OCR

Monday 9 June 2014 – 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

1 2 6 5 4 2 9 4 8 1

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 pages at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

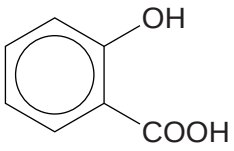
INFORMATION FOR CANDIDATES

- 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 **20** pages. Any blank pages are indicated.

Answer **all** the questions.

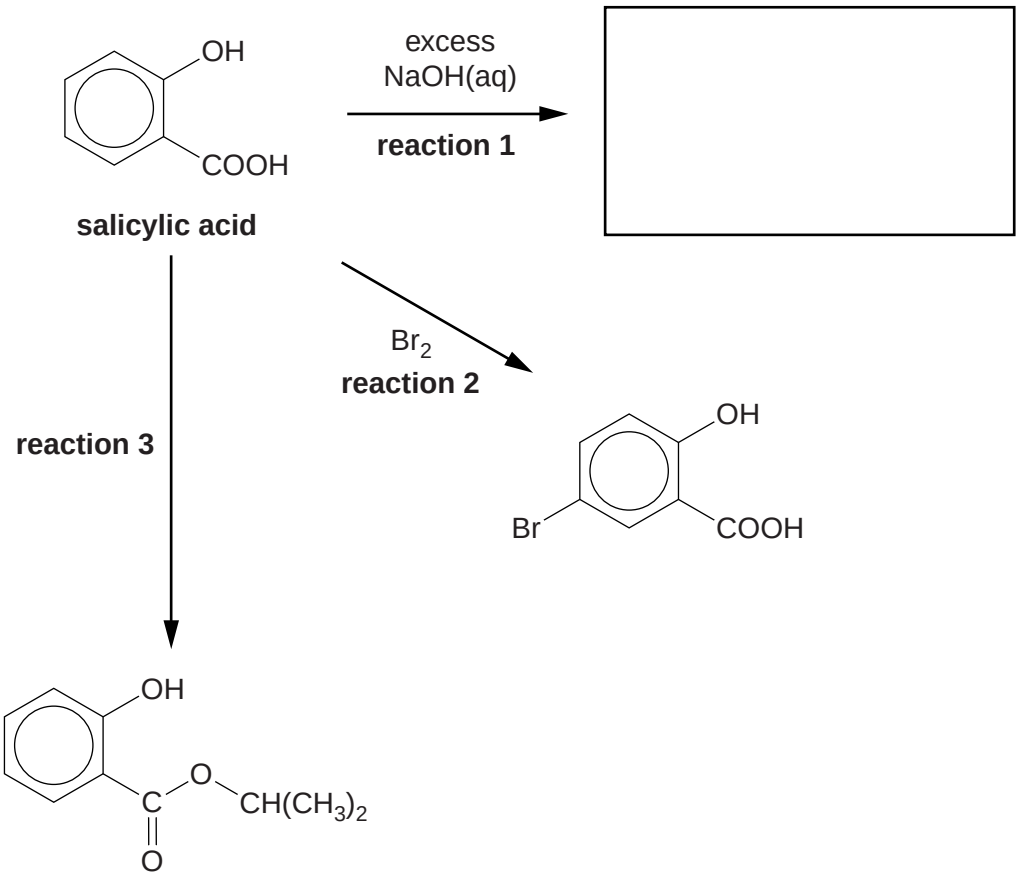
1 Salicylic acid is a naturally occurring carboxylic acid, widely used in organic synthesis.



salicylic acid

(a) The flowchart below shows some reactions of salicylic acid.

(i) In the box below, draw the structure of the organic compound formed by **reaction 1**. **[1]**



(ii) Describe what would be **observed** during **reaction 2**.

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

(iii) Write a chemical equation to represent **reaction 2**.

[1]

(iv) State the reagents and conditions in **reaction 3**.

.....

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

(b) Bromine reacts more readily with salicylic acid than with benzene.

(i) Outline the mechanism for the bromination of salicylic acid shown in **reaction 2** in the flowchart.

A halogen carrier is not required for this reaction.

The electrophile is Br_2.

[4]

(ii) Explain why bromine reacts more readily with salicylic acid than with benzene.

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

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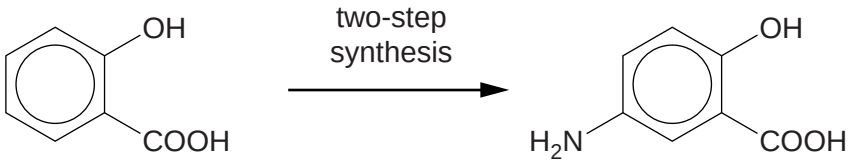
..... **[3]**

(c) Mesalazine is a drug that can be synthesised from salicylic acid in two steps.



salicylic acid **mesalazine**

(i) Suggest a **two-step** synthesis to prepare mesalazine from salicylic acid.

For **each** step

- state the reagents used,
- write a chemical equation.

[4]

(ii) Mesalazine reacts with acids to form salts.

Explain how mesalazine is able to react with acids.

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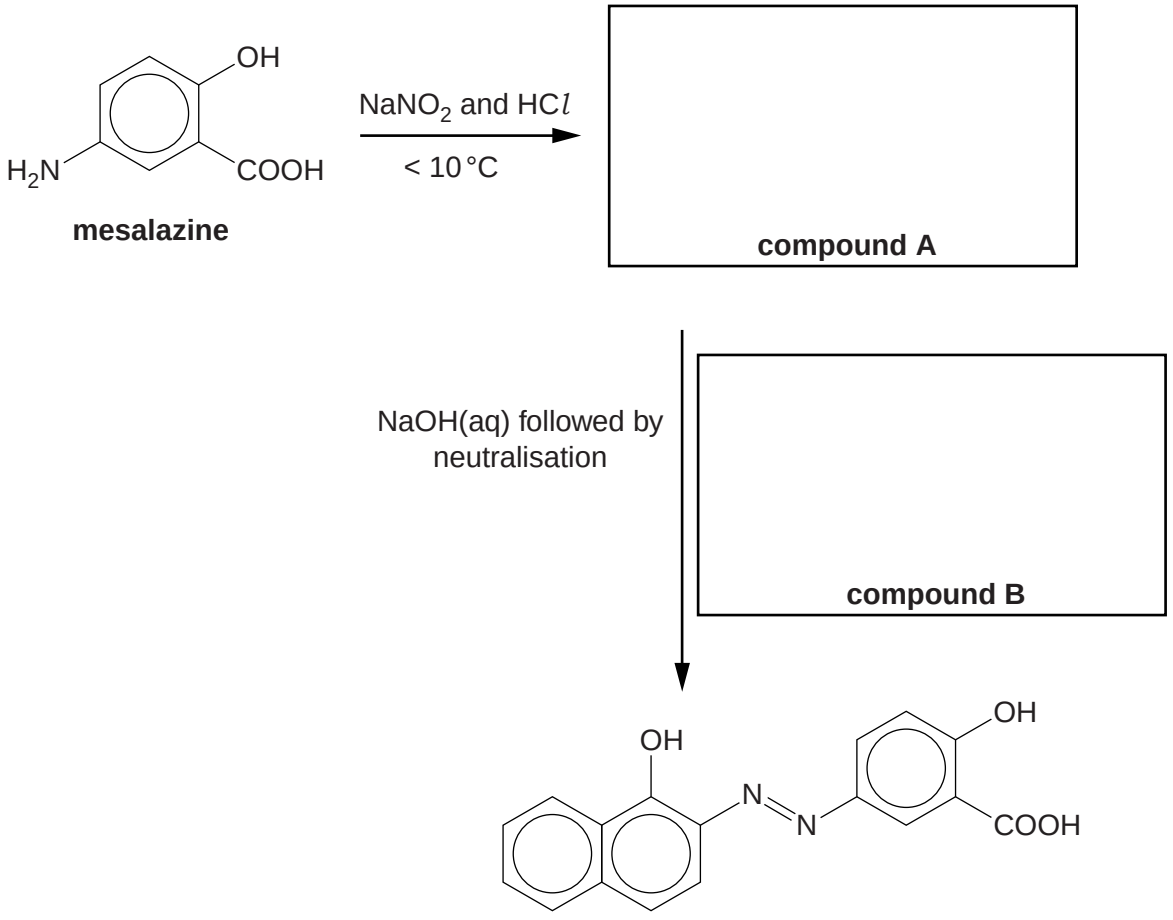
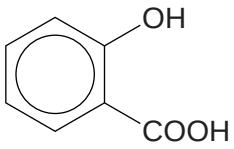
..... **[1]**

(iii) Mesalazine reacts in another two-stage process as shown below.

In the boxes, draw the structures of organic compounds **A** and **B**. **[2]**



(d) Salicylic acid can be used to form a condensation polymer similar to Terylene®.



salicylic acid

(i) Explain what is meant by the term *condensation polymer*.

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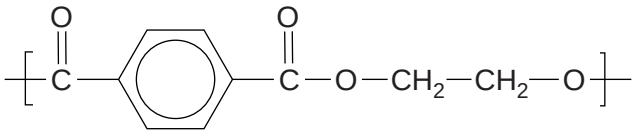
..... **[1]**

(ii) The repeat unit of Terylene® is shown below.



Terylene®

Draw the skeletal formulae of **two** monomers that can be used to form Terylene®.

[2]

(iii) Salicylic acid reacts with 3-hydroxypropanoic acid to form a mixture of condensation polymers.

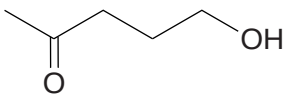
To form one polymer, the two monomers react in equal quantities.

Draw the repeat unit of this polymer, displaying the link between the monomer units.

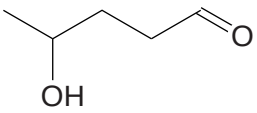
[1]

[Total: 22]

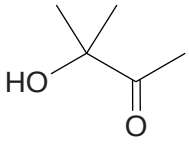
2 The following three carbonyl compounds are structural isomers of $C_5H_{10}O_2$.



compound C



compound D



compound E

(a) Describe chemical tests that you could carry out in test-tubes to distinguish between compounds **C**, **D** and **E**.

Include appropriate reagents and any relevant observations. Also include equations showing structures for the organic compounds involved.

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

(b) Aldehydes and ketones are both reduced by $NaBH_4$. When used in the presence of a $CeCl_3$ catalyst, $NaBH_4$ only reduces ketones.

Compound **F** has the structural formula $CH_3COCH_2CH_2CHO$. It is reduced by $NaBH_4$ in the presence of a $CeCl_3$ catalyst to form one of the compounds **C**, **D** or **E**.

Show the mechanism for this reduction of compound **F** and identify the product that is formed.

Use curly arrows and show relevant dipoles.

You do not need to show the role of the $CeCl_3$ catalyst.

[4]

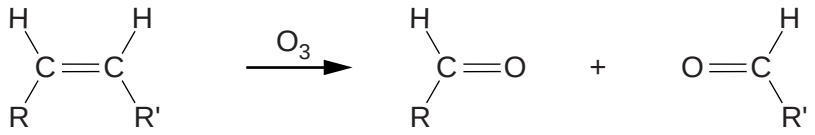
(c) Predict the number of peaks in the ^{13}C NMR spectra of compounds **C**, **D** and **E**.

Compound	**C**	**D**	**E**
Number of peaks			

[1]

(d) 'Ozonolysis' is a technique used in organic chemistry to break open a C=C double bond.

During ozonolysis, an alkene reacts with ozone, O_3. The products are carbonyl compounds, as shown below.



(i) Draw the structures of the products you would expect from the complete ozonolysis of the following alkenes.

- pent-2-ene

- hexa-2,4-diene

[3]

(ii) In another ozonolysis reaction, organic compound **G** reacted to form **only** hexane-1,6-dial.

Compound **G** has six carbon atoms.

Draw the structure of compound **G**.

[1]

[Total: 13]

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Question 3 begins on page 12

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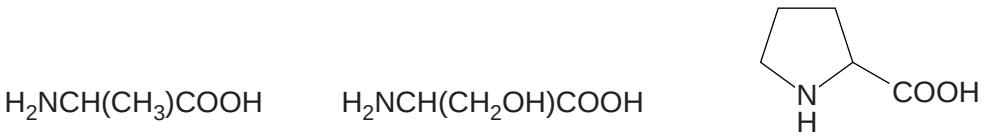
3 Alanine, serine and proline are α-amino acids.



alanine **serine** **proline**

(a) (i) Alanine and serine react together to form two different dipeptides.

Draw the structures of the **two** dipeptides that can form when alanine and serine react together.

[2]

(ii) The isoelectric points of alanine and serine are shown below.

alanine, pH = 6.0

serine, pH = 5.6

Draw the structures of the ions formed at the following pH values.

structure of **alanine** ion at **pH 6.0**

structure of **serine** ion at **pH 10.0**

[2]

(iii) Proline can polymerise to form poly(proline).

Draw the structure of the repeat unit in poly(proline).

[1]

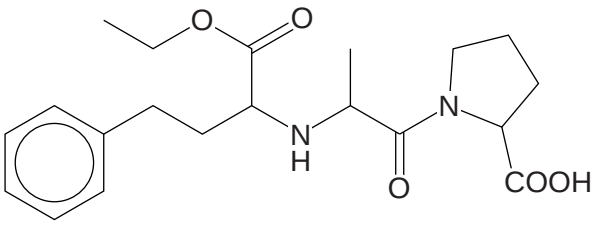
(b) A solution of serine was shaken with a few drops of D_2O. The solution was then analysed using ^1H NMR spectroscopy.

Complete the table to predict the ^1H NMR spectrum of serine after the addition of D_2O.

^1H NMR spectrum for serine		
Chemical shift, δ / ppm	**Relative peak area**	**Splitting pattern**

[2]

(c) Enalapril is a drug used in the treatment of high blood pressure.



enalapril

(i) **On the structure above**, mark each chiral centre with an asterisk (*). **[1]**

(ii) Suggest **two** benefits of using single stereoisomers in the synthesis of drugs such as enalapril.

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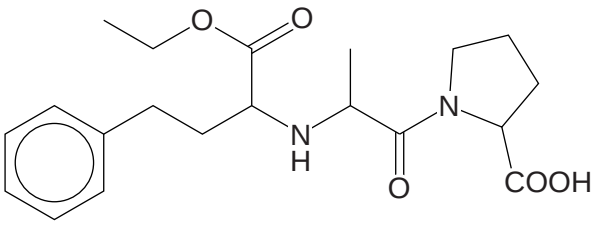
..... **[2]**

(iii) Enalapril is broken down in the body by acid hydrolysis.



enalapril

Draw the structures of the **three** organic products of the **acid hydrolysis** of enalapril.

[4]

(iv) A scientist hydrolysed enalapril in the laboratory. The scientist then analysed the mixture of products using GC–MS.

Explain how GC–MS enables the products to be identified.

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

[Total: 15]

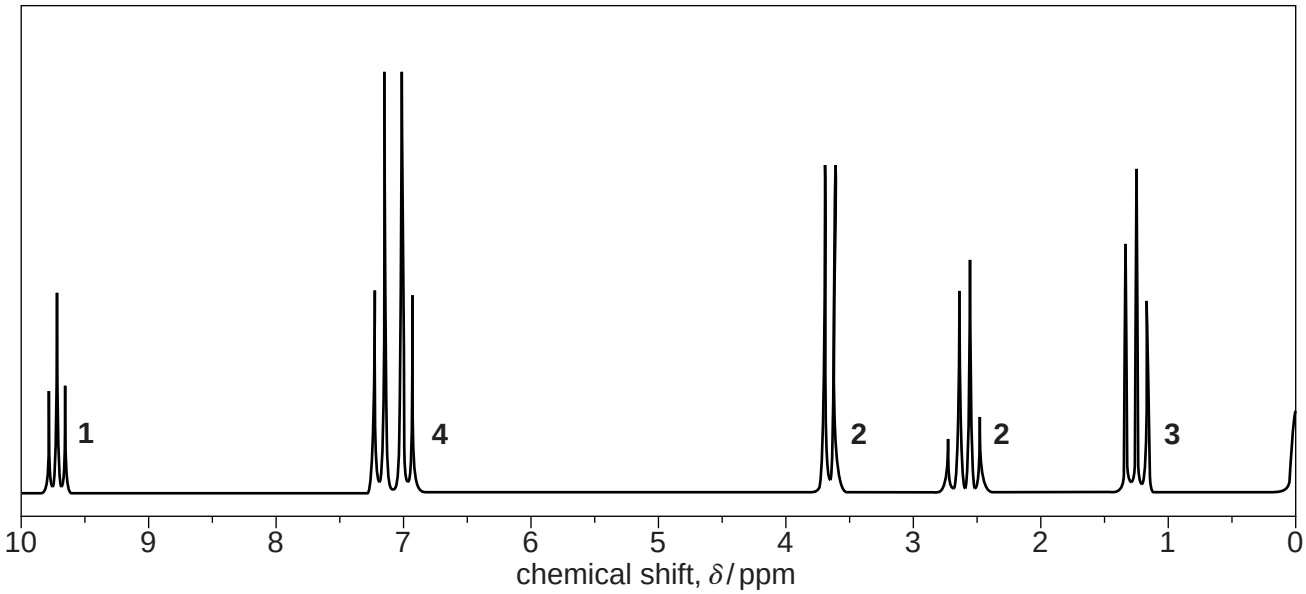
4 A chemist isolates compound **H** from a mixture and sends it for analysis.

Initial analysis shows that the molecular formula of compound **H** is $C_{10}H_{12}O$.

The ^{13}C NMR spectrum of compound **H** contained eight separate peaks.

The ^{1}H NMR spectrum of compound **H** is shown below.

^{1}H NMR spectrum
The numbers by each peak are the relative peak areas.



(a) The ^{1}H NMR spectrum contains a peak at $\delta = 0$ ppm resulting from a chemical added to the sample.

State the chemical responsible for the peak at $\delta = 0$ ppm, and state why this chemical was added to the sample.

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

(b) In the ^{1}H NMR spectrum, the peak at δ = 3.7 ppm would normally be expected at a chemical shift value about 1 ppm to the right, ie at 2.7 ppm.

Use the information in this question to determine the structure of compound **H**.

Show all your reasoning.

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

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[Total: 10]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

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