11.1 Spectroscopic Identification

Question Paper

Course	DP IB 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.

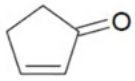
Using section 37 of the data booklet, deduce the hydrogen deficiency of Zanamivir.

[1 mark]

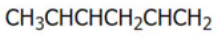
Question 1b

b)

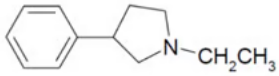
Determine which of the following molecules has the same IHD and state the IHD value.



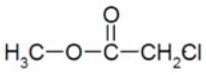
I



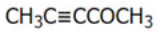
II



III



IV



V

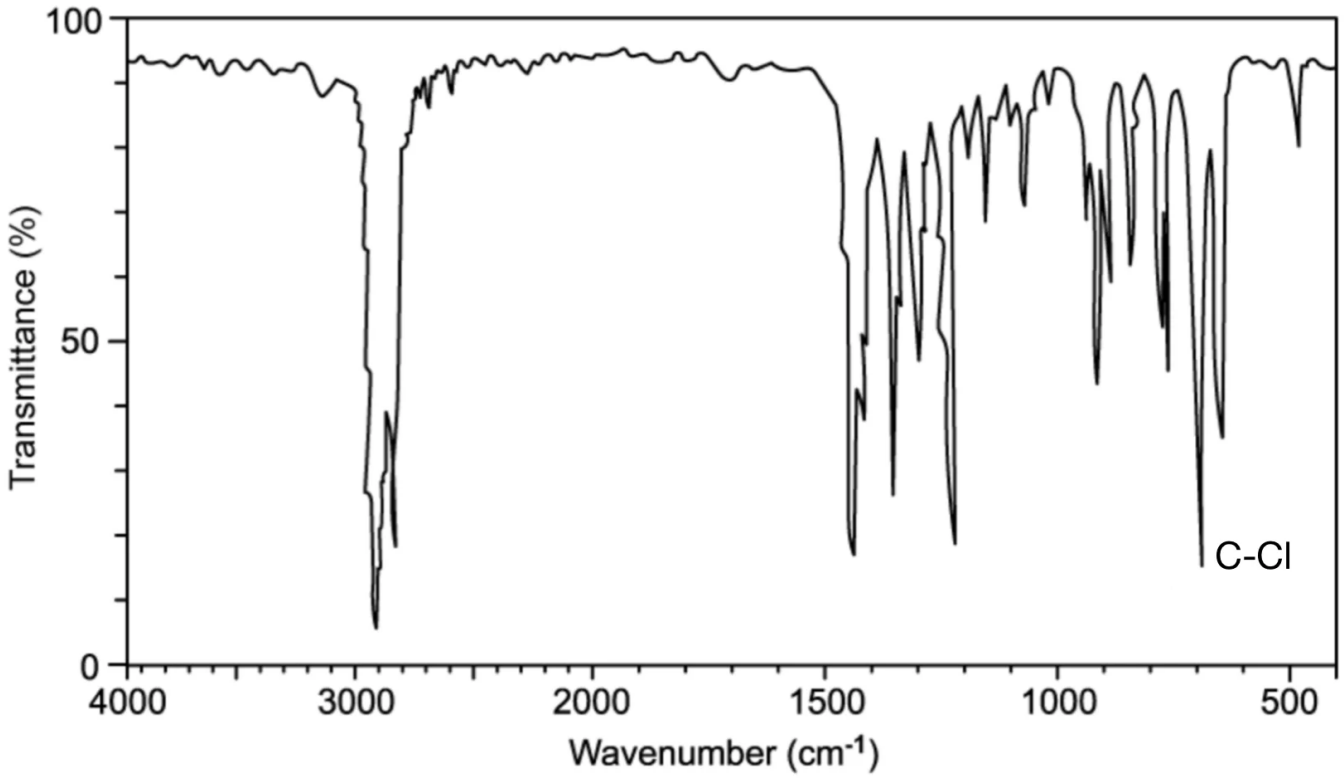
[1]

[1 mark]

Question 2a

a)

An alcohol can be prepared by hydrolysing the halogenoalkane $C_2H_5CHBClCH_3$ with aqueous sodium hydroxide. The infrared spectrum for $C_2H_5CHClCH_3$ is shown below with the C–Cl bond absorption labelled.



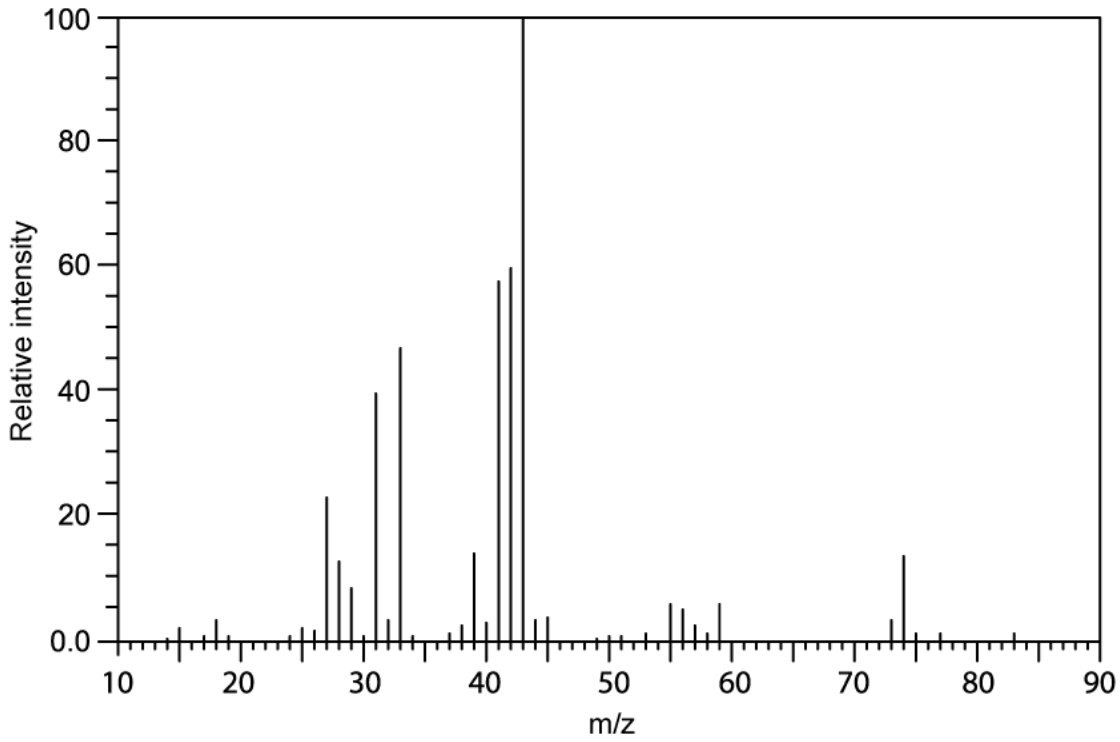
Using section 26 of the data booklet deduce how IR spectroscopy will change as a result of the above reaction.

[2 marks]

Question 2b

b)

The mass spectrum of $(CH_3)_2CHCH_2OH$ 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 $C_5H_{12}O$. 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]

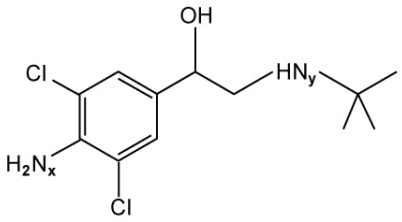
ii)
Alcohol **X** has a branched chain. Deduce the structural formula and IUPAC name of alcohol **X**. Justify your answer.

[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.

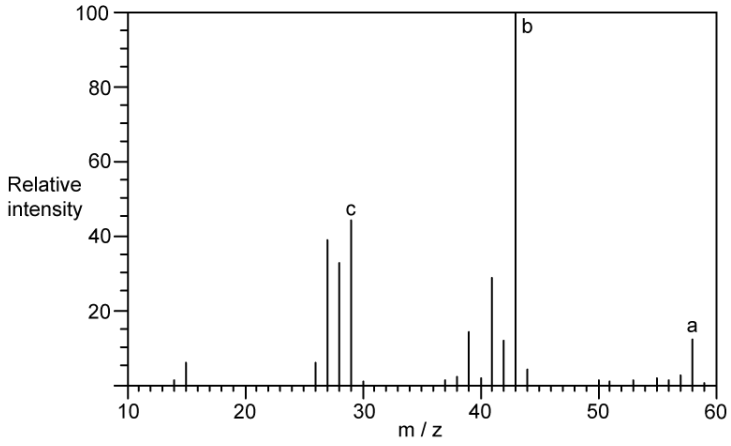
[2]

[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

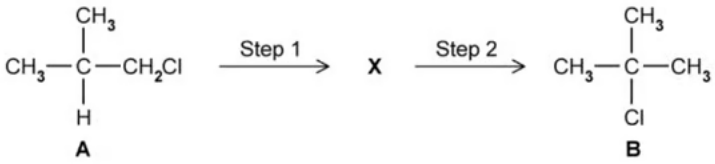
b)

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}H NMR spectra.

[2]

[2 marks]