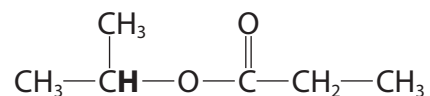


1 This question is about the ester shown below.



(a) The number of peaks seen in the **low** resolution proton nmr spectrum of this ester is

(1)

- A two.
- B three.
- C four.
- D five.

(b) The peak in the **high** resolution proton nmr spectrum corresponding to the proton in **bold** on the structure above will

(1)

- A not be split.
- B be split into three peaks.
- C be split into four peaks.
- D be split into seven peaks.

**(Total for Question = 2 marks)**

2 Which atoms are not detected by X-rays but are detected by nuclear magnetic resonance imaging which also shows their environments?

- A Carbon
- B Hydrogen
- C Nitrogen
- D Oxygen

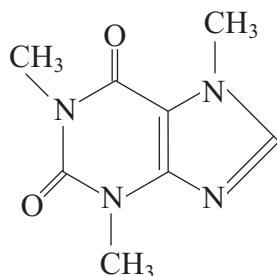
**(Total for Question = 1 mark)**

3 Which of the following interacts with the nuclei of hydrogen atoms in a nuclear magnetic resonance spectrometer?

- A Gamma rays
- B X-rays
- C Microwaves
- D Radio waves

**(Total for Question 1 mark)**

4 The structural formula of caffeine,  $C_8H_{10}O_2N_4$ , is shown below.



(a) How many main peaks would you expect in the proton nuclear magnetic resonance spectrum of caffeine?

(1)

- A 1
- B 2
- C 3
- D 4

(b) At which of the following wavenumbers is an absorption peak **not** present in the infrared spectrum of caffeine?

(1)

- A  $3600\text{ cm}^{-1}$
- B  $2925\text{ cm}^{-1}$
- C  $1690\text{ cm}^{-1}$
- D  $1660\text{ cm}^{-1}$

(c) The parent ion peak of caffeine in the mass spectrum of caffeine would be at m/e ratio

(1)

- A 101
- B 102
- C 193
- D 194

(d) Intermolecular forces between caffeine molecules would include

(1)

- A London forces only.
- B London forces and hydrogen bonds.
- C London forces and permanent dipole forces.
- D London forces, permanent dipole forces, and hydrogen bonds.

(Total for Question 4 marks)

5 How many peaks would you expect to see in a **low resolution** proton nmr spectrum of the ester  $\text{HCOOCH}_2\text{CH}_2\text{CH}_3$ ?

- A 8
- B 7
- C 4
- D 3

(Total for Question 1 mark)

6 In a **high resolution** proton nmr spectrum of ethyl ethanoate,  $\text{CH}_3\text{COOCH}_2\text{CH}_3$ , the peak due to the hydrogen atoms shown **in bold** would be a

- A singlet.
- B doublet.
- C triplet.
- D quartet.

(Total for Question 1 mark)

7 The radio waves used in proton nmr

- A must not be absorbed by the sample.
- B cause electron transitions in the hydrogen atom.
- C can only be used with organic substances.
- D cause the hydrogen nucleus to change its spin state.

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