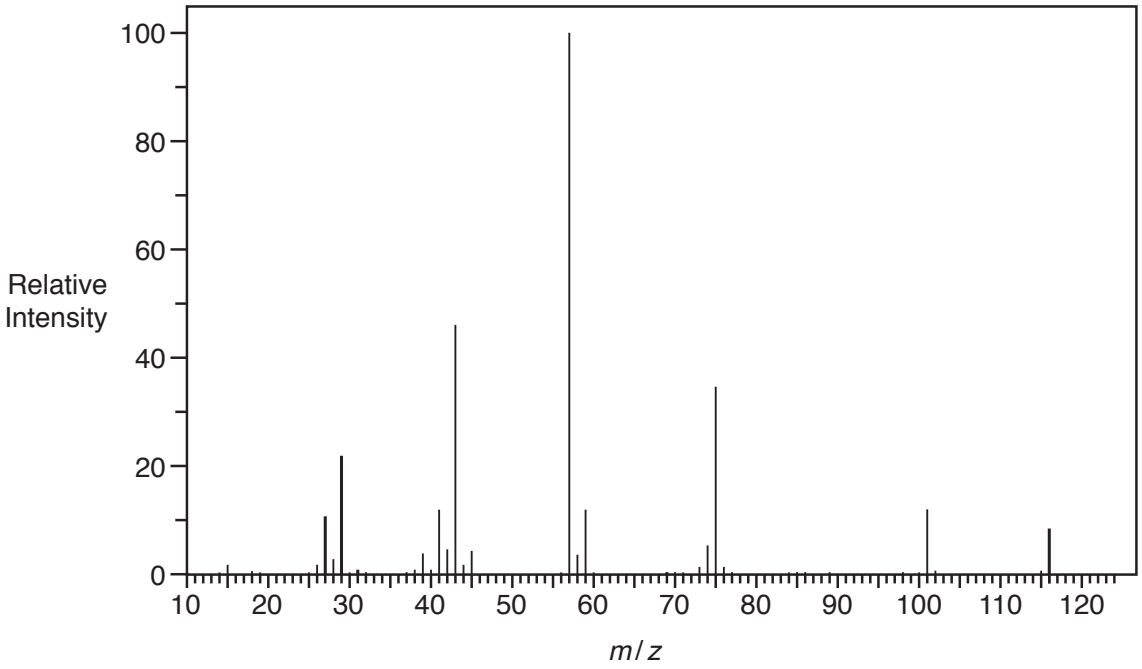
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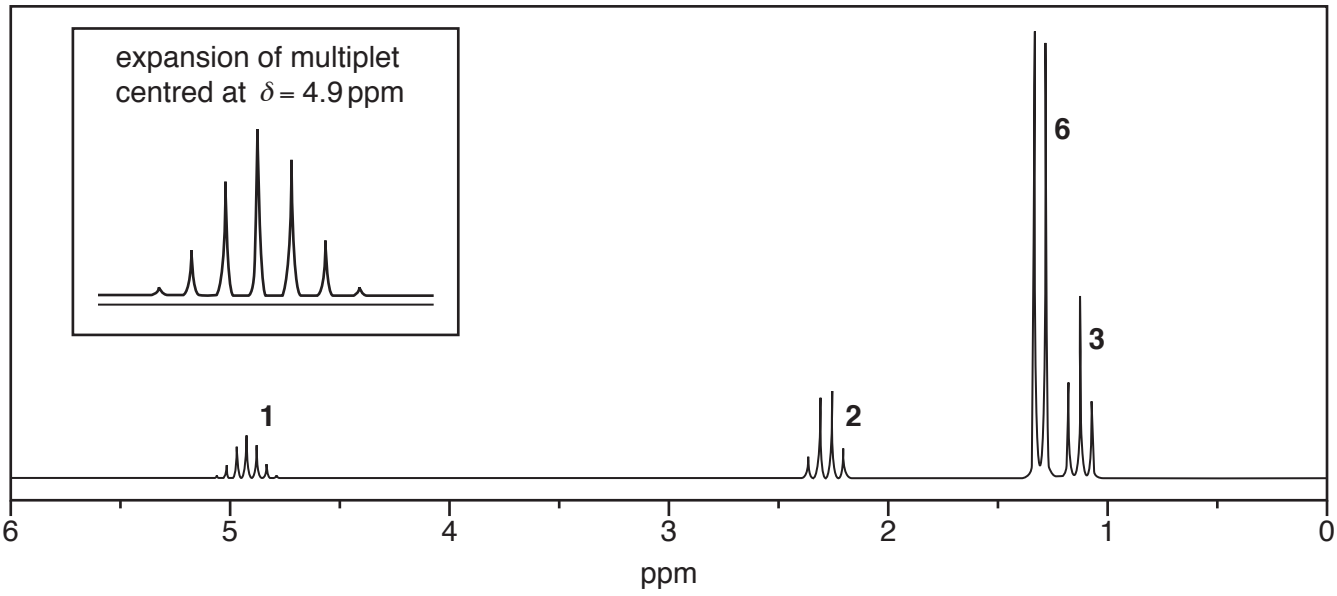
(c) The results of the analysis of an ester are shown below.

Elemental analysis by mass
C, 62.07%; H, 10.34%; O, 27.59%

Mass spectrum



Proton NMR spectrum
The numbers by each peak are the relative peak areas.



The peak centred at $\delta = 4.9$ ppm would normally be expected at a chemical shift value about 1 ppm to the right, i.e. 3.9 ppm.

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Use the results to identify the ester. Show **all** your reasoning.

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

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..... **[9]**

[Total: 18]

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

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

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