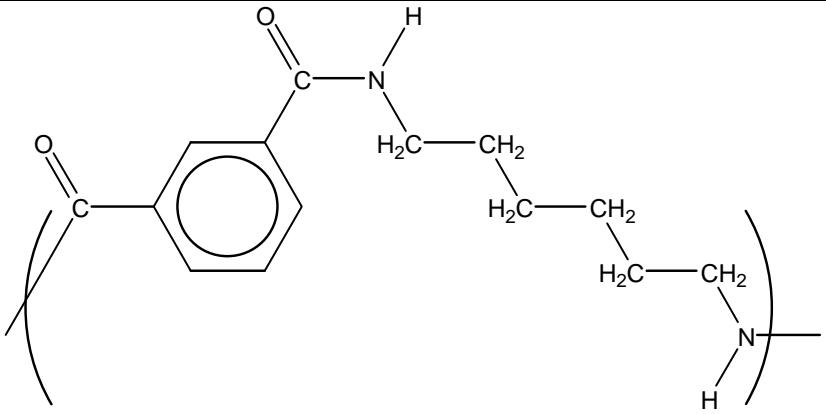
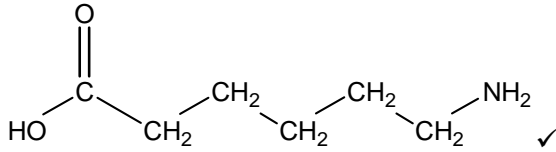
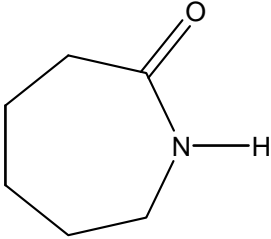
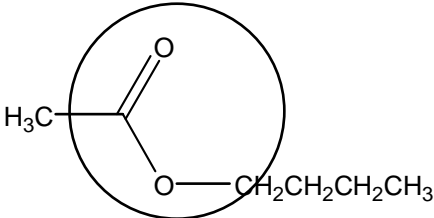


Question			Answer	Marks	Guidance
1	(a)	(i)	 <p>all correct 2 marks ✓✓ amide link only ✓</p>	2	<p>ALLOW</p> <ul style="list-style-type: none"> any correct structural formula including skeletal mixtures of structural and skeletal -CONH- Cs and Hs on ring <p>IGNORE brackets and n etc</p>
		(ii)	-CONH- circled ✓	1	ALLOW adjacent C atoms in circle
		(iii)	1,6-diamino ✓ hexane ✓ OR hexane ✓ -1,6-diamine ✓	2	<p>If butane ALLOW 1,4-diamino for ecf mark</p> <p>IGNORE commas and dashes</p> <p>ALLOW 1,6-hexanediamine</p>
	(b)	(i)	 <p>✓</p>	1	<p>ALLOW any formula that makes structure clear</p> <p>ALLOW cyclic amide</p> 

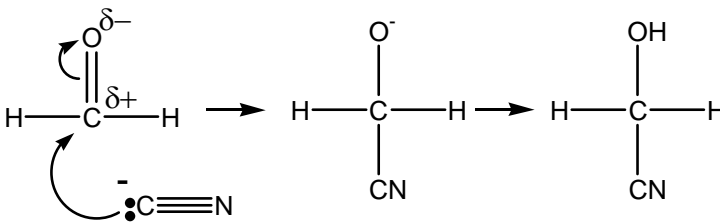
Question			Answer	Marks	Guidance
		(ii)	condensation AND water is eliminated/formed/lost ✓ IF cyclic amide in 1b(i) THEN addition AND hydrolysis (of ring) / water added	1	'addition' or 'addition polymerisation' is a CON ALLOW 'small molecule' instead of water any other named small molecule is a CON
	(c)	(i)	(polymer) <u>chains/molecules</u> are (highly) ordered/aligned AW ✓	1	ALLOW labelled diagram that shows alignment of chains by using parallel lines AW means other suitable phrases eg 'stacked closely and neatly' 'arranged regularly'/'regularity of chains'
		(ii)	PPA chains are closer together ORA ✓ so intermolecular bonds in PPA will be stronger OR more hydrogen bonds in PPA OR more intermolecular bonds in PPA ORA ✓ more energy/heat will be required to break the intermolecular bonds OR melt the polymer OR allow chains to move over each other ORA ✓	3	AS ALWAYS intermolecular bonds is synonymous with intermolecular forces NOT more areas of contact NOT just compacted together NOT just closely packed NOTE ALL 3 marking points are comparative ALLOW any named intermolecular bond NOT 'higher temperature' for 'energy'
		(iii)	cold-drawing ✓	1	NOT co-polymerising IGNORE 'necking'

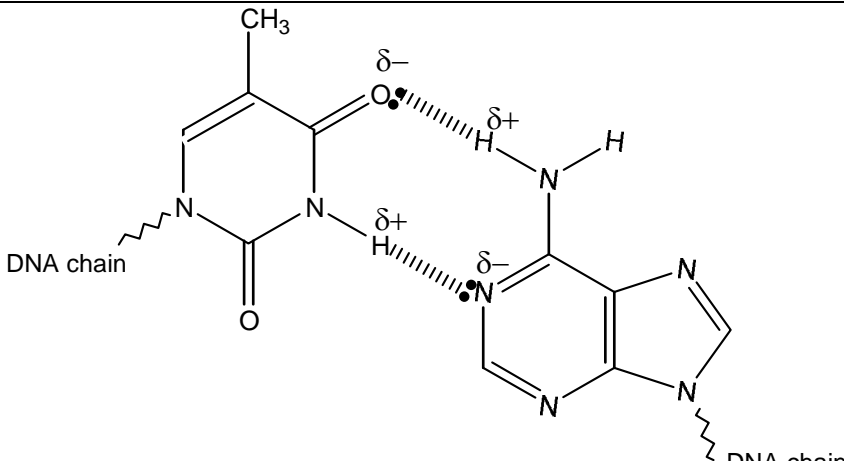
Question			Answer	Marks	Guidance
	(d)	(i)	1. elimination ✓ 2. addition ✓ 3. addition ✓	3	IGNORE 'nucleophilic'
		(ii)	can be used in step 3 AW ✓	1	NOT step 2 ALLOW <ul style="list-style-type: none"> • can be sold • can be used as a source of energy • can be recycled
	(e)		acidified dichromate ✓	1	IGNORE <ul style="list-style-type: none"> • metal cation • name of acid • wrong formulae if name given • oxidation state of 'dichromate' ALLOW $\text{H}_2\text{SO}_4/\text{H}^+$ and $\text{Cr}_2\text{O}_7^{2-}$ DO NOT ALLOW just dichromate
			Total	17	

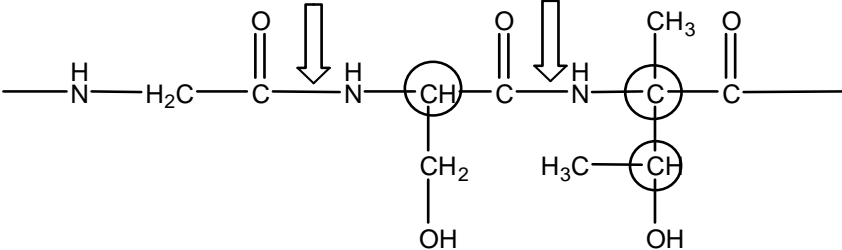
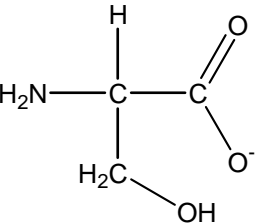
Question			Answer	Marks	Guidance
2	(a)		–COOH / carboxyl / carboxylic acid group ✓ is a proton/H ⁺ donor / loses H ⁺ ✓	2	correct equation showing dissociation gains both marks ALLOW 'gives H ⁺ ' <i>Mark separately</i>
	(b)	(i)	CH ₂ OHCOOH + NaOH → CH ₂ OHCOONa + H ₂ O ✓	1	ALLOW CH ₂ OHCOO [–] Na ⁺ , Na ⁺ CH ₂ OHCOO [–] OR Na(CH ₂ OHCOO) IGNORE state symbols NOT CH ₂ OHNaCOO
		(ii)	<div>1. moles of NaOH used in titration = 16.00/1000 x 0.250 ✓ = 0.00400</div> <div>2. moles of glycolic acid used in titration = answer from 1, <i>scaled by ratio in equation in 2bi</i> ✓ 0.00400 CHECK equation in 2(b)(i)</div> <div> 3A. moles of glycolic acid in 250 cm³ = (answer from 2) x 10 ✓ = 0.0400 mol OR 3B. mass of glycolic in 25 cm³ = (answer from 2) x <i>M_r</i> of glycolic acid ✓ 0.304 g OR 3C. concentration of glycolic acid = (answer from 2) x 1000/25 ✓ 0.16 mol dm^{–3} </div> <div>4. <i>M_r</i> of glycolic acid = 76.(0) ✓</div>	6	<p><i>There are several possible routes through this question after point 2, the 'mole route' A, the 'mass route' B and the 'concentration route' C</i></p> <p>If final answer is incorrect please annotate with ticks where the marks are awarded</p> <p>2. ALLOW by implication if 0.004 used subsequently</p> <p>The marks are awarded for the working out given in bold OR the correctly calculated answer to that working (but no mark if calculated answer is shown and is wrong)</p> <p>4. Award if 76 used correctly anywhere</p>

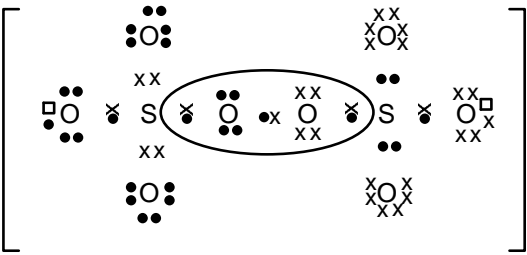
Question			Answer	Marks	Guidance
			5A. moles of glycolic acid in 100 cm ³ = (answer from 3A) x 100/14 ✓ 0.286 mol OR 5Bi. mass of glycolic acid in 250 cm ³ = (answer from 3A) x <i>M_r</i> of glycolic acid ✓ 3.04 g OR 5Bii. mass of glycolic in 250 cm ³ = (answer from 3B) x 10 = ✓ 3.04 g OR 5C. concentration of undiluted glycolic acid = (answer from 3C) x 250/14 ✓ 2.86 mol dm ⁻³		ALLOW ecf for incorrect equation AND between each step ALLOW 'Acnegone' for 'glycolic acid' ALLOW answers in standard form <i>The following on the answer line with correct corresponding comment, score as follows, irrespective of working or lack of it:</i> 21.7 scores 6 1.22 scores 5 (error in 5C) 12.2 scores 5 (error in 6C) 2.17 scores 5 (error in 3A or 5Bii) 3.04 scores 5 (error in 6) <i>these to other sf OR with incorrect comment score one mark less</i> If one of the answers above applies place correct number of ticks by answer
			6. mass of glycolic acid in 100 cm ³ undiluted = (answer from 5A) x <i>M_r</i> of glycolic acid OR = (answer from 5B) x 100/14 OR = (answer from 5C /10) x <i>M_r</i> of glycolic acid = 21.7 (3 sf) AND correct comment ✓		
	(c)	(i)	 butyl ethanoate ✓ ester link correct ✓	2	IGNORE where the circle cuts the bond as long COO is included ALLOW adjacent C atoms in circle ALLOW butylethanoate without gap
		(ii)	butan-1-ol ✓ <u>concentrated</u> sulfuric acid/hydrochloric acid ✓	2	MUST HAVE number 1 DO NOT ALLOW ecf for alcohol in 2(c)(i) ALLOW formula for acid ONLY IGNORE spelling of name for H ₂ SO ₄ as long as it is clear

Question			Answer	Marks	Guidance
		(iii)	<p>ethanoic acid: hydrogen bonding ✓ IGNORE pd-pd</p> <p>compound D: pd-pd ✓ hydrogen bonding is CON</p> <p>instantaneous dipole – induced dipole / id-id in both ✓</p>	3	<p>ALLOW 'pd-pd' / id-id abbreviations here</p> <p>ALLOW Van der Waals for id-id</p>
	(d)	(i)	<p><i>The answer requires a comment for a carboxylic acid AND an alcohol so award ONE mark from each section below:</i></p> <p>CARBOXYLIC ACID (strong) peak at 1743 (cm^{-1}) shows C=O in ester not acid OR no peak 1700 – 1725 (cm^{-1}) shows no C=O in acid OR no <u>broad</u> peak at 2500 – 3200 (cm^{-1}) shows no O–H in acid ✓</p> <p>ALCOHOL no peak greater than 3000 / in range 3200 – 3600 (allow 3640) so no O–H in alcohol ✓</p>	2	<p>answers may be given on spectrum</p> <p>to score each point, range, bond and group in which it is found must be given</p> <p>ALLOW carboxyl or carboxylic acid or COOH or ethanoic acid (or formula) for 'acid'</p> <p>FOR O–H ALLOW OH / hydroxyl FOR C=O ALLOW carbonyl NOT CO</p>
		(ii)	<p>peak at m/z 73: $\text{CH}_3\text{COOCH}_2$ / $\text{C}_3\text{H}_5\text{O}_2$ ✓ positive charge on any formula ✓</p> <p>species lost: $\text{CH}_2\text{CH}_2\text{CH}_3$ / C_3H_7 (NO charge) ✓</p>	3	<p>ALLOW any correct structural or molecular formula for both answers</p> <p>ALLOW $\text{C}_4\text{H}_9\text{O}^+$</p> <p>IF $\text{C}_4\text{H}_9\text{O}^+$ given above THEN species lost must be $\text{C}_2\text{H}_3\text{O}$ / CH_3CO</p>
	(e)	(i)	nucleophilic ✓ addition ✓	2	

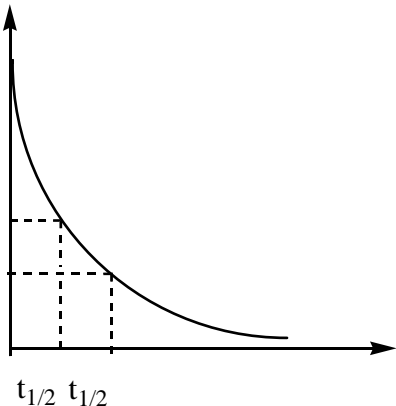
Question			Answer	Marks	Guidance
		(ii)	<p style="text-align: center;">H^+ or H_2O or HCN</p>  <p> HCHO with bond polarity correct ✓ CN^- with lone pair of electrons on C ✓ both curly arrows correct (lower one must be from C of CN) ✓ intermediate ion correct ✓ gain of H^+ from water, HCN or direct to form the cyanohydrin ✓ </p>	5	<p>ALLOW CN^- without triple bond</p> <p>ALLOW -ve charge on N of CN^-</p> <p>IGNORE any arrow used to add H^+ etc to the intermediate</p>
			Total	28	

Question			Answer	Marks	Guidance
3	(a)	(i)	repeating unit in DNA is a nucleotide ✓ formed from pentose/ sugar /deoxyribose, phosphate and a base AW ✓	2	<i>mark separately</i> ALLOW <ul style="list-style-type: none"> names for the four bases (T,A,C,G) instead of 'bases' a named example of a base IGNORE ribose for two marks it must be clear that the sugar etc makes up the nucleotide
		(ii)	proteins are formed from amino acid(s) ✓	1	
		(iii)	proteins have more amino acids than the bases/nucleotides in DNA ✓ from which to construct many unique/different/more structures/arrangements/combinations to carry genetic data AW ✓	2	ALLOW actual numbers eg there are 20/21 amino acids in proteins and only 4 bases/nucleotides in DNA
	(b)		 <p>correct formula completed for adenine AND both H bonds between correct atoms ✓ correct polarities for one hydrogen bond ✓ lone pair for one hydrogen bond ✓</p>	3	

Question		Answer	Marks	Guidance
(c)	(i)	 <p>ANY TWO of the THREE CORRECT chiral Cs ONLY ✓</p>	1	
	(ii)	arrows as in (d) (i) ✓	1	IGNORE extra arrows pointing to C–N bonds at ends of chain. Any other arrows are a CON
	(iii)	 <p>correct amino acid (see opposite) ✓</p> <p>correct formula of ion ✓</p>	2	IGNORE any cations ALLOW any correct structural formula IGNORE species formed from amino acids to right and left IGNORE <ul style="list-style-type: none"> added H⁺ to –NH₂ negative charge on alcohol i.e. –O[–] –COOH instead NO ecf IF anion formed at CH ₂ O [–] then 1 mark max for amino acid
	(iv)	<p>secondary: folding/twisting of polypeptide/amino acid chains/primary structure ✓</p> <p>tertiary: further/final folding OR 3D shape/structure ✓</p>	2	<p>ALLOW (alpha)-helix/coiled OR (beta)-sheets / pleated sheets</p> <p>ALLOW overall/global structure</p>
Total			14	

Question			Answer	Marks	Guidance
4	(a)	(i)	 <p>correct inside oval (around peroxy Os) ✓ rest correct ✓</p>	2	<p>ALLOW another symbol for S electrons</p> <p>second mark depends on first</p>
		(ii)	$(\text{NH}_4)_2 \text{S}_2\text{O}_8$ ✓	1	<p>ALLOW</p> <ul style="list-style-type: none"> with correct charges $\text{S}_2\text{O}_8(\text{NH}_4)_2$
	(b)		<p>$\text{S}_2\text{O}_8^{2-}$ (is the stronger oxidising agent) because $\text{S}_2\text{O}_8^{2-}$ has a more positive E^\ominus value ✓ indicates a greater tendency AW to gain/attract/accept electrons/to be reduced ✓</p> <p>ORA ie: $\text{S}_2\text{O}_8^{2-}$ (is the stronger oxidising agent) because $\text{Cr}_2\text{O}_7^{2-}$ has a less positive / more negative E^\ominus value ✓ indicates a smaller tendency AW to gain/attract/accept electrons/to be reduced OR indicates a greater tendency AW to lose electrons/to be oxidised ✓</p>	2	<p>without reference to oxidising strength of $\text{S}_2\text{O}_8^{2-}$ only scores 1 as it doesn't answer the question</p> <p>NOT 'higher' for 'more positive' both statements MUST BE comparative</p>
	(c)	(i)	<p>$\text{S}_2\text{O}_8^{2-} + 2\text{I}^- \rightarrow 2\text{SO}_4^{2-} + \text{I}_2$ correct equation balanced ✓</p>	1	IGNORE state symbols

Question			Answer	Marks	Guidance
		(ii)	<p>1. use filter of complementary colour to iodine/solution ✓</p> <p>2. zero colorimeter with water ✓</p> <p>3. measure absorbance readings of standard solutions/solutions of known concentration (of iodine) ✓</p> <p>4. plot calibration graph ✓</p> <p>5. take absorbance readings of the reacting mixture at known/certain times AW (must refer to time – may state units of time) ✓</p> <p>6. convert absorbance readings to iodine concentrations using the calibration curve ✓</p> <p>QWC: In order to gain the mark for point 3, 5 or 6, absorbance must be used AND spelled correctly at least once</p>	6	<p>Using starch ANYWHERE is a CON and CANNOT gain marking point 3</p> <p>ALLOW</p> <ul style="list-style-type: none"> filter/wavelength giving maximum absorption/absorbance green/blue filter suitable filter <p>orange/yellow/brown is CON</p> <p>NOT 'solvent' instead of 'water'</p> <p>IGNORE references to quenching procedures</p>

Question	Answer	Marks	Guidance
(iii)	 <p>suitable graph sketched ✓</p> <p>construction lines to determine half-lives from graph ✓</p> <p>constant half-life (means first order) ✓</p>	3	<p>graph should show a curve (NOT straight line) decreasing from left to right (ANY decreasing curve will do)</p> <p>at least two sets of construction lines should be shown on graph</p> <p>dependent on showing half-lives on graph (numbers on scale <i>or</i> by labelling with $t_{1/2}$)</p>
(d) (i)	homogeneous, reactants and catalyst/ Fe^{3+} are in the same phase / state ✓	1	<p>MUST mention 'reactants and catalyst'</p> <p>IGNORE 'redox'</p> <p>NOT 'substrate'</p> <p>ALLOW 'all in solution' for 'same phase'</p>
(ii)	<p>Fe^{2+} $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6$</p> <p>$\text{Fe}^{3+}$ $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$</p> <p>correct number of EXTRA electrons added</p> <p>14(Fe^{2+}) and 13(Fe^{3+}) ✓</p> <p>both fully correct ✓</p>	2	IGNORE $4s^0$

Question		Answer	Marks	Guidance
	(iii)	<p>1. Fe^{3+} reacts with/oxidises I^- ORA ✓</p> $2\text{Fe}^{3+} + 2\text{I}^- \rightarrow 2\text{Fe}^{2+} + \text{I}_2 \quad \checkmark$ <p><i>explanation:</i> the E° of $\text{Fe}^{3+}/\text{Fe}^{2+}$ half-cell is more positive / less negative than that of the I^-/I_2 half-cell ORA ✓ AW</p> <p>2. Fe^{2+} reacts with/reduces $\text{S}_2\text{O}_8^{2-}$ ORA ✓</p> $\text{S}_2\text{O}_8^{2-} + 2\text{Fe}^{2+} \rightarrow 2\text{SO}_4^{2-} + 2\text{Fe}^{3+} \quad \checkmark$ <p><i>explanation:</i> the E° of $\text{S}_2\text{O}_8^{2-}/\text{SO}_4^{2-}$ half-cell is more positive than that of the $\text{Fe}^{3+}/\text{Fe}^{2+}$ half-cell ORA ✓ AW</p> <p>QWC: to gain the explanation mark for either 1 or 2, the data has to be linked correctly to the reaction</p>	6	<p>IGNORE references to activation enthalpy OR variable valency/oxidation states</p> <p>ALLOW E° of Fe^{3+} is more positive etc</p> <p>ALLOW E° of $\text{S}_2\text{O}_8^{2-}$ is more positive etc</p> <p>NOTE If answer starts with Fe^{2+} rather than Fe^{3+} lose 1st mark but ecf since not answering question so can get 5 marks</p>
(e)	(i)	Rate = $k \times [\text{S}_2\text{O}_8^{2-}] \checkmark \times [\text{I}^-] \checkmark$	2	IGNORE state symbols
	(ii)	<p>uses one of the 3 sets of results:</p> <ol style="list-style-type: none"> $k = 2.0 \times 10^{-5} / (0.075 \times 0.040)$ $k = 4.0 \times 10^{-5} / (0.150 \times 0.040)$ $k = 1.0 \times 10^{-5} / (0.075 \times 0.020) \checkmark$ <p>$k = \mathbf{0.0067} \checkmark$</p> <p>$\text{mol}^{-1} \text{dm}^3 \text{s}^{-1} \checkmark$</p>	3	<p>ecf from part e(i) provided working is shown ALLOW standard form (eg 6.7×10^{-3}) Correct numerical answer without working scores 2 for calculation part</p> <p>NO ecf from first mark to second</p> <p>ALLOW any number of sig figs e.g. 0.007, 0.00667 NOT 0.006 NOR 0.0066</p> <p>ALLOW units in any order, e.g. $\text{dm}^3 \text{s}^{-1} \text{mol}^{-1}$</p>
	(iii)	$2.0 \times 10^{-5} \checkmark$ $\text{mol dm}^{-3} \text{s}^{-1} \checkmark$	2	<i>Mark separately</i>
Total			31	