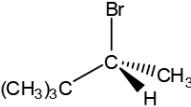
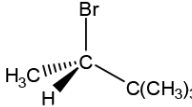
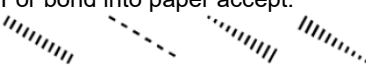
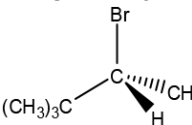
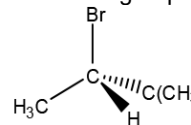
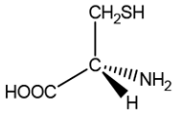
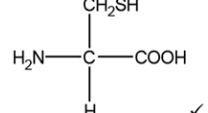
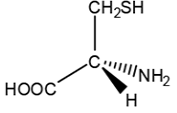
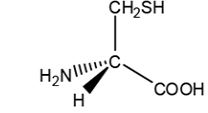
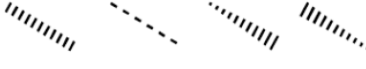
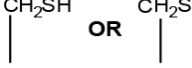

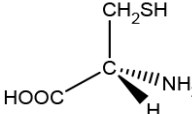
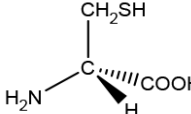
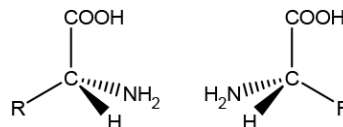


Mark scheme - Amino Acids, Amides and Chirality

Question	Answer/Indicative content	Marks	Guidance
1 i	<p>Stereoisomers</p> <p>Same structural formula AND Different arrangement (of atoms) in space OR different spatial arrangement (of atoms)</p> <p>AND</p> <p>Type: Optical ✓</p>	1 (AO1 .2)	<p>ALLOW structure/displayed/skeletal formula</p> <p>DO NOT ALLOW same empirical formula OR same general formula</p> <p>IGNORE same molecular formula IGNORE references to chiral molecules/compounds</p>
ii	<p>One 3D structure with correct groups attached to the chiral C ✓</p> <p>Two 3D structures of (CH₃)₃CCHBrCH₃ that are mirror images AND correct connectivity in both ✓</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  </div> <div style="text-align: center;">  </div> </div>	2 (AO2 .5) (AO1 .2)	<p>ALLOW small slip in one of the groups OR use of C₄H₉ 3D structures must have four central bonds with at least two wedges.</p> <p>For bond into paper accept:</p>  <p>ALLOW two 3D structures with 2 groups swapped e.g.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  </div> <div style="text-align: center;">  </div> </div>
Total		3	
2 a	<p>Correct groups attached to chiral C of cysteine seen once e.g.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  </div> <div style="text-align: center;"> <p>OR</p>  </div> </div> <p>Two 3D structures of cysteine that are mirror images with correct connectivity in both ✓</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  </div> <div style="text-align: center;">  </div> </div>	2	<p>Each structure must have four central bonds with at least two wedges.</p> <p>For bond into paper accept:</p>  <p>ALLOW bond to any part of the CH₂ of the CH₂SH group e.g. ALLOW</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  </div> <div style="text-align: center;"> <p>OR</p>  </div> </div> <p>ALLOW two 3D structures with 2 groups swapped e.g.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  </div> <div style="text-align: center;">  </div> </div> <p>IF CH₂SH is shown as 'R' ALLOW 1 mark for two 3D structures with correct connectivity that are mirror images e.g.</p>

6.2.2 Amino Acids, Amides and Chirality



Examiner's Comments

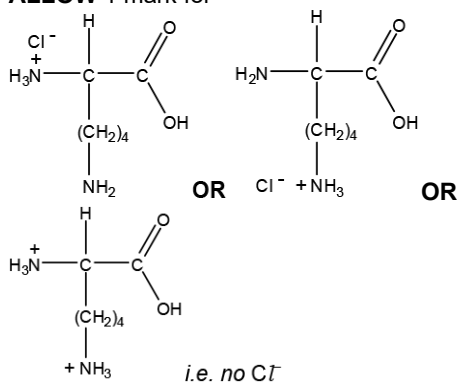
Candidates were well prepared to tackle this question and consequently most candidates scored both marks.

ALLOW any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous

Note: *Cl* is required (*question asks for salt*)

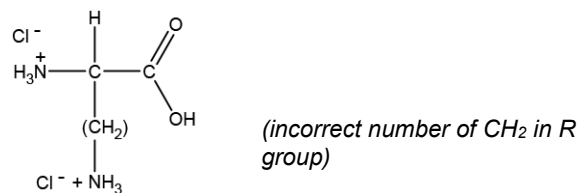
ALLOW NH_3Cl *i.e* charges **not** required

ALLOW 1 mark for

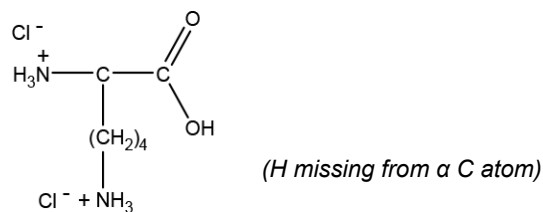


IF there is a small slip in the structure **ALLOW 1 mark** for diammonium salt e.g

2



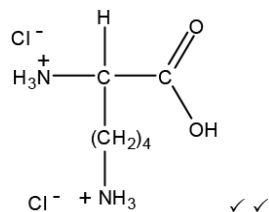
OR



Examiner's Comments

In contrast to part (a) this question proved difficult and discriminated well. The higher ability candidates correctly

Correct salt of lysine with both amine groups protonated

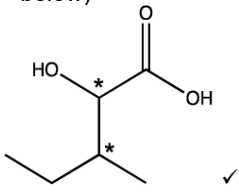


b

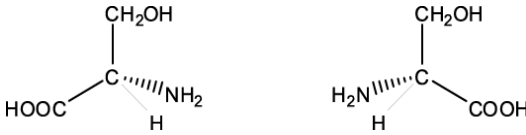
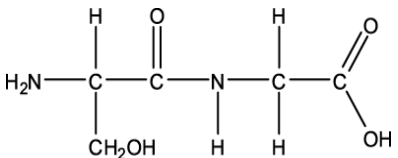
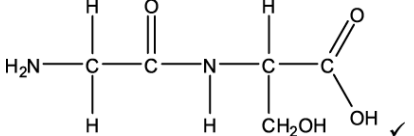
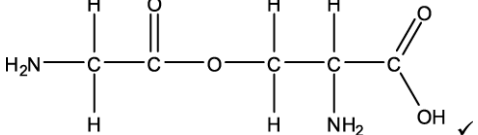
6.2.2 Amino Acids, Amides and Chirality

					identified the dichloride salt produced by the reaction of lysine with excess acid. Some candidates formed ammonium ions on both nitrogen atoms but omitted the chloride ions. Others only formed a monochloride salt, leaving the R group unchanged. These two approaches scored one mark.
			Total	4	
3	i		<p>Final (reading) /cm³ 23.15 45.95 32.45</p> <p>Initial (reading) /cm³ 0.60 23.15 10.00 ✓</p> <p>Burette readings</p> <ul style="list-style-type: none"> Correct titration results recorded with initial and final readings, clearly labeled <p>Titre / cm³ 22.55 22.80 22.45 ✓</p> <p>AND all readings recorded to two decimal places with last figure either 0 or 5</p> <p>Titres</p> <ul style="list-style-type: none"> Correct subtractions to obtain final titres to 2 DP <p>Units</p> <ul style="list-style-type: none"> Units of cm³ for initial, final and titres ✓ <p>Mean titre</p> <ul style="list-style-type: none"> mean titre $= \frac{22.55 + 22.45}{2} = 22.50 \text{ OR } 22.5 \text{ cm}^3 \checkmark$ <p><i>i.e. using concordant (consistent) titres</i></p>	4	<p>Table not required</p> <p>ALLOW initial reading before final reading</p> <p>ALLOW ECF</p> <p>ALLOW units with each value ALLOW brackets for units, i.e. (cm³)</p> <p>ALLOW ECF from incorrect concordant titres</p> <p>Examiner's Comment: This question should have been four straightforward marks, but it was actually found very challenging by candidates. Most read the scales correctly but then did not present their findings clearly, often scattering unlabelled numbers around, omitting units with absence of any heading linking them to the burettes.</p> <p>0.60 was very often shown as 0.6 and 22.80 as 22.8.</p> <p>Candidates were expected to take the mean of their closest titres but a significant number took an average of all three titres instead. The mark scheme allowed for a</p>

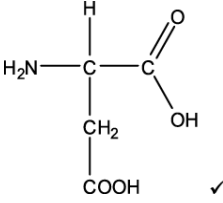
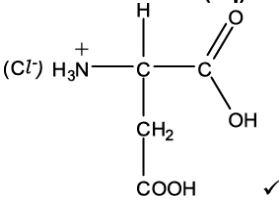
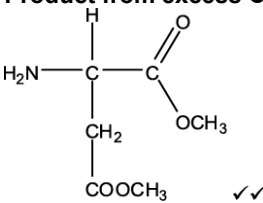
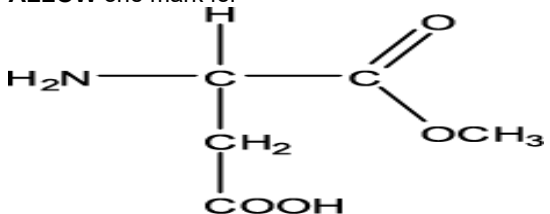
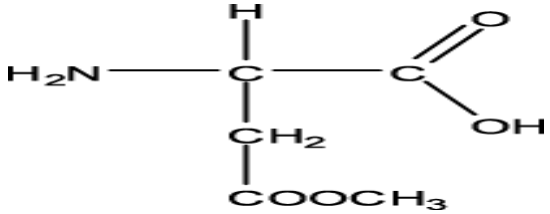
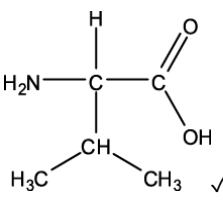
6.2.2 Amino Acids, Amides and Chirality

		<p>mean titre obtained from incorrect titres.</p> <p>Candidates need to appreciate the importance of communicating their results in a clear and comprehensive way with headings and units, and showing numerical values to the accuracy of the apparatus used.</p>
<p>ii</p>	<p>ALLOW 3SF or more throughout IGNORE trailing zeroes, e.g. ALLOW 0.084 for 0.0840</p> <p>.....</p> <p>...</p> $n(\text{NaOH}) = 0.0840 \times \frac{22.50}{1000} = 1.89 \times 10^{-3} \text{ (mol) } \checkmark$ $n(\text{A}) \text{ in } 250 \text{ cm}^3 = 10 \times 1.89 \times 10^{-3} = 1.89 \times 10^{-2} \text{ (mol) } \checkmark$ $M(\text{A}) = \frac{2.495}{1.89 \times 10^{-2}} = 132 \text{ (g mol}^{-1}\text{) } \checkmark$ $M(\text{alkyl group}) (= 132 - 75) = 57 \checkmark$ <p>R = C₄H₉ ✓</p> <p>ALLOW alkyl group in drawn structure with straight chain or branch (es) in wrong position, e.g. for R = C₄H₉, CH₃CH₂CH₂CH₂ OR (CH₃)₃C</p> <p>Structure with chiral carbon atoms identified (see * below)</p> 	<p>ALLOW ECF from incorrect mean titre in 4a(i)</p> <p>e.g. From 22.60 cm³ (mean of all 3 titres in (i), $n(\text{NaOH}) = 1.8984 \times 10^{-3}$ (mol)</p> <p>ALLOW ECF from incorrect $n(\text{NaOH})$</p> <p>ALLOW ECF from incorrect $n(\text{A})$</p> <p>ALLOW ECF from incorrect $M(\text{A}) - 75$</p> <p>ALLOW ECF for alkyl group closest to calculated $M(\text{alkyl group})$, e.g. for $M = 45$, ALLOW C₃H₇ (43)</p> <p>6 ALLOW correct structural OR skeletal OR displayed formula OR mixture of the above as long as non-ambiguous</p> <p>IGNORE poor connectivity to OH groups <i>Given in question</i></p> <p>.....</p> <p>Common error for 4 marks max</p> <p>25.00 instead of 22.50 and scaling by $\times 10$ $2.10 \times 10^{-3} \times \rightarrow 2.10 \times 10^{-2} \checkmark$ $\rightarrow 118.81 \checkmark \rightarrow 43.81 \checkmark \rightarrow \text{C}_3\text{H}_7 \checkmark$</p> <p>25.00 instead of 22.50 and scaling by $\times \frac{250}{22.50}$</p> <p>$2.10 \times 10^{-3} \times \rightarrow 2.33 \times 10^{-2} \checkmark$ $\rightarrow 106.93 \checkmark \rightarrow 31.93 \checkmark \rightarrow \text{C}_2\text{H}_5 \checkmark$</p> <p>No structure with 2 chiral centres possible ✗</p> <p>Examiner's Comment: Most candidates made some headway with this problem. Candidates were expected to process their mean titre from 4(a)(i) in a conventional titration calculation to arrive at a molar mass of 132 g mol⁻¹. From there, candidates could determine a C₄H₉ alkyl group and draw the structure</p>

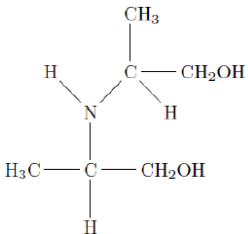
6.2.2 Amino Acids, Amides and Chirality

				<p>of compound A with two chiral carbon atoms.</p> <p>Most candidates scored some marks but processing beyond the molar mass proved to be difficult for weaker candidates. Some candidates showed a structure with a linear C₄H₉ group which contains one chiral carbon atom.</p> <p>A common error was use of 25.0 cm³, instead of the titre, as the volume of NaOH, obtaining an initial value of 2.10 × 10⁻³ mol. The mark scheme allowed processing of this value to be credited using error carried forwards. Some candidates omitted to scale their initial value by a factor of ×10, obtaining a molar mass of over 1000 g mol⁻¹, e.g. 1320 instead of 132. A large range of marks was seen and the question discriminated extremely well.</p>	
		Total	10		
4	a	i	<p>(optical isomers are) non-super imposable mirror images ✓</p> <p>Two 3D structures of serine that are mirror images irrespective of connectivity ✓</p>  <p>Correct connectivity in both structures ✓</p>	3	
		ii	<p>Dipeptide Ser-Gly</p>  <p>Dipeptide Gly-Ser</p>  <p>Esterification of OH on Ser</p> 	3	<p>ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous</p> <p>ALLOW structures in any order</p>
	b	i	<p>Structure of aspartic acid</p>	4	<p>ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous</p>

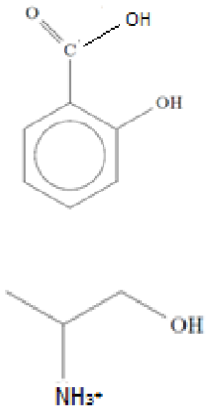
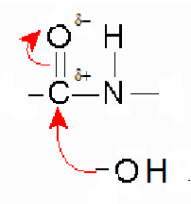
6.2.2 Amino Acids, Amides and Chirality

		 <p>✓</p> <hr/> <p>Product from HC/(aq)</p>  <p>✓</p> <hr/> <p>Product from excess CH3OH/H2SO4</p>  <p>✓✓</p>		<p>Note: the amine group could be shown as either NH₂ or NH₃⁺ (<i>acidic conditions</i>)</p> <p>ALLOW one mark for</p>  <p>OR</p> 														
		<p>Molar mass of G = $\frac{3.51}{0.0300} = 117(.0)$ (g mol⁻¹) ✓</p> <p>ii Structure of G</p>  <p>✓</p>	6	<p>ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous</p> <p>ALLOW R (group of G) is -CH(CH₃)₂ if structure of amino acid is not given</p>														
		Total	12															
5	a	i		<p>¹H NMR spectrum for 2-aminopropan-1-ol</p> <table border="1"> <thead> <tr> <th>Chemical shift, δ/ppm</th> <th>Relative peak area</th> <th>Splitting pattern</th> </tr> </thead> <tbody> <tr> <td>0.8 – 2.0</td> <td>3</td> <td>doublet</td> </tr> <tr> <td>2.3 – 3.0</td> <td>1</td> <td>multiplet</td> </tr> <tr> <td>3.3 – 4.2</td> <td>2</td> <td>doublet</td> </tr> </tbody> </table>	Chemical shift, δ/ppm	Relative peak area	Splitting pattern	0.8 – 2.0	3	doublet	2.3 – 3.0	1	multiplet	3.3 – 4.2	2	doublet	3	<p>One mark for each correct row</p> <p>ALLOW δ values as a range or a value within the specified range.</p> <p>ALLOW δ values +/- 0.2 ppm.</p> <p>ALLOW a response that implies a splitting into two for a doublet etc.</p>
Chemical shift, δ/ppm	Relative peak area	Splitting pattern																
0.8 – 2.0	3	doublet																
2.3 – 3.0	1	multiplet																
3.3 – 4.2	2	doublet																


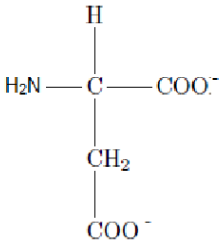
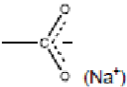
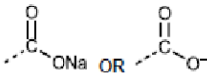
6.2.2 Amino Acids, Amides and Chirality

			✓✓✓		<p>ALLOW sextet/hextet/six (or more than 5) as alternative to multiplet Relative peak area = CH /3H etc. penalise once</p> <p>Examiner's Comments</p> <p>Although it could be argued that this question tested the same skill three times, the full range of marks was awarded and errors were seen in the chemical shift, relative peak area and splitting pattern. Fully correct responses included either a chemical shift value within the range specified on the data sheet or a range that matched the one given on the data sheet.</p>
		ii	<p><u>M⁺ peak at 75 (peak 1)</u> CH₃CH(NH₂)CH₂OH⁺/C₃H₉NO⁺</p> <p>✓</p> <p><u>Fragment peak at 44 (peak 2)</u> CH₃CH(NH₂)⁺/C₂H₆N⁺</p> <p>✓</p>	2	<p>ALLOW correct structural OR displayed OR skeletal formulae OR a combination of above as long as unambiguous</p> <p>Positive charge is essential but ALLOW maximum of one mark if both formulae are correct AND neither species has a positive charge</p> <p>Examiner's Comments</p> <p>Although peak 2 was often correct, the species responsible for the M⁺ peak was often missing a positive charge. Possibly students have learned that the particles become charged as part of the fragmentation process and don't realise that only charged particles can be detected by a mass spectrometer.</p>
	b	i	<p>Ethanolic ammonia OR ammonia/NH₃ AND ethanol ✓</p>	1	<p>ALLOW ammonia in a sealed tube ALLOW dilute ethanolic ammonia/NH₃ IGNORE heat ALLOW alcohol for ethanol DO NOT ALLOW any reference to water or hydroxide ions</p> <p>Examiner's Comments</p> <p>A well answered question. Some candidates forgot to use a solvent or suggested the use of aqueous ammonia.</p>
		ii	<p>(compound D)</p>  <p>✓</p>	1	<p>ALLOW correct structural OR displayed OR skeletal formulae OR a combination of above as long as unambiguous</p> <p>Examiner's Comments</p> <p>This question discriminated well. Although there were very few blank pages, many incorrect structures were seen.</p>

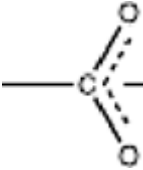
6.2.2 Amino Acids, Amides and Chirality

	c	i	Alcohol AND Amide/peptide ✓	1	<p>IGNORE phenol IGNORE hydroxyl/hydroxy IGNORE attempts to classify alcohol or amide as primary, secondary or tertiary DO NOT ALLOW hydroxide</p> <p>Examiner's Comments</p> <p>Generally well answered but incorrect functional groups included carbonyl and amine.</p>
		ii		2	<p>ALLOW correct structural OR displayed OR skeletal formulae OR a combination of above</p> <p>ALLOW correct structural OR displayed OR skeletal formulae OR combination of above as long as unambiguous</p> <p>ALLOW + on N or H i.e. $^+NH_3$ or NH_3^+ ALLOW $NH_3^+Cl^-$</p> <p>Examiner's Comments</p> <p>Many candidates were able to score one mark for this question but the amine group was often not protonated and it was surprisingly common to see the amine group as NH_2^+.</p>
			Total	10	
6	a		 <p>Curly arrow from OH^- to $C(\delta^+)$ ✓</p> <p>Dipole correct AND curly arrow from $C=O$ bond to $O(\delta^-)$ ✓</p>	2	<p>First curly arrow must come from either a lone pair on O or negative charge on O</p> <p>Examiner's Comments</p> <p>Some candidates lost a mark for the incorrect positioning of the curly arrow from the hydroxide ion. The mark scheme specifies that it should start at either the lone pair on the oxygen atom or the negative charge on the oxygen atom.</p>

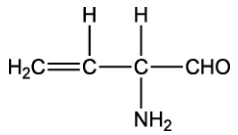
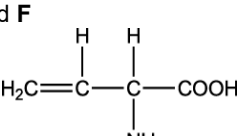
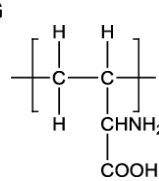
6.2.2 Amino Acids, Amides and Chirality

b	<p>Measure distance moved by spot/distance moved by solvent ✓</p> <p>Compare (R_f) value with data book values/known values ✓</p> <p>Two amino acids have the same/similar R_f value OR similar adsorption OR move the same/similar distance ✓</p>	2	<p>ALLOW attempt at calculation of R_f value using distances measured on the chromatogram IGNORE explanation of how chromatography works</p> <p>ALLOW One spot contains two amino acids ALLOW Two amino acids have not separated IGNORE relative solubility ALLOW two of the amino acids have similar structures</p> <p>Examiner's Comments</p> <p>This question discriminated well with relatively few candidates able to score all three marks. Some candidates attempted to explain how the technique separates components between a mobile phase and a stationary phase which was not required by the question. There was some confusion with gas chromatography and retention times. Vague answers about all amino acids having similar structures did not score the final marking point to explain why only two spots appeared on the chromatogram.</p>
c i	<p>The pH at which the amino acid exists as a <u>zwitterion</u> ✓</p> <p> QWC: zwitterion spelled correctly in the correct context</p>	1	<p>DO NOT ALLOW PH/ph</p> <p>ALLOW zwitter ion</p> <p>Examiner's Comments</p> <p>This definition had been learned by the majority of candidates.</p>
ii		1	<p>ALLOW correct structural OR displayed OR skeletal formulae OR combination of above as long as unambiguous Two COO^- groups are required in the structure ALLOW $-\text{COO}^- \text{Na}^+$ OR $-\text{COONa}$</p>  <p>ALLOW delocalised carboxylate ALLOW</p>  <p>DO NOT ALLOW $-\text{COO}-\text{Na}$ OR $-\text{O}-\text{Na}$ (covalent bond)</p> <p>Examiner's Comments</p> <p>Generally well answered but structures with only one</p>

6.2.2 Amino Acids, Amides and Chirality

					<p>carboxylate group were quite common and some candidates showed aspartic acid being protonated at high pH.</p>
		ii	<p>M1 structure</p> $ \begin{array}{ccccccc} & \text{H} & & \text{O} & & \text{H} & & \text{O} & & \text{H} \\ & & & & & & & & & \\ \text{H}_2\text{N} & - \text{C} & - & \text{C} & - \text{N} & - \text{C} & - & \text{C} & - \text{N} & - \text{C} & - \text{COOH} \\ & & & & & & & & & \\ & \text{H} & & & & \text{H} & & & & \text{H} \\ & & & & & & & & & \\ & \text{C} & & & & \text{C} & & & & \text{C} \\ & & & & & & & & & \\ & \text{H} & & \text{CH}_3 & & \text{H} & & & & \text{CH}_2 \\ & & & & & & & & & \\ & \text{C}_2\text{H}_5 & & & & \text{H} & & & & \text{COOH} \end{array} $ <p style="text-align: right;">✓</p> <p>M2 correct structure has three chiral centres</p> $ \begin{array}{ccccccc} & \text{H} & & \text{O} & & \text{H} & & \text{O} & & \text{H} \\ & & & & & & & & & \\ \text{H}_2\text{N} & - \text{C} & - & \text{C} & - \text{N} & - \text{C} & - & \text{C} & - \text{N} & - \text{C} & - \text{COOH} \\ & & & & & & & & & \\ & \text{H} & & & & \text{H} & & & & \text{H} \\ & & & & & & & & & \\ & \text{C} & & & & \text{C} & & & & \text{C} \\ & & & & & & & & & \\ & \text{H} & & \text{CH}_3 & & \text{H} & & & & \text{CH}_2 \\ & & & & & & & & & \\ & \text{C}_2\text{H}_5 & & & & \text{H} & & & & \text{COOH} \end{array} $ <p style="text-align: right;">✓</p>	<p>ALLOW correct structural OR displayed OR skeletal formulae OR a combination of above as long as unambiguous</p> <p>ALLOW tripeptide with the 3 amino acids in any order</p> <p>ALLOW cyclic tripeptide</p> <p>Isoleucine has two chiral centres, aspartic acid has one chiral centre and glycine has none.</p> <p>ALL three correct for one mark</p> <p>ALLOW chiral centres correctly identified if the three amino acids are part of a polypeptide chain</p> <p>Examiner's Comments</p> <p>A more challenging question with relatively few candidates able to show the position of all three chiral centres on a correct tripeptide structure. Most candidates identified the chiral centres in the amino acid backbone of aspartic acid and isoleucine and realised that glycine was not chiral, but many missed the second chiral centre in isoleucine.</p>	2
		Total	9		
7	a	i	$ \begin{array}{ccc} & \text{H} & \text{H} & & \text{O} \\ & & & & \\ \text{HO} & - \text{C} & - \text{C} & - & \text{C} \\ & & & & \backslash \\ & \text{H} & \text{NH}_2 & & \text{O} \\ & & & & \text{Na} \end{array} $ <p style="text-align: right;">✓</p> $ \begin{array}{ccc} & \text{H} & \text{H} & & \text{O} \\ & & & & \\ \text{HO} & - \text{C} & - \text{C} & - & \text{C} \\ & & & & \backslash \\ & \text{H} & \text{NH}_2 & & \text{O} \\ & & & & \\ & & & & \text{CH}_2 \\ & & & & \backslash \\ & & & & \text{C} \\ & & & & / \\ & & & & \text{C} \\ & & & & \backslash \\ & & & & \text{O} \end{array} $ <p>—NH₃⁺ in second product ✓</p>	<p>ALLOW correct structural OR displayed OR skeletal formulae OR a combination of above as long as unambiguous</p> <p>ALLOW —O[−]Na⁺ OR —O[−] (cation not required)</p> <p>DO NOT ALLOW —O—Na (covalent bond)</p> <p>DO NOT ALLOW —O (without the sodium)</p> <p>ALLOW delocalised carboxylate</p> <div style="text-align: center;">  </div> <p>Examiner's Comments</p> <p>The majority scored two marks here. The question had a three mark total for drawing two structures and this may have prompted some candidates to incorrectly form a salt with the alcohol group in reaction 1. Many were able to draw a correct structure for the ester formed in reaction 2, but very few protonated the amine group in acidic</p>	3

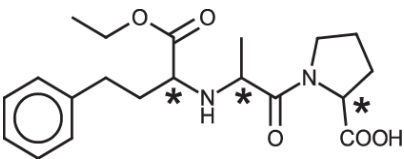

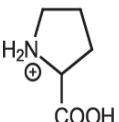
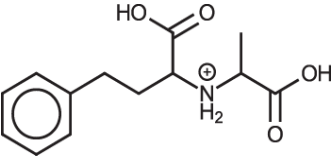


6.2.2 Amino Acids, Amides and Chirality

				conditions. The protonation of hydrolysis products has been well represented in recent papers.
		ii	perfume / fragrance / flavouring ✓	1 IGNORE solvent OR food additive Examiner's Comments Well answered with most of the correct responses referring to perfumes and flavourings which are the uses listed in the specification. Common responses marked as incorrect were suggestions that this ester could be used for making dyes, polymers or textiles.
		ii i	Reaction 3: (hot) ethanolic ammonia ✓ Reaction 4: oxidation ✓ Reaction 5: hydrolysis ✓	3 ALLOW NH ₃ (dissolved) in ethanol IGNORE other conditions ALLOW oxidation / oxidised DO NOT ALLOW redox ALLOW nucleophilic addition-elimination DO NOT ALLOW nucleophilic substitution IGNORE acid / base Examiner's Comments Most candidates were able to score at least one mark here, usually for correctly identifying reaction 4 as an oxidation reaction. Although the use of excess reagent was not required for reaction 3 , some missed ethanol as an essential solvent and reaction 5 was occasionally described as a reduction.
	b		M1 Compound E  M2 Compound F  M3 Compound G 	6 ANNOTATE ANSWER WITH TICKS AND CROSSES ETC ALLOW correct structural OR displayed OR skeletal formulae OR a combination of above as long as unambiguous Labels are not required for compound E, F, G or H IGNORE labels for M1 , M2 , M3 and M4 CH ₂ =CH must be shown in E ALLOW C ₂ H ₃ OR CHCH ₂ for CH=CH ₂ in F ALLOW ECF from error in structure of aldehyde E ALLOW multiple repeat units but must be full repeat units ALLOW end bonds shown as DO NOT ALLOW if structures have no end bonds

6.2.2 Amino Acids, Amides and Chirality

	<p>✓</p> <p>M4 Compound H</p> $\left[\begin{array}{c} \text{H} \quad \text{O} \\ \quad \\ \text{---N---C---C---} \\ \quad \\ \text{H} \quad \text{CH=CH}_2 \end{array} \right]$ <p>✓</p> <p>M5 Compound G OR</p> $\left[\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{---C---C---} \\ \quad \\ \text{H} \quad \text{CHNH}_2 \\ \quad \quad \\ \quad \quad \text{COOH} \end{array} \right]$ <p>Is an addition polymer ✓</p> <p>M6 Compound H OR</p> $\left[\begin{array}{c} \text{H} \quad \text{O} \\ \quad \\ \text{---N---C---C---} \\ \quad \\ \text{H} \quad \text{CH=CH}_2 \end{array} \right]$ <p>is a condensation polymer ✓</p>	<p>IGNORE brackets unless they are used to pick out the repeat unit from a polymer chain</p> <p>IGNORE n</p> <p>ALLOW C₂H₄NO₂ for CH(NH₂)COOH in polymer G</p> <p>ALLOW C₂H₃ OR CHCH₂ for CH=CH₂ in polymer H</p> <p>ALLOW ECF from NH₂CH₂CH=CHCOOH for the formation of compound G or compound H</p> <p>ALLOW alkene forms addition polymer / polymer with same empirical formula as monomer</p> <p>ALLOW equation for reaction</p> $n \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}_2\text{C}=\text{C}-\text{C}-\text{COOH} \\ \\ \text{NH}_2 \end{array} \longrightarrow \left[\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{---C---C---} \\ \quad \\ \text{H} \quad \text{CHNH}_2 \\ \quad \quad \\ \quad \quad \text{COOH} \end{array} \right]$ <p>ALLOW amino acid forms condensation polymer OR (molecules of) compound F join / bond / add / react / form polymer and water / small molecule ALLOW equation for reaction</p> $n \begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}_2\text{C}=\text{C}-\text{C}-\text{COOH} \\ \\ \text{NH}_2 \end{array} \longrightarrow \left[\begin{array}{c} \text{H} \\ \\ \text{---N---C---} \\ \quad \\ \text{H} \quad \text{C} \end{array} \right]$ <p>Examiner's Comments</p> <p>This question discriminated well and many well organised and well-presented answers were seen. Candidates were usually able to identify the aldehyde structure in compound E and those who failed to include a chiral centre in compound E had possibly missed essential information in the stem of the question. However, they could still score marks for the polymer structures by the application of error carried forward. Some candidates correctly identified the four structures but then missed the last two marks for a description of how the polymers are formed. Although labels were not required to score marks for the four structures, the description of the formation of the polymers had to be linked to the correct structure or</p>
--	--	---

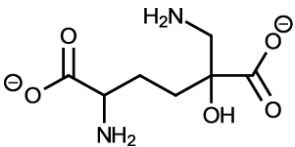
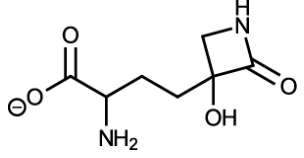
6.2.2 Amino Acids, Amides and Chirality

					the correctly labelled compound and some candidates lost marks here because their description was linked to the wrong polymer.
		Total	13		
8	i		1	<p>ALL correct for one mark</p> <p>Examiner's Comments</p> <p>This part was answered well by many candidates. Some missed the chiral centre on the proline moiety or added an asterisk to a carbonyl carbon.</p>	
	ii	<p>any two from:</p> <p>no / fewer side effects</p> <p>increases the (pharmacological) activity / effectiveness</p> <p>Reduces / stops the need for / cost / difficulty in separating stereoisomers / optical isomers</p> <p style="text-align: right;">✓✓</p>	2	<p>IGNORE toxic / harmful</p> <p>IGNORE a response that implies a reduced dose</p> <p>IGNORE "it takes (less) time to separate"</p> <p>Examiner's Comments</p> <p>Most candidates gained this mark by stating that the use of a single stereoisomer results in fewer side effects and increased pharmacological activity. Vague answers and comments about a reduced dose did not score marks.</p>	
	i	<p>  </p> <p>✓ one mark for ethanol</p> <p>  </p> <p>✓ one mark for proline with NH OR NH₂⁺</p> <p>  </p> <p>  </p> <p>with</p> <p>  </p> <p>or</p> <p>✓ one mark for remaining fragment</p> <p>✓ Fourth mark for structure of both ions shown correctly with NH₂⁺</p>	4	<p>ALLOW correct structural OR displayed OR skeletal formulae</p> <p>OR combination of above as long as unambiguous</p> <p>ALLOW + charge on H of NH₂ groups, <i>i.e.</i> NH₂⁺</p> <p>IGNORE negative (counter) ions</p> <p>Examiner's Comments</p> <p>This question discriminated well. Most candidates were able to score one mark for the formula of ethanol. Only a small number of able candidates scored full marks for including the correct formulae for the protonated amine groups formed during acid hydrolysis.</p>	
	iv	<p>idea of separating (the components / compounds)</p> <p>AND idea of (identifying compounds by) comparison with a (spectral) database</p> <p style="text-align: right;">✓</p>	1	<p>ALLOW (identifies compounds) using fragmentation (patterns) / fragment ions (but IGNORE molecular ions)</p> <p>IGNORE retention times</p> <p>Examiner's Comments</p>	

6.2.2 Amino Acids, Amides and Chirality

					To get the mark for this question candidates had to include points about the separation of the mixture and identification of the compounds. Answers based on identification using retention times or measurement of molar mass did not score the mark.
			Total	8	
9		i		1	Must be skeletal formula
		ii		2	IGNORE charges ALLOW Cs and Hs labelled on structures <i>Marks are for correct connectivity</i>
		ii i	Alanine has a chiral C atom / centre	1	
			Total	4	
1 0	a	i	Atom A: 3 bonding pairs AND 1 lone pair (therefore) pyramidal AND 107° Atom B: 3 bonding centres (and 0 lone pairs) (therefore) trigonal planar AND 120°	4	ALLOW 106–108° ALLOW 4 bonding pairs but with 1 double / π- bond (therefore 3 bonding centres)
		ii	 filter solution recrystallise	3	ALLOW correct structural OR displayed OR skeletal formulae OR a combination of above as long as unambiguous.
	b	i	 for all four	1	
		ii	Left-hand fragment OR structure with COOH rather than COO ⁻ Right-hand fragment	4	ALLOW correct structural OR displayed OR skeletal formulae OR a combination of above as long as unambiguous

6.2.2 Amino Acids, Amides and Chirality

	 <p>OR structure with COOH rather than COO⁻</p> <p>Two OR three COO⁻ shown</p>		<p>ALLOW 1 mark for structure with right-hand ring still intact</p> 
	Total	12	