

OCR A-Level Chemistry A

Organic synthesis, IR and mass spectra

Questions only

The newest questions, about an hour. All 16 are in the exam generator.

Questions

10

Total marks

40

Time allowed

54 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	2022 P2 Q11	1	
2	2023 P2 Q10	1	
3	2023 P2 Q11	1	
4	2023 P2 Q19	6	
5	2024 P2 Q11	1	
6	2024 P2 Q23	12	
7	2024 P2 Q7	1	
8	2025 P2 Q12	1	
9	2025 P2 Q17	6	
10	2025 P2 Q23	10	

Total _____ / 40 Percentage _____ %

Questions from OCR past papers, 2022–2025, reproduced for revision. Practise these topics online, with instant marking:

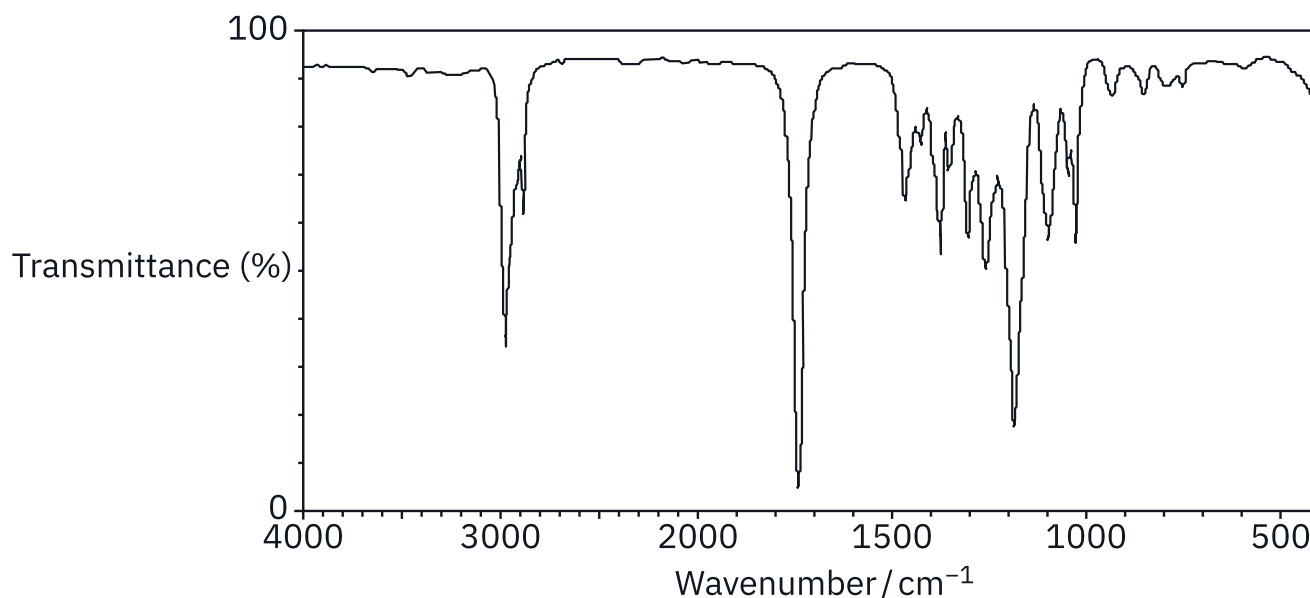
whiteboardchemistry.com/revision/exam-questions/ocr-a-level-chemistry/?topics=organic-synthesis-and-analysis&len=0

Questions

Organic synthesis, IR and mass spectra · 10 questions · 40 marks · time allowed 54 min

Q1 · June 2022 · Paper 2 (Synthesis and analytical techniques) · Q11 · [1 mark]

The infrared spectrum of an organic compound is shown below.



Which compound could have produced this spectrum?

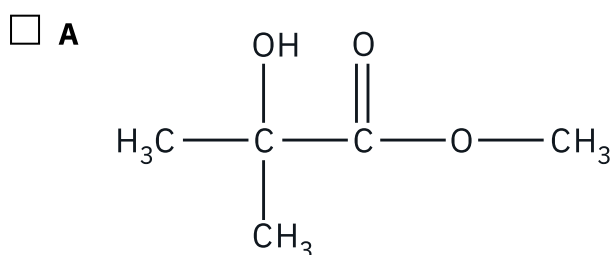
Tick (✓) one box.

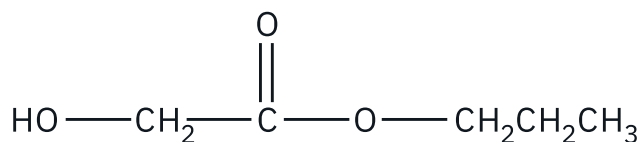
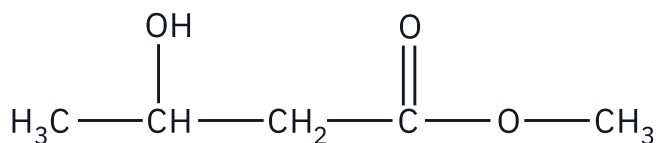
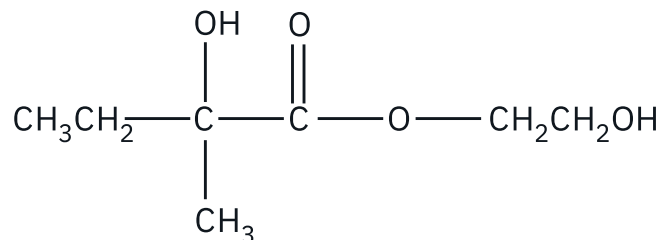
- ☐ **A** $\text{H}_2\text{C}=\text{CHCH}_2\text{CH}_2\text{OH}$
- ☐ **B** $\text{CH}_3\text{COOCH}_2\text{CH}_3$
- ☐ **C** $\text{H}_2\text{NCH}_2\text{COOCH}_3$
- ☐ **D** $(\text{CH}_3)_2\text{CHCONH}_2$

Q2 · June 2023 · Paper 2 (Synthesis and analytical techniques) · Q10 · [1 mark]

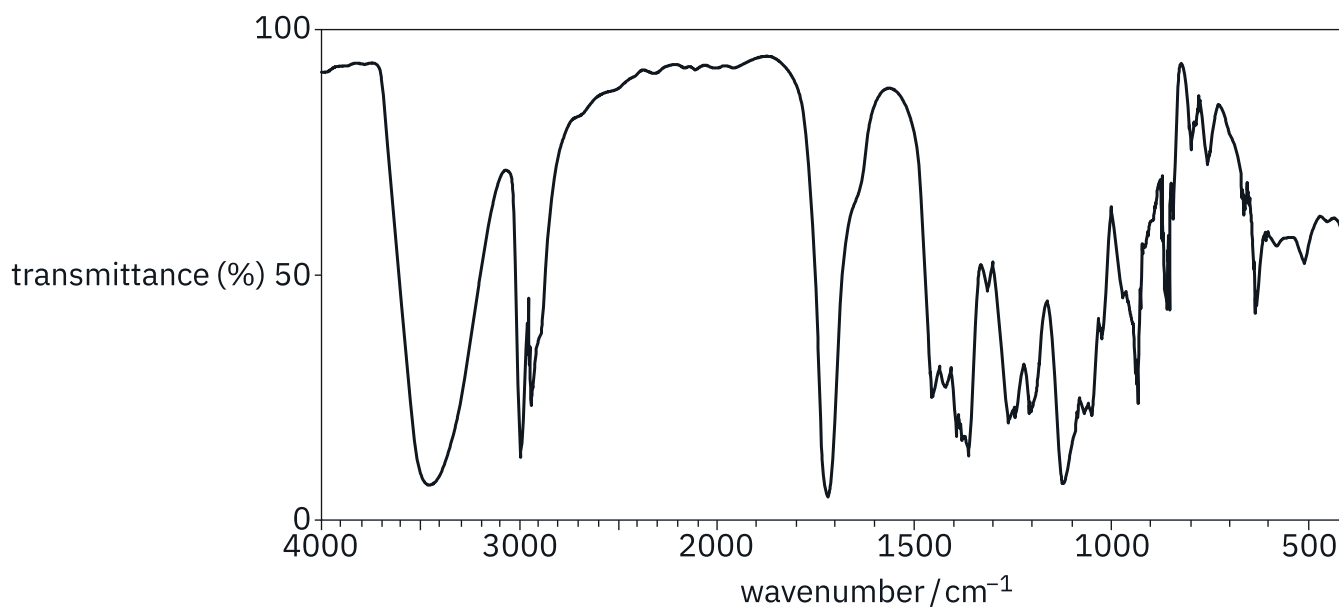
Which ester is most likely to produce a mass spectrum with a fragment ion at $m/z = 43$?

Tick (✓) one box.



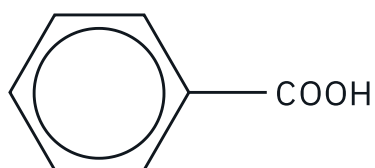
☐ B☐ C☐ D**Q3 · June 2023 · Paper 2 (Synthesis and analytical techniques) · Q11 · [1 mark]**

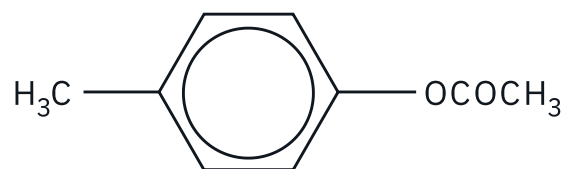
The infrared spectrum of an organic compound is shown below.



Which compound could have produced this spectrum?

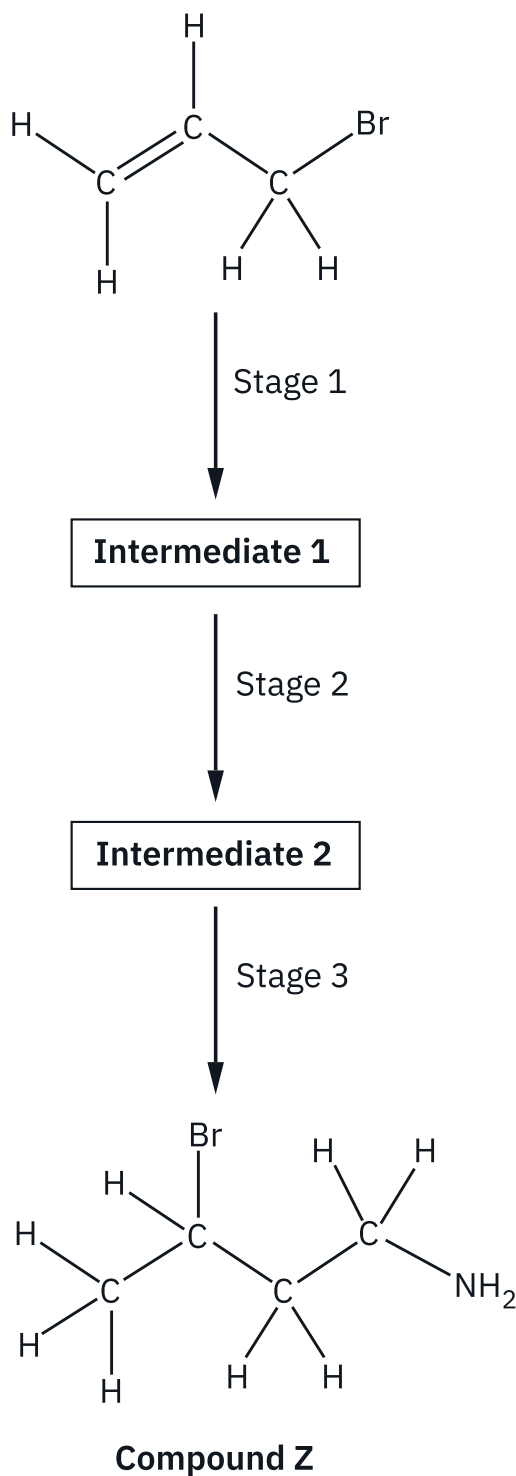
Tick (✓) one box.

☐ A

☐ **B**☐ **C**☐ **D**

Q4 · June 2023 · Paper 2 (Synthesis and analytical techniques) · Q19 · [6 marks]

19 A student intends to synthesise compound Z, as shown in the flowchart below.

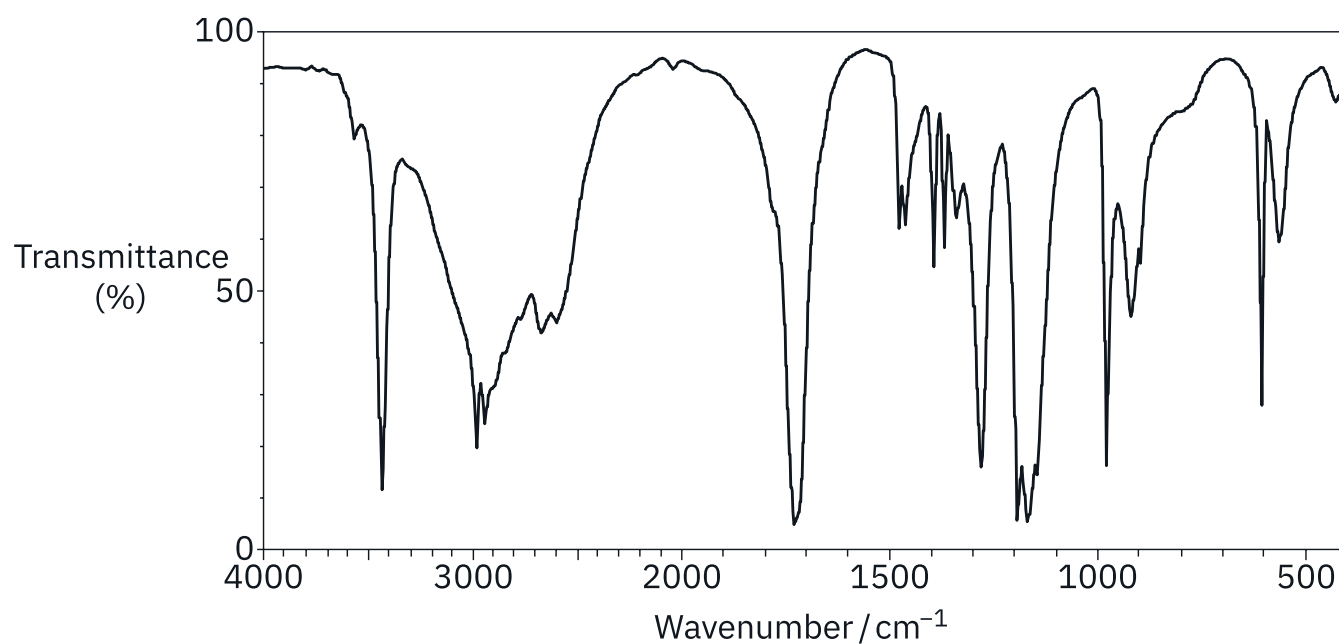


Plan this synthesis showing reagents, the structures of **intermediate 1** and **intermediate 2**, and equations.

[6 marks]

Q5 · June 2024 · Paper 2 (Synthesis and analytical techniques) · Q11 · [1 mark]

Which compound could have produced the IR spectrum shown below?



Tick (✓) one box.

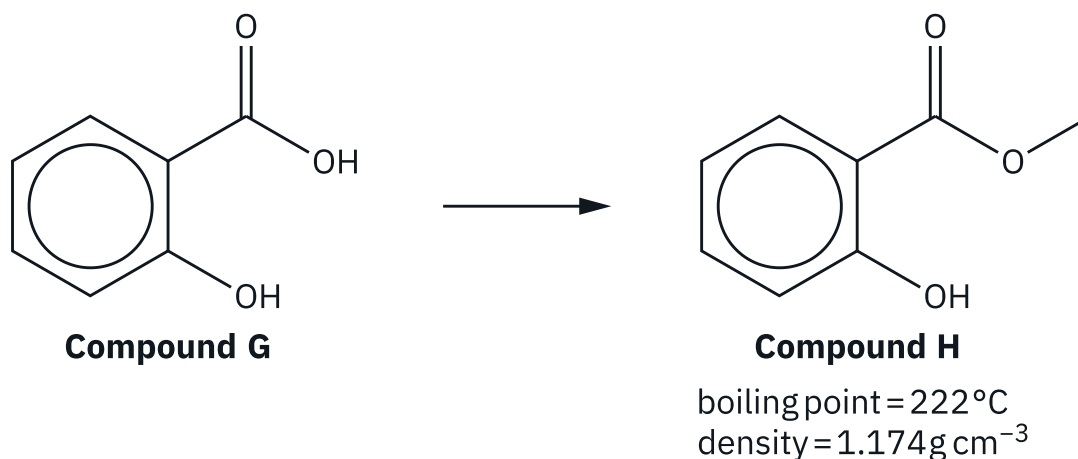
- ☐ **A** HOCH_2CHO
- ☐ **B** $\text{CH}_3\text{CH}_2\text{COOH}$
- ☐ **C** $\text{CH}_3\text{CH}_2\text{COOCH}_3$
- ☐ **D** $(\text{CH}_3)_2\text{C}(\text{OH})\text{COOH}$

Q6 · June 2024 · Paper 2 (Synthesis and analytical techniques) · Q23 · [12 marks]

This question also needs Amount of substance and Carbonyls, carboxylic acids and esters.

Oil of wintergreen is a liquid used in medicine to relieve muscle pain.

Compound H is a component in oil of wintergreen and can be synthesised from compound G, as shown below. The boiling point and density of compound H are stated.



A student prepares a sample of compound H by the method below.

Step 1 Reflux 8.97 g of compound G for 30 minutes with an excess of methanol in the presence of a small amount of sulfuric acid as a catalyst.

Step 2 Add an excess of aqueous sodium carbonate, Na₂CO₃(aq).

Two layers are obtained.

Step 3 Purify the impure compound H that forms from the resulting mixture.

The student follows this method and obtains 5.32 g of pure compound H.

23(a) Why does the student use reflux in Step 1?

[1 mark]

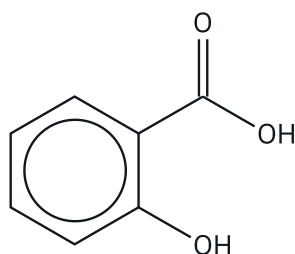
23(b)(i) In Step 2, $\text{Na}_2\text{CO}_3(\text{aq})$ removes the sulfuric acid catalyst **and** any unreacted compound G from the mixture.

Write equations for this removal.

[3 marks]

Removal of sulfuric acid

Removal of unreacted compound G



Compound G

23(b)(ii) Another student suggests that adding aqueous sodium hydroxide would be more effective in removing the sulfuric acid catalyst than $\text{Na}_2\text{CO}_3(\text{aq})$.

Comment on whether the student's suggestion is an improvement for the preparation of compound H.

[1 mark]

23(c) Calculate the percentage yield of compound H.

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

percentage yield = %

[3 marks]

23(d) Describe how to purify the impure compound H from the two layers in Step 2.

[4 marks]

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

Which statement gives a valid scientific reason for global warming?

Tick (✓) one box.

- ☐ **A** Infrared radiation causes bonds in CH₄ molecules to vibrate more.
- ☐ **B** Infrared radiation causes O₂ molecules to vibrate more.
- ☐ **C** Ultraviolet radiation causes bonds in CO₂ to vibrate more.
- ☐ **D** Ultraviolet radiation causes bonds in CFC molecules to break.

Q8 · June 2025 · Paper 2 (Synthesis and analytical techniques) · Q12 · [1 mark]

Which process does **not** involve infrared radiation?

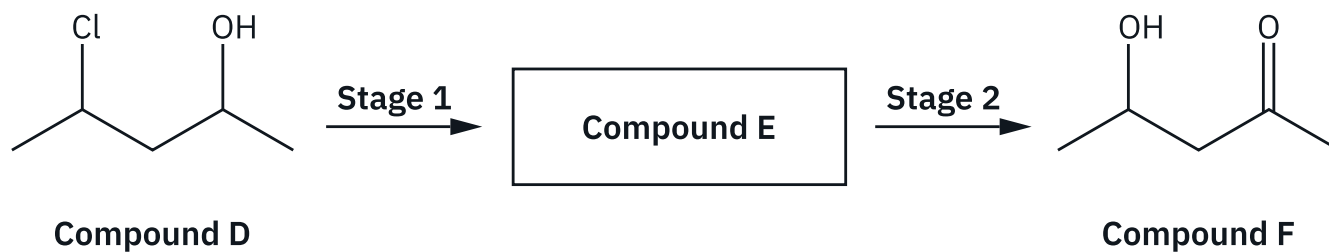
Tick (✓) one box.

- ☐ **A** Catalytic ozone depletion
- ☐ **B** Monitoring toxic gases in the air
- ☐ **C** Measuring ethanol in breathalyser tests
- ☐ **D** Global warming

Q9 · June 2025 · Paper 2 (Synthesis and analytical techniques) · Q17 · [6 marks]

17 This question is about an organic synthesis.

A student plans a two-stage synthesis of compound F from compound D, as shown below.



Plan a two-stage synthesis for the preparation of 2.50 g of compound F from compound D.

The overall percentage yield of compound F from compound D is 31.5%.

In your answer include the mass of compound D required, reagents and equations for each step.

[6 marks]

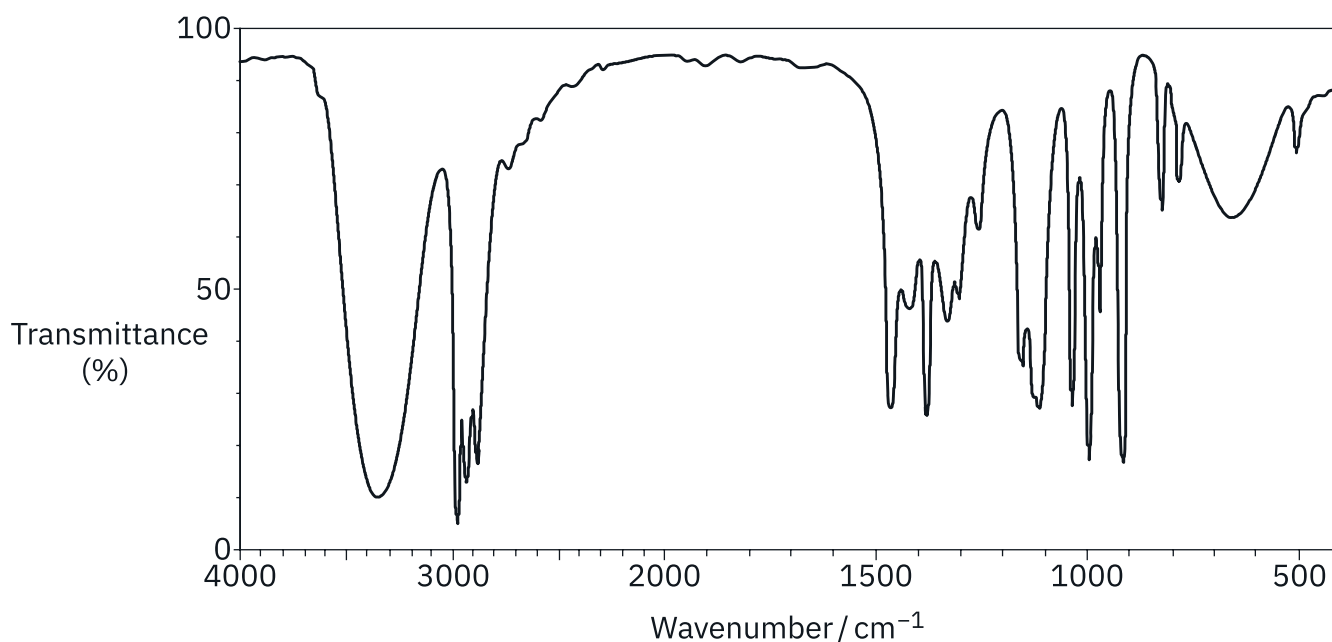
Q10 · June 2025 · Paper 2 (Synthesis and analytical techniques) · Q23 · [10 marks]

This question also needs Alcohols and haloalkanes and NMR spectroscopy.

This question is about spectral analysis.

23(a) Compound K, $C_4H_{10}O$, is refluxed with H_2SO_4 to form a mixture of compound L and compound M.

The infrared spectrum of compound K is shown.



Compound L and compound M are analysed using ^{13}C NMR spectroscopy.

- The ^{13}C NMR spectrum of compound L has 4 peaks.
- The ^{13}C NMR spectrum of compound M has 2 peaks.

Suggest the functional group in compound K, showing your reasoning, and suggest possible structures for compound K, compound L and compound M.

[4 marks]

Functional group

Reasoning

Possible structure
K
L
M

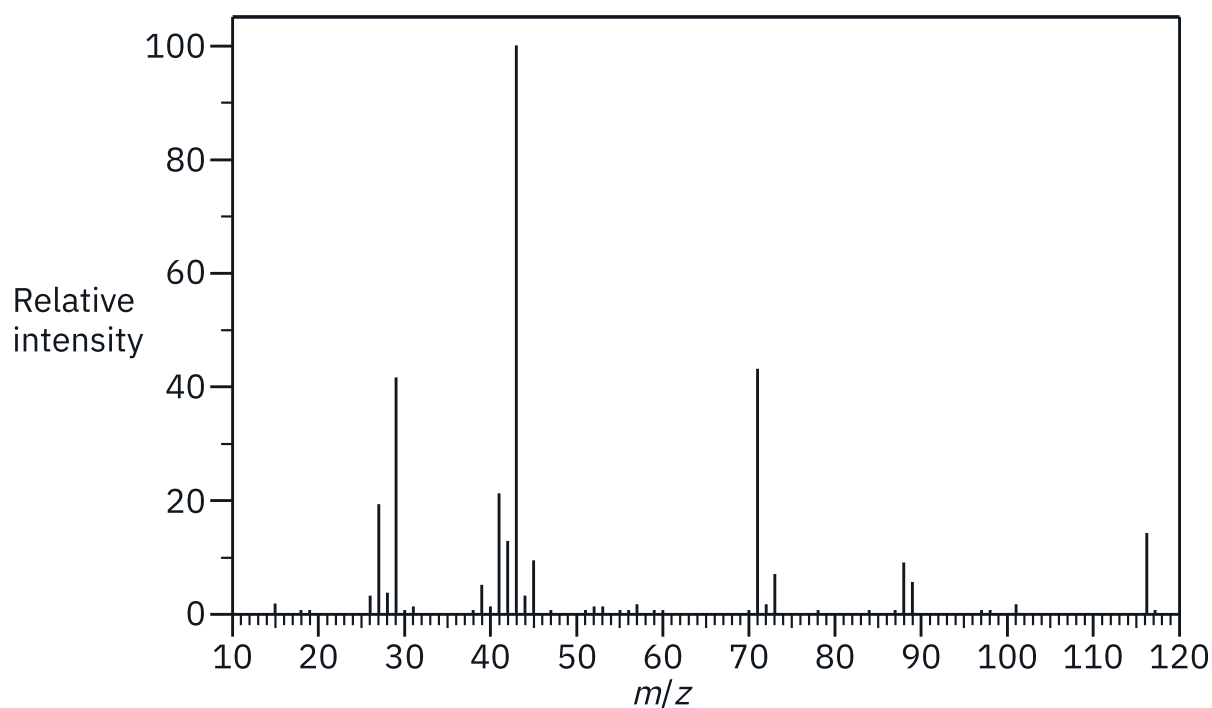
23(b) An unknown organic compound N is analysed and produces the following results.

[6 marks]

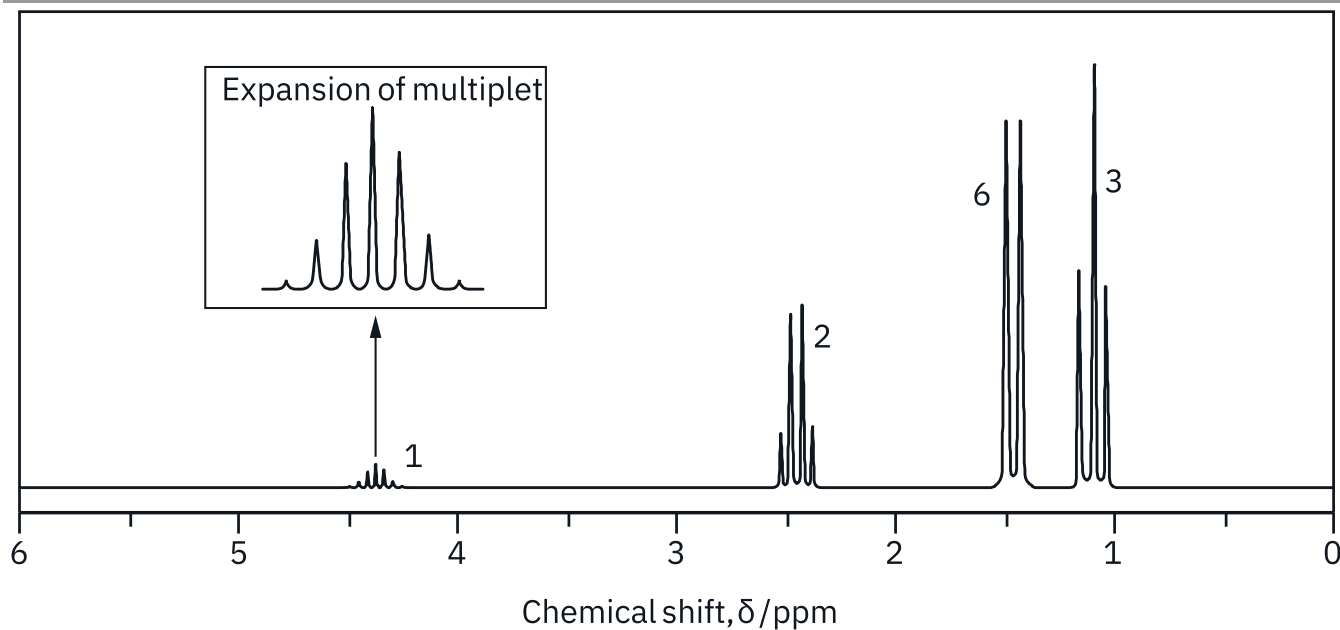
Elemental analysis by mass

C, 62.07%; H, 10.34%; O, 27.59%

Mass spectrum



Proton NMR spectrum



The numbers by the peaks are the relative peak areas.

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

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Mark scheme:

whiteboardchemistry.com/revision/exam-questions/ocr-a-level-chemistry/pdf/organic-synthesis-and-analysis-mark-scheme.pdf