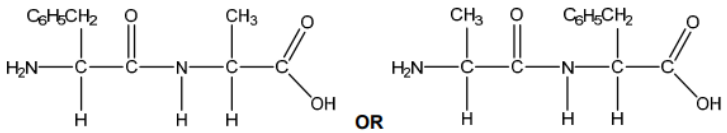
34. Nitrogen compounds

34.4 Amino acids

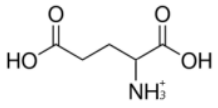
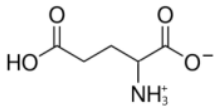
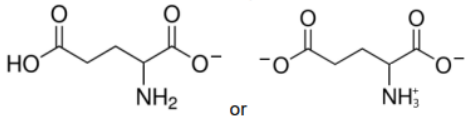
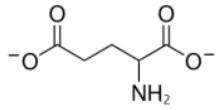
Paper 4

Marking Scheme

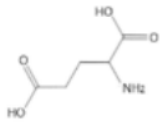
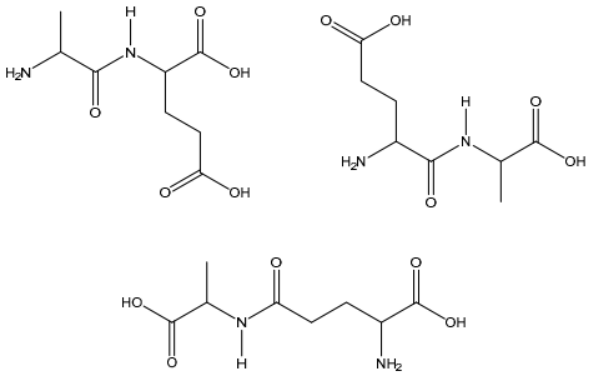
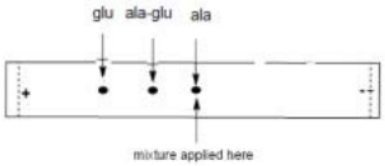
Q1.

(e)(i)	pH at which a molecule has no overall charge / is neutral / exist as a zwitterion	1
(e)(ii)	$C_6H_5CH_2CH(NH_2)COO^-$	1
(f)	 **OR** **M1** correct peptide bond displayed (there must be a saturated carbon attached to either side of the peptide group) **M2** rest of the dipeptide correct	2

Q2.

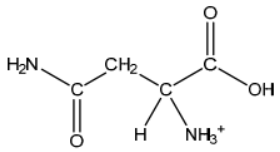
(h)	 at pH 1 [1]  at pH 3 **AND**  or at pH 9 [1]  at pH 14 [1]	3

Q3.

(c)(i)		1
(c)(ii)	 **M1** displayed peptide bond (between two amino acids) **M2** rest of the structure correct	2
(d)	 **M1** relative positions of the spots drawn **M2** Ala is a zwitterion / neutral / at its isoelectric point (at pH 6) **OR** ala-glu **AND** glu are negatively charged **M3** glu has lower M_r **OR** ala-glu has higher M_r	3

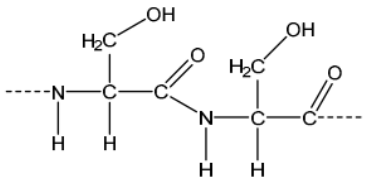
Q4.

(c)(i)	the pH at which an amino acid exists as a zwitterion **OR** the pH at which an amino acid has no overall charge	**1**

(c)(ii)		**1**

(e)	<table><tr><th>spot</th><th>identity</th></tr><tr><td>**E**</td><td>Asn</td></tr><tr><td>**F**</td><td>Lys-Asn</td></tr><tr><td>**G**</td><td>Lys</td></tr></table> **M1** table correctly completed **M2** Lys and Lys-Asn are positively charged **OR** Asn is (nearly) uncharged **M3** Lys-Asn has the highest M_r	**3**

Q5.

(d)	 **M1** peptide linkage shown displayed with saturated C each side **M2** rest of structure correct **AND** continuation bonds	**2**

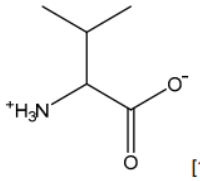
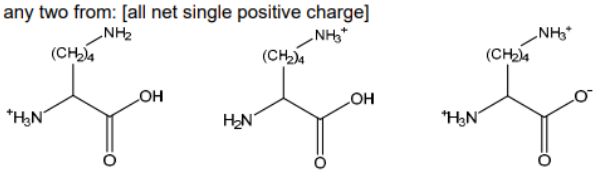
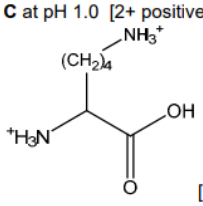
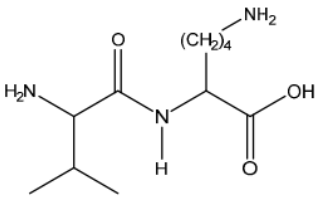
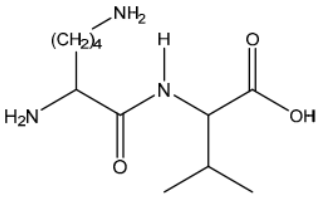
Q6.

(d)(i)	**pH** where the species is a zwitterion is the dominant form **OR pH** where the species is electrically neutral	**1**

Q7.

(a)	pH 7 $^+H_3N(CH_2)_4CHNH_2COOH$ pH 9.47 $^+H_3N(CH_2)_4CHNH_2COO^-$ [1] pH 12 $H_2N(CH_2)_4CHNH_2COO^-$ [1]	**2**

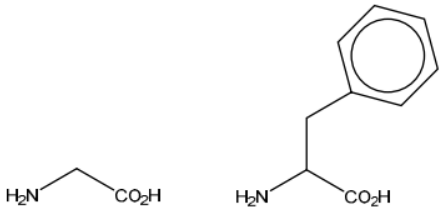
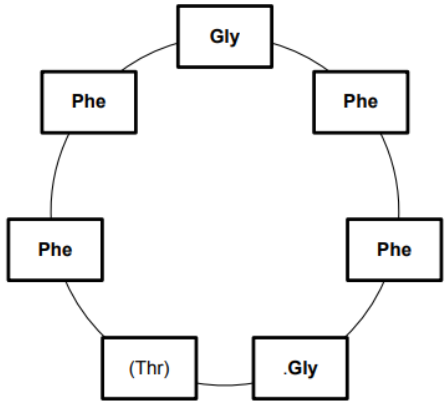
Q8.

(a)	 [1]	1
(b)	**A** and **B** any two from: [all net single positive charge]  [1] × 2 **C** at pH 1.0 [2+ positive charge]  [1]	3
(c)	M1: peptide link correct and displayed unit including C=O M2: everything else correct  **OR**  [2]	2

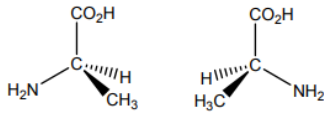
Q9.

(d)(i)	use of buffer [1]	1
(d)(ii)	• correct circuit including **DC** power supply • paper or gel labelled [1] • sample towards the middle of the paper / gel **OR** on cathode side [1]	2
(d)(iii)	anode / positive / + **AND** anode / positive / + [1]	1
(d)(iv)	M1 ala is –1 and glu is –2 [1] M2 ala is lighter / has lower M_r [1]	2

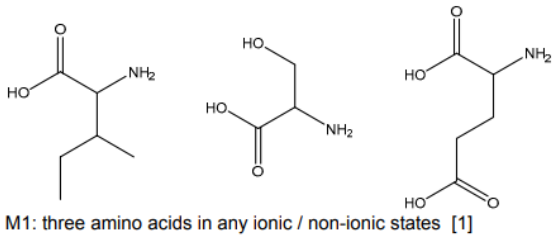
Q10.

(e)(i)	 Award one mark for each correct structure	2
(e)(ii)	 correct labelling as shown	1
(e)(iii)	electrophoresis **and** thin-layer / paper chromatography [1]	1

Q11.

(b)(i)	$H_2NCH_2CO_2H + HCl \rightarrow Cl^-H_3N^+CH_2CO_2H$ [1] $H_2NCH_2CO_2H + NaOH \rightarrow H_2NCH_2CO_2^-Na^+ + H_2O$ [1]	2
(b)(ii)	$H_3N^+CH_2CO_2^-$ [1] Proton is transferred from the CO_2H group to the NH_2 group [1]	2
(c)	 two non-superimposable mirror images for alanine drawn [1]	1

Q12.

(a)(i)	any one from: • OH^- / NaOH; aqueous / dilute; heat under reflux • H^+ / HCl / H_2SO_4, aqueous / dilute; heat under reflux • protease or named protease; water; T = 30° – 40°C all three points in each bullet [1]	1
(a)(ii)	 M1: three amino acids in any ionic / non-ionic states [1] M2: three amino acids in the correct ionic state for their conditions [1]	2

(b)	• permanent dipole-dipole • one group that will have a δ^+ and another with δ^- e.g. CO, NH, COOH, OH **BOTH** [1] • hydrogen bonds • one group that will have a $H^{\delta+}$, e.g. NH, OH and another with lone pair, e.g. NH, COOH, OH, $CONH_2$ **BOTH** [1] • ionic bonding • NH_3^+ **and** COO^- **BOTH** [1] **ALLOW** • London forces • C_4H_9 groups or parts of these alkyl groups	3