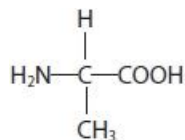


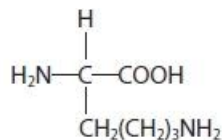
**Questions**

Q1.

Alanine and lysine are amino acids.



alanine



lysine

(a) Draw the structure of a dipeptide formed when one molecule of alanine reacts with one molecule of lysine.

(1)

(b) The dipeptide formed in part (a) is hydrolysed under **acidic** conditions and the resulting mixture is analysed by column chromatography. The column uses a polar stationary phase.

Explain why lysine leaves the chromatography column after alanine.

(2)

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**(Total for question = 3 marks)**

## Q2.

Chromatography is a technique used to separate the components of a mixture.

Gas chromatography can be used both to separate the components in a mixture and to determine the amount of each present.

(i) State why argon and nitrogen are suitable carrier gases for gas chromatography.

(1)

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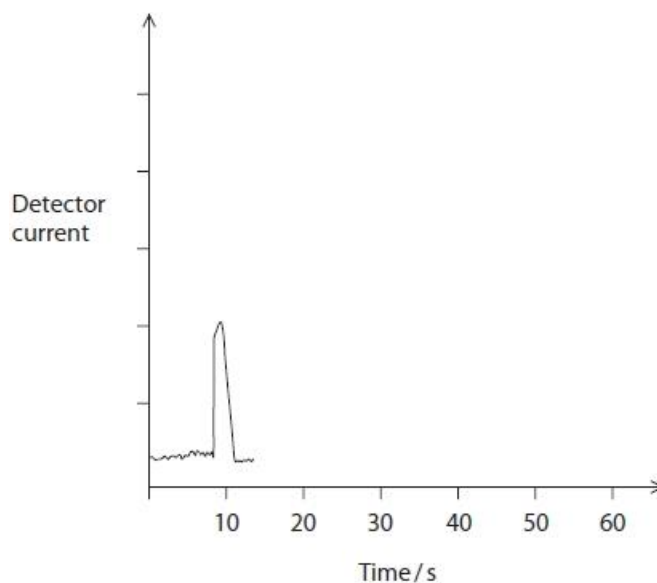
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(ii) A mixture containing one part substance **X**, two parts substance **Y** and one part substance **Z** was separated by gas chromatography.

Substance **X** has a retention time of 10 seconds, substance **Y** of 15 seconds and substance **Z** of 40 seconds.

Complete the sketch of this chromatogram.

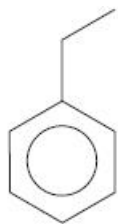
(3)



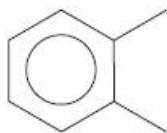
(Total for question = 4 marks)

**Q3.**

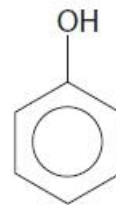
This question is about the arenes, ethylbenzene, xylene, and phenol, which can be identified in wine samples using gas chromatography.



ethylbenzene



xylene



phenol

The time taken for a compound to pass through the column in gas chromatography is called the retention time.

Explain why different compounds will have different retention times in the same column, under the same conditions.

(2)

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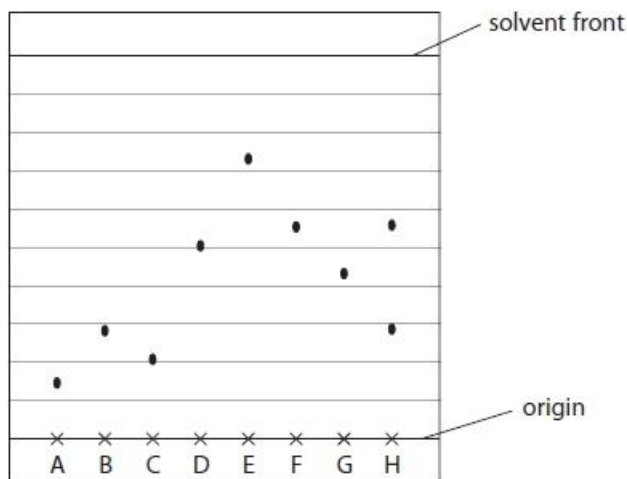
**(Total for question = 2 marks)**

## Q4.

Chromatography is a technique used to separate the components of a mixture.

A sample of a tripeptide was hydrolysed and then placed on a thin layer chromatography (TLC) plate. Samples of possible amino acids present were also placed on the TLC plate for reference.

A simplified diagram of the developed TLC plate is shown.



A – Lysine	B – Serine	C – Histidine	D – Tyrosine
E – Isoleucine	F – Methionine	G – Proline	H – Hydrolysed tripeptide

(i) Calculate the  $R_f$  value for the amino acid lysine.

Give your answer to an appropriate number of significant figures.

(1)

(ii) Identify by **name** the two amino acids present in the tripeptide, giving a reason for the lack of a third spot.

(3)

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(iii) Give **two** reasons why different amino acids have different  $R_f$  values.

(2)

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(iv) In chromatography, a 'locating' reagent is often used when the components in a mixture are colourless.

Which reagent is used to locate the amino acid spots?

(1)

- A** iodine
- B** methyl orange
- C** ninhydrin
- D** phenolphthalein

**(Total for question = 7 marks)**

**Mark Scheme**

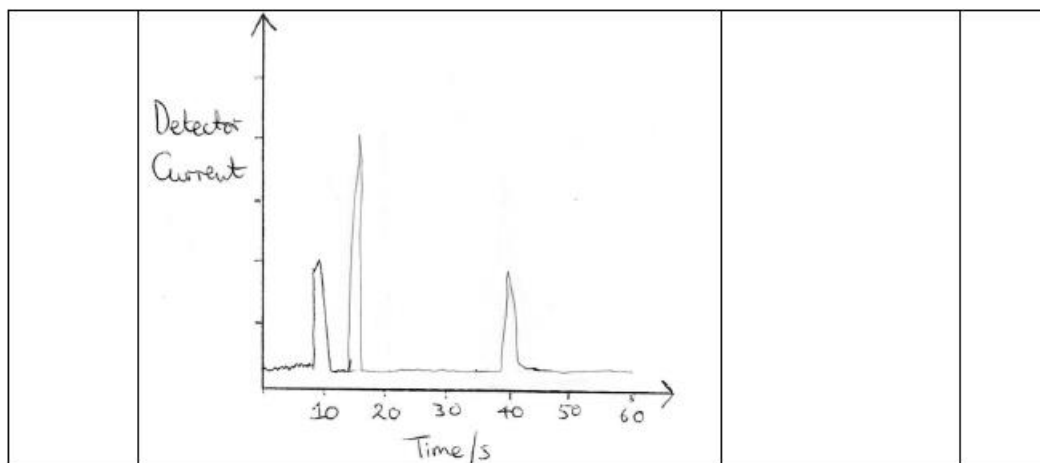
Q1.

Question Number	Acceptable Answers	Additional Guidance	Mark
(a)	<p>Any one of:</p> $\text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{C}(\text{H})(\text{NH}_2)\text{C}(=\text{O})\text{N}(\text{H})\text{C}(\text{H})(\text{CH}_3)\text{COOH}$ <p>OR</p> $\text{H}_3\text{C}-\text{C}(\text{H})(\text{NH}_2)\text{C}(=\text{O})\text{N}(\text{H})\text{C}(\text{H})(\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2)\text{COOH}$ <p>OR</p> $\text{H}_3\text{C}-\text{C}(\text{H})(\text{NH}_2)\text{C}(=\text{O})\text{N}(\text{H})\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{C}(\text{H})(\text{NH}_2)\text{COOH}$	<p>Must be the dipeptide and not the repeat unit</p> <p>Allow <math>-\text{CO}_2\text{H}</math></p> <p>Allow <math>-\text{H}_2\text{N}</math></p> <p>Allow <math>-\text{CONH}-</math> / <math>-\text{COHN}-</math> unless C-H-N</p> <p>Allow zwitterions or cyclic dipeptides</p> <p>Allow skeletal / part-skeletal formulae</p>	(1)
Question Number	Acceptable Answers	Additional Guidance	Mark
(b)	<p>An explanation that makes reference to the following points:</p> <ul style="list-style-type: none"> <li>(In acidic conditions) lysine (ion) has two positive charges (whereas alanine has only one) (1)</li> <li>(So lysine ion has) greater attraction for the stationary phase (1)</li> </ul>	<p>Ignore comments on retention time, solubility, polarity, dipoles or intermolecular forces</p> <p>Allow 'greater positive charge'</p> <p>Allow lysine has 2 <math>\text{NH}_2</math> groups that can be protonated</p> <p>Allow 'greater affinity for stationary phase'</p> <p>'adheres better to stationary phase'</p> <p>'better adsorption onto stationary phase'</p> <p>Allow 'polar phase' for 'stationary phase'</p> <p>Allow reverse argument for alanine</p> <p>Mark points M1 and M2 independently</p>	(2)

Q2.

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	A statement that makes reference to <ul style="list-style-type: none"> <li>gases are inert / do not react (with the components of the mixture)</li> </ul>	Ignore references to intermolecular bonding / stability Do not award for not an oxidising agent	(1)

Question Number	Acceptable Answer	Additional guidance	Mark
(ii)	A sketch that includes <ul style="list-style-type: none"> <li>peak at 15 seconds and 40 seconds (1)</li> <li>(peak at 15 seconds) with height at approximately twice that of the peak at 10 seconds (1)</li> <li>(peak at 40 seconds with) height at approximately the same height as that of the peak at 10 seconds (1)</li> </ul> Exemplar sketch	Penalise additional peaks Max 1 for the differences in height if both peaks are not at correct positions	(3)



Q3.

Question Number	Answer	Additional Guidance	Mark
	<p>An explanation that makes reference to the following points:</p> <p>EITHER</p> <ul style="list-style-type: none"> <li>retention time depends on the polarity or attraction / affinity / solubility / of the component for the stationary phase (1)</li> <li>The greater attraction / affinity / solubility / of the component for the stationary phase the greater the retention time (1)</li> </ul> <p>OR</p> <ul style="list-style-type: none"> <li>retention time depends on the boiling temperature of the compound (1)</li> <li>higher boiling temperature compounds spend less time in the gas phase / mobile phase so have longer retention time (1)</li> </ul>	<p>Allow 'solid phase' or 'liquid phase' for 'stationary phase'</p> <p>Allow 'retention time depends interaction with stationary phase'</p> <p>Ignore attractions to the mobile / gas phase</p> <p>Ignore comments related to mass of compounds</p>	(2)

Q4.

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	<ul style="list-style-type: none"> <li>Answer to 2 SF</li> </ul>	<p>Example of calculation:</p> $R_f = \frac{1.5}{10} = 0.15$ <p>Allow 0.14 – 0.16</p> <p>Do not award 3SF, e.g. 0.140/0.150/0.160 Do not award an answer with units</p>	(1)



Question Number	Acceptable Answer	Additional guidance	Mark
(ii)	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> <li>serine (1)</li> <li>methionine (1)</li> <li>(reason) one amino acid is present twice (in the tripeptide)</li> </ul> <p>OR</p> <p>Another amino acid has the same <math>R_f</math> value as either serine or methionine (1)</p>	<p>Allow for 1 mark out of the first two for F and B</p> <p>Allow 'there are two serine amino acids/ there are two methionine amino acids'</p> <p>Do not award if given with any other amino acid stated in the question</p> <p>Ignore reference to another amino acid not given in the table</p>	(3)

Question Number	Acceptable Answer	Additional guidance	Mark
(iii)	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> <li>amino acids have different solubility / adsorption to the stationary phase (1)</li> <li>amino acids have different solubility in the mobile phase (1)</li> </ul>	<p>Allow reverse arguments</p> <p>Do not award react with the stationary phase</p> <p>Allow "TLC plate" for stationary phase</p> <p>Allow interact with/affinity for/form different intermolecular forces with the stationary or mobile phase</p> <p>Allow "solvent" for mobile phase</p> <p>Ignore references to molecular mass/size</p>	(2)

Question Number	Answer	Mark
(iv)	<p>The only correct answer is C</p> <p><i>A is incorrect because this is a test for starch</i></p> <p><i>B is incorrect because this is a strong acid-weak base indicator</i></p> <p><i>D is incorrect because this is a weak acid-strong base indicator</i></p>	(1)