



EXAM PAPERS PRACTICE

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Detailed mark scheme

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Designed to test your ability and thoroughly prepare you

IB Chemistry: SL

11.1 Spectroscopic Identification



CHEMISTRY

SL

11.1 Spectroscopic Identification

Question Paper

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

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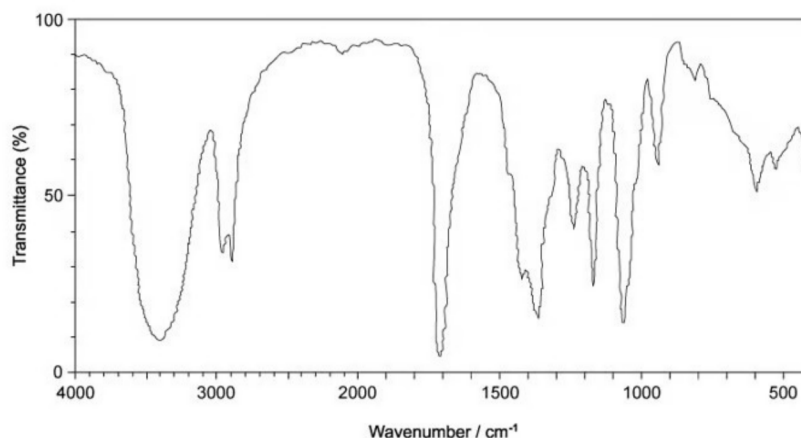
Time allowed: 20

Score: /10

Percentage: /100

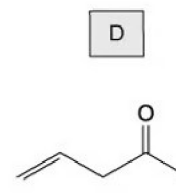
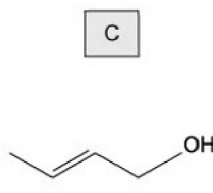
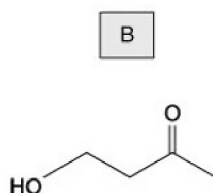
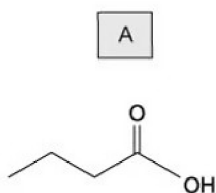
Question 1

The infrared spectrum below shows an unknown compound.



bond	wavenumber range/ cm^{-1}
C-O; hydroxyl, ester	1040 – 1300
C=C; aromatic compound, alkene	1500 - 1680
C=O amide	1640 – 1690
carbonyl, carboxyl	1670 – 1740
ester	1710 - 1750
C≡N; nitrile	2200 – 2250
C-H; alkane	2850 – 2950
N-H; amine, amide	3300 – 3500
O-H; carboxyl	2500 – 3000
hydroxyl	3200 - 3600

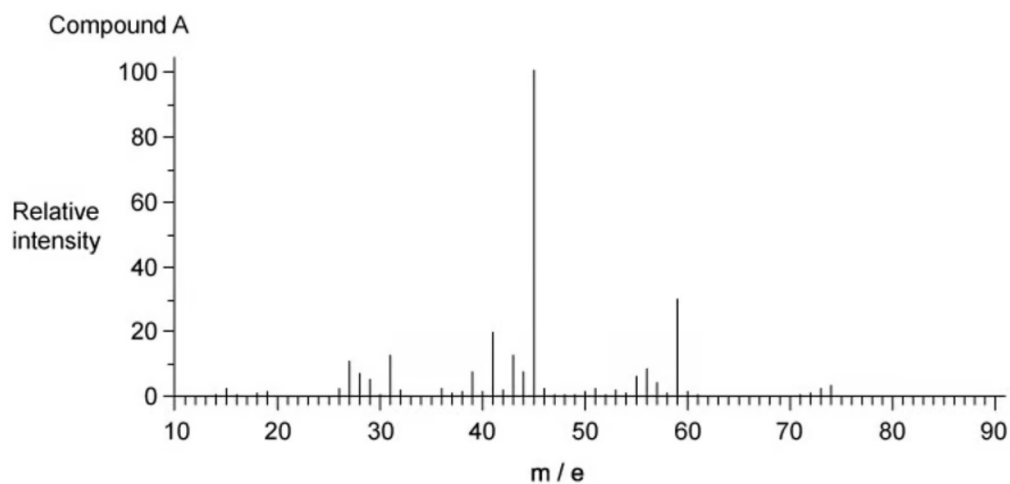
Which compound could have produced the infrared spectrum?



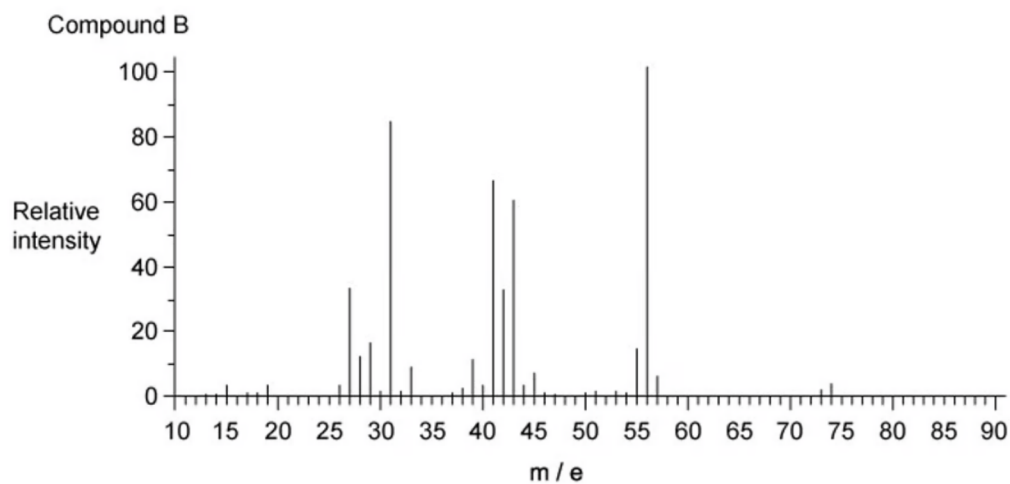
[1 mark]

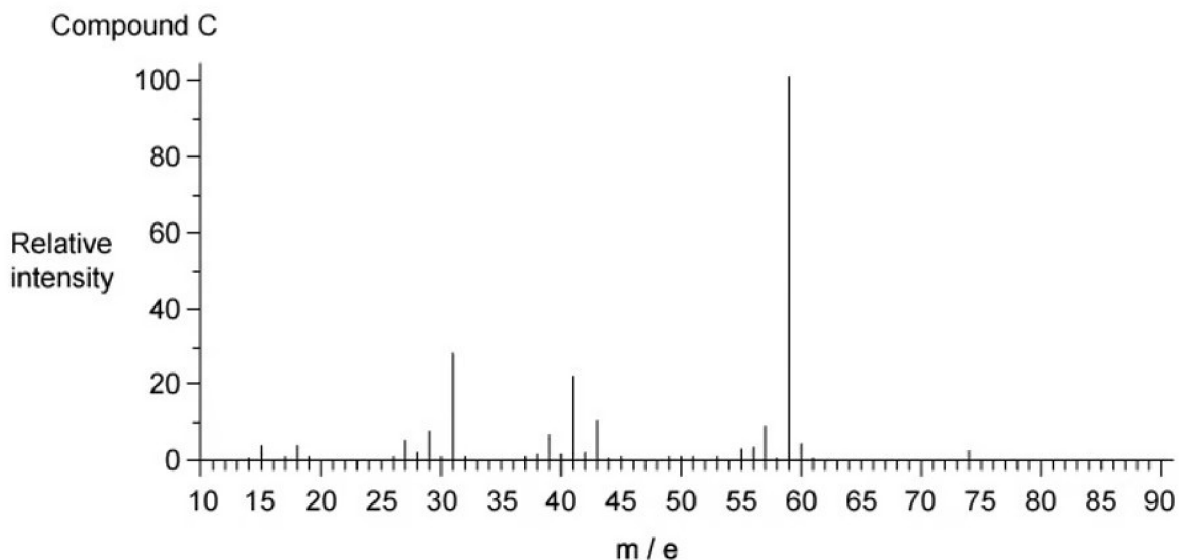
Question 2

The mass spectra of three compounds A, B and C are shown below.



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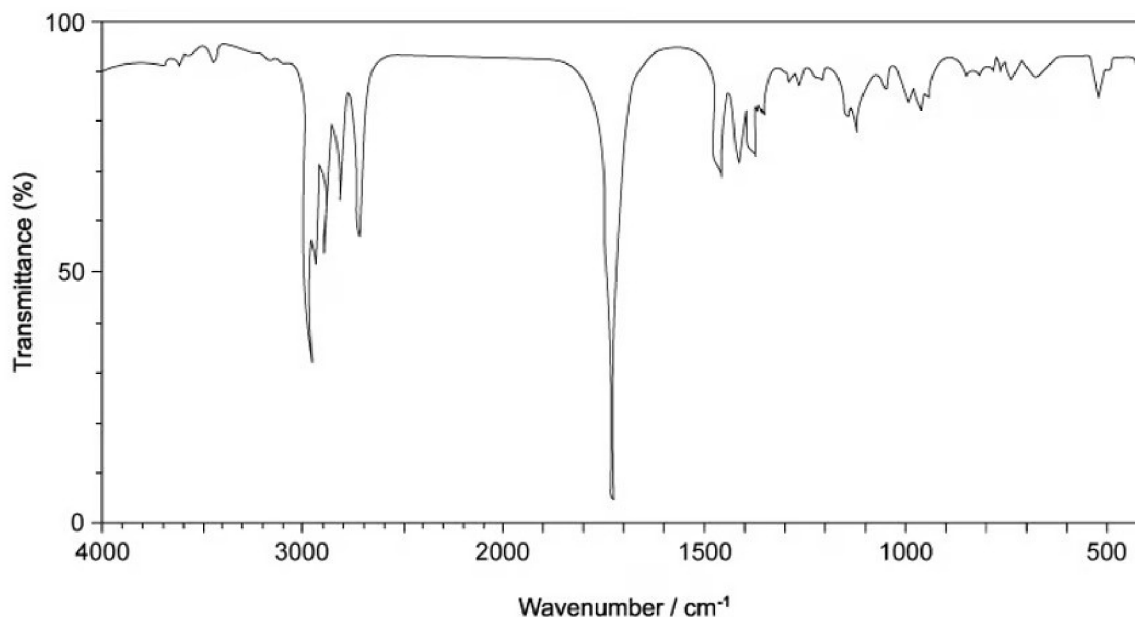
What evidence from the spectra of the three compounds A, B and C, suggests they could be isomers?

- A. all show a molecular ion peak at 74
- B. all show a molecular ion peak at 13
- C. all show a molecular ion peak at 73
- D. all show a molecular ion peak at 33

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Question 3

The diagram shows an infrared spectrum of a compound.



bond	wavenumber range/ cm^{-1}
C—O; hydroxyl, ester	1040 – 1300
C=C; aromatic compound, alkene	1500 - 1680
C=O amide	1640 – 1690
carbonyl, carboxyl	1670 – 1740
ester	1710 - 1750
C≡N; nitrile	2200 – 2250
C—H; alkane	2850 – 2950
N—H; amine, amide	3300 – 3500
O—H; carboxyl	2500 – 3000
hydroxyl	3200 - 3600

Which compound would give this spectrum?

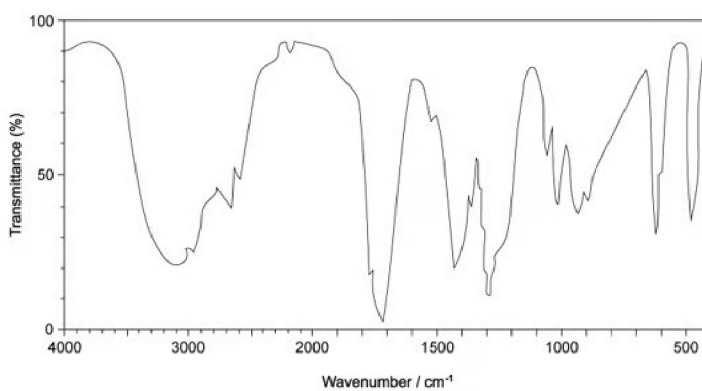
- A. butanoic acid
- B. butanal
- C. butan-1-ol
- D. 1-bromobutane

[1 mark]

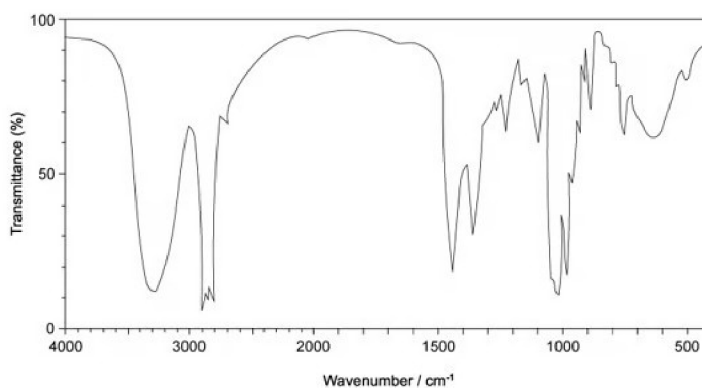
Question 4

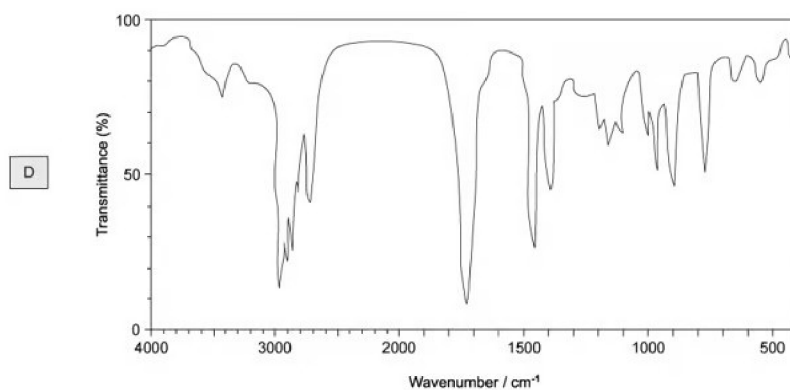
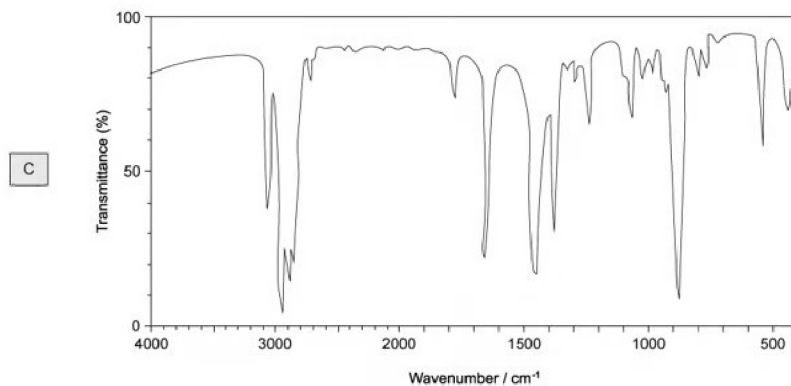
Which of the following infrared spectra could show a carboxylic acid?

A



B





bond	wavenumber range/ cm ⁻¹
C-O; hydroxyl, ester	1040 – 1300
C=C; aromatic compound, alkene	1500 - 1680
C=O amide carbonyl, carboxyl ester	1640 – 1690 1670 – 1740 1710 - 1750
C≡N; nitrile	2200 – 2250
C-H; alkane	2850 – 2950
N-H; amine, amide	3300 – 3500
O-H; carboxyl hydroxyl	2500 – 3000 3200 - 3600

[1 mark]

Question 5

A periodic table is needed for this question

A compound XF_n is a fluoride of another halogen, X, and it is known that $n > 1$. The highest m/e peak in the mass spectrum of XF_n is assigned to the parent ion and comes as a single peak at $m/e = 222$.

Which of the following statements is **incorrect**?

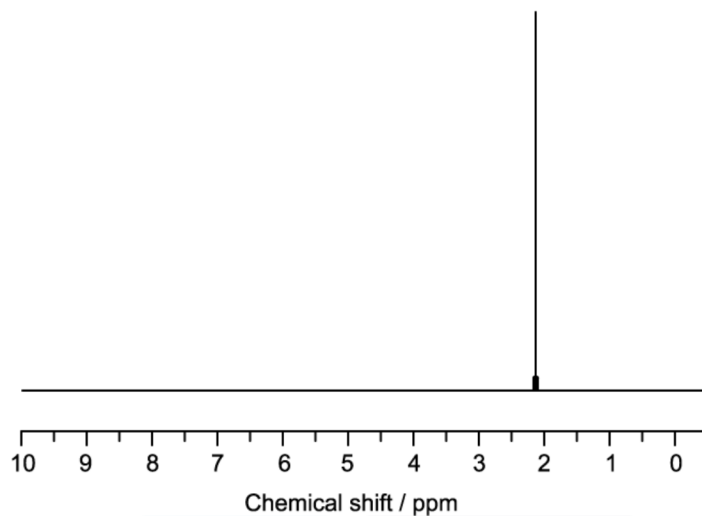
- A. $n = 5$
- B. the compound could contain bromine
- C. there are no isotopes of X or F
- D. the compound is a fluoride of iodine

[1 mark]

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Question 6

What does the ^1H NMR spectrum below tell you about a molecule?



- A. There is only one isotope of hydrogen present in the molecule
- B. The molecule is a hydrocarbon
- C. There is only one hydrogen atom in the molecule
- D. There is only one hydrogen environment in the molecule

[1 mark]

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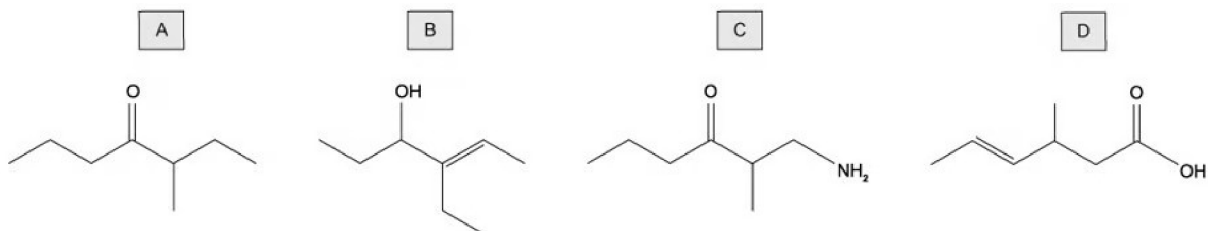
Question 7

An organic compound is analysed by mass spectrometry and infrared spectroscopy. The following data is obtained.

mass spectrometry	infrared spectroscopy
molecular ion peak at $m/e = 128$	sharp peak at 1720 cm^{-1}
fragment ion peak at $m/e = 15$	no broad peak around 3200 cm^{-1}

bond	wavenumber range/ cm^{-1}
C-O; hydroxyl, ester	1040 – 1300
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C-H; alkane	2850 – 2950
N-H; amine, amide	3300 – 3500
O-H; carboxyl hydroxyl	2500 – 3000 3200 - 3600

Which of the following compounds could be consistent with the data given?



[1 mark]

Question 8

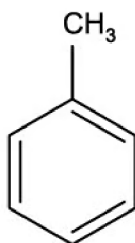
Which molecule has an index of hydrogen deficiency (IHD) = 1?

- A. C_6H_{10}
- B. C_2Br_2
- C. C_4H_9N
- D. C_3H_8O

[1 mark]

Question 9

How many peaks would you expect to see in a 1H NMR spectrum of methylbenzene?

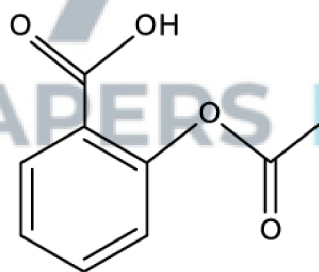


- A. 3
- B. 4
- C. 5
- D. 6

[1 mark]

Question 10

What is the index of hydrogen deficiency (IHD) for this molecule of aspirin?



- A. 3
- B. 4
- C. 5
- D. 6

[1 mark]