EXAM PAPERS PRACTICE

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Detailed mark scheme

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Time allowed
**64 Minutes**

**Score** /53

**Percentage** %

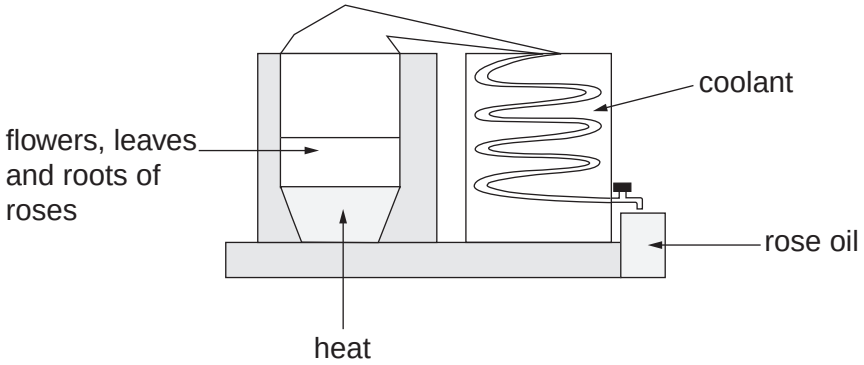
# CHEMISTRY

## OCR AS & A LEVEL

## Topic Questions

## Module 6: Organic chemistry and analysis

**1** 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.

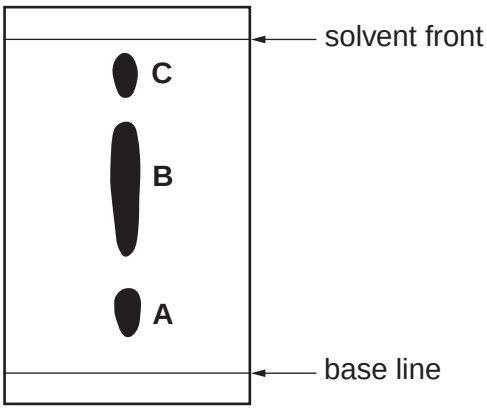



**Fig. 5.1**

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

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

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..... **[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.

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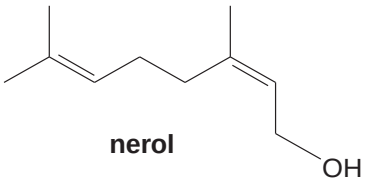
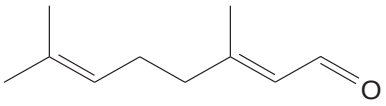
..... **[1]**

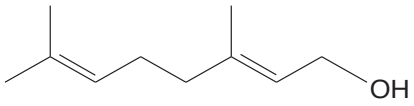
**(b)** GC–MS was used to identify the compounds present in the rose oil as nerol, geraniol, citral and menthol, shown below. These compounds all have stereoisomers.



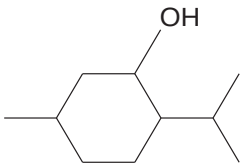

**nerol**




**citral**




**geraniol**




**menthol**

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

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

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

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

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

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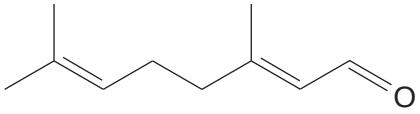
..... **[1]**

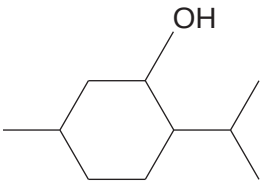
**(iv)** Draw a circle around the feature in citral that causes the stereoisomerism.




**citral**

**[1]**

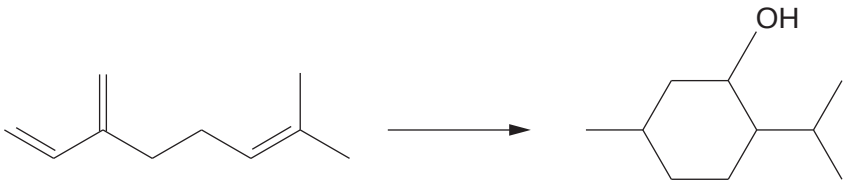
**(v)** Identify with asterisks (*) **all** the chiral centres in menthol that cause the stereoisomerism.




**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**

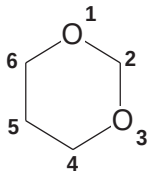
Calculate the mass of menthol that can be synthesised from 34.0 g of myrcene.
The percentage yield is 60%. $M_r$ (Myrcene) = 136.

mass of menthol = ..... g **[3]**

**[Total: 12]**

**2** A company was planning to build a power station that will burn plastic waste. The local residents were concerned about possible emission of pollutants such as dioxanes and aromatic hydrocarbons. The residents employed an independent chemical engineer to advise about possible emissions.

Some scientists suspect that dioxanes, such as 1,3-dioxane, and aromatic hydrocarbons may be linked to some types of cancer.




**1,3-dioxane**

**(a)** Predict the splitting patterns in the proton NMR spectrum of 1,3-dioxane.

Identify which protons are responsible for each splitting pattern.

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

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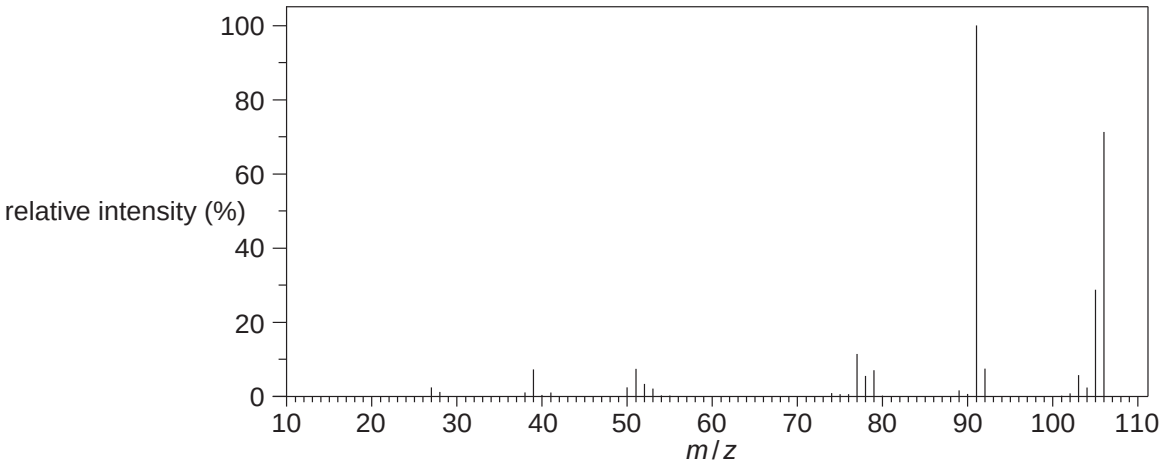
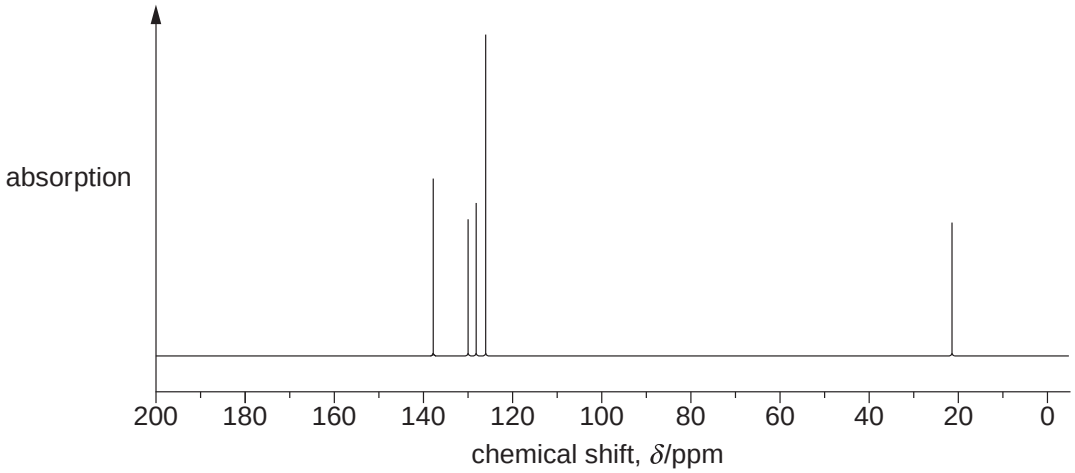
..... **[3]**

**(b)** The independent chemical engineer investigated an unknown aromatic hydrocarbon.
He obtained the mass spectrum and the $^{13}C$ NMR spectrum of the aromatic hydrocarbon, which are shown below.




The aromatic hydrocarbon is one of **four** possible isomers.

Use the spectra to identify the aromatic hydrocarbon.

Show **all** of your working and explain how you ruled out the other three isomers.

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aromatic hydrocarbon is:

**[6]**

**[Total: 9]**

**3** An industrial chemist discovered five bottles of different chemicals (three esters and two carboxylic acids) that were all labelled $C_5H_{10}O_2$.

The different chemicals had the structural formulae below.

$CH_3CH_2COOCH_2CH_3$ $(CH_3)_3CCOOH$ $CH_3COOCH(CH_3)_2$

$(CH_3)_2CHCH_2COOH$ $(CH_3)_2CHCOOCH_3$

**(a)** The chemist used both infrared and $^{13}C$ NMR spectroscopy to identify the two carboxylic acids and to distinguish between them.

How do both types of spectra allow the carboxylic acids to be identified and distinguished?

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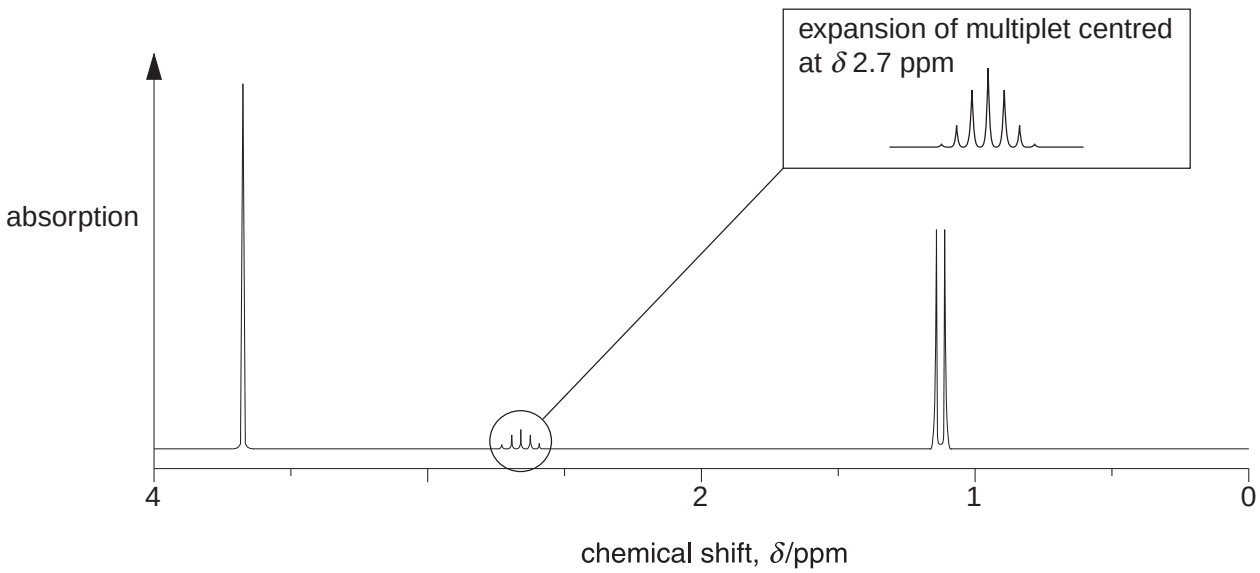
..... **[3]**

**(b)** The chemist analysed one of the esters by $^1H$ NMR spectroscopy. The spectrum is shown below.



Analyse the splitting patterns and the chemical shift values to identify the ester.

Give your reasoning.

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

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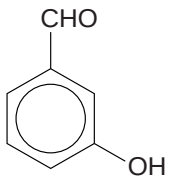
..... **[6]**

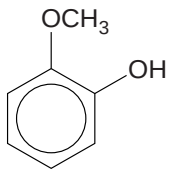
**[Total: 9]**

**4** A student analysed a mixture of compounds found in red wine using gas chromatography followed by mass spectrometry (GC-MS).

Two of the compounds found to be present in the mixture are shown below.




**compound A**




**compound B**

**(a)** The column in the gas chromatogram is packed with solid beads coated with a liquid polymer.

How does gas chromatography (GC) separate the compounds in the mixture?

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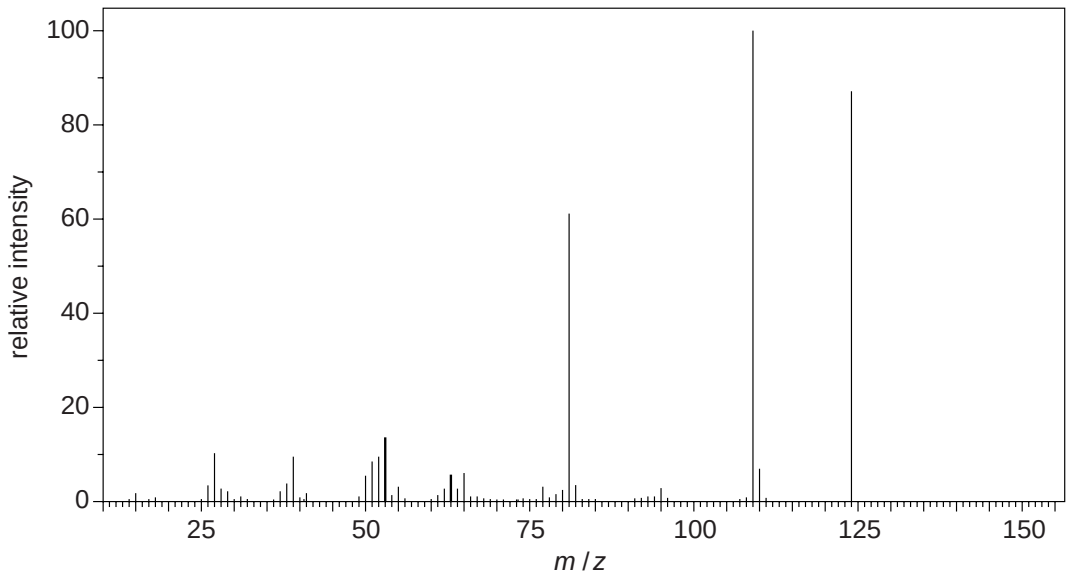
..... **[1]**

**(b)** The mass spectrum (MS) of the **first** compound to emerge from the column is shown below.




**(i)** Identify the compound responsible for this spectrum.

Give a reason for your answer.

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 **[1]**

**(ii)** What does your answer to **(b)(i)** suggest about the interaction of this compound with the phases present in the column?

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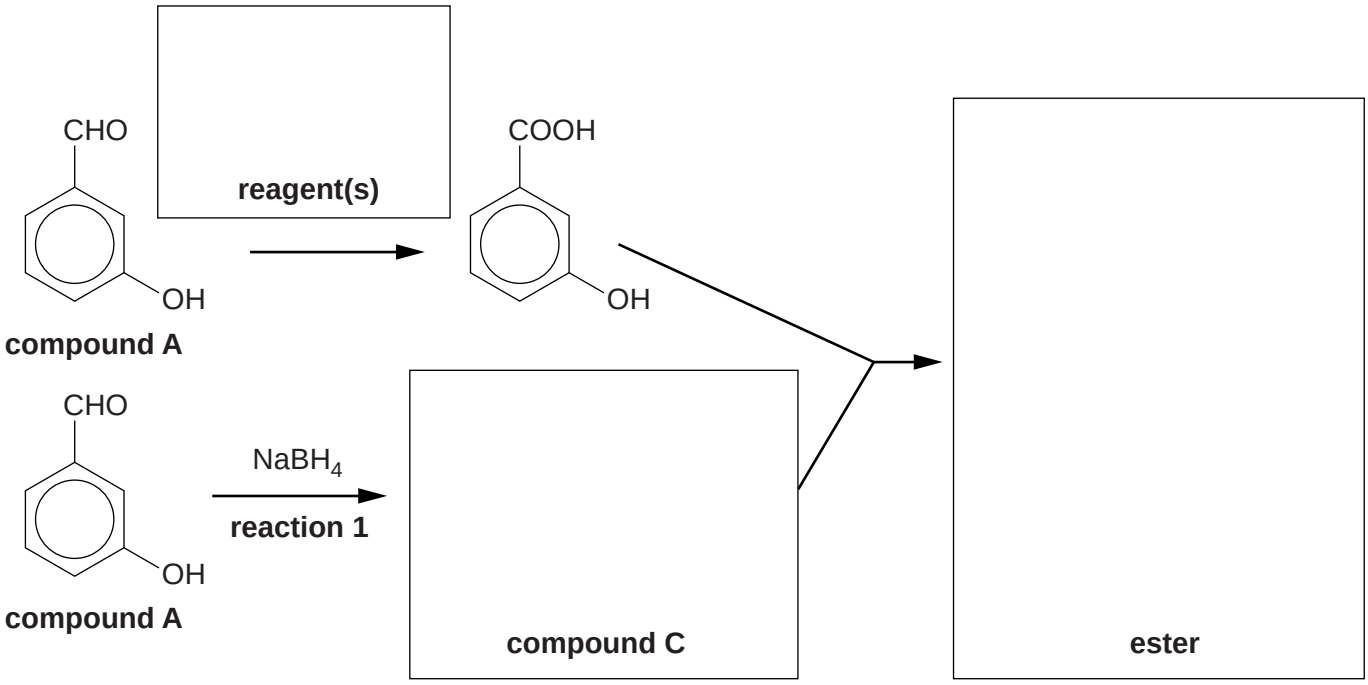
..... **[1]**

**(c)** In red wine, compound **A** slowly forms an ester.

The formation of the ester can also be done in the laboratory, as shown in the flowchart below. Separate portions of compound **A** are used in the formation of the ester.

**(i)** Complete the boxes in the flowchart below.

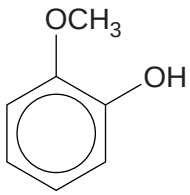



**[3]**

**(ii)** Give the mechanism to show the formation of compound **C** in **reaction 1**.
Use curly arrows and relevant dipoles.

**[3]**

**(d)** 1 mol of compound **B** reacts with 2 mol of bromine, $Br_2$ by electrophilic substitution.



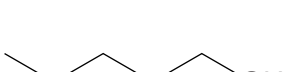

**compound B**

Write a balanced equation for this reaction, showing clearly the structure of the organic compound.

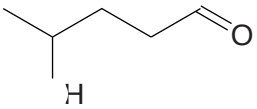
**[1]**

**[Total: 10]**

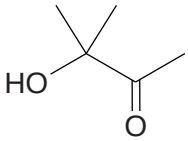
**5** The following three carbonyl compounds are structural isomers of $C_5H_{10}O_2$.




**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]**

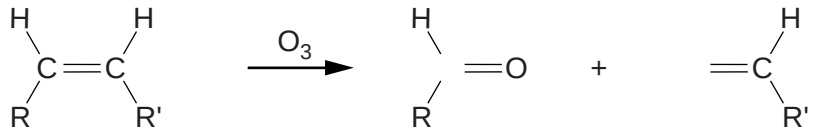
**(c)** Predict the number of peaks in the $^{13}C$ NMR spectra of compounds **C**, **D** and **E**.

| **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]**