

Question Number	Acceptable Answers	Reject	Mark
23(a)(i)	Lone pair(s) (of electrons on the nitrogen) ALLOW Non-bonded pair(s)	Spare pair	1

Question Number	Acceptable Answers	Reject	Mark
1(a)(ii)	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2 + \text{H}_2\text{O} \rightleftharpoons$ $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_3^+ + \text{OH}^-$ ALLOW \rightarrow for \rightleftharpoons IGNORE state symbols even if incorrect Right hand ions must be shown separately ALLOW $\text{C}_4\text{H}_9\text{NH}_2$	Reject near misses	1

Question Number	Acceptable Answers	Reject	Mark
21(a)(iii)	<p>two of:</p> <p>Butyl / alkyl groups are electron donating / are electron pushing / are electron releasing</p> <p>Two (alkyl) groups in dibutylamine (but only one in butylamine)</p> <p>Lone pair (of electrons) on the nitrogen more readily available / higher electron density on the nitrogen or NH_2 or amine group / N more delta negative / N or NH_2 accepts a proton more readily (2)</p> <p>Stand alone marks</p> <p>Accept reverse argument for butylamine</p> <p>IGNORE 'electronegativity of nitrogen increasing'</p>		2

Question Number	Acceptable Answers	Reject	Mark
<p>1(a)(iv)</p>	<p>mark</p> <p>For the idea of the lone pair being withdrawn towards the ring</p> <p>Lone pair pulled into the ring</p> <p>Lone pair (of electrons) on the nitrogen overlap</p> <p>Lone pair interacts with π electrons / lone pair interacts with delocalized electrons of the (benzene) ring</p> <p>Lone pair (of electrons) on the nitrogen donated to the (benzene) ring (1)</p> <p>NOTE The reference to the lone pair may be found in a later part of the answer and credited</p> <p>Second mark</p> <p>EITHER</p> <p>For the idea of the lone pair being less available</p> <p>OR</p> <p>The nitrogen (atom) must be specified as below e. Lone pair is less readily available</p> <p>Nitrogen (atom) has lower electron density</p> <p>N (atom) or lone pair is less able to accept protons / H^+ (1)</p> <p>ALLOW N is less δ^- for second mark</p>		<p>2</p>

Question Number	Acceptable Answers	Mark
1(b)	<p>I $(\text{Cu}(\text{H}_2\text{O})_6)^{2+} + 2\text{C}_4\text{H}_9\text{NH}_2 \rightarrow \text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2 + 2\text{C}_4\text{H}_9\text{NH}_3^+$</p> <p>ALLOW</p> <p>I $(\text{Cu}(\text{H}_2\text{O})_6)^{2+} + 2\text{C}_4\text{H}_9\text{NH}_2 \rightarrow \text{Cu}(\text{OH})_2 + 2\text{C}_4\text{H}_9\text{NH}_3^+ + 4\text{H}_2\text{O}$ (2)</p> <p>II $(\text{Cu}(\text{H}_2\text{O})_6)^{2+} + 4\text{C}_4\text{H}_9\text{NH}_2 \rightarrow \text{Cu}(\text{H}_2\text{O})_2(\text{C}_4\text{H}_9\text{NH}_2)_4^{2+} + 4\text{H}_2\text{O}$</p> <p>ALLOW</p> <p>II $(\text{Cu}(\text{H}_2\text{O})_6)^{2+} + 4\text{C}_4\text{H}_9\text{NH}_2 \rightarrow \text{Cu}(\text{C}_4\text{H}_9\text{NH}_2)_4^{2+} + 6\text{H}_2\text{O}$ (2)</p> <p>Each correct equation scores 2 marks: 1 mark for the formula of the copper complex ion and 1 mark for the rest of the equation being correct Ligands can be in either order</p> <p>IGNORE state symbols even if incorrect</p> <p>IGNORE (lack of) square brackets around complex ions</p>	4

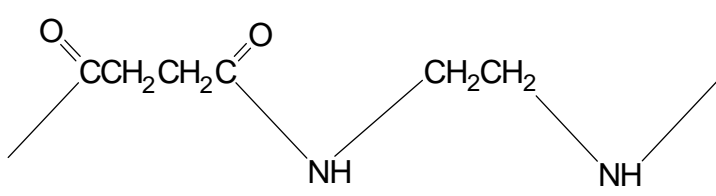
Question Number	Acceptable Answers	Reject	Mark
1(c)	<p>Reaction is a nucleophilic substitution (1)</p> <p>It is unusual because benzene normally reacts with electrophiles / by electrophilic substitution</p> <p>OR</p> <p>Positive charge withdraws electrons from the ring (making it susceptible to nucleophilic attack)</p> <p>OR</p> <p>Expect nucleophiles to be repelled by the electron density of the ring (1)</p>		2

Question Number	Acceptable Answers	Reject	Mark
2(a)	$\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2 + 2\text{HCl} \rightarrow \text{H}_3\text{N}^+\text{CH}_2\text{CH}_2\text{NH}_3^+ + 2\text{Cl}^-$ <p style="text-align: center;">(1) organic product</p> <p>Positive charges can be on nitrogens</p> <p>Balancing with HCl and Cl⁻ (1)</p> <p>Chloride ions can be at ends of product ie $\text{ClH}_3\text{NCH}_2\text{CH}_2\text{NH}_3\text{Cl}$ for right hand side, with or without charges, but if given charges must balance</p> $\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2 + 2\text{H}^+ \rightarrow \text{H}_3\text{N}^+\text{CH}_2\text{CH}_2\text{NH}_3^+$ (2) <p>Reaction with 1 mol HCl for 1 max</p> <p>If molecular formulae used 1 max</p> <p>IGNORE state symbols even if wrong</p>	Covalent bond to Cl, (-Cl)	2

Question Number	Acceptable Answers	Reject	Mark
2(b)(i)	<p>Blue or green or blue-green or lavender</p> <p>ALLOW qualification of blue or green e.g. dark blue, but not with another colour e.g. blue purple</p>	Any other colour e.g. Purple Violet	1

Question Number	Acceptable Answers	Reject	Mark
2(b)(ii)	<p>The entropy change of the system is positive (1)</p> <p>Because there is an increase in the number of particles/entities/moles/molecules</p> <p>OR</p> <p>The number of particles/entities/moles goes from four to seven</p> <p>OR</p> <p>Complex with three molecules goes to a complex with six molecules (1)</p> <p>Second mark depends on a positive entropy change</p>	<p>Additional incorrect numbers</p> <p>molecules/atoms from four to seven</p>	2

Question Number	Acceptable Answers	Reject	Mark
2(b)(iii)	They will rotate the plane of plane- polarised light (equally in opposite directions) Allow They will rotate the plane of polarised light (equally in opposite directions) OR They will rotate plane- polarised light (equally in opposite directions)	Optically active Reflect/ bend/ refract	1

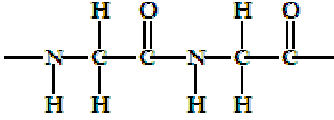
Question Number	Acceptable Answers	Reject	Mark
2(c)(i)	 <p>Amide linkage correct (1)</p> <p>Further detail correct, including trailing bonds (1)</p> <p>IGNORE brackets ALLOW multiple units</p> <p>Second mark dependent on correct amide link</p> <p>ALLOW fully correct structural formulae for 1 {OCCH₂CH₂CONHCH₂CH₂NH}</p> <p>Can start with NH group</p>		2

Question Number	Acceptable Answers	Reject	Mark
2(c)(ii)	Condensation (1) Hydrogen chloride/HCl/water/H ₂ O or another small molecule/is produced/lost/formed/removed (as well as the polymer) (1) Mark independently	Addition/elimination	2

Question Number	Acceptable Answers	Reject	Mark
* 2(c) (iii)	<p>Types of force Hydrogen bonds</p> <p>and (permanent) dipole(-permanent dipole) forces</p> <p>and London/van der Waals'/dispersion forces OR Explanation e.g temporary/induced dipoles (1)</p> <p>All three needed for 1st mark (which is given even if the forces are later explained incorrectly)</p> <p>Hydrogen bonds (Between) the hydrogen atoms on the nitrogen atoms and ... OR (Between) N-H and ... (1)</p> <p>... (the lone pair of electrons on) oxygen/nitrogen atoms (1)</p> <p>These marks can be shown by a diagram</p> <p>Permanent dipole-permanent dipole forces Because the C=O / carbon-oxygen bond/the C-N bond is polar/a dipole OR N and/or O are electronegative atoms</p> <p>This mark can be shown by a diagram providing the polarity of the bond is shown (1)</p> <p>London forces Polymer has large number of/many electrons OR Explanation e.g temporary/induced/fluctuating dipoles (1)</p>	<p>Just p.d.- p.d</p> <p>Just v d W</p> <p>Large molecular mass alone</p>	5

Question Number	Acceptable Answers	Reject	Mark
3(a)(i)	<p>Formula showing -NH_3^+ and -COO^- /-CO_2^-</p> <p>Charges can be anywhere on functional group</p> <p>Rest of the molecule must be correct</p> <p>ALLOW displayed/part displayed formula</p>		1

Question Number	Acceptable Answers	Reject	Mark
3(a)(ii)	<p>Any two from</p> <p>High energy needed (to overcome) (1)</p> <p>strong ionic/electrostatic forces OR strong forces between oppositely charged ions/between positive and negative (1)</p> <p>between different (zwitter)ions</p> <p>OR</p> <p>between -NH_3^+ and -COO^-</p> <p>OR</p> <p>between one molecule and another</p> <p>OR</p> <p>Chains of zwitterions/molecules (1)</p>	<p>any reference to intermolecular forces eg (strongly) polar/bond polarity</p> <p>if they state the ionic bond is within the same molecule</p>	2

Question Number	Acceptable Answers	Reject	Mark
3(a)(iii)	<div style="text-align: center;">  </div> <p>Correct peptide link (1)</p> <p>Minimum two residues and extension to the rest of the molecule (1)</p> <p>ALLOW -NHCH₂CONHCH₂CO- (2)</p> <p>Drawn the other way round, i.e. starting with the carbonyl group</p> <p>Brackets around outside with 'n' ie {.....}n</p> <p>Second mark depends on first</p>		2

Question Number	Acceptable Answer	Reject	Mark
<p>*3(b) QWC</p>	<p>Key Points</p> <p>KP1 Spot (of hydrolysate) on paper/tlc/thin layer chromatogram (1)</p> <p>KP2 Marker spots of known amino-acids/measure R_f (1)</p> <p>KP3 Run in (suitable) solvent/discussion of comparative solubilities in phases (1)</p> <p>KP4 (Spray with) ninhydrin (and heat) [Stand alone mark] (1)</p> <p>KP 5 Marker spots and the unknown spots correspond ALLOW Compare R_f values of marker spots with hydrolysate spots (1)</p> <p>OR</p> <p>If 2-d chromatography used (2 different solvents run in two directions at right angles):</p> <p>KP1 Spot (of hydrolysate) on paper/tlc/thin layer chromatogram (1)</p> <p>KP2 Run in (suitable) solvent in one direction (1)</p> <p>KP3 Develop in suitable/different solvent at right angles OR discussion of comparative solubilities in phases (1)</p> <p>KP4 Spray with ninhydrin (and heat) (1)</p> <p>KP5 Compare hydrolysate spots with same experiment for known amino acids (1)</p> <p>OR</p>	<p>Spot one amino acid/protein</p> <p>Water alone as solvent</p> <p>Spot one amino acid</p>	<p>5</p>

	<p>if column/GLC/GC used</p> <p>KP1 Put amino acid mixture (Hydrolysate) into column (1)</p> <p>KP2 Separately known amino-acids into column (1)</p> <p>KP3 Detect amino acids in effluent with Ninhydrin/mass spectrometry (1)</p> <p>KP4 Measure retention times/discussion of comparative solubilities in phases (1)</p> <p>KP 5 Compare retention times (1)</p>	Spot one amino acid	
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