

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**  
**A2 GCE**  
**F324/01**

**CHEMISTRY A**  
**Rings, Polymers and Analysis**

**MONDAY 9 JUNE 2014: Afternoon**  
**DURATION: 1 hour 15 minutes**  
**plus your additional time allowance**

**MODIFIED ENLARGED**

<b>Candidate forename</b>		<b>Candidate surname</b>	
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<b>Centre number</b>						<b>Candidate number</b>				
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**Candidates answer on the Question Paper.**

**OCR SUPPLIED MATERIALS:**

***Data Sheet for Chemistry A***

**OTHER MATERIALS REQUIRED:**

**Scientific calculator**

**READ INSTRUCTIONS OVERLEAF**

## **INSTRUCTIONS TO CANDIDATES**

**The Insert will be found inside this document.**

**Write your name, centre number and candidate number in the boxes on the first page. 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.**

## **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 with this Question Paper.

You are advised to show all the steps in any calculations.

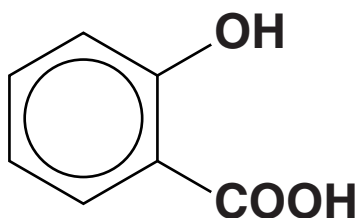
The total number of marks for this paper is 60.

Any blank pages are indicated.

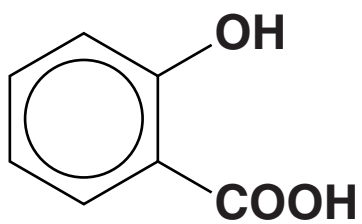
**Answer ALL the questions.**

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

**SALICYLIC ACID**



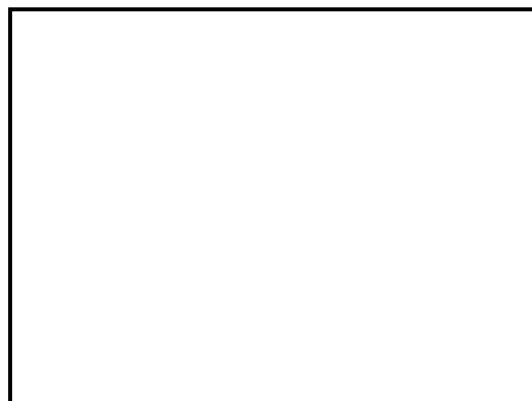
- (a) The flowchart opposite shows some reactions of salicylic acid.**
- (i) In the box opposite, draw the structure of the organic compound formed by REACTION 1. [1]**
- (ii) Describe what would be OBSERVED during REACTION 2.**
- \_\_\_\_\_
- \_\_\_\_\_ [1]
- (iii) Write a chemical equation to represent REACTION 2. [1]**



**SALICYLIC ACID**

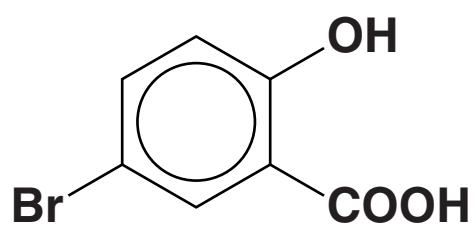
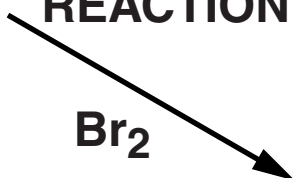
**REACTION 1**

**excess  
NaOH(aq)**

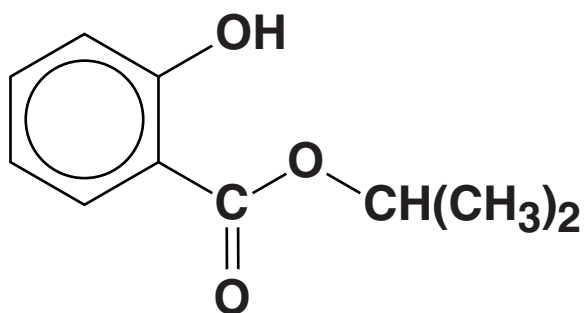


**REACTION 2**

**Br<sub>2</sub>**



**REACTION 3**



**(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<sub>2</sub>. [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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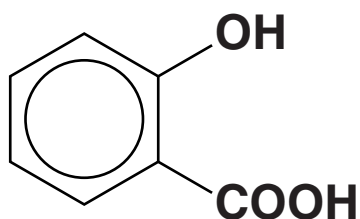
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[3]

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

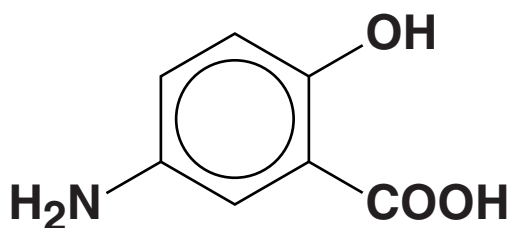
**SALICYLIC ACID**



**two-step  
synthesis**



**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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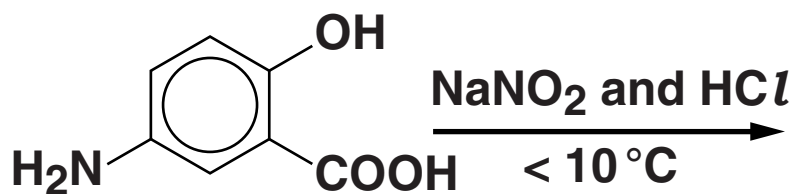
**[1]**

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

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

**[2]**

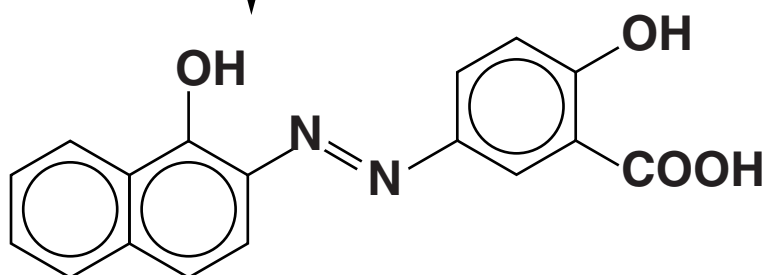
## MESALAZINE



**COMPOUND A**

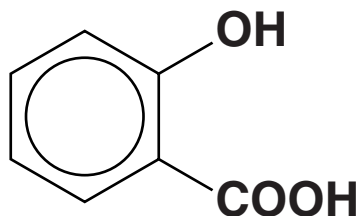
$\text{NaOH(aq)}$  followed by  
neutralisation

**COMPOUND B**



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

## SALICYLIC ACID

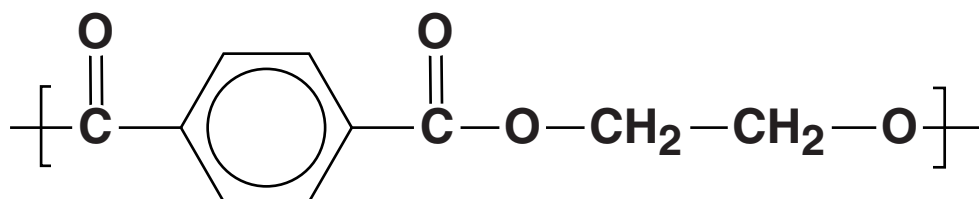


- (i) Explain what is meant by the term 'condensation polymer'.

\_\_\_\_\_ [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® below. [2]

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

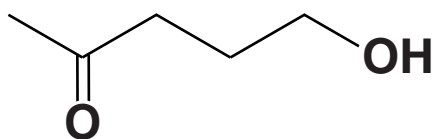
**To form one polymer, the two monomers react in equal quantities.**

**Draw the repeat unit of this polymer, displaying the link between the monomer units below. [1]**

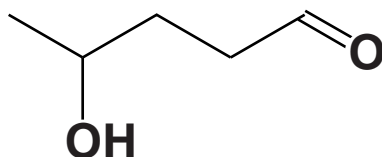
**[TOTAL: 22]**

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

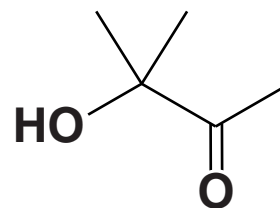
**COMPOUND C**



**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  $\text{NaBH}_4$ . When used in the presence of a  $\text{CeCl}_3$  catalyst,  $\text{NaBH}_4$  only reduces ketones.

Compound F has the structural formula  $\text{CH}_3\text{COCH}_2\text{CH}_2\text{CHO}$ . It is reduced by  $\text{NaBH}_4$  in the presence of a  $\text{CeCl}_3$  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  $\text{CeCl}_3$  catalyst.

[4]

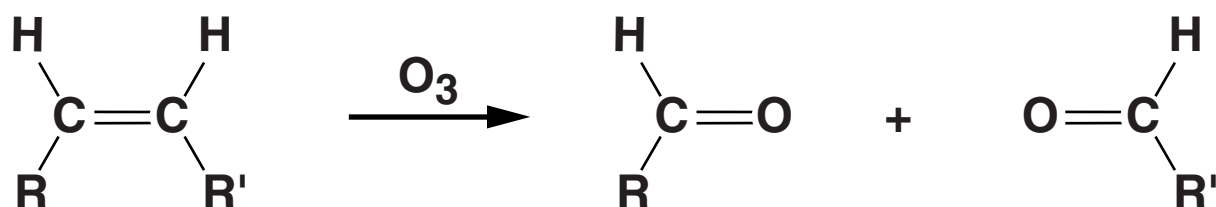
**(c) Predict the number of peaks in the  $^{13}\text{C}$  NMR spectra of compounds C, D and E.**

<b>Compound</b>	<b>C</b>	<b>D</b>	<b>E</b>
<b>Number of peaks</b>			

**[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. [3]

pent-2-ene

hexa-2,4-diene



- (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 below. [1]

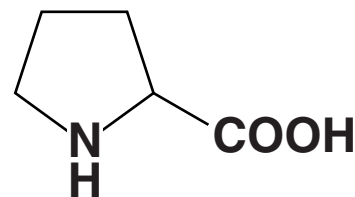
[TOTAL: 13]

**3 Alanine, serine and proline are  $\alpha$ -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,  $\text{pH} = 6.0$

serine,  $\text{pH} = 5.6$

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

structure of  
ALANINE ion  
at  $\text{pH} 6.0$



structure of  
SERINE ion  
at  $\text{pH} 10.0$



[2]

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

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

[1]

- (b) A solution of serine was shaken with a few drops of  $\text{D}_2\text{O}$ . The solution was then analysed using  $^1\text{H}$  NMR spectroscopy.

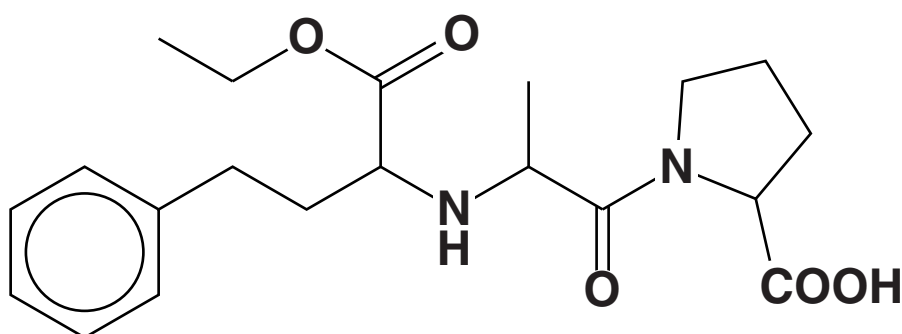
Complete the table to predict the  $^1\text{H}$  NMR spectrum of serine after the addition of  $\text{D}_2\text{O}$ .

$^1\text{H}$ NMR spectrum for serine		
Chemical shift, $\delta/\text{ppm}$	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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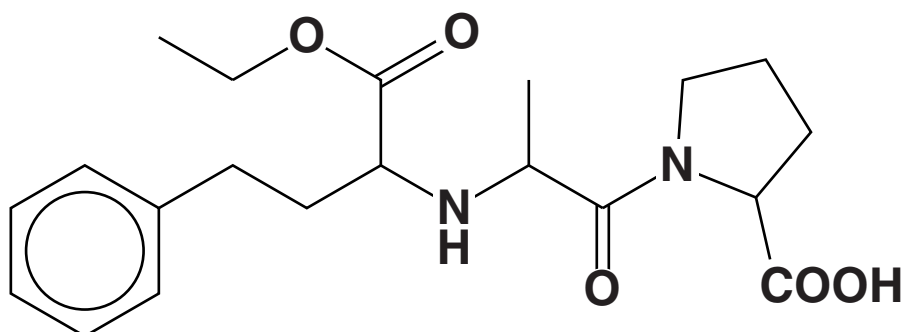
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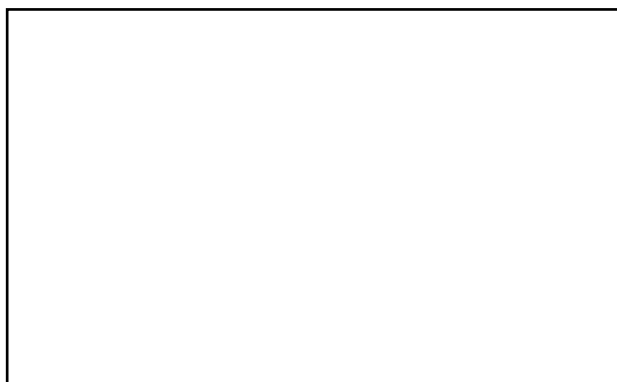
**[2]**

- (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 in the boxes below.** [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.

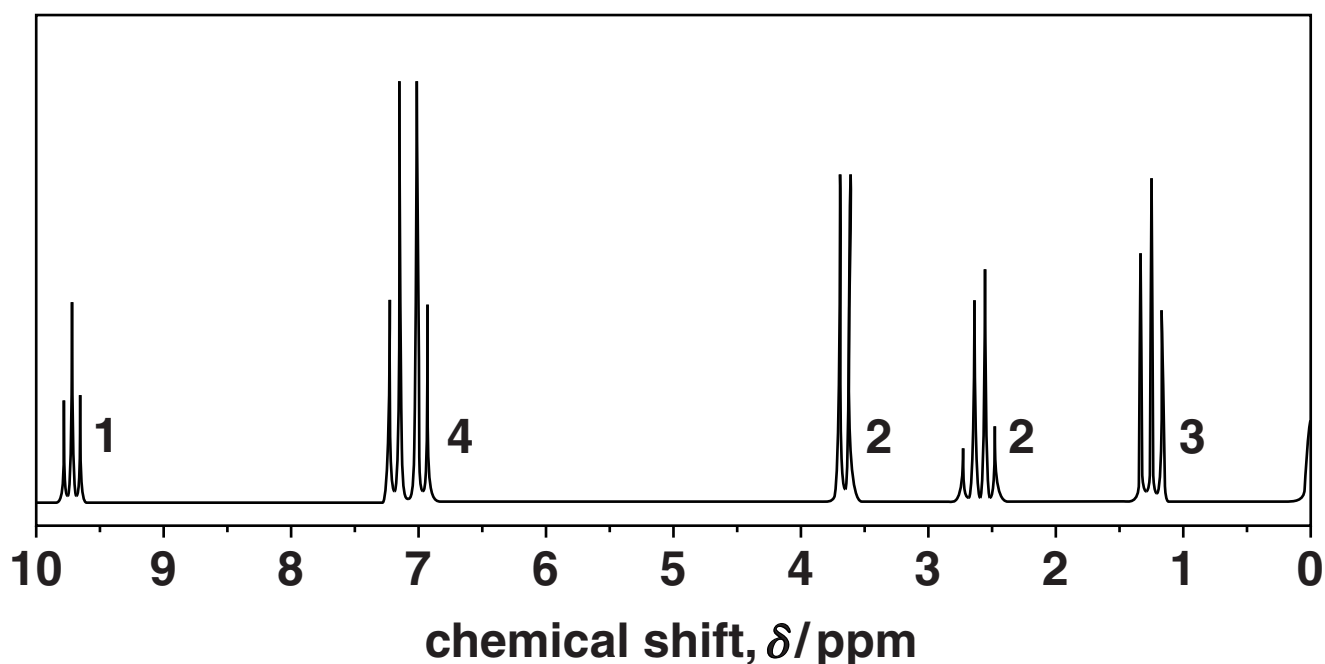
Initial analysis shows that the molecular formula of compound H is  $C_{10}H_{12}O$ .

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

The  $^1H$  NMR spectrum of compound H is shown below.

$^1H$  NMR spectrum

The numbers by each peak are the relative peak areas.





- (a) The  $^1\text{H}$  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  $^1\text{H}$  NMR spectrum, the peak at  $\delta = 3.7$  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. [9]**

[9]

[illegible]

[illegible]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

**[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.**


[illegible]





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