

# 11.1 Spectroscopic Identification

## Question Paper

Course	DPIB Chemistry
Section	11. Measurements & Data Processes
Topic	11.1 Spectroscopic Identification
Difficulty	Hard

**Time allowed:** 40  
**Score:** /28  
**Percentage:** /100

### Question 1a

a)

Zanamivir is an inhibitor used to treat infections caused by the influenza A and B viruses.

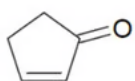
Using section 37 of the data booklet, deduce the hydrogen deficiency of Zanamivir.

[1 mark]

### Question 1b

b)

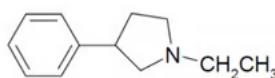
Determine which of the following molecules has the same IHD and state the IHD value.



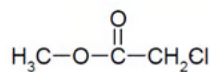
I



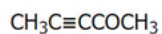
II



III



IV



V

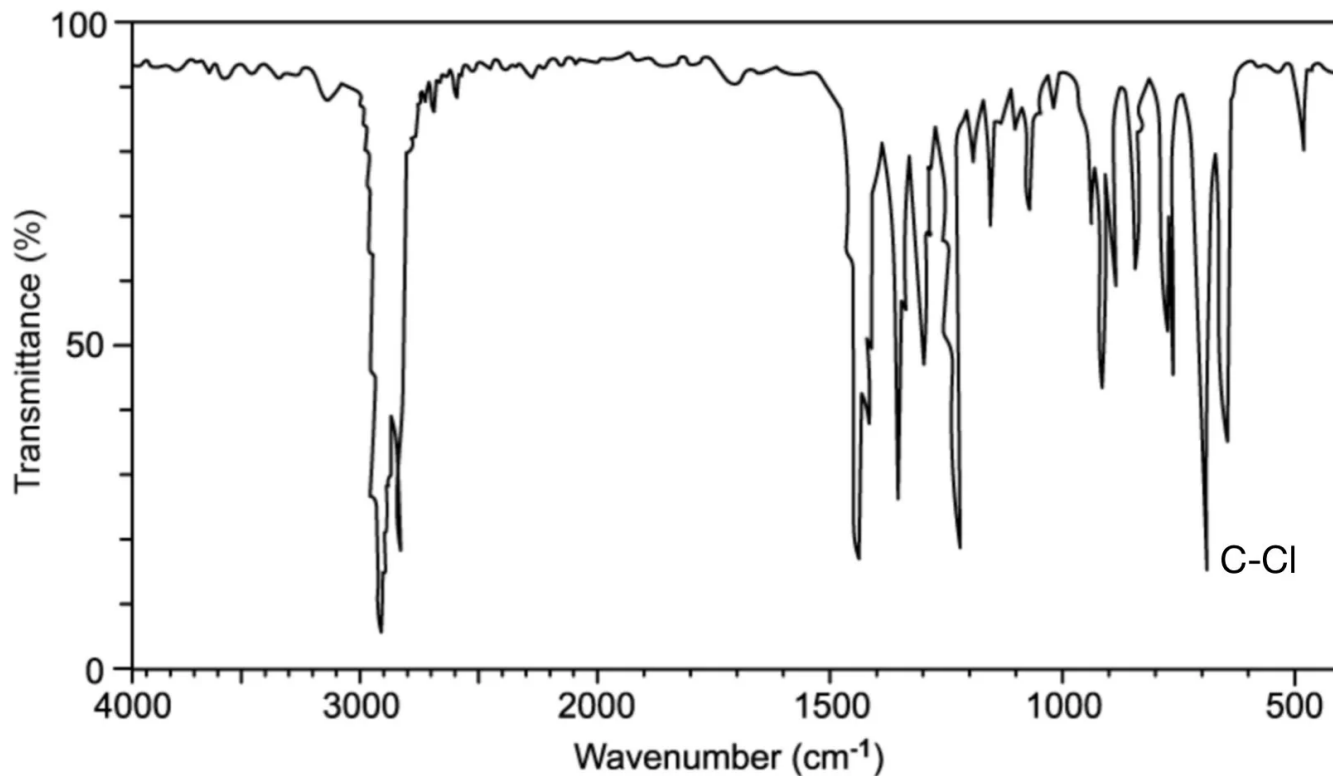
[1]

[1 mark]

### Question 2a

a)

An alcohol can be prepared by hydrolysing the halogenoalkane  $C_2H_5CHClCH_3$  with aqueous sodium hydroxide. The infrared spectrum for  $C_2H_5CHClCH_3$  is shown below with the C-Cl bond absorption labelled.



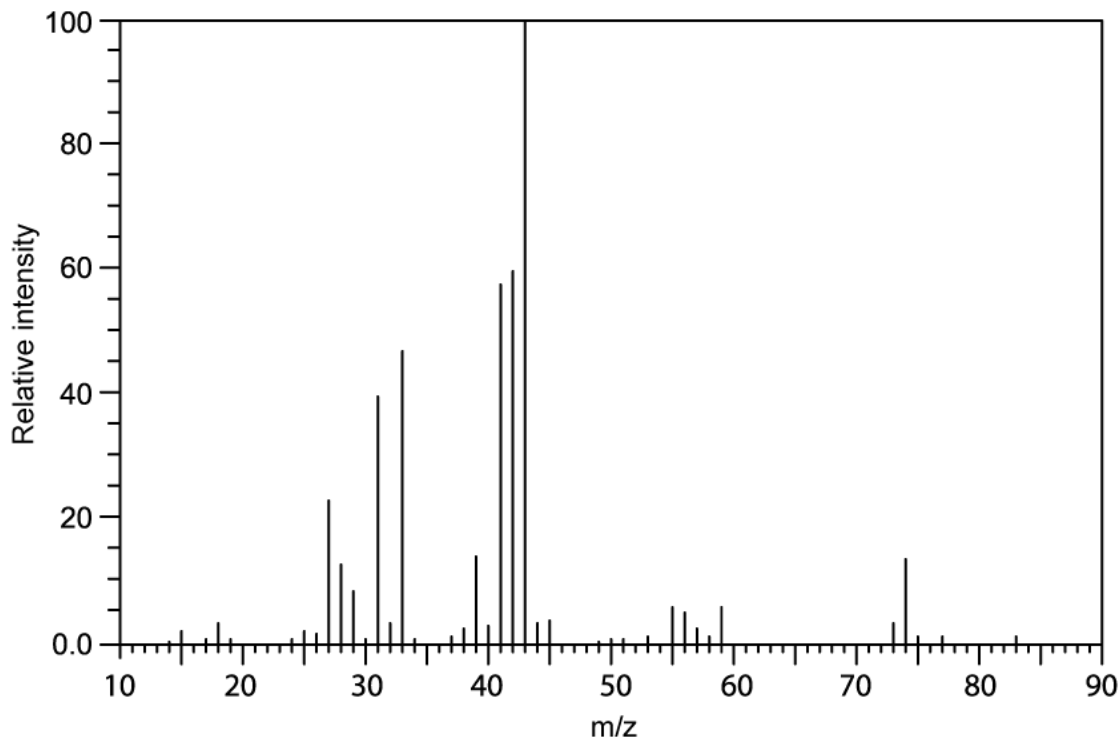
Using section 26 of the data booklet deduce how IR spectroscopy will change as a result of the above reaction.

[2 marks]

### Question 2b

b)

The mass spectrum of  $(\text{CH}_3)_2\text{CHCH}_2\text{OH}$  is shown below.



Deduce which ion is responsible for the peak with the greatest relative intensity.

[1]

[1 mark]

### Question 2c

c)

Alcohol **X** has the following percentage composition by mass. Carbon = 68.2%, hydrogen = 13.6%, oxygen = 18.2%. The molecular ion peak in the mass spectrum for alcohol **X** occurs at  $m/z = 88$ .

i)

Use this information and section 6 of the data booklet to show that the molecular formula for alcohol **X** is  $\text{C}_5\text{H}_{12}\text{O}$ . Include your working.

[2]

ii)

When alcohol **X** is oxidised, a carboxylic acid can be formed. State what information this gives about alcohol **X**.

[1]

[3 marks]

### Question 2d

d)

The mass spectrum of alcohol **X** has a major peak at  $m/z = 45$ .

i)

Draw the structure of the species that could give this peak.

[1]

ii)

Alcohol **X** has a branched chain. Deduce the structural formula and IUPAC name of alcohol **X**. Justify your answer.

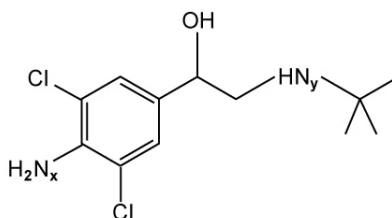
[2]

[3 marks]

### Question 3a

a)

Clenbuterol, shown below, is considered a performance enhancing drug and is believed to increase short term work rate and cardiovascular output.



Deduce the functional groups marked x and y and state to which class they belong to.

[2]

[2 marks]

### Question 3b

b)

Determine the  $m/z$  value of the molecular ion,  $M^+$ , of clenbuterol. Justify your answer.

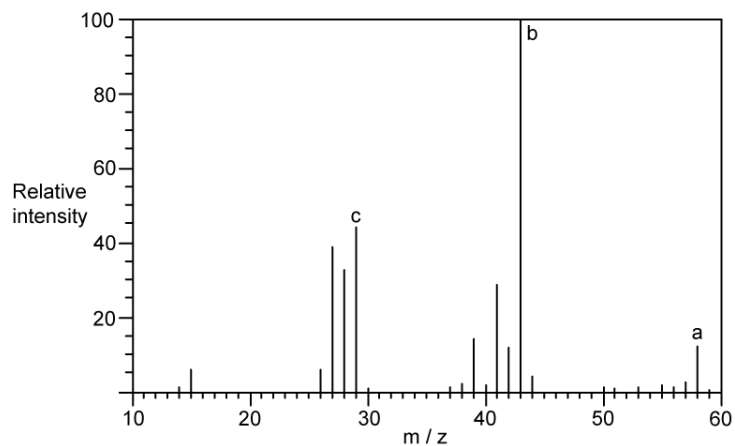
[2]

[2 marks]

### Question 3c

c)

Two students, **P** and **Q**, were provided with the mass spectrum of an alkane, shown in below. Student **P** analysed peaks **a** and **b** and concluded that the alkane was one of two structures. Student **Q** analysed peaks **a**, **b** and **c** and was able to identify one possible alkane structure.



i)

Deduce which fragments of the alkane correspond to peaks **a**, **b** and **c**.

[3]

ii)

Suggest why the two students obtained different conclusions.

[2]

[5 marks]

**Question 4a**

a)

Four samples containing isomeric alcohols with molecular formula  $C_4H_{10}O$ , were studied using  $^1H$  NMR spectroscopy  
Draw structural formulas of the alcohols and deduce the number of peaks in the NMR spectrum of each alcohol

[4]

**[4 marks]****Question 4b**

b)

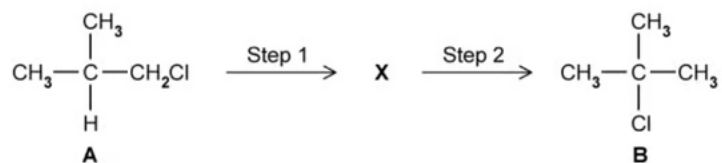
Two of the alcohols produce the same number of peaks in an  $^1H$  NMR spectrum. Suggest how they may be distinguished, by further spectroscopy analysis.

**[2 marks]**

### Question 4c

c)

Compound A can be converted into compound B via an intermediate species.



Suggest how you would be able to determine the difference between Compounds **A** and **B** by analysis of their  $^1\text{H}$  NMR spectra.

[2]

[2 marks]