

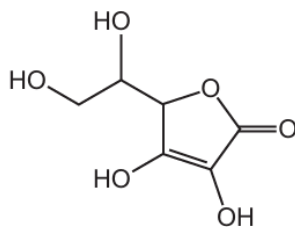
22. Analytical techniques

22.2 Mass spectrometry

Paper 1

Question Paper

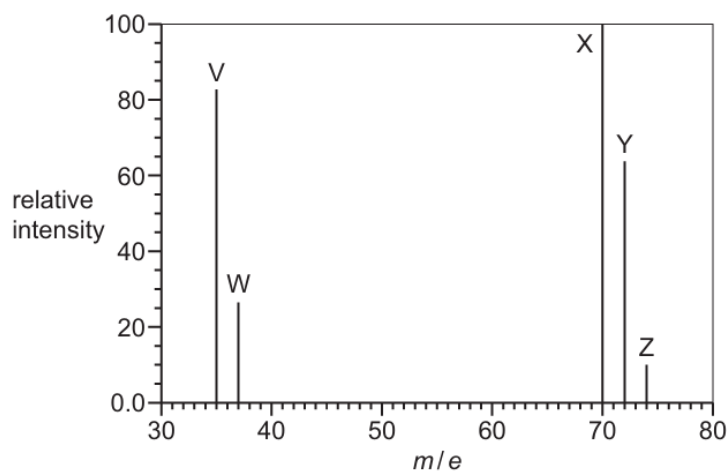
- 1 Vitamin C has the structure shown.



The mass spectrum of vitamin C has a molecular ion peak with an m/e value of 176 and a relative abundance of 7.0%.

What is the abundance of the $M + 1$ peak?

- A 0.462% B 0.539% C 0.616% D 0.693%
- 2 The diagram shows the mass spectrum of a sample of chlorine. Peaks V, W, X, Y and Z are labelled.



Which statements about this spectrum are correct?

- 1 The relative atomic mass of chlorine can be calculated from the abundances and m/e values of 2 of the 5 peaks.
 - 2 37.0 g of the species responsible for peak Z contains 3.011×10^{23} molecules.
 - 3 The relative molecular mass of chlorine can be calculated from the abundances and m/e values of peaks X, Y and Z.
- A 1, 2 and 3 B 1 and 2 only C 1 and 3 only D 2 and 3 only

- 3 The relative atomic mass of antimony is 121.76.

Antimony has **two** isotopes. The mass numbers of the two isotopes differ by two. The isotope with the lower mass number is the more abundant.

What is the percentage abundance of the isotope with the **higher** mass number?

- A 12% B 38% C 62% D 88%

- 4 In the mass spectrum of compound J, the ratio of the height of the M + 1 ion peak to the height of the M + ion peak is 4 : 91.

Compound J forms a carboxylic acid when heated with acidified $K_2Cr_2O_7$.

What is compound J?

- A butanal
B butanone
C propan-1-ol
D propanenitrile

- 5 Oxygen has three stable isotopes, ^{16}O , ^{17}O and ^{18}O . All three isotopes are present in a sample of oxygen gas, O_2 , which was analysed using a mass spectrometer.

How many peaks associated with the O_2^+ ion would be expected?

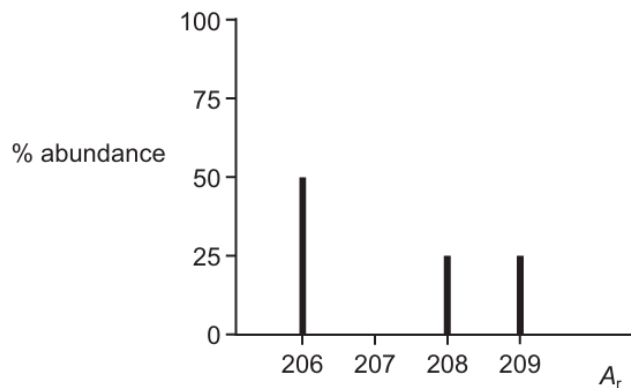
- A 3 B 5 C 6 D 9

- 6 There are two naturally occurring isotopes of bromine. One isotope has 44 neutrons. The other isotope has 46 neutrons.

Ignoring fragments, how many peaks are there in the mass spectrum of tribromomethane, $^{12}C^1HBr_3$?

- A 2 B 3 C 4 D 6

- 7 The diagram shows the relative abundance of different isotopes of lead in a sample of lead ore. The abundance of 208 is half that of 206. The abundances of 208 and 209 are equal.



What is the relative atomic mass of the lead in the sample?

- A** 207.00 **B** 207.25 **C** 207.50 **D** 207.67
- 8 In the mass spectrum of a compound, Z, the relative abundances of the M and M+1 peaks are in the ratio 13 : 1.

What is compound Z?

- A** butyl butanoate
B hexan-3-one
C 2,2,3-trimethylhexane
D 3,3-dimethylpentan-1-ol

- 9 A molecule of an organic compound, P, contains three carbon atoms and shows a strong absorption at 1720 cm^{-1} in its infrared spectrum.

P is reacted with an excess of hot acidified potassium dichromate(VI) forming organic product Q.

Q shows a strong absorption at 1700 cm^{-1} and a strong, broad absorption centred at 2800 cm^{-1} in its infrared spectrum.

bond	functional group containing the bond	characteristic infrared absorption range (in wavenumbers)/ cm^{-1}
C–O	hydroxy, 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 hydroxy	2500–3000 3200–3600

What is P?

- A propanal
- B propanone
- C propan-1-ol
- D propan-2-ol

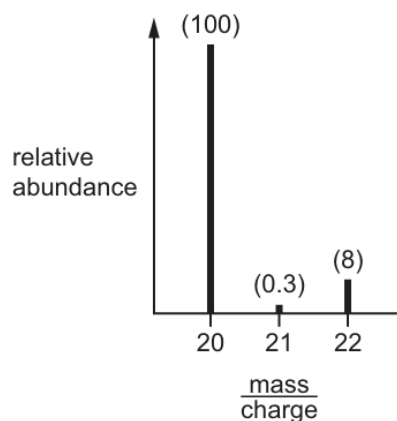
- 10 Three organic compounds are listed.

- 1 ethanal
- 2 propan-1-ol
- 3 propan-2-ol

Which compounds will have a mass spectrum that contains a fragment peak at $m/e = 43$?

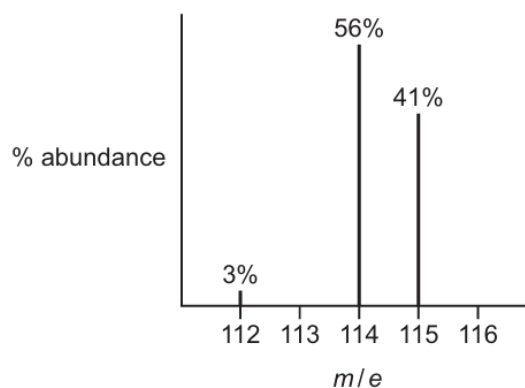
- A 1 only
- B 1 and 2 only
- C 2 and 3 only
- D 1, 2 and 3

- 11** The mass spectrum of a sample of neon is shown. The relative abundance of each peak is written in brackets above it.



What is the relative atomic mass, A_r , of this sample of neon?

- A** 20.15 **B** 20.20 **C** 21.00 **D** 21.82
- 12** A sample of element X is analysed using mass spectrometry. The mass spectrum obtained is shown.



What is the relative atomic mass of this sample of element X?

- A** 113.7 **B** 114.0 **C** 114.2 **D** 114.4
- 13** Oxygen has three stable isotopes, ^{16}O , ^{17}O and ^{18}O . All three isotopes are present in a sample of oxygen gas, O_2 , which was analysed using a mass spectrometer.

How many peaks associated with the O_2^+ ion would be expected?

- A** 3 **B** 5 **C** 6 **D** 9