

OCR A-Level Chemistry A

NMR spectroscopy

Questions only

The newest questions, about an hour. All 19 are in the exam generator.

Questions

10

Total marks

42

Time allowed

57 min

Name

Class or teacher

Date

Instructions

- Answer all questions in the spaces provided.
- Use black ink. Show your working for every calculation.
- You may use a scientific calculator and the OCR Data Sheet.
- Print the separate mark scheme when you are ready to mark your answers.

For marking

Q	Source	Marks	Score
1	2018 P2 Q22	18	
2	2022 P2 Q12	1	
3	2022 P2 Q15	1	
4	2023 P2 Q1	1	
5	2023 P2 Q23	6	
6	2023 P2 Q9	1	
7	2024 P2 Q14	1	
8	2024 P2 Q24	6	
9	2025 P2 Q15	1	
10	2021 P2 Q21	6	

Total _____ / 42 Percentage _____ %

Questions from OCR past papers, 2018–2025, reproduced for revision. Practise these topics online, with instant marking:
whiteboardchemistry.com/revision/exam-questions/ocr-a-level-chemistry/?topics=nmr-spectroscopy&len=0

Questions

NMR spectroscopy · 10 questions · 42 marks · time allowed 57 min

Q1 · June 2018 · Paper 2 (Synthesis and analytical techniques) · Q22 · [18 marks]

This question also needs Alcohols and haloalkanes, Alkanes, Amount of substance and 4 other topics.

The relative molecular masses and boiling points of some fuels are shown in Table 22.1.

Fuel	Relative molecular mass	Boiling point / °C
hexane	86	69
pentan-1-ol	88	138
heptane	100	98

Table 22.1

22(a) Write an equation for the incomplete combustion of heptane.

[1 mark]

22(b) Explain the difference in the boiling points of the fuels in Table 22.1.

[4 marks]

Fuel additives are often used to improve the combustion of a fuel.

22(c)(i) Compound N is a fuel additive containing carbon, hydrogen and oxygen only.

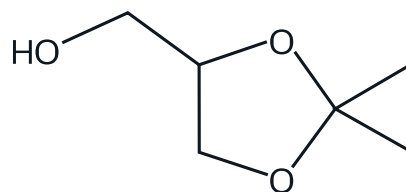
Complete combustion of 1.71 g of compound N produces 2.97 g of CO_2 and 1.62 g of H_2O . The relative molecular mass of compound N is 76.0.

Calculate the molecular formula of N and suggest a possible structure for the compound.

compound N

[5 marks]

22(c)(ii) Solketal has been investigated as a potential fuel additive.



solketal

Solketal is synthesised from propane-1,2,3-triol and a carbonyl compound.

Construct a balanced equation for this synthesis.

Show structures for the organic compounds in your equation.

[2 marks]

22(d) A scientist is researching compounds that might be suitable as fuel additives.

One of the compounds gives the analytical results below.

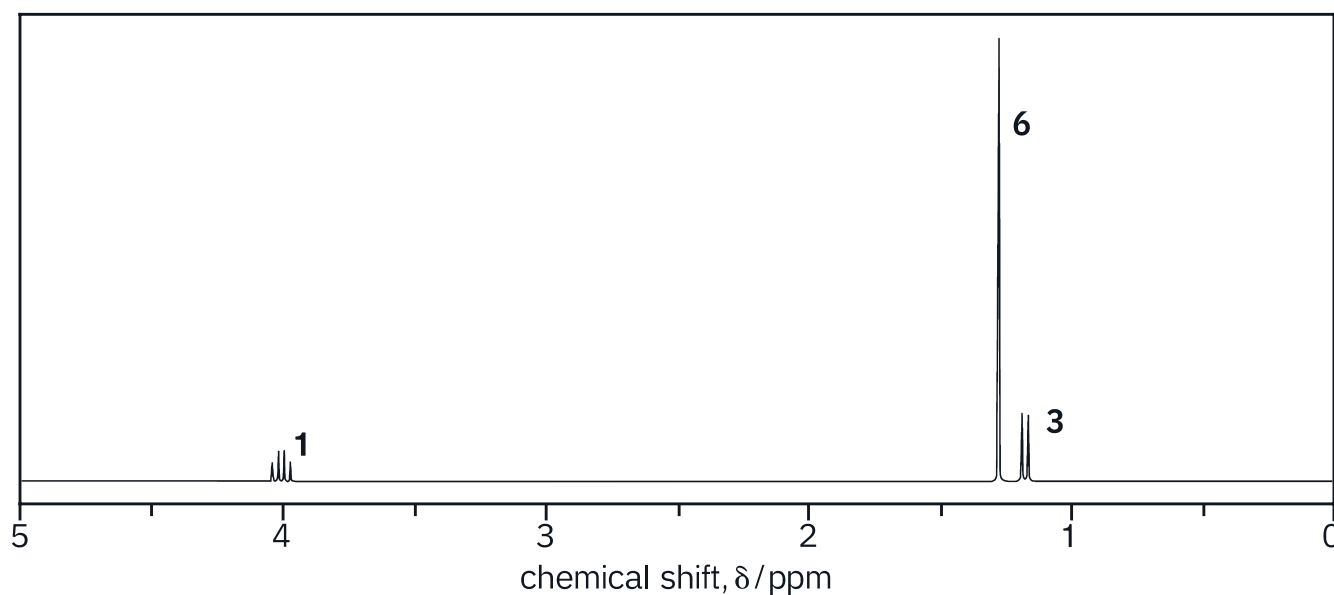
Elemental analysis by mass:

C: 54.54%; H: 9.10%; O: 36.36%

Mass spectrum:

Molecular ion peak at $m/z = 132.0$

^1H NMR spectrum in D_2O



The numbers by the peaks are the relative peak areas.

When the spectrum is run without D_2O , there are two additional peaks with the same relative peak areas at 11.0 ppm and 3.6 ppm.

Use the information provided to suggest a structure for the compound.

Show all your reasoning.

[6 marks]

Q2 · June 2022 · Paper 2 (Synthesis and analytical techniques) · Q12 · [1 mark]

Which compound produces two triplets in its ^1H NMR spectrum?

Tick (✓) one box.

- ☐ **A** $\text{CH}_3\text{CH}_2\text{COOCH}_2\text{CH}_3$
- ☐ **B** $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$
- ☐ **C** $\text{HOOCCH}_2\text{CH}_2\text{COOH}$
- ☐ **D** $\text{HOOCCH}_2\text{CH}_2\text{CH}_2\text{COOH}$

Q3 · June 2022 · Paper 2 (Synthesis and analytical techniques) · Q15 · [1 mark]

Which isomer(s) of $\text{C}_5\text{H}_{12}\text{O}$ has/have 4 peaks in its/their ^{13}C NMR spectrum?

1 3-methylbutan-2-ol

2 2-methylbutan-2-ol

3 2-methylbutan-1-ol

Tick (✓) one box.

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

Q4 · June 2023 · Paper 2 (Synthesis and analytical techniques) · Q1 · [1 mark]

Which compound is used for proton exchange in NMR spectroscopy?

Tick (✓) one box.

- ☐ **A** CCl_4
- ☐ **B** CDCl_3
- ☐ **C** D_2O
- ☐ **D** $\text{Si}(\text{CH}_3)_4$

Q5 · June 2023 · Paper 2 (Synthesis and analytical techniques) · Q23 · [6 marks]

23 An unknown organic compound is analysed.

The results are shown below.

[6 marks]

Addition of 2,4-DNP

No visible change

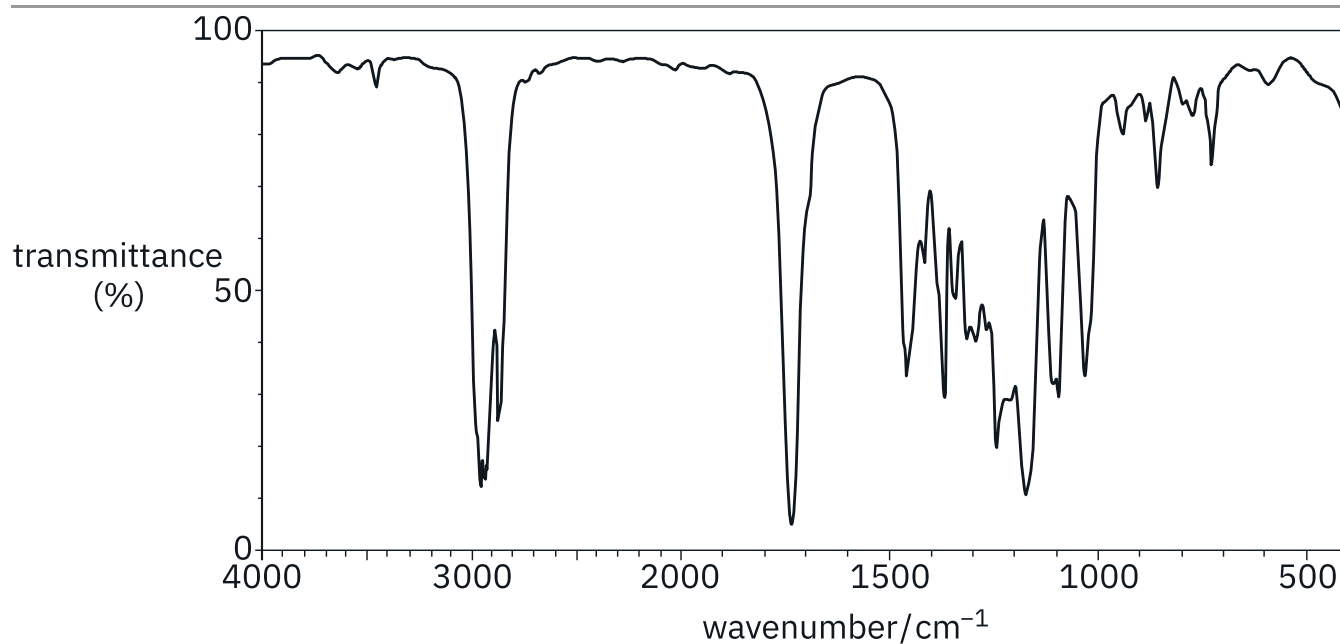
Elemental analysis by mass

C, 66.63%; H, 11.18%; O, 22.19%

Mass spectrum

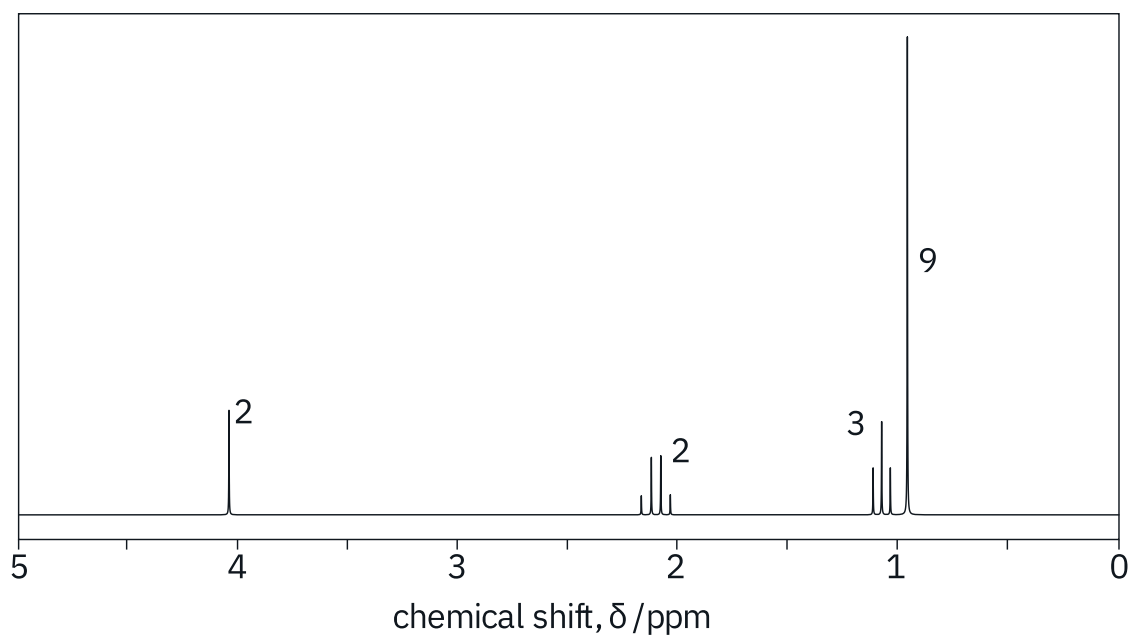
Molecular ion peak at $m/z = 144.0$

IR spectrum



Proton NMR spectrum

The numbers by each peak are the relative peak areas.



Use the information to identify the organic compound.

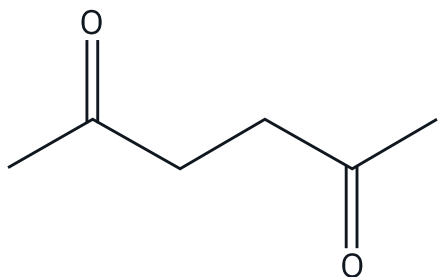
Show **all** your reasoning.

Q6 · June 2023 · Paper 2 (Synthesis and analytical techniques) · Q9 · [1 mark]

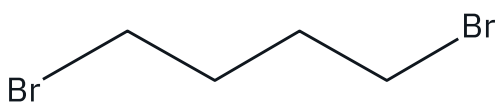
Which compound has the greatest number of peaks in its proton NMR spectrum?

Tick (✓) one box.

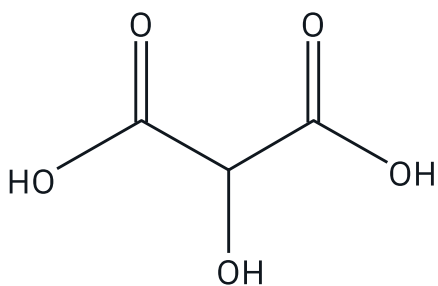
☐ **A**



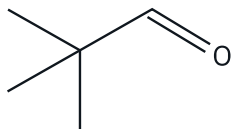
☐ **B**



☐ **C**



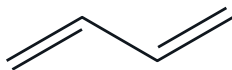
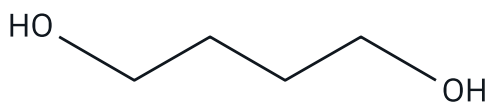
☐ **D**



Q7 · June 2024 · Paper 2 (Synthesis and analytical techniques) · Q14 · [1 mark]

The structures of 3 compounds, **1**, **2** and **3**, are shown below.

Which compound(s) would produce a carbon-13 NMR spectrum with 2 peaks?

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

Tick (✓) one box.

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

Q8 · June 2024 · Paper 2 (Synthesis and analytical techniques) · Q24 · [6 marks]

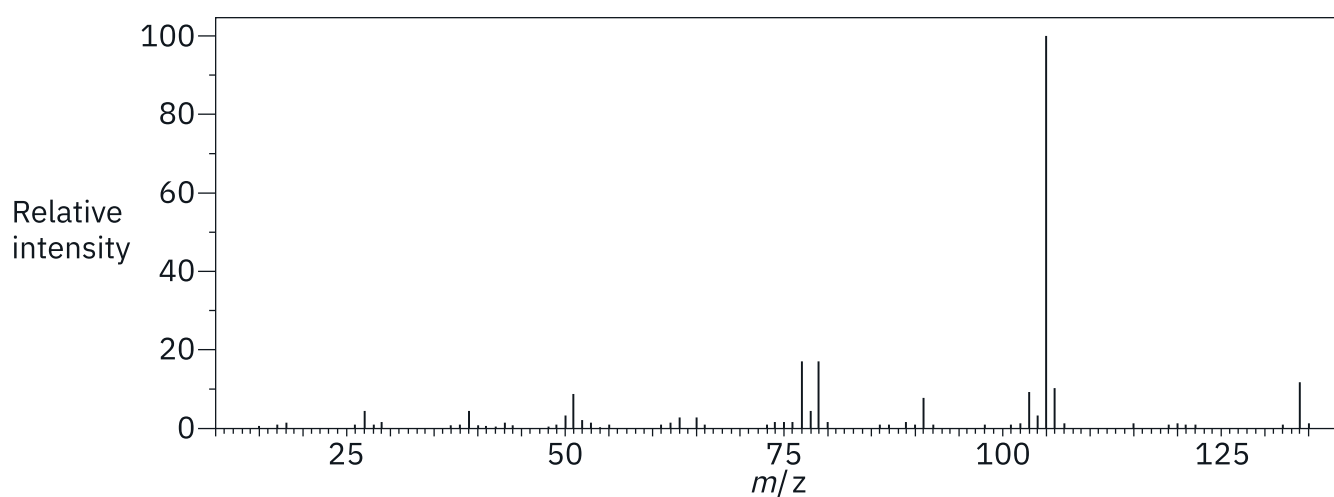
24 Analysis of an unknown organic compound J produces the following results.

[6 marks]

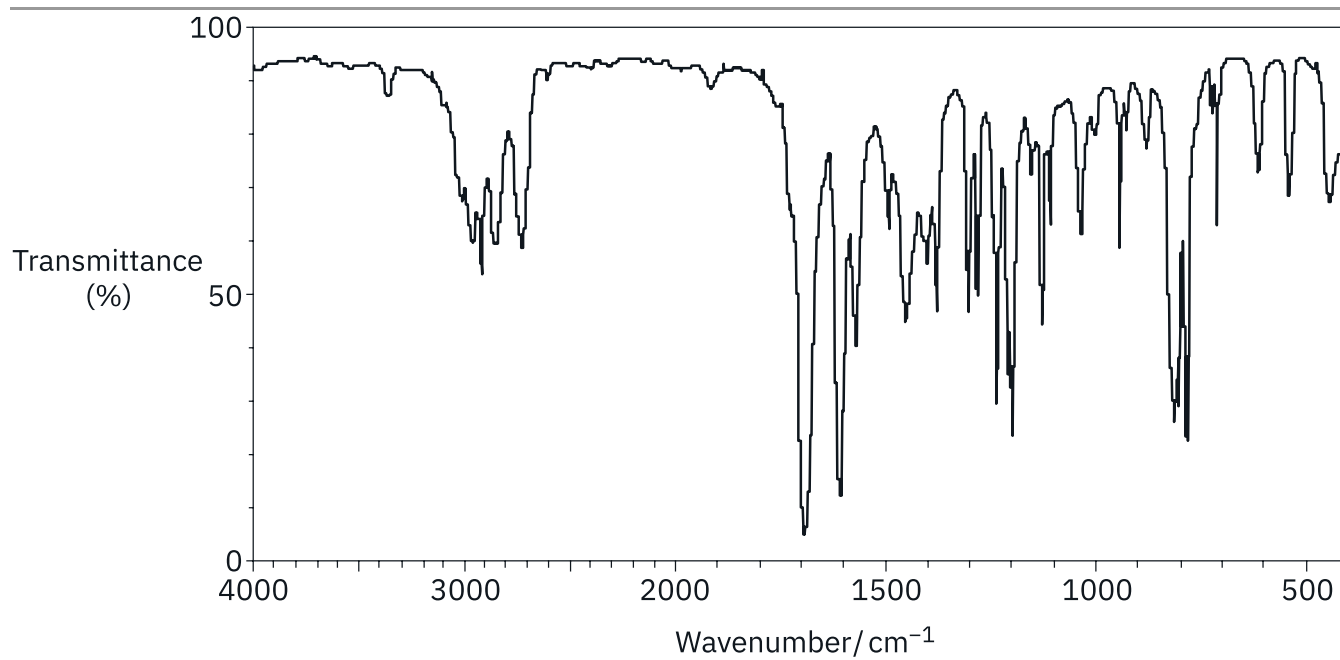
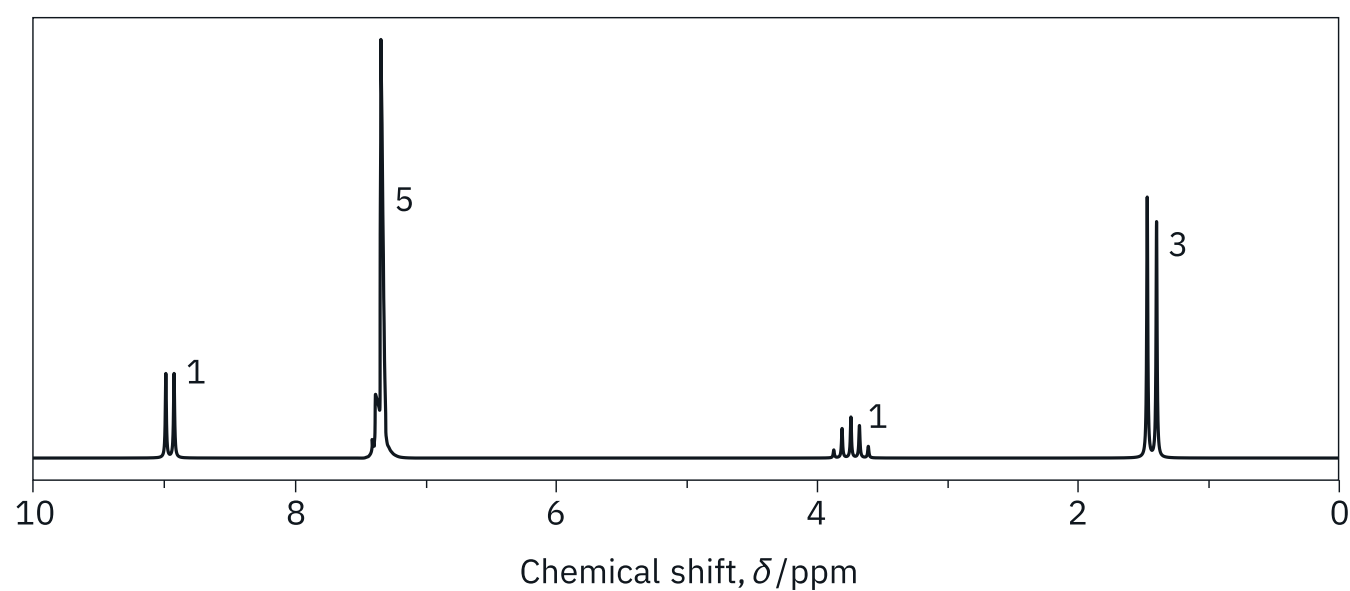
Elemental analysis by mass of compound J

C, 80.60%; H, 7.46%; O, 11.94%

Mass spectrum of compound J



IR spectrum of compound J

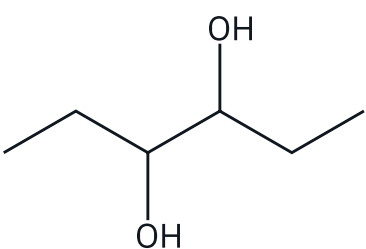
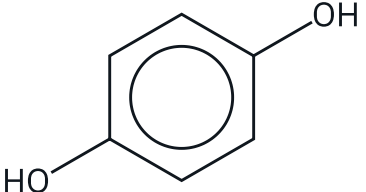
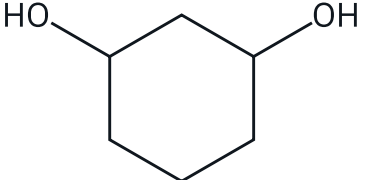
**Proton NMR spectrum of compound J**

The numbers by the peaks are the relative peak areas.

Determine the structure of compound J, showing **all** your reasoning.

Q9 · June 2025 · Paper 2 (Synthesis and analytical techniques) · Q15 · [1 mark]

Which compound(s) has/have **three** peaks in their ^{13}C NMR spectrum?

1	
2	
3	

Tick (✓) one box.

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

Q10 · November 2021 · Paper 2 (Synthesis and analytical techniques) · Q21 · [6 marks]

This question also needs Amount of substance, Basic concepts of organic chemistry and Chromatography and

functional group tests.

21 Compounds D, E and F are isomers with the molecular formula $C_5H_{10}O$.

One of the compounds is alicyclic.

A student carries out test-tube tests on the compounds.

The observations are shown below.

Compound	2,4-DNP	$H^+/Cr_2O_7^{2-}$, reflux	Bromine water
D	No change	Green solution	No colour change
E	Orange precipitate	No colour change	No colour change
F	Orange precipitate	No colour change	No colour change

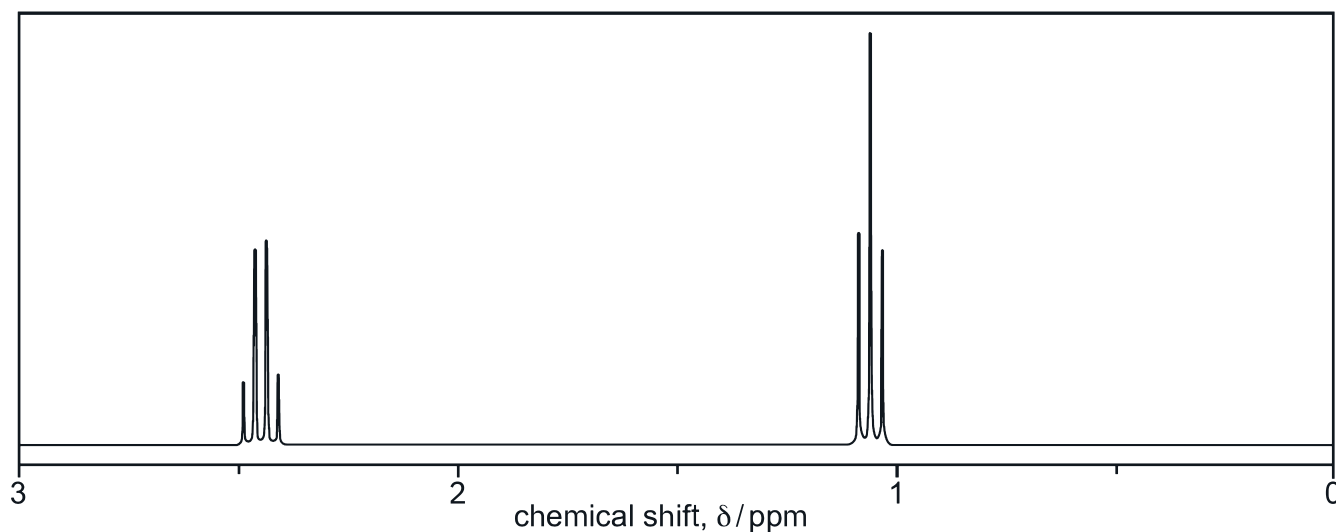
^{13}C NMR spectrum of D

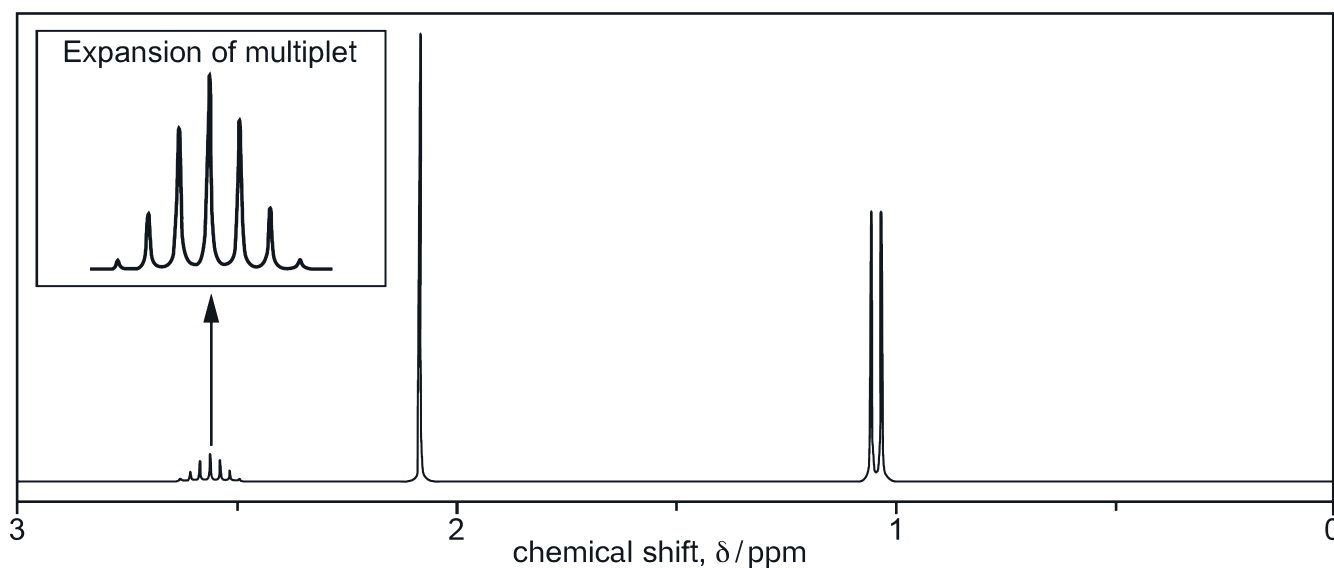
Compound D has 3 peaks at δ / ppm: 24, 36, 73.

^1H NMR spectra of E and F

The integration data has been omitted.

Compound E



Compound F

Analyse the observations and results to identify the structures of D, E and F.

Explain your reasoning.

[6 marks]

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Mark scheme:

whiteboardchemistry.com/revision/exam-questions/ocr-a-level-chemistry/pdf/nmr-spectroscopy-mark-scheme.pdf