Other 1/2 spin Nuclei

Question Paper 2

Level	Pre U
Subject	Chemistry
Exam Board	Cambridge International Examinations
Topic	Other 1/2 spin nuclei-NMC
Booklet	Question Paper 2

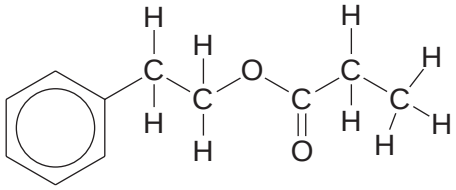
Time Allowed: **68 minutes**

Score: **/57**

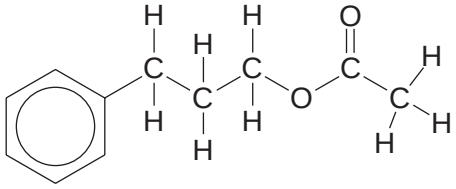
Percentage: **/100**

Grade Boundaries:

1. The structures of a pair of isomers are shown.



isomer 1



isomer 2

(a) Give the molecular formula of these isomers.

.....[1]

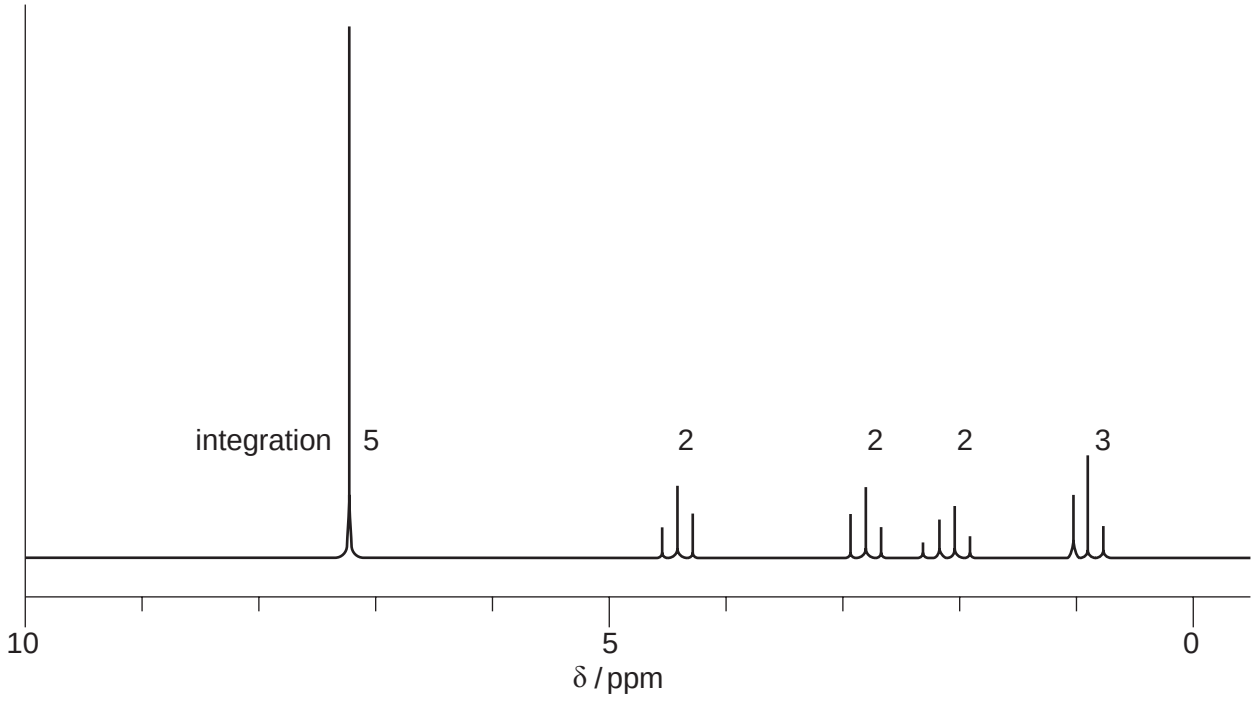
(b) What type of isomerism is shown by these two isomers?

.....[1]

(c) Isomer 1 is called 2-phenylethyl propanoate. Give the name of isomer 2.

.....[1]

(d) The ^{1}H NMR spectrum of one of the isomers is shown.



Explain which of isomers 1 or 2 corresponds to the ^{1}H NMR spectrum shown. You should refer to the splitting patterns and integration values of **all** the peaks in your answer. Note that the phenyl group protons appear as a single peak.

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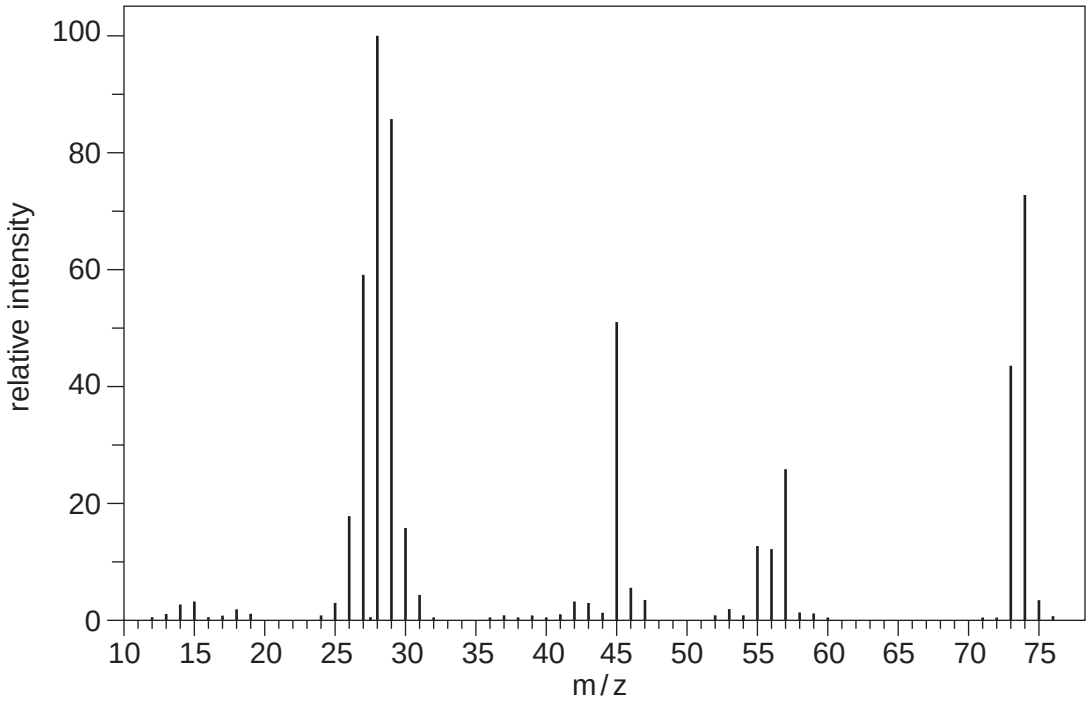
.....[6]

(e) **X** and **Y** are two compounds that can be made by hydrolysis of isomer 1.

X has the composition by mass C, 48.6%; H, 8.11%; O, 43.2%. The mass spectrum of **X** is shown.



(i) Calculate the empirical formula of **X**.

empirical formula of **X** .....[2]

(ii) Deduce the molecular formula of **X**.

molecular formula of **X** .....[1]

(iii) Identify the particle responsible for the peak at m/z 45.

.....[2]

(iv) Explain the origin and relative intensity of the peak at m/z 75.

.....

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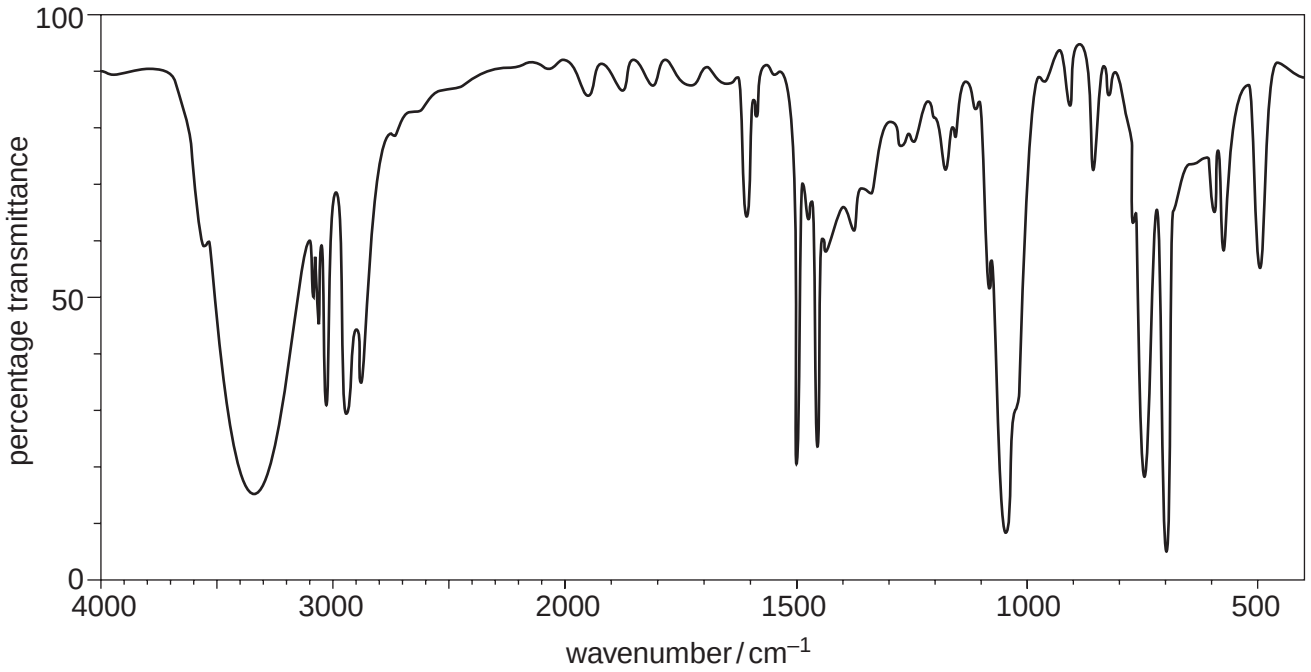
.....[2]

(f) The IR spectrum of **Y** is shown.



(i) Show the structure of **Y** and explain how the IR spectrum confirms the identity of the functional group present.

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.....[2]

(ii) Show the structure of **X** and explain how its spectrum will compare to that of **Y**.

.....

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.....[2]

[Total: 20]

2. The enantiomers of a compound with a chiral centre are normally described as having identical physical and chemical properties, apart from their effect on the plane of plane polarised light.

In many cases the enantiomers also have different odours. For example, (*R*)-(+)-2-methylbutan-1-ol has a fermented, fatty odour, while (*S*)-(–)-2-methylbutan-1-ol smells fresh.

(a) Explain what is meant by each of the terms *enantiomers* and *chiral centre*.

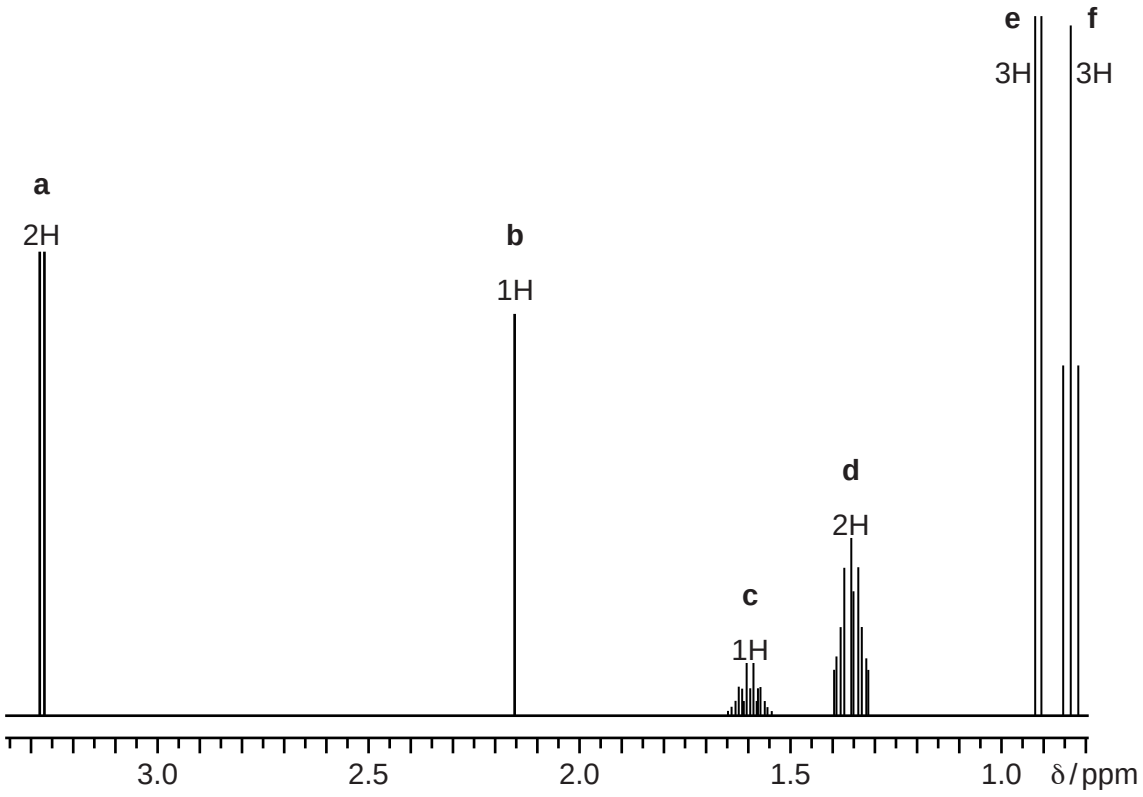
enantiomers .....

.....

chiral centre .....

.....[2]

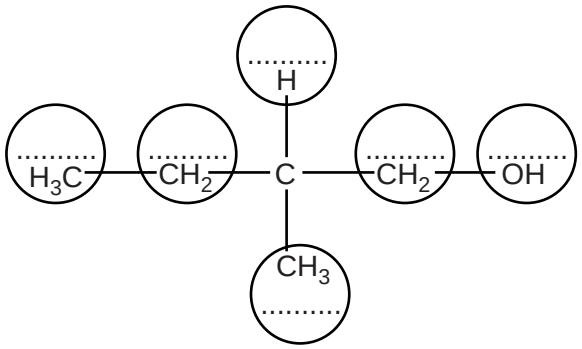
(b) The diagram of the proton NMR spectrum of 2-methylbutan-1-ol has the signals labelled **a–f** for ease of reference, and the signal integrations are given.



(i) Give the relative intensities of the peaks in signal **f**.

.....[1]

(ii) Label the structure of 2-methylbutan-1-ol, with the letters **a–f**, to indicate which protons are responsible for each signal in the spectrum.



[3]

(c) Oxidation of 2-methylbutan-1-ol, by acidified potassium dichromate(VI) with immediate distillation, produces a compound, **P**.

P turns acidified potassium dichromate(VI) from orange to green and produces **Q**.

Q effervesces on addition of sodium carbonate solution.

A pure enantiomer of **P**, when reacted with hydrogen cyanide, produces **R** as a mixture of optical isomers.

R forms **S**, with no change in functional group level, on reaction with dilute hydrochloric acid.

(i) Give the **displayed** formula and name of **P**. Ignore stereochemistry.

name .....[2]

(ii) State the type of reaction involved in the conversion of **P** to **Q**.

.....[1]

(iii) Identify **Q** and write a balanced equation, using molecular formulae, for its reaction with sodium carbonate.

identity of **Q** .....

equation .....[2]

(iv) Give the structural formula of **R**, name the mechanism by which it is formed from **P** and explain why it forms as a mixture of optical isomers.

structural formula

name of mechanism .....

explanation .....

.....[4]

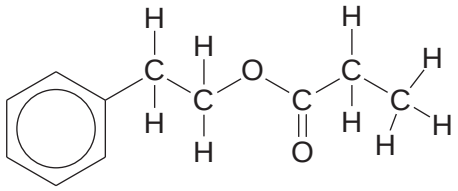
(v) Identify **S** and state the type of reaction involved in its formation from **R**.

identity of **S** .....

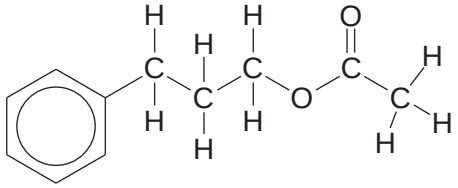
type of reaction.....[2]

[Total: 17]

3. Fig. 6.1 shows the structures of a pair of isomers.



isomer 1



isomer 2

Fig. 6.1

(a) Give the molecular formula of these isomers.

.....[1]

(b) What type of isomerism is shown by these two isomers?

.....[1]

(c) Isomer 1 is named 2-phenylethyl propanoate. Give the name of isomer 2.

.....[1]

(d) The ^{1}H NMR spectrum of one of the isomers is shown in Fig. 6.2.

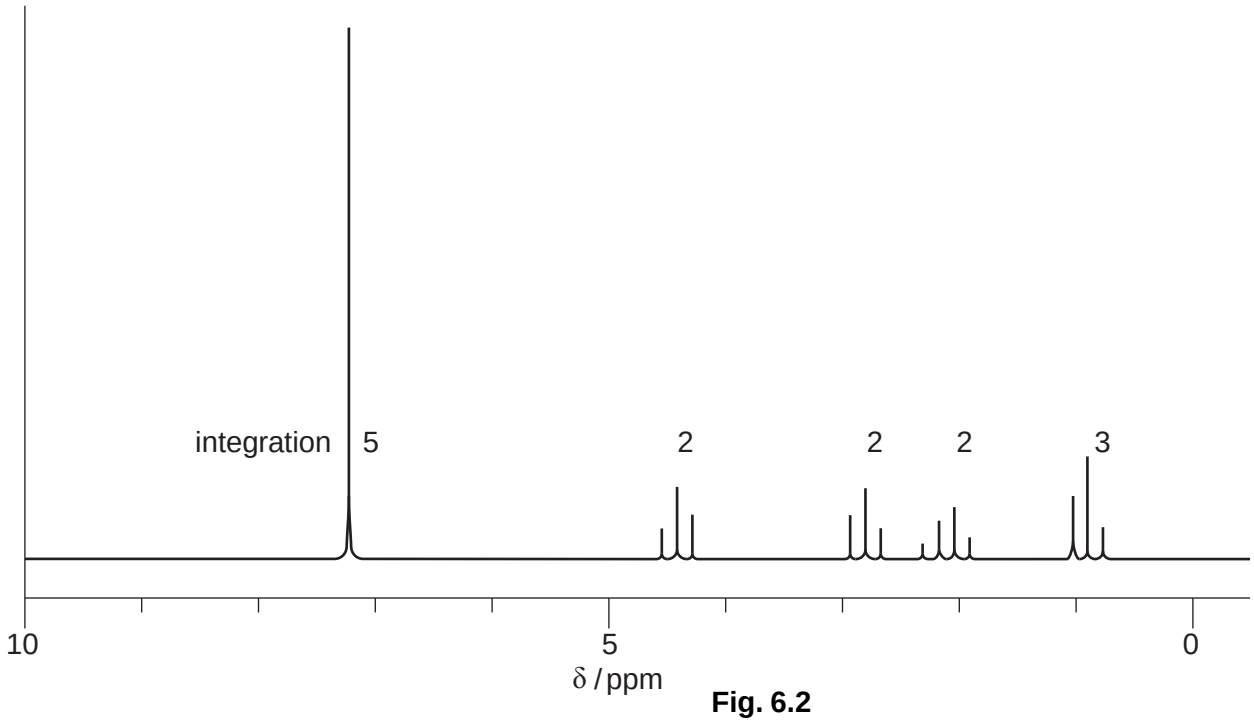


Fig. 6.2

Explain which of the two isomers corresponds to the ^{1}H NMR spectrum in Fig. 6.2. You should refer to the splitting patterns and integration values of **all** the peaks in your answer. Note that the phenyl group protons appear as a single peak.

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.....[6]

(e) **X** and **Y** are two compounds that can be made by hydrolysis of isomer 1 in Fig. 6.1.

X has the composition by mass C, 48.6%; H, 8.11%; O, 43.2%. The mass spectrum of **X** is shown in Fig. 6.3.

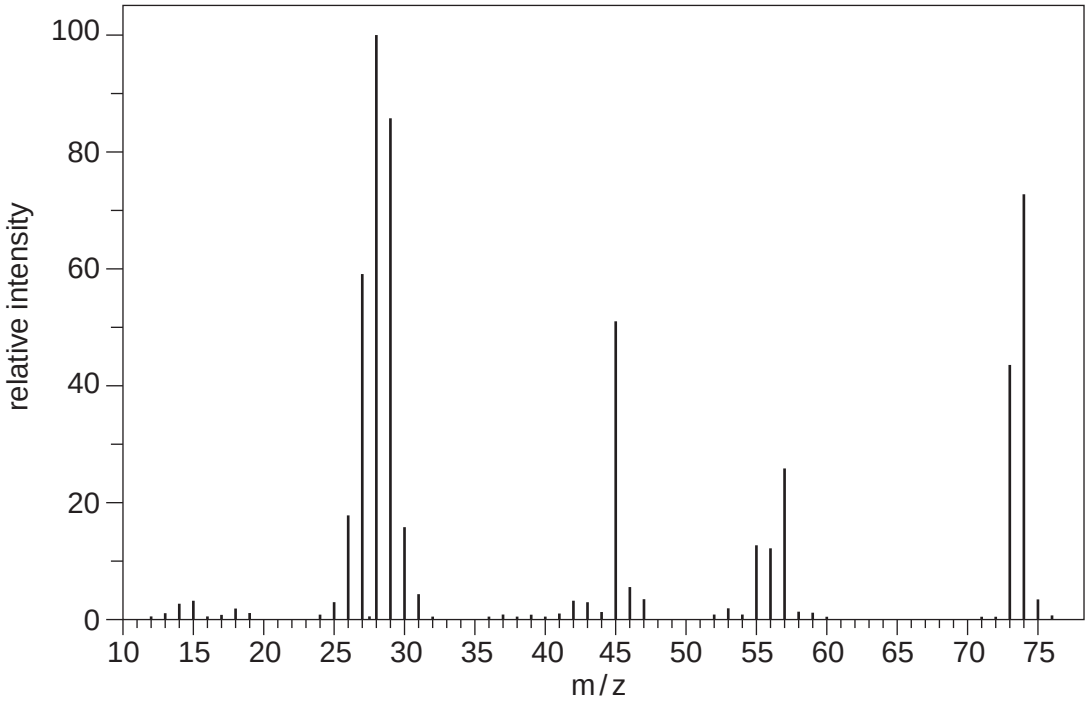

Fig. 6.3

(i) Calculate the empirical formula of **X**.

empirical formula of **X** .....[2]

(ii) Deduce the molecular formula of **X**.

molecular formula of **X** .....[1]

(iii) Identify the particle responsible for the peak at m/z 45.

.....[2]

(iv) Explain the origin and relative intensity of the peak at m/z 75.

.....

.....

.....[2]

(f) The IR spectrum of **Y** is shown in Fig. 6.4.

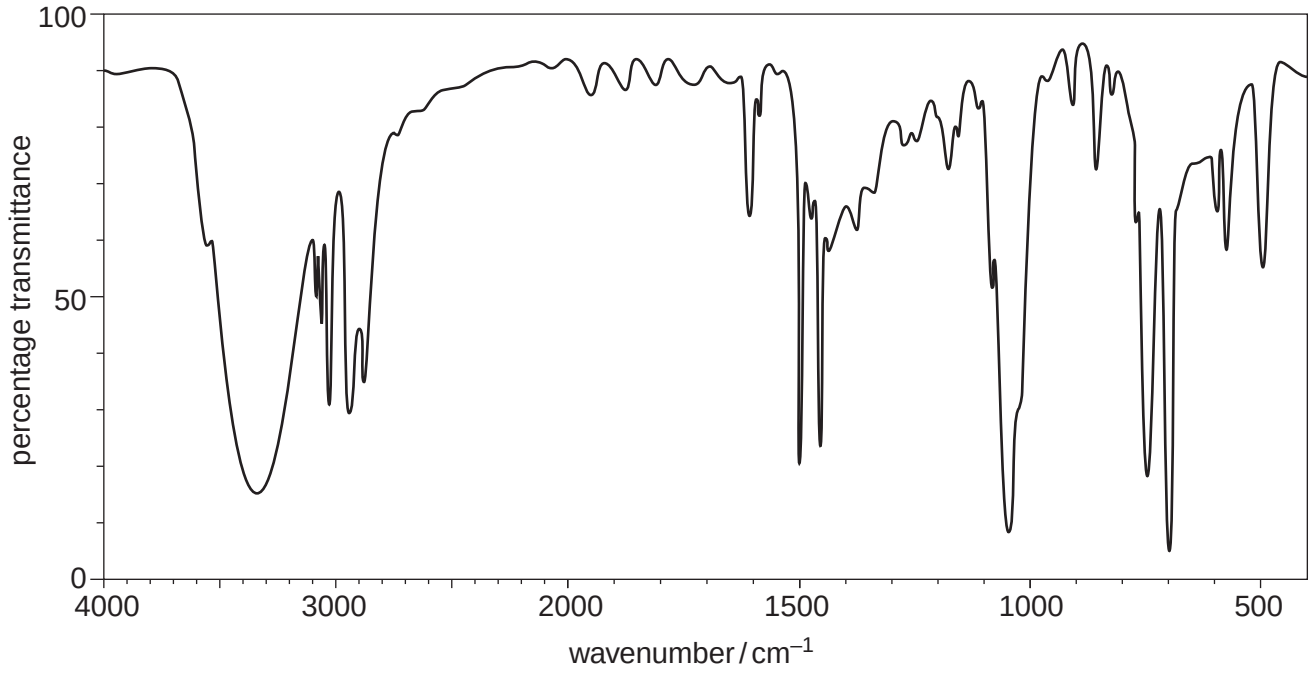

Fig. 6.4

(i) Show the structure of **Y** and explain how the spectrum in Fig. 6.4 confirms the identity of the functional group present.

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..... [2]

(ii) Show the structure of **X** and explain how its IR spectrum will compare to that of **Y**.

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..... [2]

[Total: 20]