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— **TUITION** —

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CHEMISTRY

ORGANIC CHEMISTRY II

Level & Board	AQA (A-LEVEL)
TOPIC:	NMR SPECTROSCOPY
PAPER TYPE:	QUESTION PAPER - 1
TOTAL QUESTIONS	10
TOTAL MARKS	/28

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NMR Spectroscopy - 1

1. The proton n.m.r. spectrum of Q shows 4 peaks.

Compound Q has the molecular formula $C_4H_8O_2$

The table below gives δ values for each of these peaks together with their splitting patterns and integration values.

δ /ppm	2.20	2.69	3.40	3.84
Splitting pattern	singlet	triplet	singlet	triplet
Integration value	3	2	1	2

What can be deduced about the structure of Q from the presence of the following in its n.m.r. spectrum?

(a) The singlet peak at $\delta = 2.20$

(1)

(b) The singlet peak at $\delta = 3.40$

(1)

(c) Two triplet peaks.

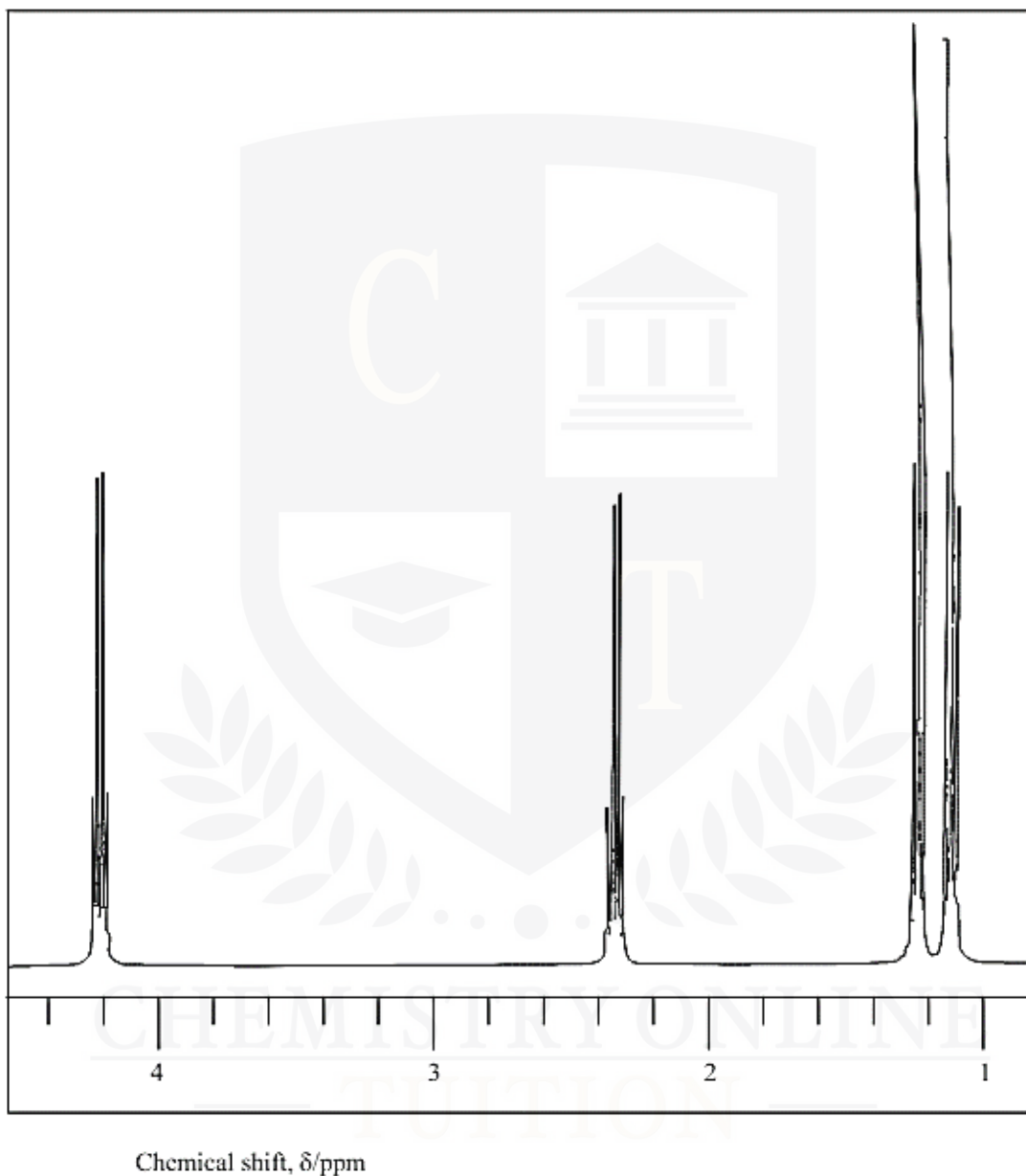
(1)

2. Which amine has only three peaks in its proton NMR spectrum?

- A. Methylamine
- B. Trimethylamine
- C. Diethylamine
- D. Propylamine

(1)

3. The proton n.m.r. spectrum of an ester, A, is shown below.



The measured integration trace gives the ratio 0.50 to 0.50 to 0.75 to 0.75 for the peaks at δ 4.13, 2.32, 1.33 and 1.09, respectively.

(a) The mass spectrum of compound A has a molecular ion peak at $m/z = 102$.

Deduce the molecular formula of compound A.

(3)

(b) What is the ratio of the numbers of each type of proton?

(1)

(c) What can be deduced about the arrangement of protons from the splitting patterns in the n.m.r. spectrum?

(1)

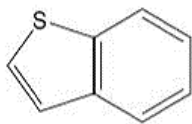
(d) Deduce the structure of compound A and label with the letters a, b, c and d the four groups of equivalent protons.

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(1)

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4. How many peaks does this compound have in its ^{13}C spectrum?



- A. 5
- B. 6
- C. 7
- D. 8

(1)

5. The ester formed when ethanol reacts with ethanoic anhydride was analysed by high-resolution proton n.m.r. spectroscopy.

(a) Give the structural formula of the ester.

(1)

(b) How many different types of proton are present in this ester?

(1)

(c) Describe the splitting pattern of the ethyl group in the n.m.r. spectrum of the ester.

(1)

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6. How many peaks are there in the ^{13}C NMR spectrum of 1,4-dimethylbenzene?

- A. 8
- B. 4
- C. 3
- D. 2

(1)

7. Draw the structures of the three branched-chain alkenes with molecular formula C_5H_{10} .

Draw the structures of the three dibromoalkanes, $\text{C}_5\text{H}_{10}\text{Br}_2$, formed when these three alkenes react with bromine.

One of these dibromoalkanes has only three peaks in its proton n.m.r. spectrum.

Deduce the integration ratio and the splitting patterns of these three peaks.

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(8)

8. Which one of the following pairs of reagents reacts to form an organic product that shows only 2 peaks in its proton n.m.r. spectrum?

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- A. Butan-2-ol and acidified potassium dichromate(VI)
- B. Ethanoyl chloride and methanol
- C. Propanoic acid and ethanol in the presence of concentrated sulphuric acid
- D. Ethene and hydrogen in the presence of nickel

(1)

9. State the number of peaks, their integration ratio and any splitting of peaks in the proton n.m.r. spectrum of 2,3-dichlorobutane.

(3)

10. Which one of the following pairs reacts to form an organic product with only 2 singlets in its proton n.m.r. spectrum?

- A. Ethene and bromine
- B. Propan-2-ol and acidified potassium dichromate(VI)
- C. Ethanol and concentrated sulphuric acid
- D. Epoxyethane and water in the presence of dilute sulphuric acid

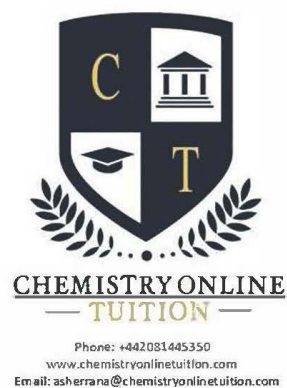
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- Tutoring students in UK and worldwide since 2008
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