Structural Analysis (combined techniques) A Level only

Question Paper 1

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	
Topic	Structural Analysis (combined techniques)
Paper	A Level only
Booklet	Question Paper 1

Time allowed: **46 minutes**

Score: **/34**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

A student was given three compounds, an aldehyde, a ketone, and a carboxylic acid.

(a) The student carried out the same two chemical tests on each compound. This allowed her to distinguish between all three compounds.

- Describe two suitable tests that the student could have used.
- Show how the observations would allow her to distinguish between the compounds. [4]

(b) Explain how the student could use infrared spectroscopy to confirm which compound is a carboxylic acid. [1]

(c) The aldehyde has the molecular formula $C_5H_{10}O$.

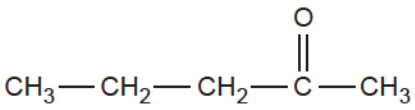
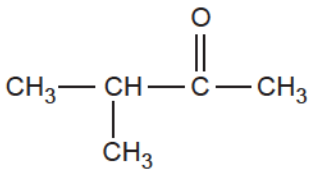
The ^1H NMR spectrum of the aldehyde contains a doublet at δ = 0.9 ppm with a relative peak area of six compared with the aldehyde proton.

Analyse this information to deduce the structure of the aldehyde. Explain your reasoning. [3]

(d) The ketone also has the molecular formula $C_5H_{10}O$. There are three structural isomers of this formula that are ketones.

(i) Two of these isomers are shown below.

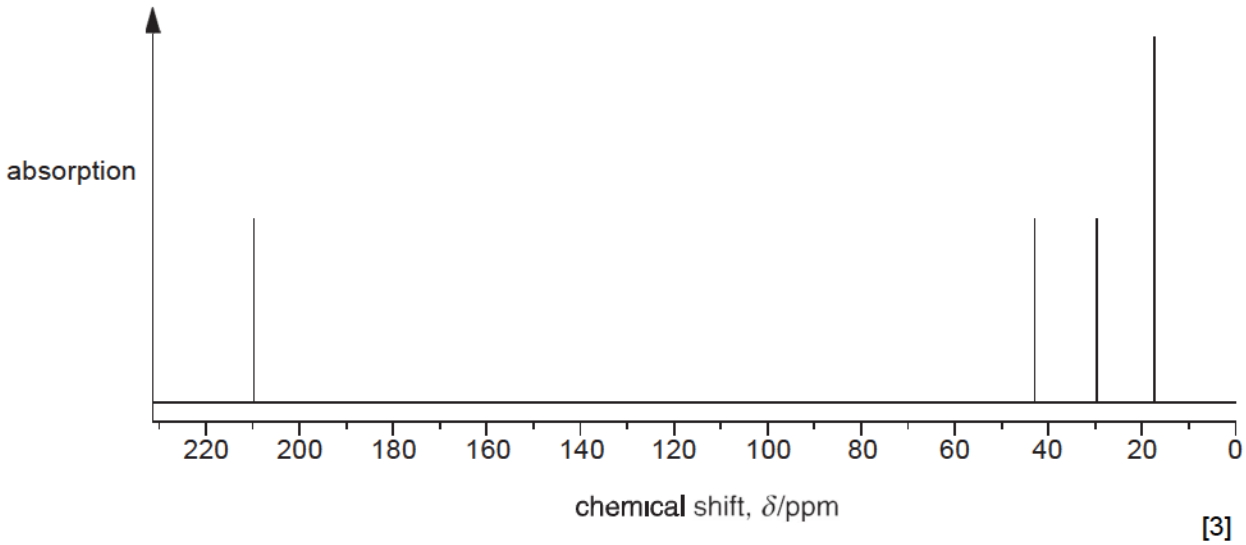
Draw the structural formula of the third structural isomer in the box below.

		
ketone 1	**ketone 2**	**ketone 3**

[1]

(ii) The ^{13}C NMR spectrum of the ketone given to the student is shown below.

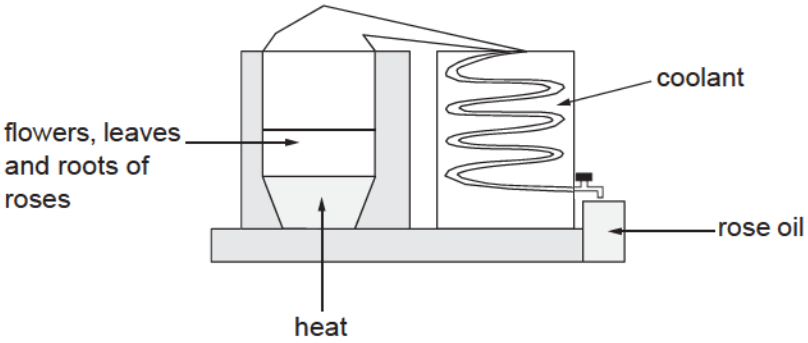
- Use the spectrum to identify the ketone. Explain your reasoning.
- Identify the carbon responsible for the peak at δ = 210 ppm.



[3]

[Total 12 Marks]

Rose oil can be extracted from the flowers, leaves and roots of roses using the apparatus below.



(a) The rose oil contains a mixture of compounds, some of which can be separated by using thin-layer chromatography (TLC). The chromatogram obtained is shown below.

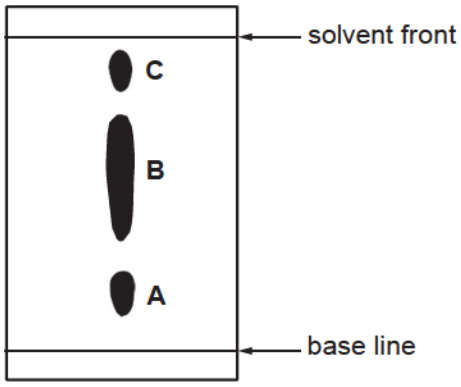


Fig. 5.1

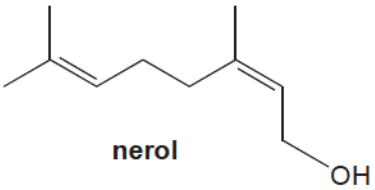
(i) Explain how TLC separates compounds in the mixture.

In your answer, you should use appropriate technical terms, spelled correctly. [1]

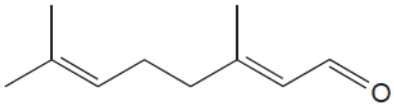
(ii) Estimate the R_f value of **A**. [1]

(iii) Using the chromatogram in **Fig. 5.1**, suggest why it is **not** possible to conclude that the rose oil contains **only** three different compounds. [1]

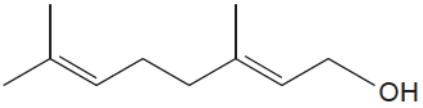
(b) GC–MS was used to identify the compounds present in the rose oil as nerol, geraniol, citral and menthol, shown below. These compounds all have stereoisomers.



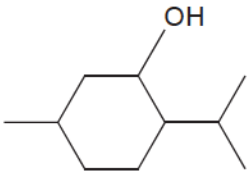
nerol



citral



geraniol



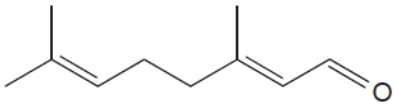
menthol

(i) Explain how GC–MS can be used to identify these compounds in the rose oil. [1]

(ii) Suggest, with a reason, which two compounds might be present in **B** in **Fig. 5.1**. [1]

(iii) Explain what is meant by the term *stereoisomers*. [1]

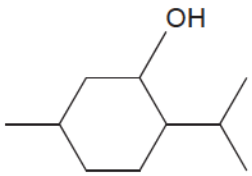
(iv) Draw a circle around the feature in citral that causes the stereoisomerism.



citral

[1]

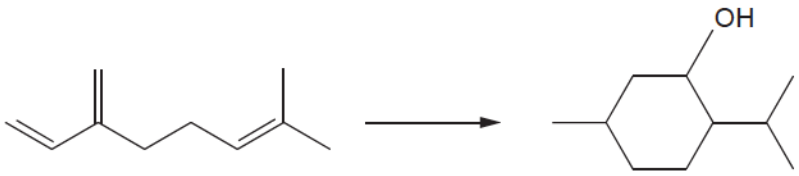
(v) Identify with asterisks (*) **all** the chiral centres in menthol that cause the stereoisomerism.



menthol

[2]

(c) Menthol is used in a wide range of products including lip balms, cough medicines and perfumery. The demand for menthol exceeds the supply from natural sources. Menthol is manufactured, using a chiral synthesis, from myrcene, a readily available starting material.



myrcene **menthol**

Calculate the mass of menthol that can be synthesised from 34.0 g of myrcene.
The percentage yield is 60%. M_r (Myrcene) = 136.

[3]

[Total 12 Marks]

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.

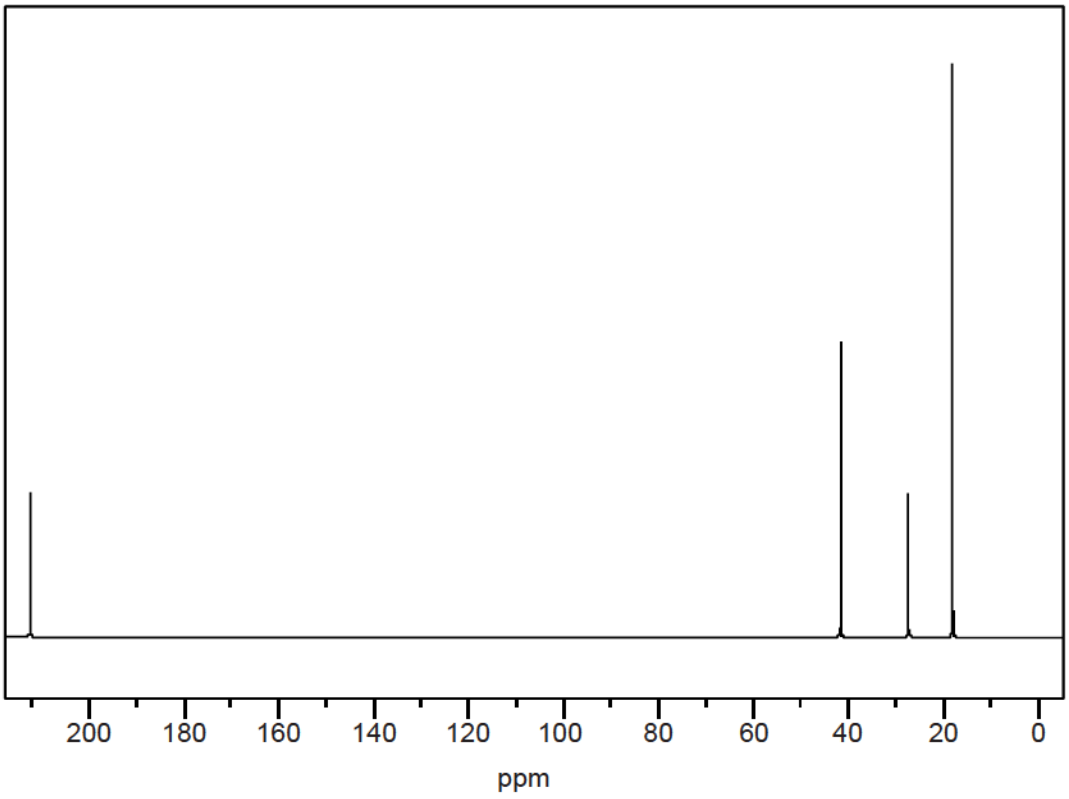
State a suitable reducing agent for this reaction and write an equation to show the preparation of pentan-1-ol.
Use [H] to represent the reducing agent in the equation. [2]

(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 22.8cm^3 of 0.125 $moldm^{-3}$ 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

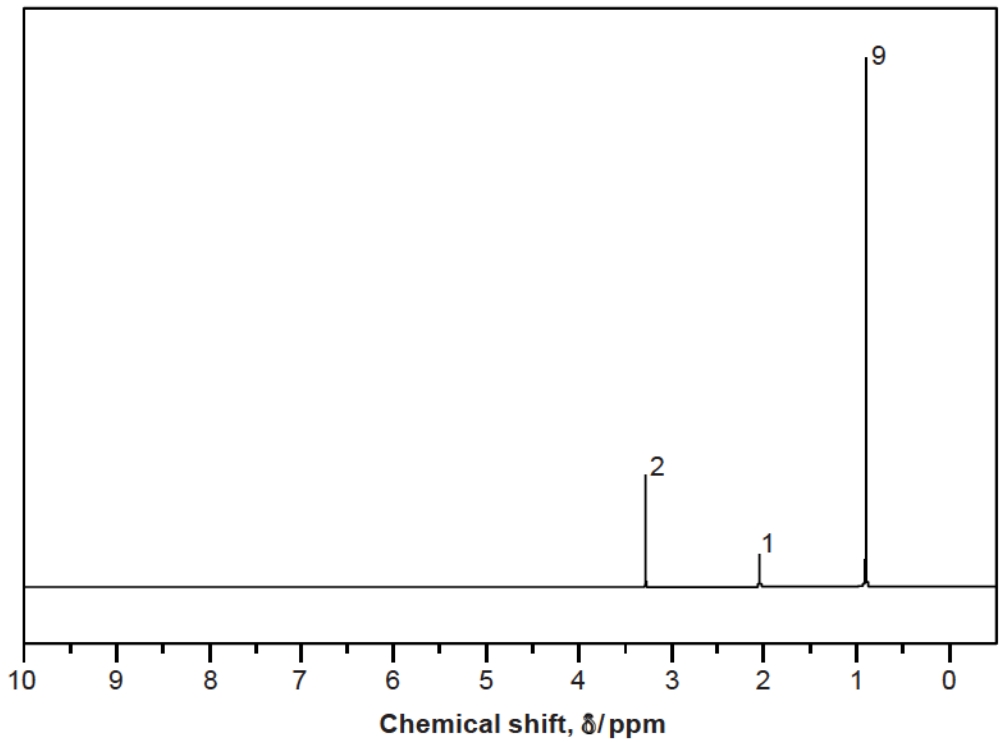
I

[7]

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

The ^1H 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 Marks]