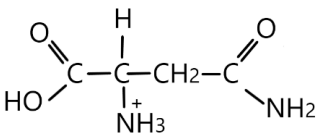
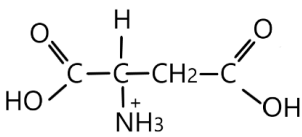
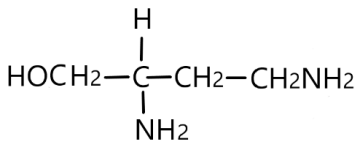
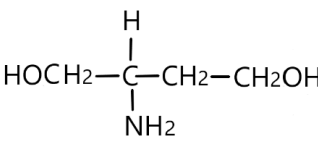
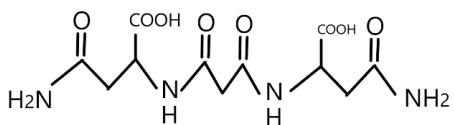
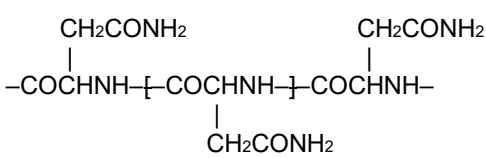
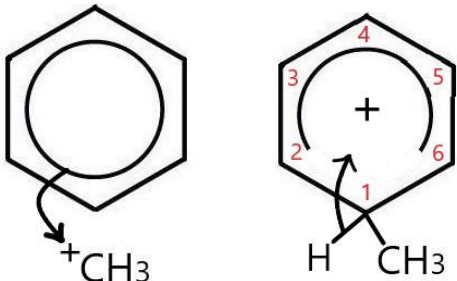
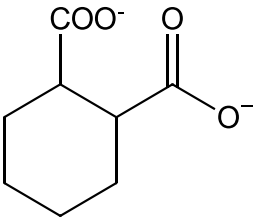
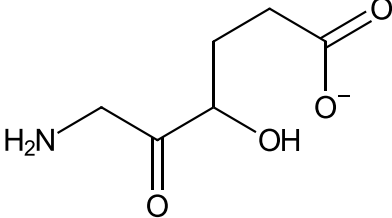


8(a)	the pH at which an amino acid exists as a zwitterion
8(b)	M1: $[\text{HOOCCH}(\text{NH}_3^+)\text{CH}_2\text{CONH}_2]^+$ M2: $[\text{HOOCCH}(\text{NH}_3^+)\text{CH}_2\text{COOH}]^+$  
8(c)	M1: $\text{HOCH}_2\text{CH}(\text{NH}_2)\text{CH}_2\text{CH}_2\text{NH}_2$ M2: $\text{HOCH}_2\text{CH}(\text{NH}_2)\text{CH}_2\text{CH}_2\text{OH}$  
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] 
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

9(a)	- all C atoms are sp^2 hybridised - bonds between C atoms are σ and π - C–C σ bonds are formed by overlap of sp^2 hybrid orbitals - C–C π bonds are formed by overlap of p orbitals - bonds between C and H atoms are σ - C–H bonds are formed by overlap of sp^2 hybrid orbitals and s orbitals Any two [1], any four [2], all six [3]
9(b)	CH_3Cl and $AlCl_3$
9(c)	 M1: curly arrow from within hexagon towards $+C$ M2: intermediate, usual rules for horseshoe and $+$ charge M3: curly arrow from C–H bond into ring AND H^+ product
9(d)	M1: HNO_3 AND H_2SO_4 M2: concentrated AND $25^\circ C \leq T \leq 60^\circ C$
9(e)	alkaline $KMnO_4$
9(f)	4-nitrobenzoic acid
9(g)	(hot) concentrated HCl and Sn
9(h)	M1: perform step 3 before step 2 OR perform step 2 before step 1 M2: $COOH$ is 3-directing OR NO_2 is 3-directing

8(a)	- chlorobenzene is less reactive than ethanoyl chloride - p orbital / lone pair on Cl / $-Cl$ will overlap / delocalise into the ring OR C of $COCl$ has most electron deficient OR has an electronegative oxygen atom / two electronegative atoms / electron withdrawing $C=O$ group - due to partial double C–Cl bond OR C–Cl bond strengthened (more) / stronger bond between Cl and benzene / ring OR C–Cl weakened in $ROCl$ any two [1], all three [2]
8(b)(i)	- nitrile - amide - ketone / carbonyl - ester any two [1], all four [2]
8(b)(ii)	8 / eight
8(b)(iii)	no need to separate optical isomers

8(c)	  M1: amide bond hydrolysed and COO⁻ and NH₂ formed M2: nitrile bond hydrolysed and COO⁻ formed M3: ester bond hydrolysed and COO⁻ and OH formed
8(d)(i)	percentage = $100 \times 28 / (28 + 58 + 13 + 42) = 19.9 (\%)$ min 2sf
8(d)(ii)	D is attracted more strongly to the stationary phase / forms stronger intermolecular forces with the stationary phase