

# NMR

## A Level only

### Question Paper 1

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Organic Chemistry & Analysis
Topic	NMR
Paper	A Level only
Booklet	Question Paper 1

**Time allowed:** 31 minutes

**Score:** /23

**Percentage:** /100

**Grade Boundaries:**

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

## Question 1

Which compound is used as a standard for NMR chemical shift measurements?

- A.  $\text{Si}(\text{CH}_3)_4$
- B.  $\text{CDCl}_3$
- C.  $\text{D}_2\text{O}$
- D.  $\text{CCl}_4$

[1]

## Question 2

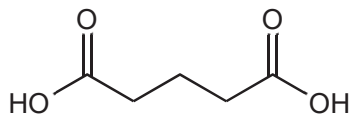
What is the number of peaks in the  $^1\text{H}$  NMR spectrum of  $\text{HOOCCH}_2\text{CHOHCH}_2\text{COOH}$ ?

- A. 3
- B. 4
- C. 5
- D. 6

[1]

### Question 3

The compound below is analysed by  $^1\text{H}$  NMR spectroscopy.



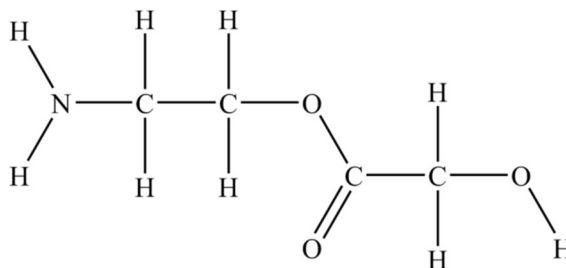
How many peaks are observed in the  $^1\text{H}$  NMR spectrum?

- A. 5
- B. 4
- C. 3
- D. 2

[1]

## Question 4

The structure of molecule **Z** is shown below.



Which of the following statements is/are true?

- 1: The carbon-13 NMR spectrum of **Z** shows four peaks
- 2: The proton NMR spectrum of **Z** shows five peaks
- 3: The proton NMR spectrum of **Z** run in  $D_2O$  shows three peaks

- A** 1, 2 and 3  
**B** Only 1 and 2  
**C** Only 2 and 3  
**D** Only 1

[1]

## Question 5

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

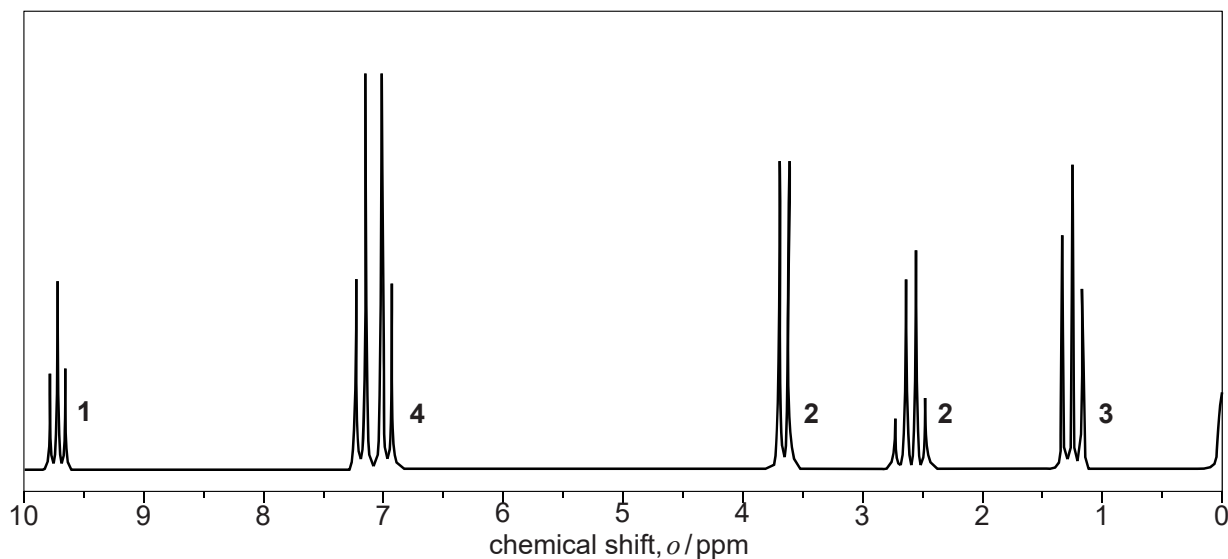
Initial analysis shows that the molecular formula of compound **H** is  $C_{10}H_{12}O$ .

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  $^1H$  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.

[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.*

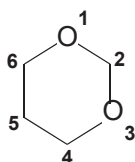
[9]

[Total 10 Marks]

## Question 6

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.

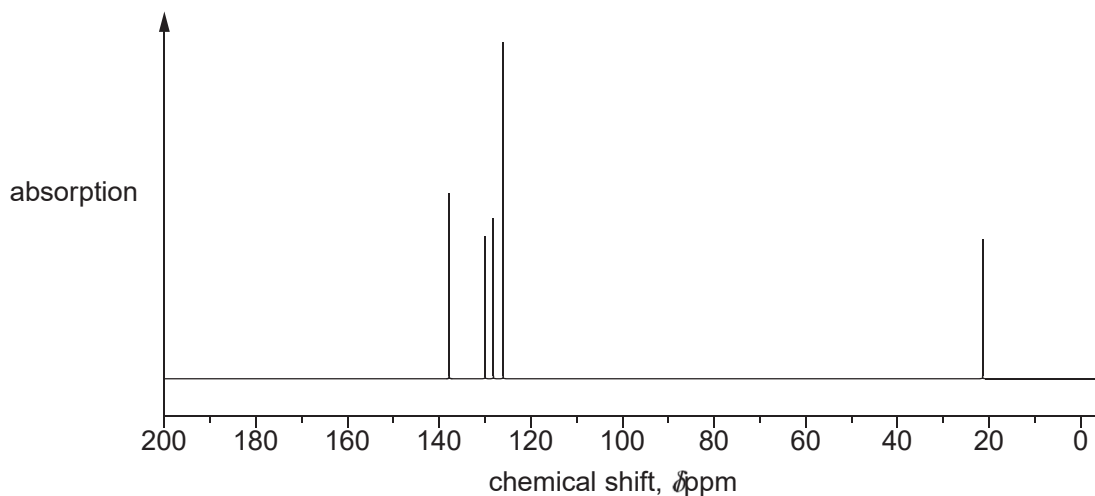
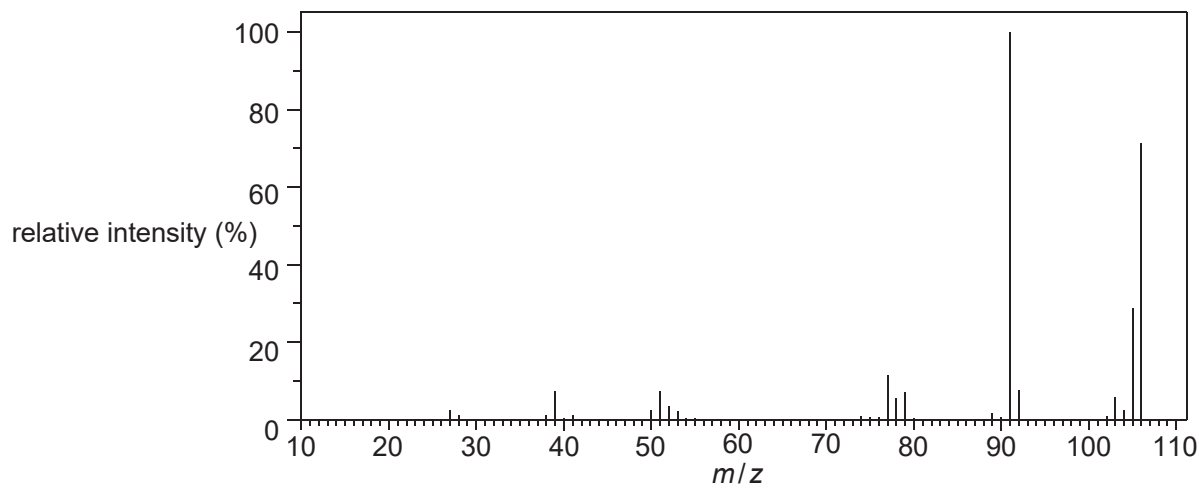


*In your answer, you should use appropriate technical terms, spelled correctly.*

[3]



- (b) The independent chemical engineer investigated an unknown aromatic hydrocarbon. He obtained the mass spectrum and the  $^{13}\text{C}$  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.

aromatic hydrocarbon is:

[6]

[Total 9 Marks]