OCR
Oxford Cambridge and RSA

Tuesday 14 June 2016 – 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

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 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.

OCR is an exempt Charity

Turn over

Answer **all** the questions.

1 Stearic acid, oleic acid and linoleic acid are examples of naturally occurring fatty acids.

Traditional name	**Structure**	**Systematic name**
Stearic acid	$C_{17}H_{35}COOH$	Octadecanoic acid
Oleic acid	$C_{17}H_{33}COOH$	Octadec-9-enoic acid
Linoleic acid	$C_{17}H_{31}COOH$	Octadeca-9,12-dienoic acid

(a) Suggest which fatty acid in the table is most likely to be linked with concerns about heart disease and obesity.

Explain your choice.

....

.... **[1]**

(b) Sodium stearate is the salt formed when stearic acid reacts with sodium hydroxide solution.

Write an equation for the formation of sodium stearate.

.... **[1]**

(c) A triglyceride formed from stearic acid can be found in some types of food.

Draw the structure of this triglyceride with any functional groups fully displayed.

[2]

(d) Partial hydrogenation of linoleic acid may result in the formation of *trans*-octadec-12-enoic acid.

(i) Draw the **skeletal** formula of *trans*-octadec-12-enoic acid.

[2]

(ii) Some fatty acids show *cis-trans* isomerism because there is restricted rotation about a C=C double bond.

State **one** other feature of these molecules that enables them to show *cis-trans* isomerism.

....

.... **[1]**

[Total: 7]

2 Some organic compounds contain nitrogen atoms. Examples include condensation polymers and azo dyes.

(a) A section of a condensation polymer is shown below.

$$–CO(CH_2)_4CONH(CH_2)_6NHCO(CH_2)_4CONH(CH_2)_6NH–$$

(i) In the boxes below, draw the structures of the two monomers that form this condensation polymer.

[2]

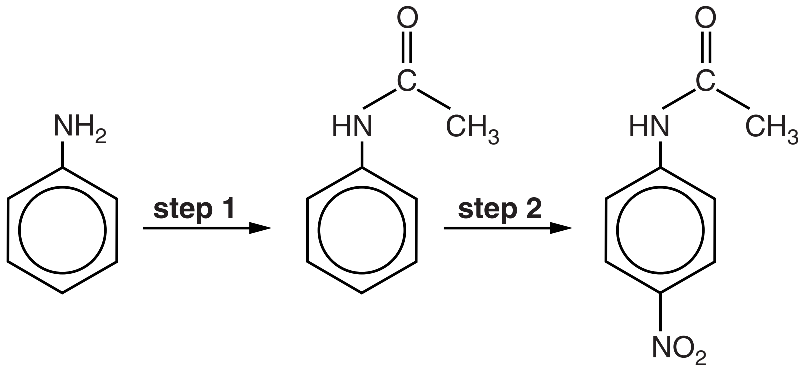
(ii) Name the type of condensation polymer and give a use for this polymer.

Type ....

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

(b) A student plans a two-step synthesis starting with phenylamine.

The steps of the synthesis are shown below.



phenylamine **compound A** **compound B**

(i) In **step 1**, phenylamine reacts with ethanoic anhydride to make compound **A** and one other organic product.

Draw the structure of ethanoic anhydride, with the functional group displayed, and suggest the structure of the other organic product formed in **step 1**.

ethanoic anhydride	**other organic product**

[2]

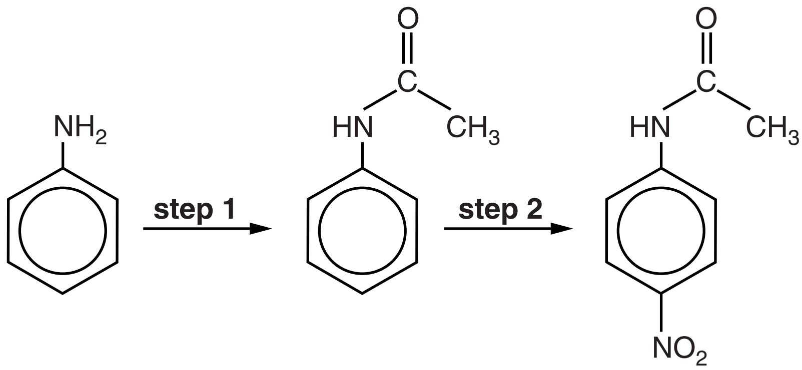
(ii) Calculate the mass of compound **A** that can be synthesised from 3.00 g of phenylamine in **step 1**. The percentage yield of this reaction is 61.0%.

M_r (phenylamine) = 93.0

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

mass of compound **A** = ... g **[3]**

The steps of the synthesis are shown again below.



phenylamine **compound A** **compound B**

(iii) In **step 2**, compound **A** is converted into compound **B** using a mixture of concentrated nitric acid and concentrated sulfuric acid.

Outline, with the aid of curly arrows, the mechanism for the conversion of compound **A** into compound **B**.

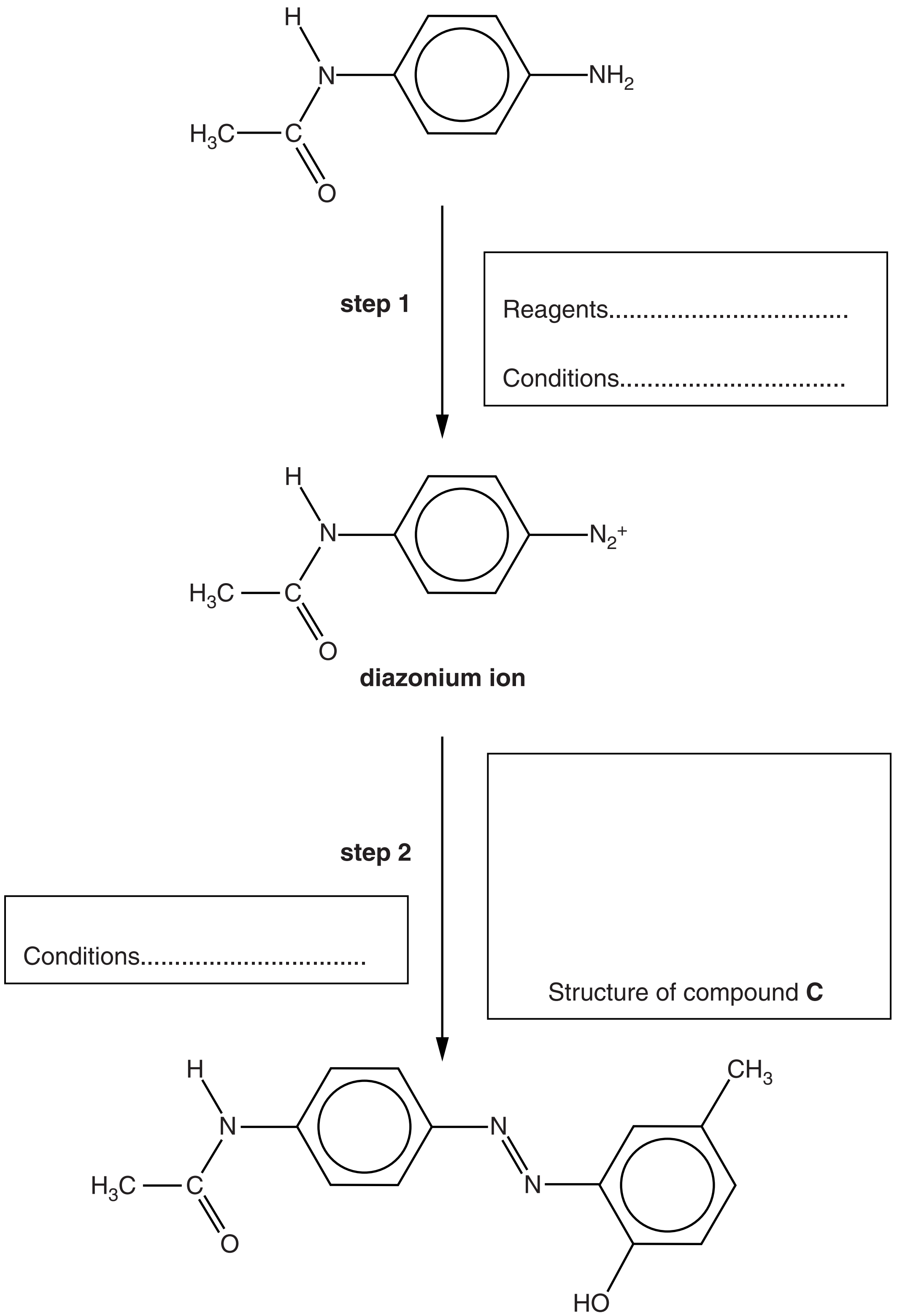
Use equations to explain how sulfuric acid acts as a catalyst in this reaction.

[5]

(c) An azo dye is synthesised in two steps. In **step 2** the diazonium ion is reacted with compound **C** to form the azo dye.

Complete the flowchart for this synthesis.

Write your answers in the boxes.



azo dye

[4]

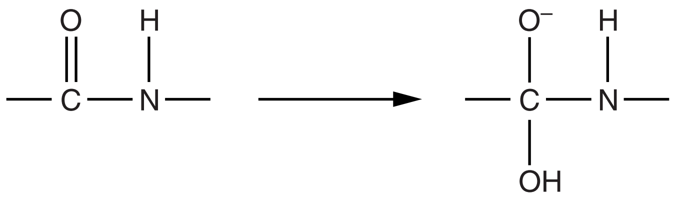
[Total: 17]

3 The building blocks of peptides and proteins are α-amino acids.

A tripeptide is hydrolysed to form a mixture of three different α-amino acids.

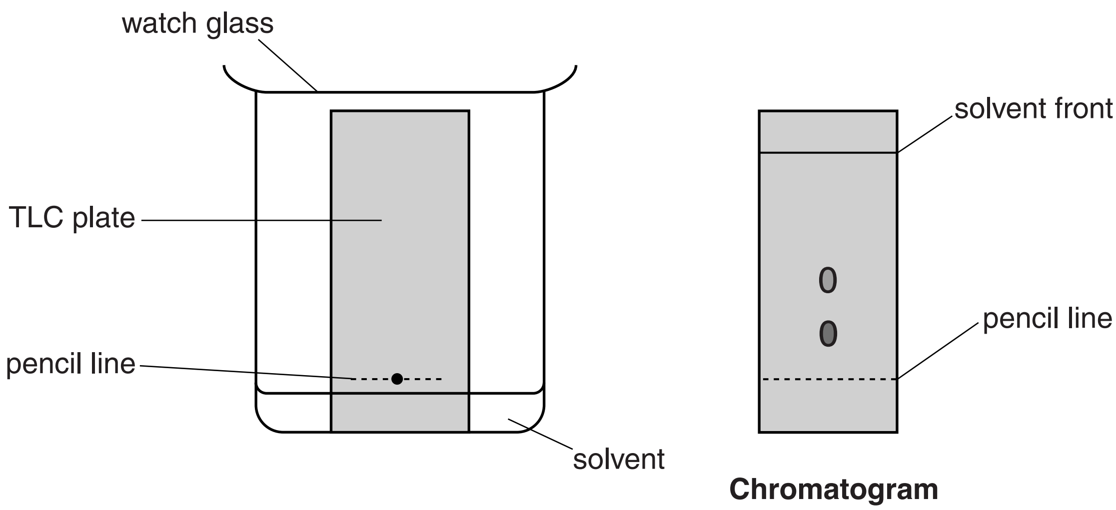
(a) The first step of an incomplete mechanism for the alkaline hydrolysis of the tripeptide is shown below.

Add curly arrows and relevant dipoles to the diagram to suggest how the hydroxide ion takes part in the first step of this mechanism.



[2]

(b) The tripeptide is hydrolysed and the resulting mixture containing the three amino acids is neutralised.
A student tries to separate and identify the three amino acids in the mixture using thin-layer chromatography (TLC). The diagram below shows the apparatus for the experiment and the chromatogram produced.



Explain how the chromatogram can be used to identify amino acids.
The student thinks that there should be three spots on the chromatogram.

Suggest why there are only two spots.

....

....

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....

....

.... **[3]**

(c) The three α-amino acids in the tripeptide are aspartic acid, glycine and isoleucine.

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

α-amino acid	**R-group**
aspartic acid	$–CH_2COOH$
glycine	–H
isoleucine	$–CH(CH_3)CH_2CH_3$

(i) Aspartic acid has an isoelectric point of 2.77.

What is meant by the term *isoelectric point*?

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

....

....

.... **[1]**

(ii) Draw the structure of aspartic acid when it is dissolved in a solution with a high pH.

[1]

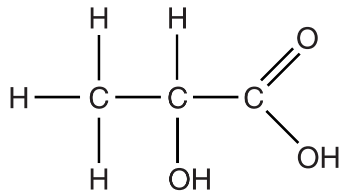
(iii) Suggest a structure for the tripeptide.

On your structure, mark each chiral centre with an asterisk (*).

[2]

[Total: 9]

4 This question is about the preparation, properties and uses of lactic acid.



lactic acid

(a) What is the systematic name of lactic acid?

.... **[1]**

(b) Lactic acid can be produced by chemical synthesis or by the fermentation of sugars using bacteria.

Describe **one** important difference between lactic acid manufactured by chemical synthesis and lactic acid manufactured by the fermentation of sugars.

....

....

....

.... **[1]**

(c) When heated strongly, lactic acid forms a cyclic 'diester'.
The diester has the molecular formula, $C_6H_8O_4$.

Draw the structure of the cyclic diester.

[1]

(d) Poly(lactic acid), PLA, is used to make 'dissolvable' stitches (for holding wounds together). PLA breaks down into smaller molecules after one or two weeks.

(i) Draw the structure of **one** repeat unit in PLA.

[1]

(ii) Explain how PLA breaks down and why the stitches 'dissolve'.

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

....

....

....

....

....

.... **[3]**

[Total: 7]

5 A chemistry teacher carries out an experiment to synthesise 2-aminopropan-1-ol, $CH_3CH(NH_2)CH_2OH$.

(a) The teacher asks a university chemistry department to test the 2-aminopropan-1-ol using proton NMR spectroscopy and mass spectrometry.

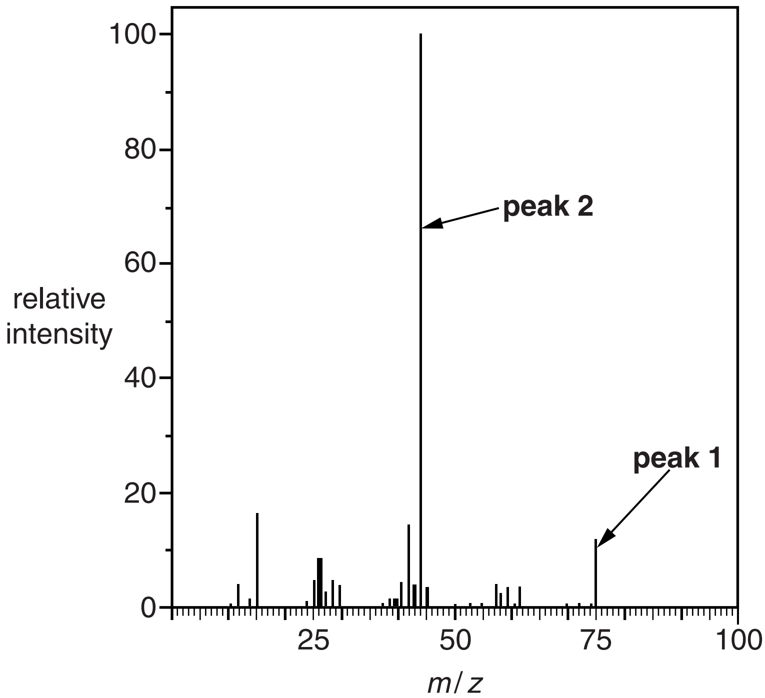
(i) For the ^1H NMR analysis, the sample was dissolved in D_2O.

Complete the table to predict the ^1H NMR spectrum of $CH_3CH(NH_2)CH_2OH$ after dissolving in D_2O.

^1H NMR spectrum for $CH_3CH(NH_2)CH_2OH$, dissolved in D_2O		
Chemical shift, δ/ppm	**Relative peak area**	**Splitting pattern**

[3]

(ii) The mass spectrum for $CH_3CH(NH_2)CH_2OH$ is shown below.



Give the formulae for the species responsible for **peak 1** and **peak 2** in the mass spectrum.

peak 1

peak 2

[2]

(b) The teacher synthesises 2-aminopropan-1-ol, $CH_3CH(NH_2)CH_2OH$, from 2-chloropropan-1-ol, $CH_3CHClCH_2OH$.

(i) State the reagents and conditions required for this synthesis.

....

.... **[1]**

(ii) The sample prepared by the teacher from 2-chloropropan-1-ol is not pure. It also contains compound **D**.

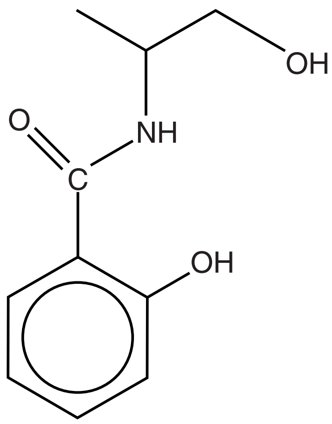
Compound **D** has a molecular formula of $C_6H_{15}NO_2$.

Suggest the structure of compound **D**.

Compound **D**

[1]

(c) In a separate experiment, the chemistry teacher prepares compound **E** from 2-aminopropan-1-ol.



compound E

(i) One of the functional groups in compound **E** is a phenol.

Name the other functional groups in compound **E**.

....

.... **[1]**

(ii) Draw the structures of the **two** organic products formed when compound **E** is heated under reflux with dilute hydrochloric acid.

[2]

[Total: 10]

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Turn over for the next question

6 There are several isomeric alcohols with the formula $C_5H_{11}OH$.

(a) Pentan-1-ol, $CH_3(CH_2)_3CH_2OH$, can be prepared in the laboratory by the reduction of an aldehyde.

State a suitable reducing agent for this reaction and write an equation to show the preparation of pentan-1-ol.
Use [H] to represent the reducing agent in the equation.

Reducing agent ....

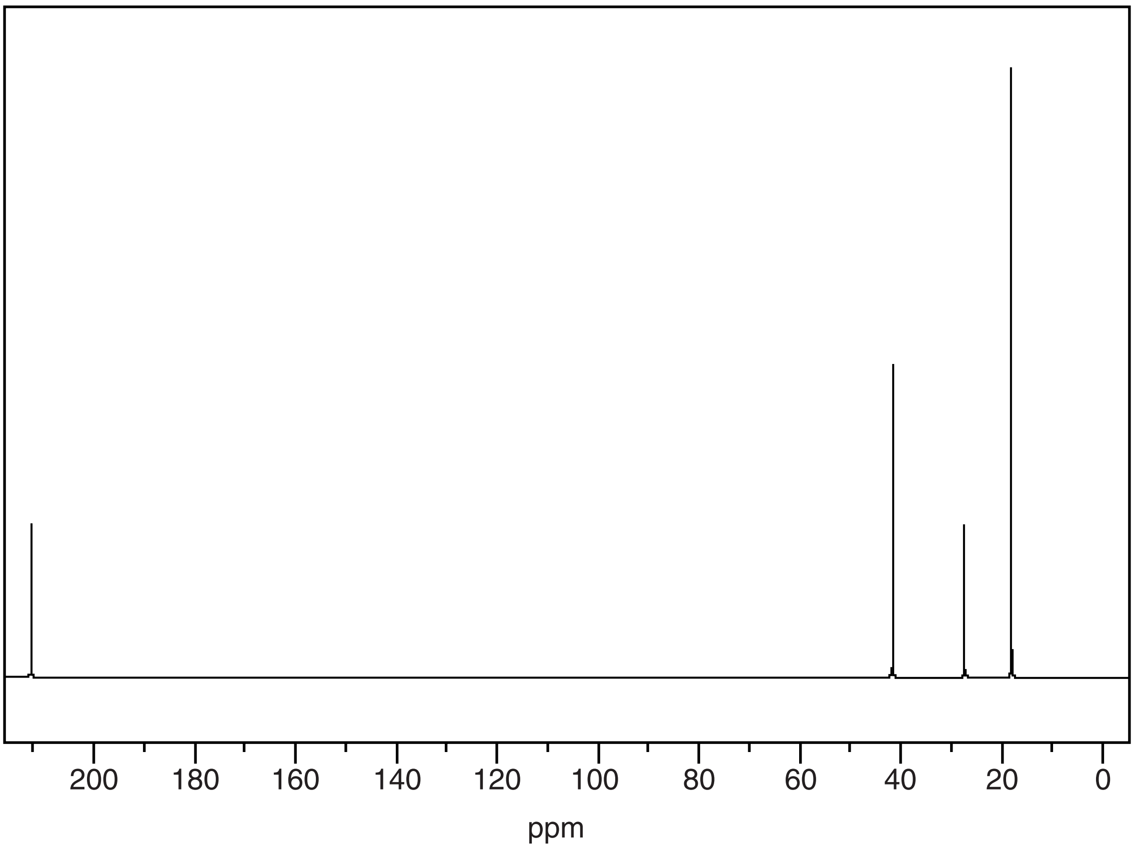
Equation ....
[2]

(b) Compound **F** is a structural isomer of $C_5H_{11}OH$.

Compound **F** is converted to compound **G** when heated under reflux with acidified potassium dichromate(VI) solution.

Compound **G** reacts with 2,4-dinitrophenylhydrazine to form an orange solid but compound **G** does not react with Tollens' reagent.

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



Compound **H** is a carboxylic acid. In a titration, 0.211 g of carboxylic acid **H** requires 22.8 cm^3 of 0.125 $mol\,dm^{-3}$ NaOH for neutralisation.

Compound **F** reacts with compound **H** in the presence of concentrated sulfuric acid to form organic compound **I**.

Identify compounds **F**, **G**, **H** and **I** and draw their structures in the boxes below.

Show your working **only** for the identification of compound **H**.

....

....

....

....

....

....

....

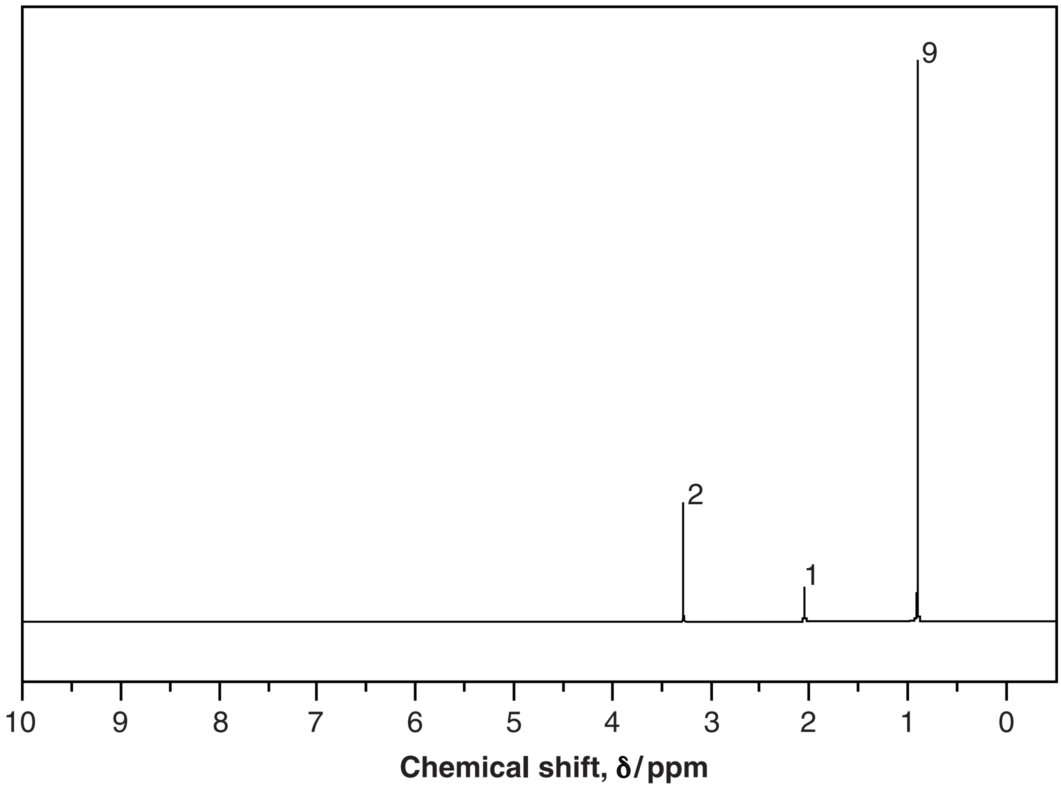
F	**G**
H	**I**

[7]

(c) Compound **J** is another structural isomer of $C_5H_{11}OH$.

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

The numbers next to each peak are the relative peak areas.



Identify compound **J** and draw its structure in the box below.

J

[1]

[Total: 10]

END OF QUESTION PAPER

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).