**1** How many molecular ion peaks (parent ion peaks) are in the mass spectrum of

1,2-dibromoethane?

Assume the only isotopes present are $^{1}H$, $^{12}C$, $^{79}Br$ and $^{81}Br$.

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

**(Total for Question = 1 mark)**

**2** This question is about two isomeric alcohols and two isomeric carbonyl compounds.

Butan-1-ol, $CH_3CH_2CH_2CH_2OH$

Butan-2-ol, $CH_3CH_2CH(OH)CH_3$

Butanal, $CH_3CH_2CH_2CHO$

Butanone, $CH_3CH_2COCH_3$

(a) Which of these compounds would **not** produce a colour change when heated with acidified sodium dichromate(VI) solution?

**(1)**

☒ **A** Butan-1-ol

☒ **B** Butan-2-ol

☒ **C** Butanal

☒ **D** Butanone

(b) Which compound could give a peak at $m/e = 31$ in its mass spectrum?

**(1)**

☒ **A** Butan-1-ol

☒ **B** Butan-2-ol

☒ **C** Butanal

☒ **D** Butanone

(c) Which compound could **not** give a peak at $m/e = 43$ in its mass spectrum?

**(1)**

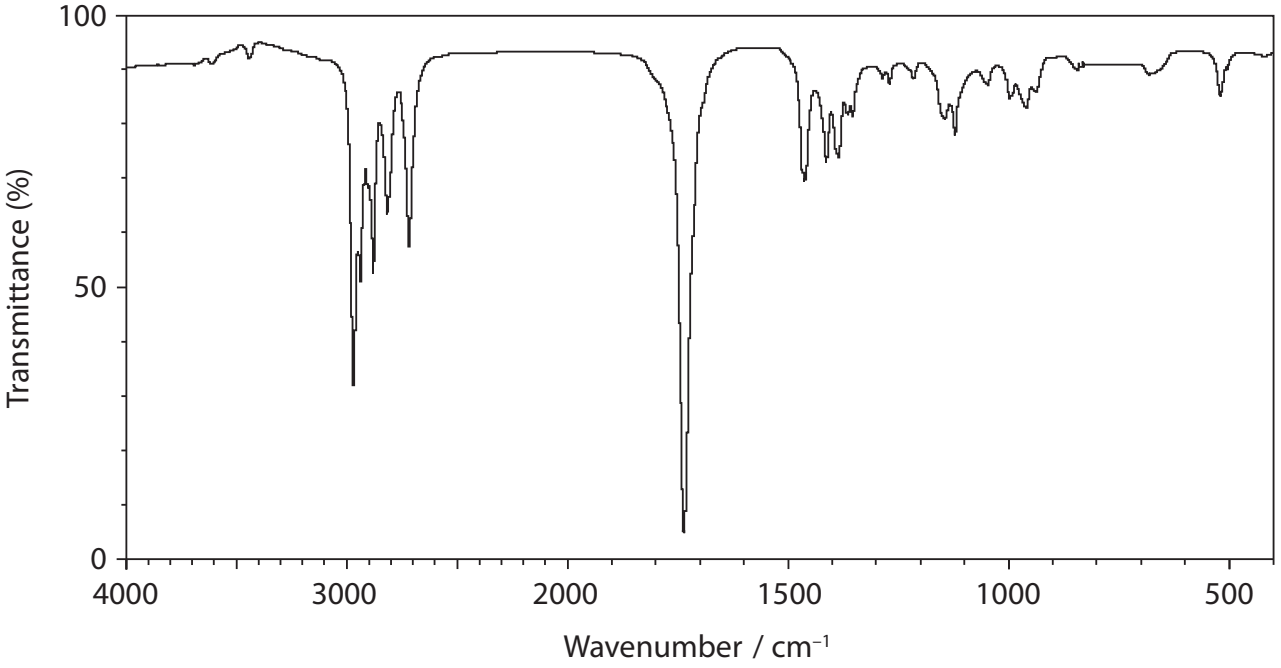
☒ **A** Butan-1-ol

☒ **B** Butan-2-ol

☒ **C** Butanal

☒ **D** Butanone

(d) The infrared spectrum of one of these compounds is given below.




Use the infrared absorptions, in wavenumbers, to identify the compound.

| Bond | Wavenumber range / $cm^{-1}$ |
|---|---|
| O—H (alcohol) | 3750 – 3200 |
| C—H (alkane) | 2962 – 2853 |
| C—H (aldehyde) | 2900 – 2820 and 2775 – 2700 |
| C=O (aldehyde or ketone) | 1740 – 1680 |

The compound with this IR spectrum is

**(1)**

☒ **A** butan-1-ol.

☒ **B** butan-2-ol.

☒ **C** butanal.

☒ **D** butanone.

**(Total for Question = 4 marks)**

**3** The correct sequence for the processes that occur in a mass spectrometer is

☒ **A** vaporization, ionization, acceleration, deflection and detection.

☒ **B** vaporization, acceleration, ionization, deflection and detection.

☒ **C** ionization, vaporization, acceleration, deflection and detection.

☒ **D** ionization, vaporization, deflection, acceleration and detection.

**(Total for Question = 1 mark)**

**4** Which of the following ions would be deflected **most** in a mass spectrometer?

☒ **A** $^{35}Cl^{+}$

☒ **B** $^{37}Cl^{+}$

☒ **C** $^{37}Cl^{2+}$

☒ **D** $(^{35}Cl —^{37}Cl)^{+}$

**(Total for Question = 1 mark)**

**5** In a mass spectrum of butane, $C_4H_{10}$, where would a peak be seen for the molecular ion if it had a charge of 2+?

☒ **A** 29

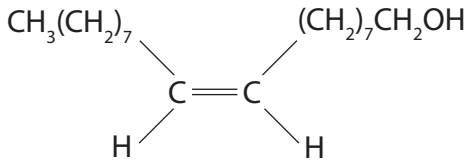
☒ **B** 56

☒ **C** 58

☒ **D** 60

**(Total for Question = 1 mark)**

**6** The formula for oleyl alcohol, which is present in sperm whale oil and was used as a lubricant, is shown below.




(a) The systematic name for oleyl alcohol is

**(1)**

☒ **A** *E*-octadec-9-en-1-ol.

☒ **B** *Z*-octadec-9-en-1-ol.

☒ **C** *E*-octadec-8-en-1-ol.

☒ **D** *Z*-octadec-8-en-1-ol.

(b) Which intermolecular forces are present between oleyl alcohol molecules?

**(1)**

☒ **A** London forces only

☒ **B** Hydrogen bonds and London forces only

☒ **C** Hydrogen bonds and permanent dipole–dipole forces only

☒ **D** Hydrogen bonds, permanent dipole–dipole and London forces

(c) Which of the following is the most likely structure of the species to cause a peak at *m/e* 31 in the mass spectrum of oleyl alcohol?

**(1)**

☒ **A** $CH_3O$

☒ **B** $CH_2OH$

☒ **C** $CH_3O^+$

☒ **D** $CH_2OH^+$

(d) What would you expect to see if oleyl alcohol is tested separately with bromine water and heated with acidified sodium dichromate(VI) solution?

**(1)**

| | Bromine water | Acidified sodium dichromate(VI) solution |
|---|---|---|
| ☒ **A** | Decolorises | Turns green |
| ☒ **B** | No colour change | No colour change |
| ☒ **C** | Decolorises | No colour change |
| ☒ **D** | No colour change | Turns green |

**(Total for Question = 4 marks)**

**7** Bromine has two isotopes with relative isotopic masses 79 and 81. Which of the following values for mass/charge ratio could correspond to a peak in the mass spectrum of bromine, $Br_2$? You should assume the ions detected have a single positive charge.

☒ **A** 79.9

☒ **B** 80

☒ **C** 159

☒ **D** 160

**(Total for Question = 1 mark)**

**8** The concentration of a solution of potassium iodate(V) can be determined by the liberation of iodine, followed by titration with sodium thiosulfate.

A suitable indicator is

☒ **A** methyl orange.

☒ **B** phenolphthalein.

☒ **C** starch.

☒ **D** universal indicator.

**(Total for Question = 1 mark)**

**9** The thermite reaction, shown below, is a useful industrial process.

$$Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(l) + Al_2O_3(s)$$

The iron in this reaction undergoes

☒ **A** disproportionation.

☒ **B** oxidation.

☒ **C** redox.

☒ **D** reduction.

**(Total for Question = 1 mark)**

**10** This question is about the following isomeric compounds with the molecular formula $C_4H_8O$ and molar mass 72 g $mol^{-1}$.

**A** $CH_3CH_2CH_2CHO$

**B** $(CH_3)_2CHCHO$

**C** $CH_3CH_2COCH_3$

**D** $CH_3CH{=}CHCH_2OH$

(a) Which compound would you expect to give a peak at *m/e* = 41 in its mass spectrum?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which compound would NOT react with an acidified solution of potassium dichromate(VI)?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) Which compound would give a pale yellow precipitate when reacted with iodine in alkaline solution?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(d) Which compound can be reduced to give a chiral product?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(e) Which compound would NOT react with hydrogen cyanide under suitable conditions to form a hydroxynitrile?

**(1)**

☒ **A**

☒ **B**

☒ **C**

☒ **D**

**(Total for Question = 5 marks)**

**11** There would be a major peak in the mass spectrum for butan-1-ol, $CH_3CH_2CH_2CH_2OH$, but **not** for butan-2-ol, $CH_3CH_2CH(OH)CH_3$, at *m/e* value

☒ **A** 15

☒ **B** 17

☒ **C** 29

☒ **D** 43

**(Total for Question 1 mark)**

**12** How many molecular ion peaks (parent ion peaks) occur in the mass spectrum of 1,2-dibromoethane, $CH_2BrCH_2Br$?

Assume the only isotopes present are $^{1}H$, $^{12}C$, $^{79}Br$ and $^{81}Br$.

☒ **A** 1

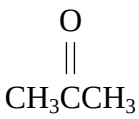
☒ **B** 2

☒ **C** 3

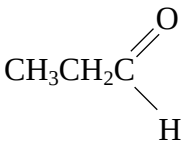
☒ **D** 4

**(Total for Question 1 mark)**

**13** Which of the following features is shown by the mass spectra of propanone and propanal?



**propanone**

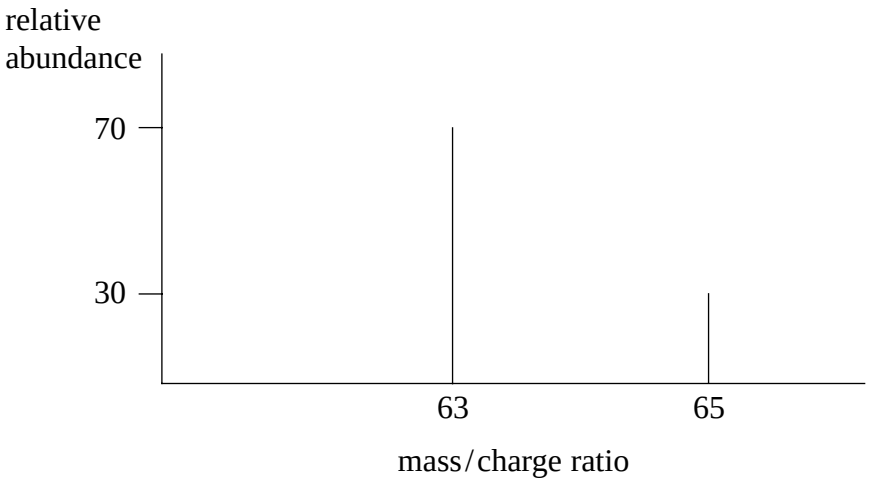


**propanal**

| | | *m/e* of the molecular ion | Fragmentation pattern |
|---|---|---|---|
| ☒ | **A** | same | same |
| ☒ | **B** | same | different |
| ☒ | **C** | different | same |
| ☒ | **D** | different | different |

**(Total for Question = 1 mark)**

**14** The mass spectrum for a sample of a metal is shown below.




The relative atomic mass of the metal is

☒ **A** 63.2

☒ **B** 63.4

☒ **C** 63.6

☒ **D** 64.0

**(Total for Question = 1 mark)**

**15** Which of the following ions would undergo the greatest deflection in a mass spectrometer?

☒ **A** $^{35}Cl^{2+}$

☒ **B** $^{35}Cl^{+}$

☒ **C** $^{37}Cl^{+}$

☒ **D** $^{35}Cl^{37}Cl^{+}$

**(Total for Question = 1 mark)**

**16** Which of the following values for the mass/charge ratio for singly charged ions would be present in the mass spectrum of propanal, $CH_3CH_2CHO$, but not of propanone, $CH_3COCH_3$?

☒ **A** 15

☒ **B** 29

☒ **C** 43

☒ **D** 58

**(Total for Question = 1 mark)**

**17** Propanal, $CH_3CH_2CHO$, and propanone, $CH_3COCH_3$, are isomers, but only propanal has a significant peak in its mass spectrum at mass/charge ratio

☒ **A** 15

☒ **B** 29

☒ **C** 43

☒ **D** 58

**(Total for Question = 1 mark)**

**18** Two ketones, $CH_3COCH_2CH_2CH_3$ and $CH_3CH_2COCH_2CH_3$, both have $M_r$ 86. Which peak due to fragmentation into singly charged ions would you expect to be present in the mass spectrum of one but not the other?

☒ **A** 71

☒ **B** 57

☒ **C** 43

☒ **D** 29

**(Total for Question 1 mark)**