Amines, Amides, Amino Acids & Proteins

Mark Scheme

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Transition Metals & Organic Nitrogen Chemistry
Sub Topic	Amines, Amides, Amino Acids & Proteins
Booklet	Mark Scheme

Time Allowed: **53 minutes**

Score: **/44**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

Question Number	Correct Answer	Reject	Mark
1	**C**		1

Question Number	Correct Answer	Reject	Mark
2	**A**		1

Question Number	Correct Answer	Reject	Mark
3(a)	**B**		1

Question Number	Correct Answer	Reject	Mark
3(b)	**D**		1

Question Number	Correct Answer	Reject	Mark
4	**C**		1

Question Number	Correct Answer	Reject	Mark
5	D		1

Question Number	Correct Answer	Reject	Mark
6	B		1

Question Number	Correct Answer	Reject	Mark
7	B		**1**

Question Number	Correct Answer	Reject	Mark
8	B		**1**

Question Number	Correct Answer	Reject	Mark
9	C		**1**

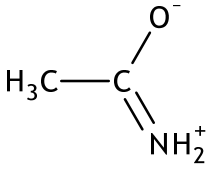
Question Number	Acceptable Answer	Reject	Mark
10(a)(i)	(Both have hydrogen bonds) methylamine has stronger London / dispersion / induced dipole(-induced dipole) / van der Waals forces **(1)** As it has more electrons ALLOW greater surface area **(1)** ALLOW (Both have hydrogen bonds) stronger hydrogen bonds in methylamine because of electron donating effect of the methyl group ..... **(1)** ... makes the nitrogen lone pair more available **(1)** IGNORE just 'hydrogen bonds stronger' If no other marks are scored then 'both molecules have hydrogen bonds **and** London forces' scores 1 mark		2

Question Number	Acceptable Answer	Reject	Mark
10(a)*(ii)	Amines form hydrogen bonds with water (molecules) **(1)** As molar mass (of the amine) increases, the size / strength of the London forces/ dispersion / induced dipole(-induced dipole) / van der Waals forces (between amine molecules) increase ALLOW The size of the hydrophobic group increases **(1)** So the energy needed to break the London forces (of the amines) increases (becomes more and more similar to the energy released in forming hydrogen bonds) OR the nett gain in / release of energy becomes (progressively) smaller **(1)** IGNORE References to hydrophilic groups		3

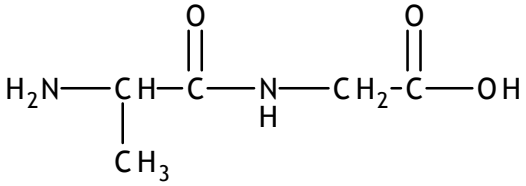
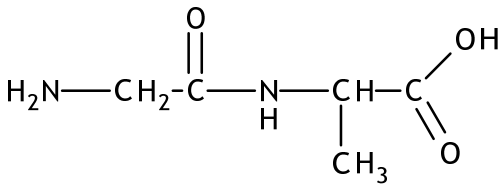
Question Number	Acceptable Answer	Reject	Mark
10(a)(iii)	$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^-$ ALLOW → for ⇌ & $CH_3NH_3^+$ OH^- IGNORE Position of charges		1

Question Number	Acceptable Answer	Reject	Mark
10(a)(iv)	Basic strength depends on the (donation / availability of) the lone pair (of electrons on the nitrogen atom) ALLOW Basic strength depends on the ability of a nitrogen atom to accept a proton **(1)** Methyl groups are electron donating (so lone pair donation increases / lone pair more available) **(1)** **Lone pair** of (nitrogen on) phenylamine interacts with π / delocalised electrons of the benzene ring (so lone pair donation decreases / lone pair less available) ALLOW **Lone pair** delocalised into the (benzene) ring 'Non-bonding electron pair' for lone pair **(1)**	N becomes more electronegative Just 'electron pair'	3

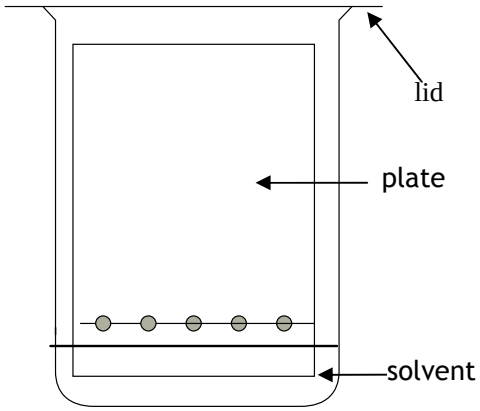
Question Number	Acceptable Answer	Reject	Mark
10(b)(i)	If neither answer refers to an electron **pair** then max 1 for this item **Arrow 1** Movement of **π electron pair** / **π electrons** (to oxygen atom) OR Movement of a pair of electrons from the double bond **(1)** **Arrow 2** Movement of **lone pair** / **non-bonded pair** of electrons (from the nitrogen) (to C—N bond) **(1)** If **neither** of these marks is scored then 'each arrow shows the movement of an electron **pair**' scores 1 mark	Just "breaking of the π bond"	2

Question Number	Acceptable Answer	Reject	Mark
10(b)(ii)			1

Question Number	Acceptable Answer	Reject	Mark
10(b)(iii)	(The electron movement shown above means that) the carbonyl carbon has a smaller (partial) positive charge than an aldehyde or ketone ALLOW no positive charge OR carbonyl carbon is resistant to **nucleophilic** attack		1

Question Number	Acceptable Answer	Reject	Mark
10(c)(i)	One mark for each structure with fully displayed, structural or skeletal formulae and in any orientation   Penalise lack of displayed double bonds once only ALLOW If continuation bonds added to the dimers max 1. Two fully correct polymer structures **(1)**		2

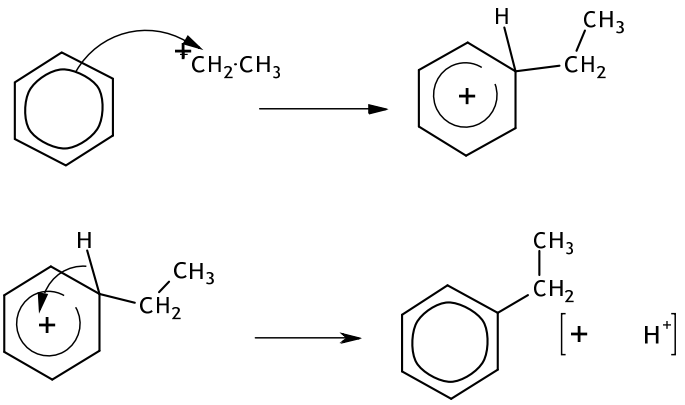
Question Number	Acceptable Answer	Reject	Mark
10(c)(ii)	The amine group (of glycine & alanine) is protonated & cannot act as a nucleophile ALLOW (Glycine & alanine) form zwitterions IGNORE References to activation energy		1

Question Number	Acceptable Answer	Reject	Mark
10(c)*(iii)	Dot samples of the amino acid mixture (and known amino acids) on the plate and dip the plate in the solvent (1) Use of ninhydrin to make amino acids visible / as a developer (1) Compare distance travelled of mixture components and known amino acids OR Compare R_f with data book values (1) The first mark may be awarded for a suitable diagram e.g.  ALLOW 'Paper' or 'glass slide' for 'plate' IGNORE Omission of lid in diagram.	Amino acids dissolved in mobile phase solvent	3

Total for Question 10 = 19 marks

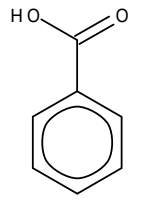
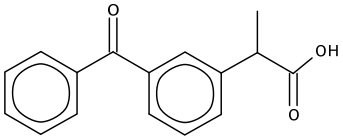
Question Number	Acceptable Answers	Reject	Mark
11(a)	= PCl_5 / phosphorus(V) chloride / phosphorus pentachloride / PCl_3 / phosphorus(III) chloride / phosphorus trichloride / $SOCl_2$ / thionyl chloride / thionyl dichloride **(1)** **B** = benzene / C_6H_6 or ring structures **(1)** **C** = bromine / Br_2 **(1)**	Bromine water / Bromine and $FeBr_3$	3

Question Number	Acceptable Answers	Reject	Mark
11(b)(i)	$CH_3CH_2Br + AlBr_3 \rightarrow CH_3CH_2^+ + AlBr_4^-$ **(1)** ALLOW $C_2H_5^+$ + sign anywhere on formula of electrophile ($AlBr_3$ is an) electron pair acceptor / lone pair acceptor / Lewis acid / Friedal-Crafts catalyst **(1)** ALLOW polarizes C-Br bond IGNORE Halogen carrier	Accepts electrons Just 'catalyst'	2

Question Number	Acceptable Answers	Reject	Mark
11(b)(ii)	 TE on incorrect electrophile in (b)(i) Curly arrow from on or within the circle to positively charged carbon ALLOW Curly arrow from anywhere within the hexagon Arrow to **any** part of the electrophile including to the + charge **(1)** Intermediate structure including charge with horseshoe covering at least 3 carbon atoms, **and** facing the tetrahedral carbon **and** with some part of the positive charge within the horseshoe ALLOW dotted horseshoe **(1)** Curly arrow from C—H bond to anywhere in the benzene ring reforming delocalized structure **(1)** Correct Kekulé structures score full marks Ignore any involvement of AlX_4^- in the final step NOTE $C_2H_5^+$ as electrophile can score all 3 marks	Curly arrow on or outside the hexagon Partial bonds to H and CH_3	3

Question Number	Acceptable Answers	Reject	Mark
11(c)(i)	KCN / potassium cyanide / NaCN / sodium cyanide **(1)** In ethanol (dependent on mark 1) ALLOW alcohol / aqueous ethanol / aqueous alcohol **(1)** ethanolic or alcoholic KCN (etc) scores both marks BUT CN^- / HCN in ethanol scores second mark	cyanide / CN^- HCN	2

Question Number	Acceptable Answers	Reject	Mark
11(c)(ii)	Name / formula of any strong aqueous acid OR named strong aqueous alkali followed by acidification Ignore heat / reflux / dilute / conc	H^+ / H_3O^+	1

Question Number	Acceptable Answers	Reject	Mark
11(d)(i)	1700-1680 (cm^-  benzenecarboxylic acid 1700-1680 (cm^-  ketoprofen 1725-1700 1 mark for each correct range / reverse range Single numbers within range = max 2 marks		3

Question Number	Acceptable Answers	Reject	Mark
11(d)(ii)	Only (the carboxylic acid group in) ketoprofen will give a peak at 1725 – 1700 cm^{-1} ALLOW Ketoprofen has 2 absorptions whilst benzenecarboxylic acid has one Correct TE identifying a unique range	 Just ketoprofen has more peaks	1

Total for Question 11 = 15 marks