1. June/2022/Paper_41/No.6(b, f, g)

(b) Asparagine is an amino acid that contains a chiral carbon atom and displays stereoisomerism.

Separate samples of asparagine are dissolved in $CDCl_3$ and analysed using carbon-13 and proton (^1H) NMR spectroscopy.

asparagine

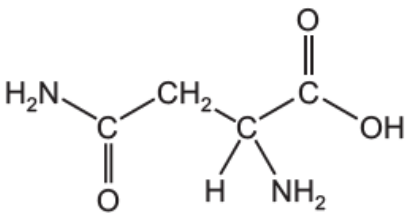


Fig. 6.1

Predict the number of peaks seen in the carbon-13 and proton (^1H) NMR spectra of asparagine.

	carbon-13 NMR	proton (^1H) NMR
number of peaks		

[1]

(f) Thin-layer and gas-liquid chromatography can be used to analyse mixtures of substances.

Each type of chromatography makes use of a stationary phase and a mobile phase.

(i) Complete Table 6.1 with an example of each of these.

Table 6.1

	stationary phase	mobile phase
thin-layer chromatography		
gas-liquid chromatography		

[1]

(ii) An unknown amino acid is analysed using thin-layer chromatography. Two chromatographs of the unknown amino acid and four reference amino acids, **P**, **Q**, **R** and **S**, are obtained using two different solvents.

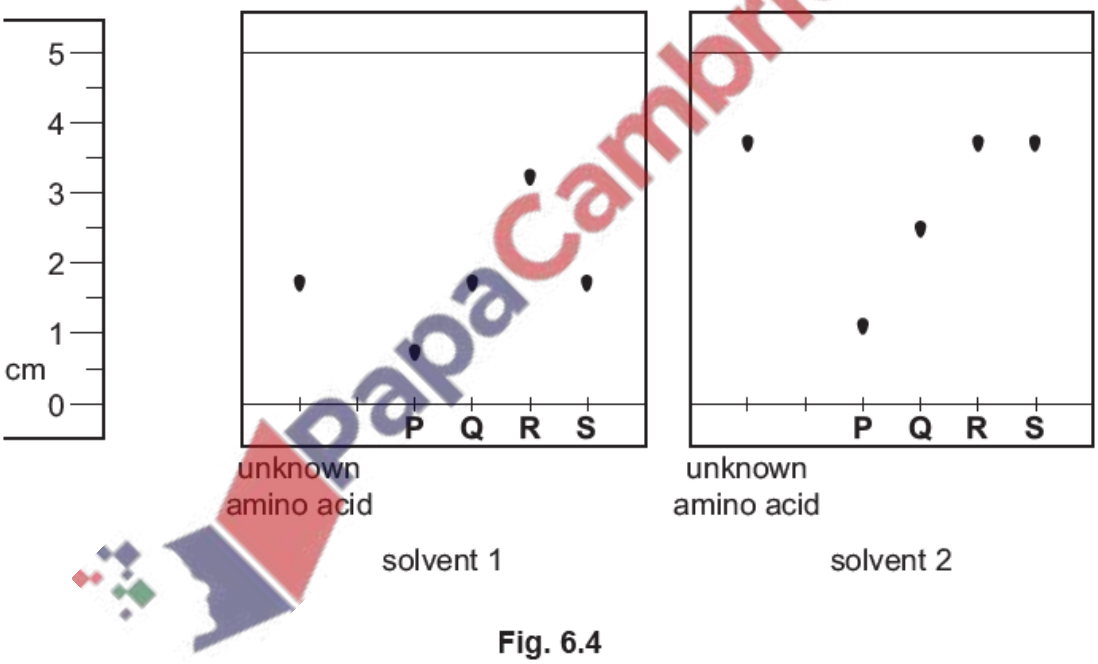


Fig. 6.4

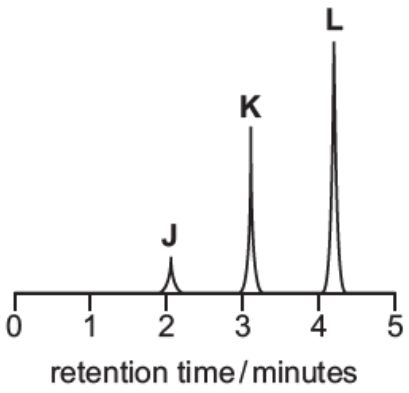
Identify the unknown amino acid. Justify your answer.

.....

.....

..... [1]

(g) A mixture containing three organic compounds is analysed by gas chromatography and mass spectrometry. The gas chromatogram is shown.



peak	J	K	L
area / mm^2	8	44	58

Fig. 6.5

The area underneath each peak is proportional to the mass of the respective compound in the mixture.

The concentration of **K** in the mixture is 5.52×10^{-2} g dm^{-3}.

Calculate the concentration, in mol dm^{-3}, of compound **L** in the mixture.
[M_r: **L**, 116]

concentration of **L** = ... mol dm^{-3} [1]

2. June/2022/Paper_42/No.7

(a) State the uses of TMS and D_2O in NMR spectroscopy.

TMS .....

D_2O .....

[1]

(b) The three isomeric ketones with molecular formula $C_5H_{10}O$ are:

- pentan-2-one
- pentan-3-one
- 3-methylbutanone.

(i) Complete Table 7.1 to show the number of peaks observed in the proton (^1H) NMR spectrum and in the carbon-13 NMR spectrum for each compound listed.

Table 7.1

ketone	number of peaks observed in the proton (^1H) NMR spectrum	number of peaks observed in the carbon-13 NMR spectrum
pentan-2-one		
pentan-3-one		
3-methylbutanone		

[2]

(ii) State **all** the ketones with molecular formula $C_5H_{10}O$ that have:

a doublet in their proton (^1H) NMR spectrum

.....

a singlet in their proton (^1H) NMR spectrum.

.....

[2]

(c) Cortisone, $C_{21}H_{28}O_5$, is a naturally occurring chemical that contains chiral carbon atoms.

cortisone

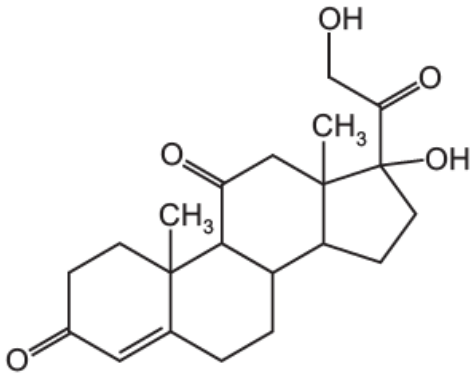


Fig. 7.1

(i) Deduce the number of chiral carbon atoms in one molecule of cortisone.

..... [1]

(ii) Cortisone is reacted with an excess of $NaBH_4$.

State the molecular formula of the organic compound formed.

..... [1]

(iii) Cortisone is an optically active molecule.

Explain what is meant by optically active.

.....

.....

..... [1]

[Total: 8]