

8(a)	the pH at which an amino acid exists as a zwitterion
8(b)	M1: $[\text{HOOCCH}(\text{NH}_3^+)\text{CH}_2\text{CONH}_2]^+$ M2: $[\text{HOOCCH}(\text{NH}_3^+)\text{CH}_2\text{COOH}]^+$ $\begin{array}{c} \text{O} & \text{H} & & \text{O} \\ \parallel & & & \parallel \\ \text{HO}-\text{C} & -\text{C}- & \text{CH}_2- & \text{C}- \\ & & & \\ & \text{NH}_3^+ & & \text{NH}_2 \end{array}$ $\begin{array}{c} \text{O} & \text{H} & & \text{O} \\ \parallel & & & \parallel \\ \text{HO}-\text{C} & -\text{C}- & \text{CH}_2- & \text{C}- \\ & & & \\ & \text{NH}_3^+ & & \text{OH} \end{array}$
8(c)	M1: $\text{HOCH}_2\text{CH}(\text{NH}_2)\text{CH}_2\text{CH}_2\text{NH}_2$ M2: $\text{HOCH}_2\text{CH}(\text{NH}_2)\text{CH}_2\text{CH}_2\text{OH}$ $\begin{array}{c} \text{H} \\ \\ \text{HOCH}_2-\text{C}-\text{CH}_2-\text{CH}_2\text{NH}_2 \\ \\ \text{NH}_2 \end{array}$ $\begin{array}{c} \text{H} \\ \\ \text{HOCH}_2-\text{C}-\text{CH}_2-\text{CH}_2\text{OH} \\ \\ \text{NH}_2 \end{array}$
8(d)(i)	$\text{HOOCCH}_2\text{COOH} + 2\text{SOCl}_2 \rightarrow \text{ClOCCH}_2\text{COCl} + 2\text{SO}_2 + 2\text{HCl}$ [1]
8(d)(ii)	$\text{HOOCCH}(\text{CH}_2\text{CONH}_2)\text{NHCOCH}_2\text{CONHCH}(\text{CH}_2\text{CONH}_2)\text{COOH}$ M1: three molecules joined, with four correct amide groups only M2: whole structure correct as above, displayed formula accepted, skeletal formula as below accepted
8(e)	M1: hydrolysis of amide to carboxylate ion M2: hydrolysis of $-\text{COOH}$ to carboxylate ion and rest of molecule $-\text{OOCCH}(\text{NH}_2)\text{CH}_2\text{COO}^-$

8(f)	- three monomer residues - all linkages correct - correct trailing bonds - repeat unit marked contains correct atoms Any two [1], any three [2], all four [3] $\begin{array}{c} \text{CH}_2\text{CONH}_2 \qquad \qquad \text{CH}_2\text{CONH}_2 \\ \qquad \qquad \qquad \\ -\text{COCHNH}-\{ \text{COCHNH} \}-\text{COCHNH}- \\ \\ \text{CH}_2\text{CONH}_2 \end{array}$
8(g)(i)	- rotate the plane of the plane polarised light - by the same angle - in opposite directions Any two [1], all three [2]
8(g)(ii)	racemic mixture