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EDEXCEL A LEVEL CHEMISTRY: QUESTIONS BY TOPIC

Organic Chemistry III (18)

A Level Chemistry Topic 18

10 questions · 111 marks · Mark schemes included

Pearson Edexcel A Level Chemistry (9CH0), June 2017 - June 2025

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 info@guidemygrades.com

 Piccadilly Business Centre, Unit C, Aldow Enterprise Park
Blackett Street, Manchester, M12 6AE

HOW TO USE THIS BOOKLET

Questions run from the lowest mark tariff to the highest, so similar questions sit together.

Click any row below to jump straight to that question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

QUESTION	SOURCE	MARKS	PAGE
1. Q3	A Level Paper 3 June 2017	7	4
2. Q6	A Level Paper 3 June 2023	7	6
3. Q6 <i>also Topic 17</i>	A Level Paper 2 June 2017	9	10
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QUESTIONS

10 questions · 111 marks · lowest tariff first

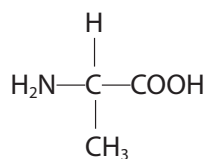


7-MARK QUESTIONS

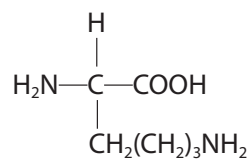
2 questions in this booklet



3 Alanine and lysine are amino acids.



alanine



lysine

(a) Give the systematic (IUPAC) name for **lysine**.

(1)

(b) Draw the **structure** of the organic product formed when **lysine** reacts with the following reagents:

(3)

aqueous sodium hydroxide, NaOH(aq)

excess dilute hydrochloric acid, HCl(aq)

methanol, with warming, in the presence of a few drops of concentrated sulfuric acid.



- (c) Draw the structure of a dipeptide formed when one molecule of alanine reacts with one molecule of lysine.

(1)

- (d) The dipeptide formed in part (c) is hydrolysed under **acidic** conditions and the resulting mixture is analysed by column chromatography. The column uses a polar stationary phase.

Explain why lysine leaves the chromatography column after alanine.

(2)

(Total for Question 3 = 7 marks)



6 Amino acids can be separated using chromatography.

(a) State how chromatography separates the components of a mixture.

(1)

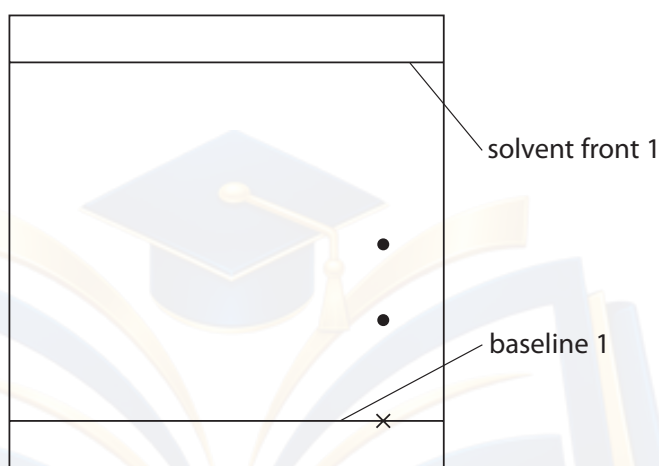
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(b) A sample of a tripeptide was hydrolysed and then placed on an 'X' at the bottom right-hand corner of a piece of chromatography paper.

A simplified diagram of a developed chromatogram is shown.



(i) Give a possible reason for the presence of only two spots for the tripeptide other than two amino acids have almost identical R_f values.

(1)

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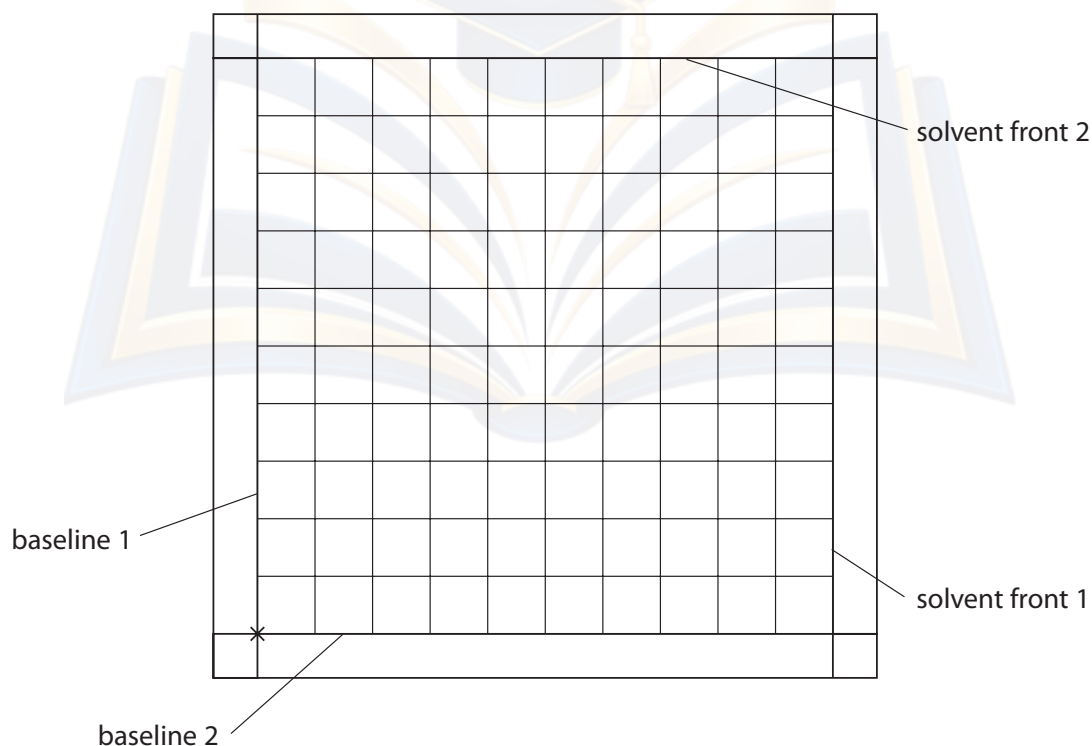


- (ii) Some amino acid mixtures cannot be effectively separated in one chromatography 'run'.
The chromatography paper from the first run is dried but not developed.
The chromatography paper is then rotated clockwise by 90° and placed in a different solvent.

Complete the simplified diagram of the developed chromatography paper after a second 'run' for a tripeptide of alanine, glycine and valine by adding **labelled** spots for each amino acid.

Amino acid	R_f in solvent 1	R_f in solvent 2
alanine	0.38	0.43
glycine	0.33	0.26
valine	0.39	0.58

(3)



(iii) Name a reagent that locates colourless amino acids by producing a coloured compound.

(1)

(c) State the technique that is used in conjunction with gas chromatography (GC) when carrying out forensic testing.

(1)

(Total for Question 6 = 7 marks)



9-MARK QUESTIONS

2 questions in this booklet

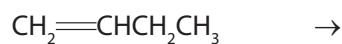


6 This is a question about polymerisation.

(a) But-1-ene and cyclohexene both form addition polymers.

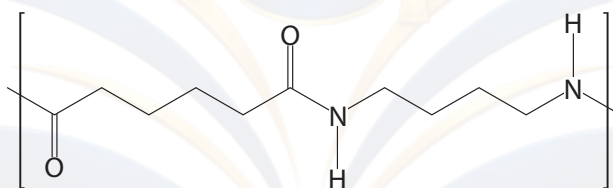
Draw a section of each polymer, showing **two** repeat units.

(2)



(b) Deduce the two monomers needed to produce the polyamide shown.

(2)

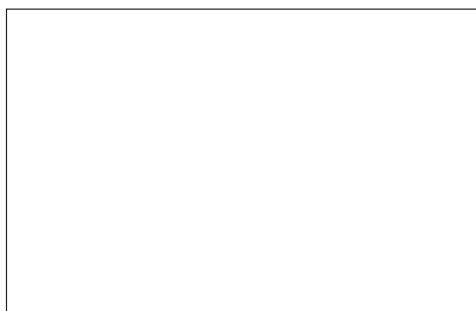
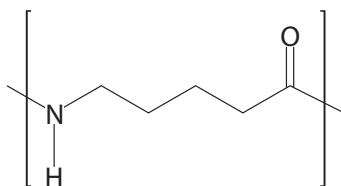


and



(c) Deduce the single monomer that could be used to produce the polyamide shown.

(1)



(d) PLA is a biodegradable polyester which is made from 2-hydroxypropanoic acid, $\text{CH}_3\text{CH}(\text{OH})\text{COOH}$.

(i) Draw the two enantiomers of 2-hydroxypropanoic acid.

(2)

(ii) State how separate samples of these two enantiomers could be distinguished in a laboratory.

(1)

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.....

(iii) Biodegradable polyesters break down naturally.

State why this is an advantage.

(1)

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.....

(Total for Question 6 = 9 marks)



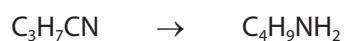
9 This question is about amines.

(a) Phenylamine is an aromatic amine and butylamine is an aliphatic amine.

Phenylamine can be prepared from nitrobenzene.

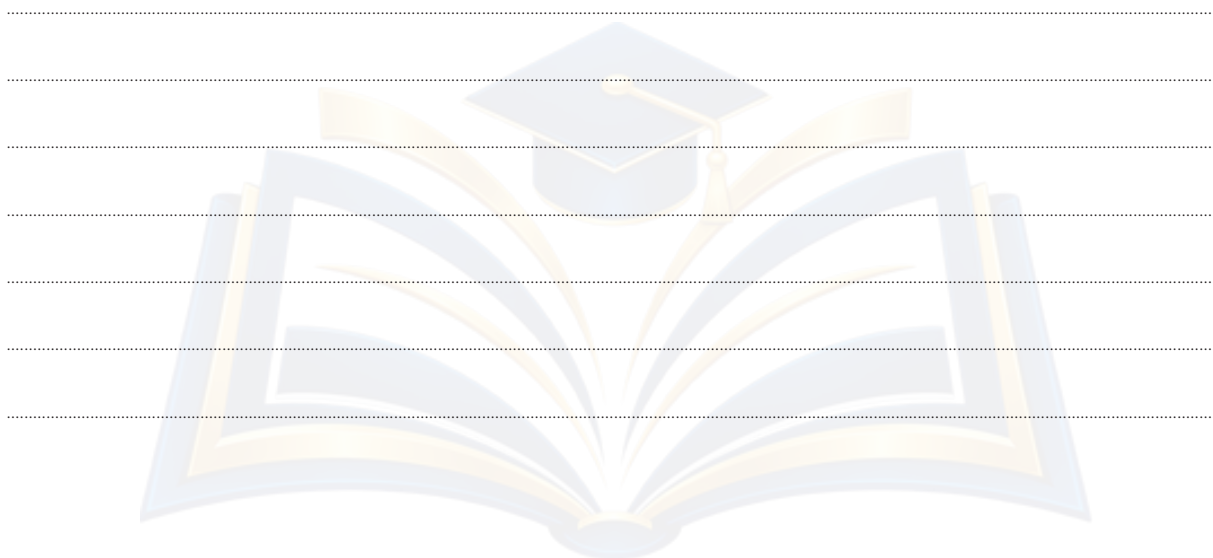


Butylamine can be prepared from butanenitrile.



Compare and contrast these two preparations of amines.

(3)



(3)

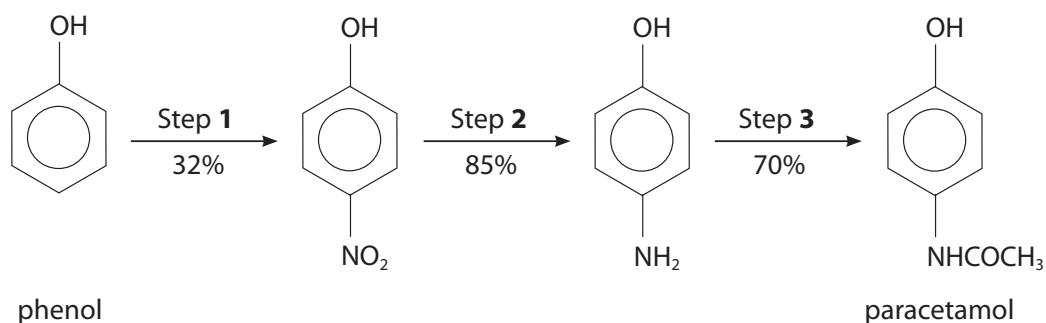


10-MARK QUESTIONS

1 question in this booklet



- 9 The painkiller paracetamol can be synthesised from phenol in three steps. The percentage yield for each step is shown.



- (a) In Step 1 another product also forms. The two products can be distinguished using their ^{13}C NMR spectra.

Complete the table to show the number of peaks in each ^{13}C NMR spectrum.

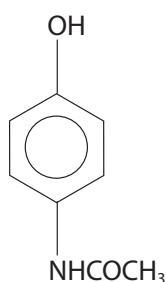
(2)

Product		
Number of peaks in the ^{13}C NMR spectrum		

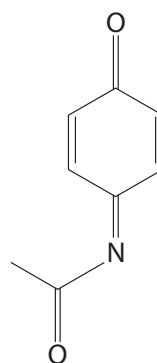
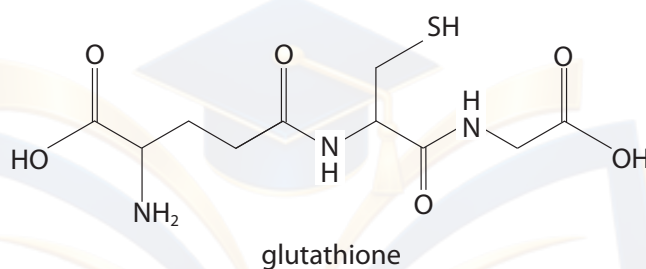
- (b) Calculate the minimum mass of phenol needed to synthesise 1.00 kg of paracetamol. [M_r values: paracetamol = 151.0 phenol = 94.0]

(3)

- (c) When metabolised in the body, paracetamol forms a toxic compound **Z**. This is then removed in the liver by a reaction with the tripeptide glutathione.



paracetamol

compound **Z**

glutathione

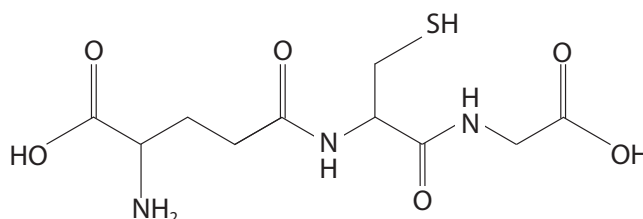
- (i) The conversion of paracetamol to compound **Z** is

(1)

- ☐ **A** addition
- ☐ **B** hydrolysis
- ☐ **C** oxidation
- ☐ **D** reduction

- (ii) Draw a circle around each of the chiral carbon atoms in glutathione.

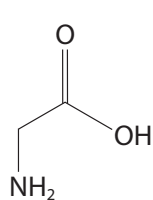
(1)



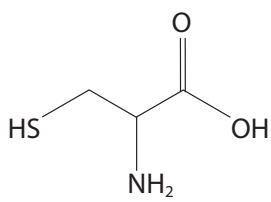
(iii) Glutathione is formed from glycine and two other amino acids.

Which two amino acids combine with glycine to form glutathione?

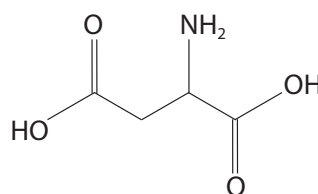
(1)



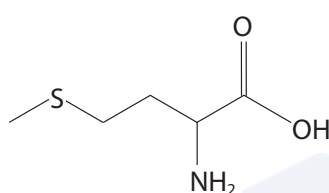
glycine



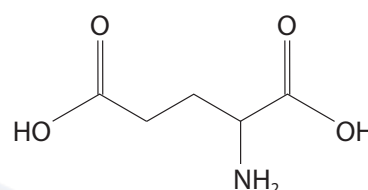
cysteine



aspartic acid



methionine



glutamic acid

- ☒ **A** aspartic acid and cysteine
- ☒ **B** glutamic acid and cysteine
- ☒ **C** glutamic acid and methionine
- ☒ **D** aspartic acid and methionine

(d) Explain why amino acids such as glycine are crystalline solids at room temperature.

(2)

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(Total for Question 9 = 10 marks)

11-MARK QUESTIONS

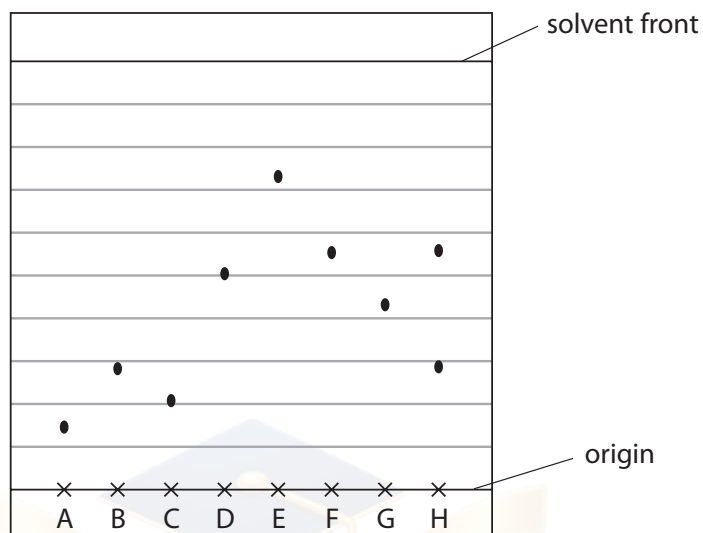
1 question in this booklet



3 Chromatography is a technique used to separate the components of a mixture.

- (a) A sample of a tripeptide was hydrolysed and then placed on a thin layer chromatography (TLC) plate. Samples of possible amino acids present were also placed on the TLC plate for reference.

A simplified diagram of the developed TLC plate is shown.



A – Lysine	B – Serine	C – Histidine	D – Tyrosine
E – Isoleucine	F – Methionine	G – Proline	H – Hydrolysed tripeptide

- (i) Calculate the R_f value for the amino acid lysine.
Give your answer to an appropriate number of significant figures.

(1)

- (ii) Identify by **name** the two amino acids present in the tripeptide, giving a reason for the lack of a third spot.

(3)

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(iii) Give **two** reasons why different amino acids have different R_f values.

(2)

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(iv) In chromatography, a 'locating' reagent is often used when the components in a mixture are colourless.

Which reagent is used to locate the amino acid spots?

(1)

- ☐ **A** iodine
- ☐ **B** methyl orange
- ☐ **C** ninhydrin
- ☐ **D** phenolphthalein

(b) Gas chromatography can be used both to separate the components in a mixture and to determine the amount of each present.

(i) State why argon and nitrogen are suitable carrier gases for gas chromatography.

(1)

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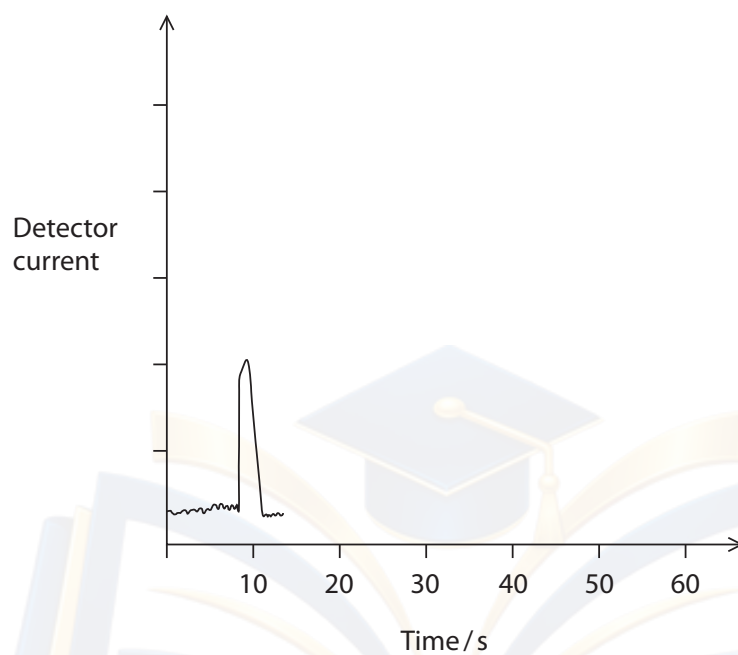


- (ii) A mixture containing one part substance **X**, two parts substance **Y** and one part substance **Z** was separated by gas chromatography.

Substance **X** has a retention time of 10 seconds, substance **Y** of 15 seconds and substance **Z** of 40 seconds.

Complete the sketch of this chromatogram.

(3)



(Total for Question 3 = 11 marks)

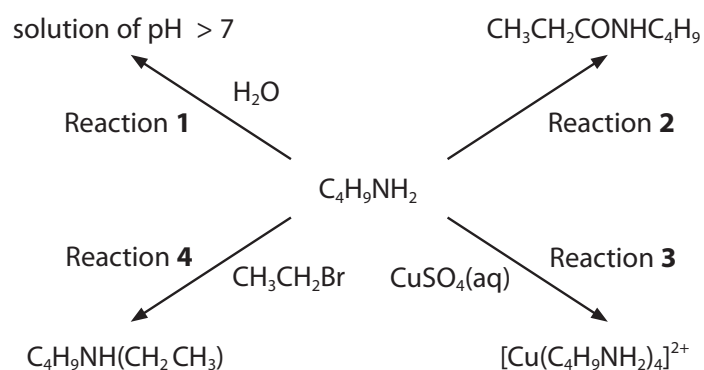
12-MARK QUESTIONS

1 question in this booklet



10 This question is about the amines butylamine, $\text{C}_4\text{H}_9\text{NH}_2$, and phenylamine, $\text{C}_6\text{H}_5\text{NH}_2$.

The reaction scheme shows some reactions of butylamine, a primary amine.



- (a) (i) Write the equation for **Reaction 1** to show why the pH of the solution is greater than 7. State symbols are not required.

(1)

- (ii) Explain why phenylamine is a weaker base than butylamine.

(3)

- (b) Give the name and structural formula of the compound needed to react with butylamine in **Reaction 2**.

(2)

Name

Structural formula

(c) What is seen when excess butylamine is used in Reaction 3?

(1)

- ☐ A blue solution
- ☐ B blue precipitate
- ☐ C yellow solution
- ☐ D yellow precipitate

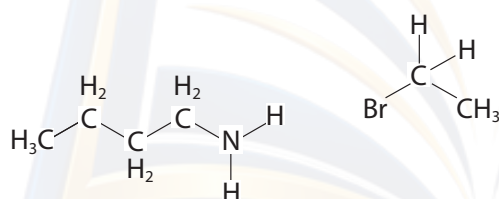
(d) (i) What is the type and mechanism of the reaction in Reaction 4?

(1)

- ☐ A electrophilic addition
- ☐ B electrophilic substitution
- ☐ C nucleophilic addition
- ☐ D nucleophilic substitution

(ii) Complete the diagram to show the mechanism for Reaction 4. Include curly arrows, and relevant lone pairs and dipoles.

(4)



(Total for Question 10 = 12 marks)



14-MARK QUESTIONS

1 question in this booklet



7 Organic compounds containing nitrogen include amides, amines, amino acids and nitriles.

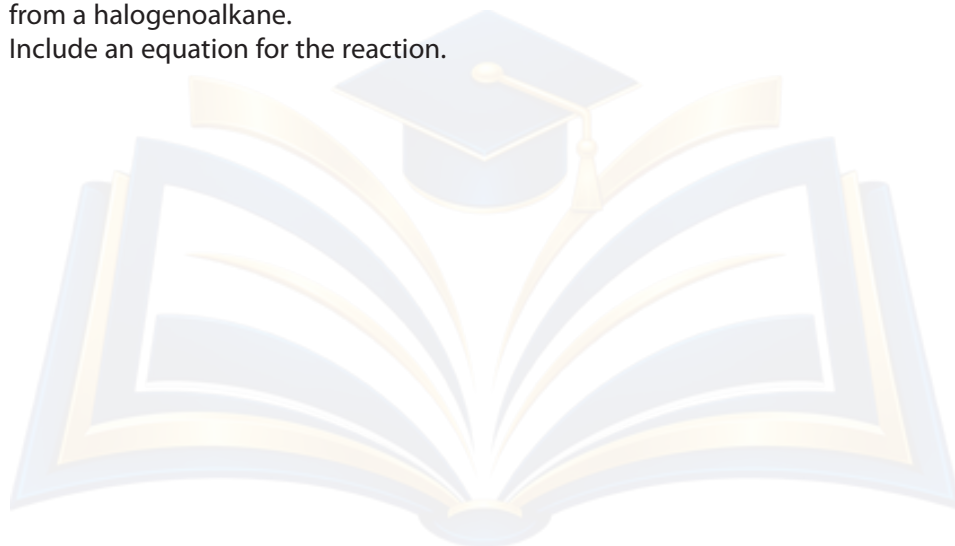
(a) Propylamine, $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$, may be formed from either a nitrile or a halogenoalkane.

- (i) Give the reagent and essential condition for the formation of propylamine from a nitrile.
Include an equation for the reaction.

(2)

- (ii) Give the reagent and essential conditions for the formation of propylamine from a halogenoalkane.
Include an equation for the reaction.

(3)



(b) A compound produced a peak due to an N—H stretching vibration in its infrared spectrum with a wavenumber of 3220 cm^{-1} .

This compound could be

(1)

- ☒ A an amide
- ☒ B an amine
- ☒ C either an amide or an amine
- ☒ D neither an amide nor an amine

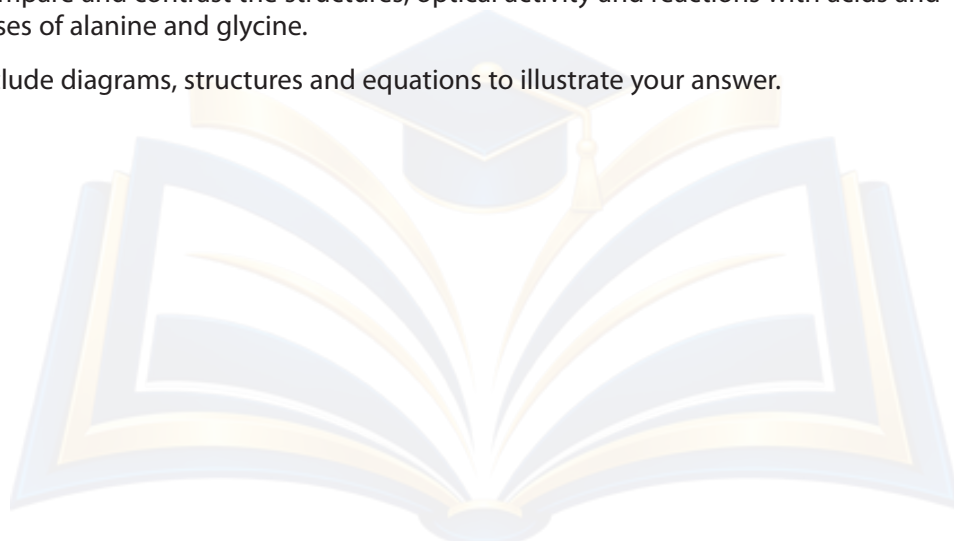
*(c) Alanine and glycine are amino acids.

Amino acid	Structure
alanine	
glycine	

Compare and contrast the structures, optical activity and reactions with acids and bases of alanine and glycine.

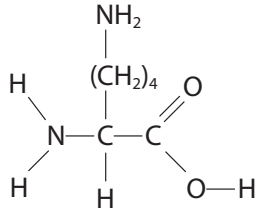
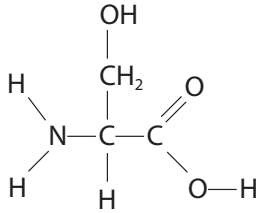
Include diagrams, structures and equations to illustrate your answer.

(6)





(d) Lysine and serine are two more amino acids.

Amino acid	Structure of amino acid
lysine	
serine	

Explain the difference in the volumes of $0.010 \text{ mol dm}^{-3}$ hydrochloric acid required to completely react with separate 10.0 cm^3 samples of aqueous lysine and of aqueous serine, both of concentration $0.010 \text{ mol dm}^{-3}$.

(2)

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(Total for Question 7 = 14 marks)

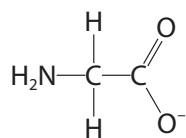
16-MARK QUESTIONS

2 questions in this booklet



9 Some organic compounds contain metals.

(a) Glycinate ions are formed from the amino acid glycine.



glycinate ion

(i) Explain the effect, if any, of an aqueous solution containing glycinate ions on plane-polarised monochromatic light.

(2)

(ii) A hot aqueous solution of glycine is added to a hot solution of copper(II) ethanoate. When the mixture is cooled, crystals of copper(II) glycinate are formed.

Write the equation for this reaction.
State symbols are not required.

(2)

(iii) In an experiment, the crystals are filtered, weighed and the percentage yield calculated.

Student 1 obtained a yield of 102.6%.

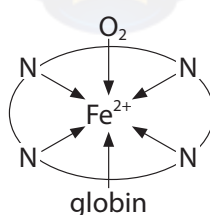
Student 2 obtained a yield of 56.4%.

The expected yield is 82% and the students carried out the calculation correctly.

Discuss possible reasons for the yields obtained by these students.

(4)

(b) Haemoglobin is an iron(II) complex. It carries oxygen around the body. Part of the structure of haemoglobin is shown.



The four nitrogen atoms are part of a multidentate ligand in the haem group.

Explain why inhaling carbon monoxide can be fatal.

(2)



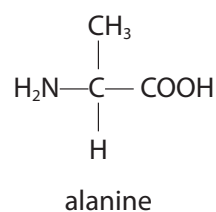
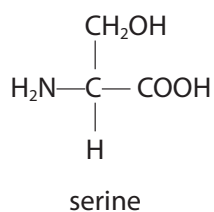


(Total for Question 9 = 16 marks)



8 This question is about amino acids and related compounds.

The structures of two amino acids are shown.



(a) Both amino acids contain a chiral carbon atom.

(i) State what is meant by the term 'chiral carbon atom'.

(1)

.....

.....

.....

(ii) Draw diagrams of the two stereoisomers of **alanine**, showing their three-dimensional shape.

(2)

(b) Draw the **skeletal** formulae of the two dipeptides that could form when serine and alanine react.

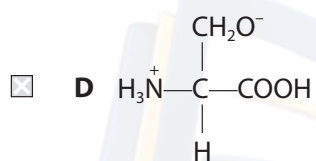
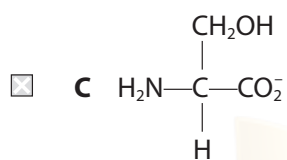
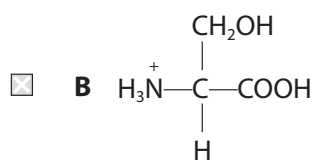
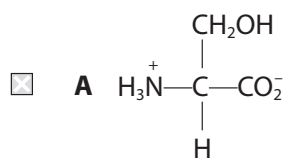
(2)

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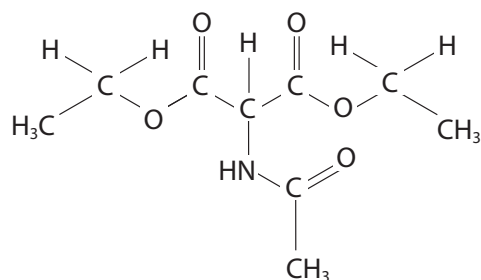
(c) Serine exists as a zwitterion.

What is the formula of this zwitterion?

(1)

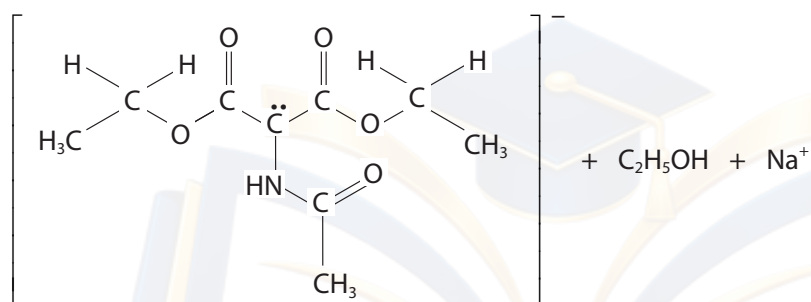


(d) Alanine can be synthesised as shown.

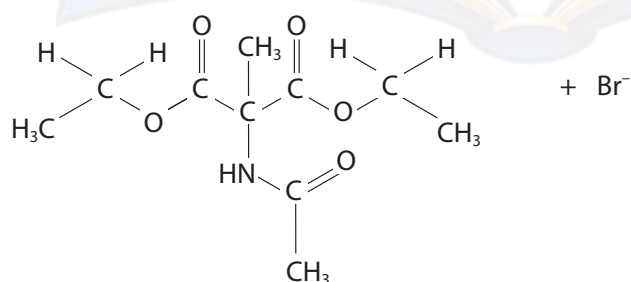


Compound **X**

Step 1 $\text{C}_2\text{H}_5\text{O}^-\text{Na}^+$

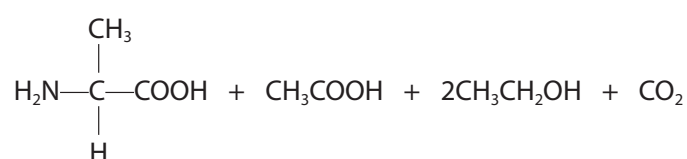


Step 2 CH_3Br



Compound **Y**

Step 3



- (i) Sodium ethoxide, $\text{C}_2\text{H}_5\text{ONa}$, needed in Step 1, is formed by the reaction of sodium with ethanol.

Write the equation for this reaction.
State symbols are not required.

(1)

- (ii) Name the **two** functional groups present in Compound **Y**.

(2)

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.....

- (iii) Give the reagent needed and conditions required for Step 3.

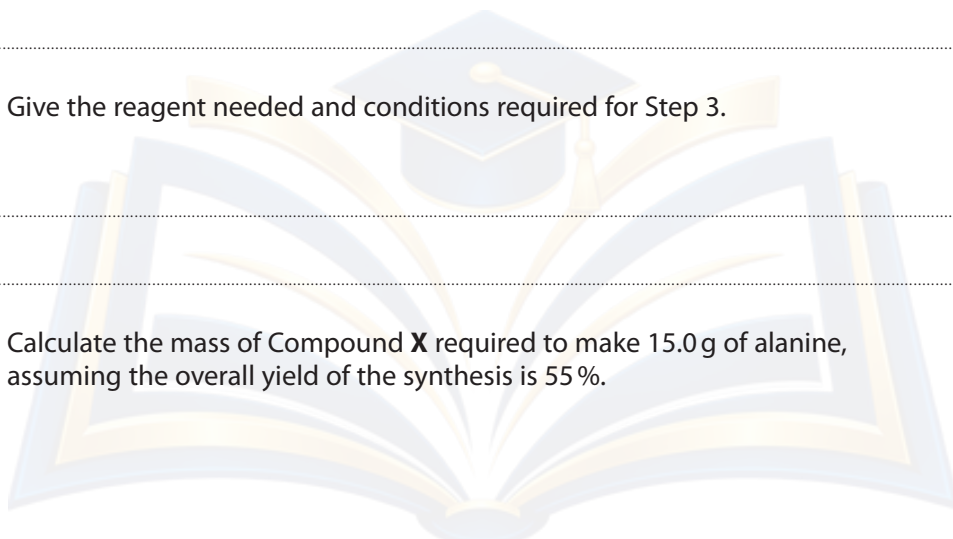
(2)

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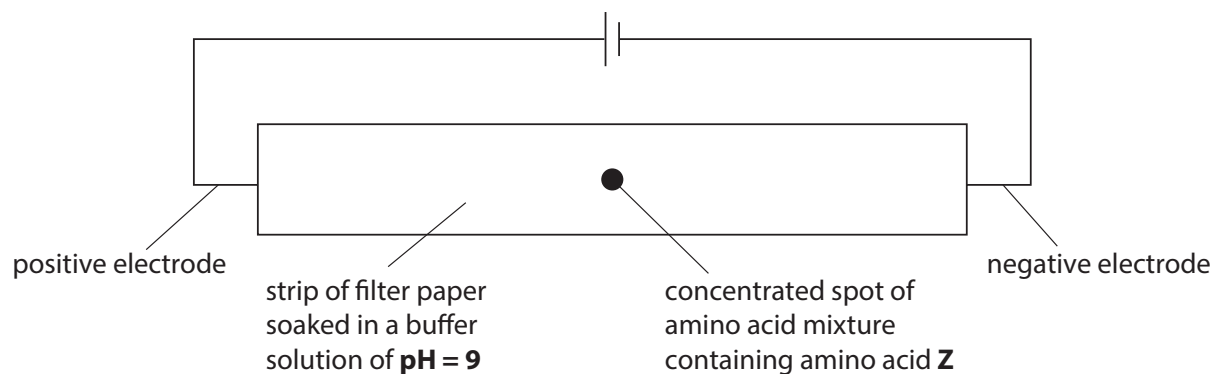
- (iv) Calculate the mass of Compound **X** required to make 15.0 g of alanine, assuming the overall yield of the synthesis is 55 %.

(3)

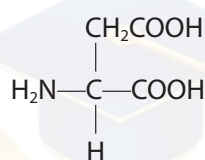


- (e) A mixture of amino acids can be separated using a technique called paper electrophoresis. A simplified diagram is shown.

The movement of the amino acid on the paper depends on any charge on the amino acid, and this is determined by the pH of the buffer solution.



Amino acid **Z** has the structure shown.



amino acid **Z**

Explain in which direction, if any, amino acid **Z** would move when a current flows in the circuit with a buffer solution of pH = 9.

(2)

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(Total for Question 8 = 16 marks)



MARK SCHEMES

official Edexcel mark schemes



Question Number	Acceptable Answers	Additional Guidance	Mark
3(a)	2,6-diaminohexanoic acid	Allow 2,6-diaminehexanoic acid Ignore any additional commas or hyphens or spaces Do not award 2,6-diamminohexanoic acid	(1)

Question Number	Acceptable Answers	Additional Guidance	Mark
3(b)	- Deprotonated structure $\begin{array}{c} \text{H} \\ \\ \text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{CH}_2 - \text{C} - \text{COO}^- \\ \\ \text{NH}_2 \end{array} \quad (\text{Na}^+)$ - Protonated structure $\begin{array}{c} \text{H} \\ \\ \text{H}_3\text{N}^+\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2 - \text{C} - \text{COOH} \\ \\ ^+\text{NH}_3 \end{array} \quad (2\text{Cl}^-)$ - Ester structure $\begin{array}{c} \text{H} \\ \\ \text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{CH}_2 - \text{C} - \text{COOCH}_3 \\ \\ \text{NH}_2 \end{array}$	(1) Allow displayed /structural /condensed formulae Allow NH_2- Allow $-\text{CO}_2^-$ Allow $-\text{COONa}$ but penalise if O-Na covalent bond is shown (1) Both NH_2 groups must be protonated Allow NH_3^+- / $^+\text{H}_3\text{N}-$ Allow $-\text{CO}_2\text{H}$ (1) Allow CO_2CH_3 Allow NH_3^+- or NH_2- for each amine group Penalise wrong side chain only once If alanine used throughout then only MP3 can be awarded	(3)

Question Number	Acceptable Answers	Additional Guidance	Mark
3(c)	Any one of: $\text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{CH}_2-\overset{\text{H}}{\underset{\text{NH}_2}{\text{C}}}-\overset{\text{O}}{\parallel}\text{C}-\overset{\text{H}}{\text{N}}-\overset{\text{CH}_3}{\underset{\text{H}}{\text{C}}}-\text{COOH}$ OR $\text{H}_3\text{C}-\overset{\text{H}}{\underset{\text{NH}_2}{\text{C}}}-\overset{\text{O}}{\parallel}\text{C}-\overset{\text{H}}{\text{N}}-\overset{\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2}{\underset{\text{H}}{\text{C}}}-\text{COOH}$ OR $\text{H}_3\text{C}-\overset{\text{H}}{\underset{\text{NH}_2}{\text{C}}}-\overset{\text{O}}{\parallel}\text{C}-\overset{\text{H}}{\text{N}}-\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2-\overset{\text{H}}{\underset{\text{NH}_2}{\text{C}}}-\text{COOH}$	Must be the dipeptide and not the repeat unit Allow $-\text{CO}_2\text{H}$ Allow $-\text{H}_2\text{N}$ Allow $-\text{CONH}-$ / $-\text{COHN}-$ unless C-H-N Allow zwitterions or cyclic dipeptides Allow skeletal / part-skeletal formulae	(1)

Question Number	Acceptable Answers	Additional Guidance	Mark
3(d)	An explanation that makes reference to the following points: (In acidic conditions) lysine (ion) has two positive charges (whereas alanine has only one) (1) (So lysine ion has) has greater attraction for the stationary phase (1)	Ignore comments on retention time, solubility, polarity, dipoles or intermolecular forces Allow 'greater positive charge' Allow lysine has 2 NH₂ groups that can be protonated Allow 'greater affinity for stationary phase' 'adheres better to stationary phase' 'better adsorption onto stationary phase' Allow 'polar phase' for 'stationary phase' Allow reverse argument for alanine Mark points M1 and M2 independently	(2)

(Total for Question 3 = 7 marks)

Question Number	Answer	Additional Guidance	Mark
6(a)	An answer that makes reference to the following point: • each component in the mixture is attracted to mobile and stationary phases but more strongly to one than to the other	Allow affinity for 'attracted to' Allow different for 'more strongly' Allow solvent for mobile phase Do not allow reference to reacting with either of the phases	(1)

Question Number	Answer	Additional Guidance	Mark
6(b)(i)	An answer that makes reference to the following point: • two of the amino acids present are the same	Ignore one amino acid has not moved from the original pencil line Ignore one amino acid is still 'seen' Ignore one amino acid is still present on the original pencil line Ignore one amino acid is insoluble	(1)

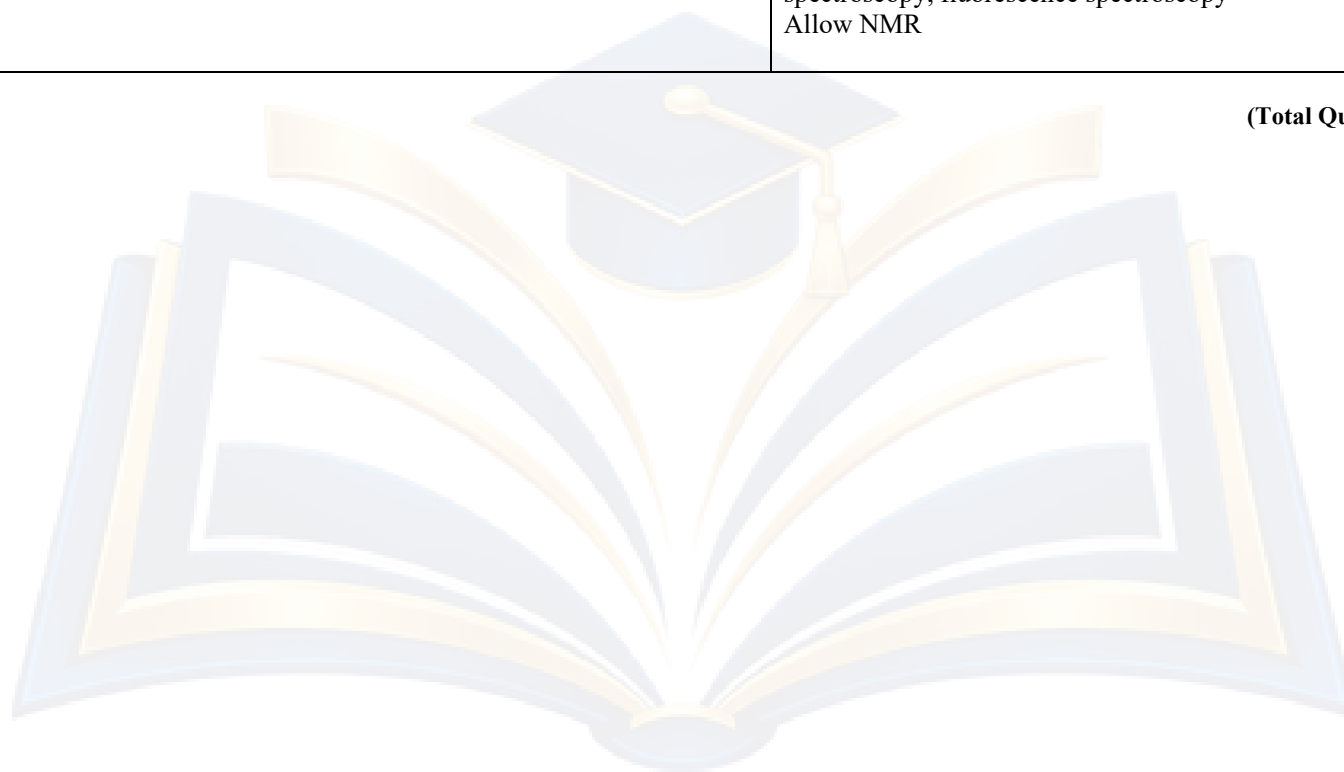


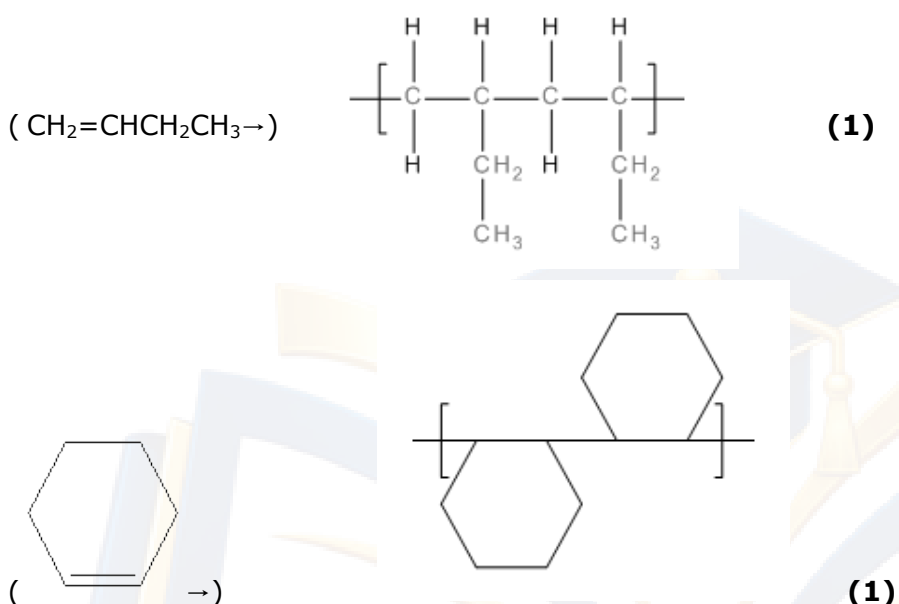
Question Number	Answer	Additional Guidance	Mark
6(b)(ii)	3 spots moved in correct (horizontal) position for solvent 1 (1) 3 spots moved in correct (vertical) position for solvent 2 (1) - labelling of alanine, glycine and valine provided in correct R_f position for M1 or M2 (1)	Allow a tolerance of $\pm \frac{1}{4}$ 0.25 of a square within each large square Any alterations to the grid dimensions scores (0) Example of suitable diagram	(3)

Question Number	Answer	Additional Guidance	Mark
6(b)(iii)	An answer that makes reference to the following point: ninhydrin	Allow phosphomolybdic acid (commonly referred to as PMA) or <i>p</i>-anisaldehyde or cerium molybdate (Hanessian's stain) or bromocresol green	(1)

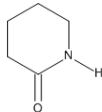
Question Number	Answer	Additional Guidance	Mark
6(c)	An answer that makes reference to the following point: • mass spectrometry	Allow mass spectroscopy Allow just 'MS' Allow mass spec Allow infrared spectroscopy, UV spectroscopy, visible spectroscopy, fluorescence spectroscopy Allow NMR	(1)

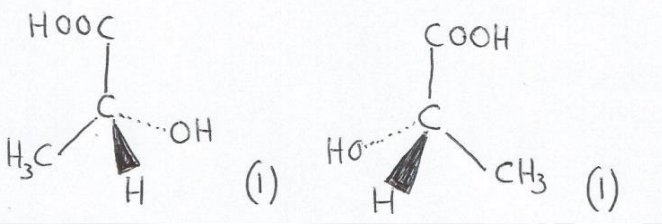
(Total Question 6 = 7 marks)



Question Number	Answer	Additional Guidance	Mark
6(a)	(CH₂=CHCH₂CH₃→) (1) 	Accept skeletal, structural or displayed formulae or combination of which is clear, e.g. -C₂H₅ Brackets are not essential Ignore 'n' Ignore orientation of side chains Ignore bond length Ignore where bond goes to for the ethyl groups Penalise lack of 'end-bonds' once only Award 1 mark max if only one repeat unit given for each polymer Ignore more than 2 repeat units	(2)

Question Number	Answer	Additional Guidance	Mark
6(b)	- HOOC — (CH₂)₄ — COOH or ClOC — (CH₂)₄ — COCl - H₂N — (CH₂)₄ — NH₂ (1) (1)	Accept skeletal, structural or displayed formulae Penalise use of C₄H₈ once only Penalise missing H's once only The monomers can be in either order Do not award monofunctionality	(2)

Question Number	Answer	Additional Guidance	Mark
6(c)	$\text{H}_2\text{N} - (\text{CH}_2)_4 - \text{COOH}$	Accept skeletal, structural or displayed formulae Allow $\text{H}_2\text{N} - (\text{CH}_2)_4 - \text{COCl}$ Ignore connectivity Allow  Allow use of C_4H_8 here only Penalise missing hydrogens	(1)

Question Number	Answer	Additional Guidance	Mark
6(d)(i)	Allow 	Diagram must be 3-dimensional with either wedges or dashes to score 2 marks Ignore orientation of group at the top Ignore vertical bond to H of OH group	(2)

Question Number	Answer	Additional Guidance	Mark
6(d)(ii)	They rotate the plane of plane-polarised light (equally) and in opposite/different directions OR Determine in which direction they rotate the plane of plane-polarised light	Allow one plane	(1)

Question Number	Answer	Additional Guidance	Mark
6(d)(iii)	Does not accumulate in the environment/does not occupy landfill	Accept answers that outline the benefit of avoiding other means of disposal such as incineration, use of toxic chemicals Ignore just less harm to environment/less harm to animal life/less pollution/less of an "eyesore"/less energy to break it down	(1)

(Total for Question 6 = 9 marks)



Question Number	Answer	Additional Guidance	Mark
9(a)	An answer that makes reference to (similarity) both are reduction reactions (1) (difference 1) reagents for preparation of phenylamine are tin and (conc.) hydrochloric acid (1) (difference 2) reagents for preparation of butylamine are either Hydrogen gas and nickel catalyst or lithium tetrahydridoaluminate(III) and (dry) ether (1)	Ignore both require hydrogen Allow Iron for tin Do not award dilute hydrochloric acid/ sulfuric acid Lithium aluminium hydride / Lithal / LiAlH_4	(3)

Question Number	Answer	Additional Guidance	Mark
9(b)	An answer that makes reference to: (similarity) both are basic because they have a lone pair of electrons on the nitrogen atom which accepts a proton (1) (difference 1) in $\text{C}_6\text{H}_5\text{NH}_2$ the lone pair of electrons of the nitrogen atom becomes incorporated with the delocalised ring of electrons and so is less able to accept a proton hence a weaker base (1) (difference 2) the alkyl group/ C_4H_9 is electron-releasing / positively inductive and means the lone pair of electrons of the nitrogen atom are more able to accept a proton hence a stronger base (1)	Diagrams can be used to score Comparison of basicity/nitrogen's lone pair of electrons/proton acceptance only need to be mentioned once.	(3)

Question Number	Answer	Additional Guidance	Mark
9(c)	- equation (1) - name (1)	$\text{C}_2\text{H}_5\text{COCl} + \text{C}_5\text{H}_{11}\text{NH}_2 \rightarrow \text{C}_2\text{H}_5\text{CONHC}_5\text{H}_{11} + \text{HCl}$ or  Allow skeletal/structural/combination of formulae Allow $\text{C}_2\text{H}_5\text{COCl} + 2\text{C}_5\text{H}_{11}\text{NH}_2 \rightarrow \text{C}_2\text{H}_5\text{CONHC}_5\text{H}_{11} + \text{HCl} + \text{C}_5\text{H}_{11}\text{NH}_3\text{Cl}$ Do not award molecular formulae N-pentylpropanamide Do not award N-pentylpropylamine	(2)

Question Number	Answer	Additional Guidance	Mark
9(d)	amine monomer structure or name	$\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$ / 1,6-diaminohexane Accept any mixture of displayed, structural or skeletal formulae Do not award molecular formulae or $\text{H}_2\text{N C}_6\text{H}_{12} \text{NH}_2$ If name and formula given then both must be correct	(1)

(Total Question 9 = 9 marks)

Question Number	Answer	Additional Guidance	Mark
		Example of reaction mechanism	(4)



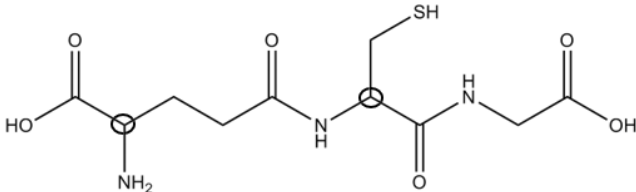
Question Number	Answer	Additional Guidance			Mark			
9(a)	• number of peaks in first product (1) • number of peaks in second product (1)	<table><tr><td>Number of peaks in the ¹³C NMR spectrum</td><td>4</td><td>6</td></tr></table>			Number of peaks in the ¹³ C NMR spectrum	4	6	(2)
Number of peaks in the ¹³ C NMR spectrum	4	6						



Question Number	Answer	Additional Guidance	Mark
9(b)	- calculate amount paracetamol (1) - calculate mass of phenol if 100% yield (1) - calculate mass of phenol taking into account overall yield (1) OR - Target mass of paracetamol, accounting for % yield (1) - Target moles of paracetamol, accounting for % yield (1) - calculate mass of phenol taking into account overall yield (1)	<u>Example of calculation</u> $1000 \div 151 = 6.6225 \text{ (mol)}$ $6.6225 \times 94.0 = 622.52 \text{ (g)}$ $622.52 \times (100 \div 19.04) = 3269.5 \text{ g} = 3.27 \text{ kg}$ OR $1000 \times 100 \div 19.04 = 5252.1 \text{ (g)}$ $5252.1 \div 151 = 34.782 \text{ (mol)}$ $34.782 \times 94 = 3269.5 \text{ (g)} = 3.27 \text{ kg}$ NOTE overall % yield is $0.32 \times 0.85 \times 0.7 = 19.04 \%$ Allow full marks for final answer calculated from intermediate values rounded to 2 or more SF e.g. 3.28 from 19.0 and 622.5 Allow TE throughout Ignore SF except 1 SF Correct answer with no working scores (3)	(3)



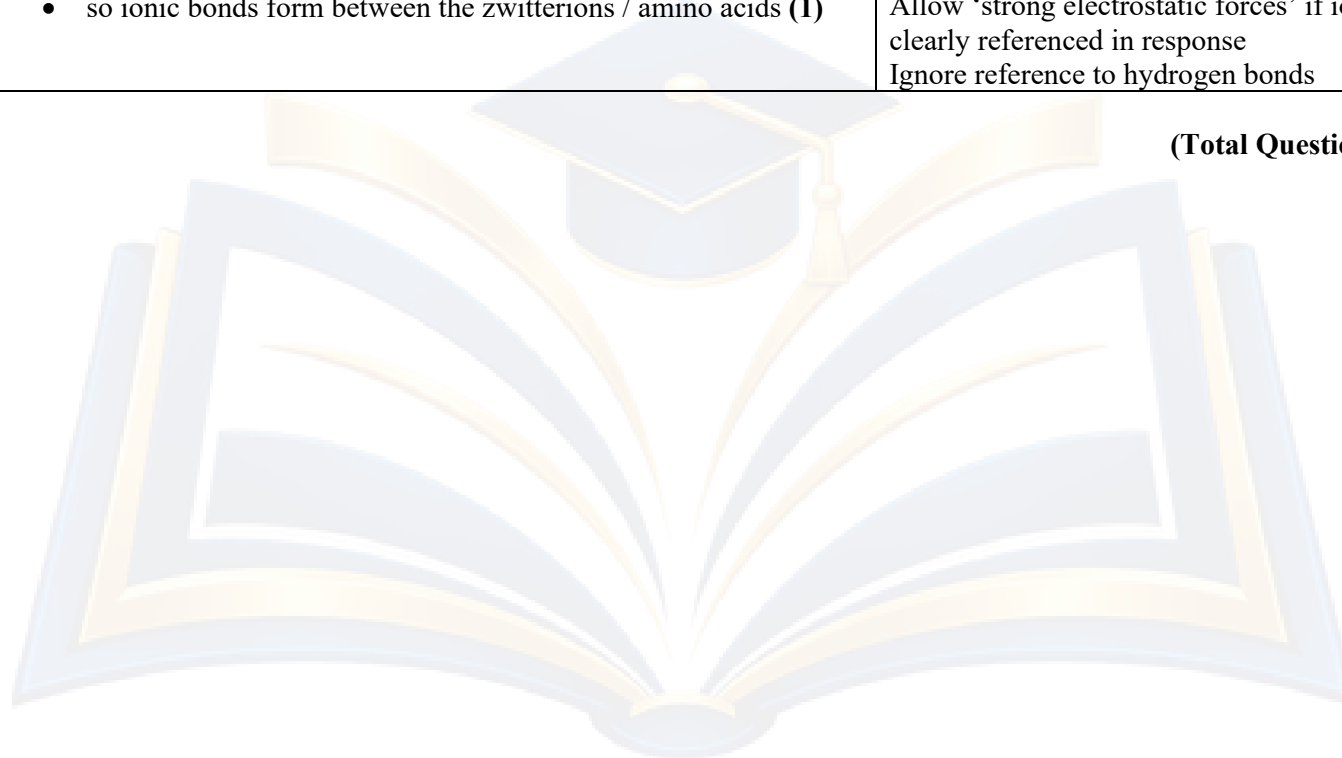
Question Number	Answer	Mark
9(c)(i)	The only correct answer is C (oxidation) <i>A is incorrect as there is no evidence the species have added to the benzene ring</i> <i>B is incorrect as there is no evidence of chemical breakdown due to reaction with water</i> <i>D is incorrect as the -NH group and -OH group have lost hydrogen atoms</i>	(1)

Question Number	Answer	Additional guidance	Mark
9(c)(ii)	both carbon atoms circled	 Allow any other labelling e.g. asterisk / arrow Do not award additional incorrect carbon atoms	(1)

Question Number	Answer	Mark
9(c)(iii)	The only correct answer is B (glutamic acid and cysteine) <i>A is incorrect as aspartic acid has only 4 carbon atoms</i> <i>C is incorrect as the sulfur atom in methionine has a methyl group attached</i> <i>D is incorrect as the sulfur atom in methionine has a methyl group attached and aspartic acid has only 4 carbon atoms</i>	(1)

Question Number	Answer	Additional Guidance	Mark
9(d)	An explanation that makes reference to the following points • amino acids exist as zwitterions • so ionic bonds form between the zwitterions / amino acids	(1) maybe shown on a diagram allow (a single molecule of an amino acid) forms positive and negative ions Allow 'strong electrostatic forces' if ions clearly referenced in response Ignore reference to hydrogen bonds	(2)

(Total Question 9 = 10 marks)



Question Number	Acceptable Answer	Additional guidance	Mark
3(a)(i)	Answer to 2 SF	<u>Example of calculation:</u> $R_f = \frac{1.5}{10} = 0.15$ Allow 0.14 – 0.16 Do not award 3SF, e.g. 0.140/0.150/0.160 Do not award an answer with units	(1)

Question Number	Acceptable Answer	Additional guidance	Mark
3(a)(ii)	An answer that makes reference to the following: - serine (1) - methionine (1) (reason) one amino acid is present twice (in the tripeptide) OR Another amino acid has the same R_f value as either serine or methionine (1)	Allow for 1 mark out of the first two for F and B Allow 'there are two serine amino acids/ there are two methionine amino acids' Do not award if given with any other amino acid stated in the question Ignore reference to another amino acid not given in the table	(3)



Question Number	Acceptable Answer	Additional guidance	Mark
3(a)(iii)	An answer that makes reference to the following: - amino acids have different solubility / adsorption to the stationary phase (1) - amino acids have different solubility in the mobile phase (1)	Allow reverse arguments Do not award react with the stationary phase Allow "TLC plate" for stationary phase Allow interact with/affinity for/form different intermolecular forces with the stationary or mobile phase Allow "solvent" for mobile phase Ignore references to molecular mass/size	(2)

Question Number	Answer	Mark
3(a)(iv)	The only correct answer is C <i>A is incorrect because this is a test for starch</i> <i>B is incorrect because this is a strong acid-weak base indicator</i> <i>D is incorrect because this is a weak acid-strong base indicator</i>	(1)

Question Number	Acceptable Answer	Additional guidance	Mark
3(b)(i)	A statement that makes reference to gases are inert / do not react (with the components of the mixture)	Ignore references to intermolecular bonding / stability Do not award for not an oxidising agent	(1)



Question Number	Acceptable Answer	Additional guidance	Mark
3(b)(ii)	A sketch that includes • peak at 15 seconds and 40 seconds (1) • (peak at 15 seconds) with height at approximately twice that of the peak at 10 seconds (1) • (peak at 40 seconds with) height at approximately the same height as that of the peak at 10 seconds (1) Exemplar sketch	Penalise additional peaks Max 1 for the differences in height if both peaks are not at correct positions	(3)

(Total for Question 3 = 11 marks)



Question Number	Answer	Additional Guidance	Mark
10(a)(i)	balanced equation	<u>Example of equation</u> $\text{C}_4\text{H}_9\text{NH}_2 + \text{H}_2\text{O} \rightleftharpoons \text{C}_4\text{H}_9\text{NH}_3^+ + \text{OH}^-$ + sign can be on N Product ions must be shown as 2 species Allow arrow for $\rightleftharpoons$ Ignore state symbols even if incorrect	(1)

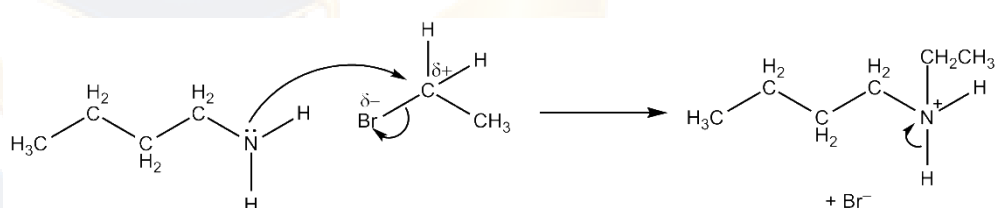
Question Number	Answer	Additional Guidance	Mark
10(a)(ii)	An explanation that makes reference to the following points - lone pair of electrons on the nitrogen atom (1) - the interaction of the lone pair and the pi electrons of the ring (1) - so less able to accept a proton (1) allow 2 possible marking points for reverse argument - butyl group pushes electrons towards lone pair on nitrogen - so it is more able to accept a proton	Allow the lone pair delocalises into the benzene ring	(3)



Question Number	Answer	Additional Guidance	Mark
10(b)	- correct name - correct formula	(1) Propanoyl chloride Allow propanoic anhydride (1) $\text{CH}_3\text{CH}_2\text{COCl}$ Allow $(\text{CH}_3\text{CH}_2\text{CO})_2\text{O}$ Allow displayed or skeletal formula Allow 1 mark for correct name and formula for propanoic acid Allow 1 mark for name and formulae of acyl chloride / acid anhydride with incorrect number of carbon atoms	(2)
Question Number	Answer		Mark
10(c)	The only correct answer is A (blue solution) <i>B is incorrect because the product is not a precipitate</i> <i>C is incorrect because the product is not yellow</i> <i>D is incorrect because the product is neither yellow nor a precipitate</i>		(1)



Question Number	Answer	Mark
10(d)(i)	The only correct answer is D (nucleophilic substitution) <i>A is incorrect because the reaction is not an addition or electrophilic</i> <i>B is incorrect because the attacking species is not an electrophile</i> <i>C is incorrect because the reaction is not an addition</i>	(1)

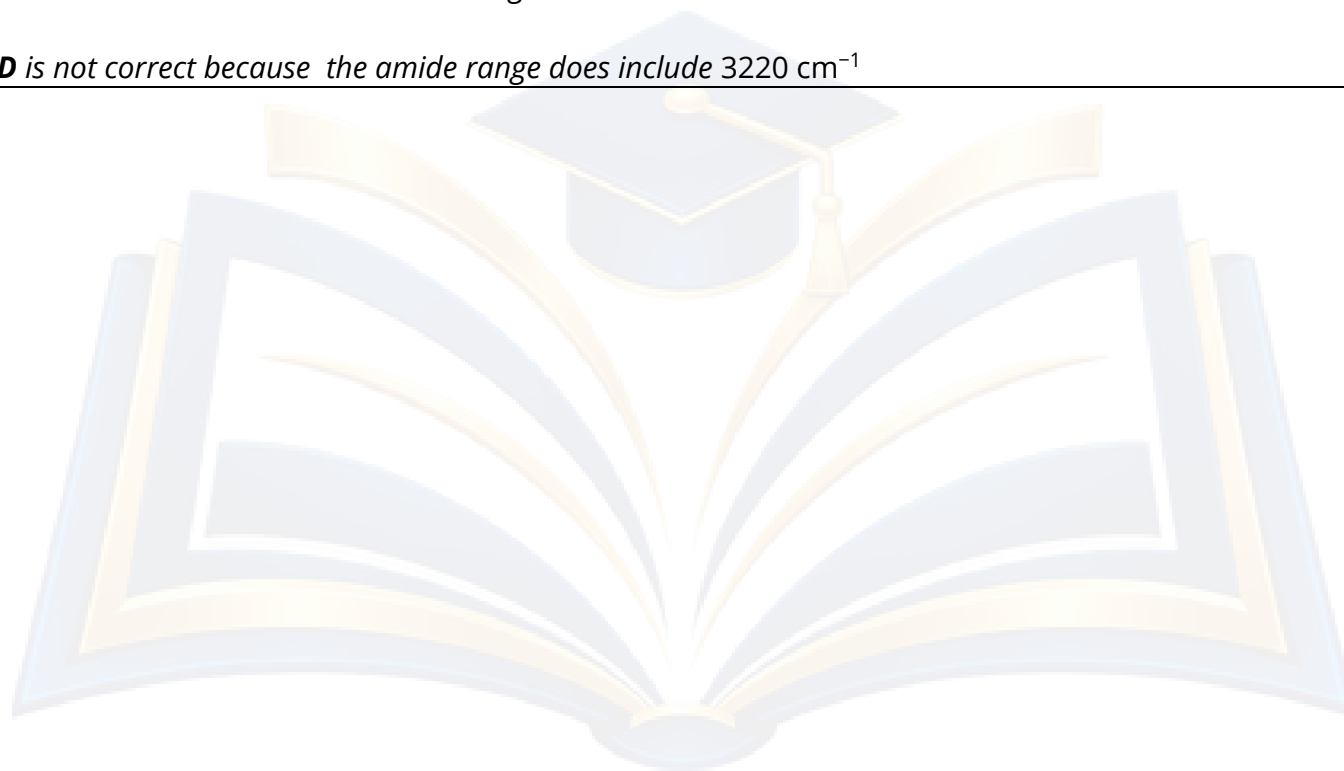
Question Number	Answer	Additional Guidance	Mark
10(d)(ii)	- arrow from lone pair on nitrogen atom to carbon atom (1) - dipole shown and arrow from C-Br bond to Br or just beyond (1) - formula of intermediate including + charge on the N atom and Br⁻ (1) - arrow from N-H bond to N⁺ (1)	 Ignore transition state Ignore arrow from Br⁻ ion to H in intermediate	(4)

(Total Question 10 = 12 marks)

Question Number	Answer	Additional Guidance	Mark
7(a)(i)	A description which includes - equation (1) - LiAlH₄ in (dry) ether (followed by dilute acid) or H₂ with Ni / Pt / Pd (1)	<u>Example of equation</u> $\text{CH}_3\text{CH}_2\text{CN} + 4[\text{H}] \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$ $\text{CH}_3\text{CH}_2\text{CN} + 2\text{H}_2 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$ Allow names or formulae but both must be correct if given together Allow Lithal Allow hydrogen to be given in the equation or written over the arrow Ignore references to heat or a temperature	(2)
Question Number	Answer	Additional Guidance	Mark
7(a)(ii)	A description which includes - equation from any halogenoalkane (1) - ethanolic/alcoholic ammonia (1) - heat and under pressure (1)	<u>Example of equation</u> $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} + \text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 + \text{HBr}$ or $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br} + 2\text{NH}_3 \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2 + \text{NH}_4\text{Br}$ Allow use of state symbol (alc)/(EtOH)/(eth) with NH₃ Allow ammonia to be given in equation or written over the arrow Accept heat and in a sealed tube Ignore mechanisms If a contradictory chemical is stated then penalise once against M2 or M3	(3)



Question Number	Answer	Mark
7(b)	The only correct answer is A (an amide) <i>B is not correct because the amine range does not include 3220 cm^{-1}</i> <i>C is not correct because the amine range does not include 3220 cm^{-1}</i> <i>D is not correct because the amide range does include 3220 cm^{-1}</i>	(1)



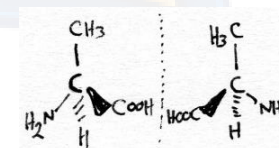
Question Number	Answer	Additional Guidance	Mark												
7(c)	This question assesses the student’s ability to show a coherent and logically structured answer with linkages and fully sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content. <table><tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr><tr><td>6</td><td>4</td></tr><tr><td>5-4</td><td>3</td></tr><tr><td>3-2</td><td>2</td></tr><tr><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td></tr></table> The following table shows how the marks should be awarded for structure and lines of reasoning	Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points	6	4	5-4	3	3-2	2	1	1	0	0	Guidance on how the mark scheme should be applied: The mark for indicative content should be added to the mark for lines of reasoning. For example, a response with four indicative marking points that is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning). If there were no linkages between the points, then the same indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and zero marks for linkages).	(6)
Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points														
6	4														
5-4	3														
3-2	2														
1	1														
0	0														



		Number of marks awarded for structure of answer and sustained lines of reasoning			
	Answer shows a coherent logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2			More than one indicative marking point may be made within the same comment or explanation Accept annotated diagrams to illustrate the indicative points
	Answer is partially structured with some linkages and lines of reasoning	1			
	Answer has no linkages between points and is unstructured	0			
					Ignore reference to other amino acid properties



	Indicative content IP1 (Similarity) - they are both 2-amino acids / alpha amino acids / naturally occurring/ zwitterions IP2 - equation for the reaction with an acid IP3 - equation for the reaction with a base IP4 - alanine has a chiral centre/ asymmetric carbon atom/ non-superimposable mirror images and glycine does not IP5 (an aqueous solution of) alanine rotates the plane (of polarisation) of plane-polarised (monochromatic) light but glycine does not IP6 - diagram to show enantiomers of alanine	The zwitterions can be evidenced from each amino acid zwitterion in an equation e.g. $\text{NH}_3^+\text{CH}(\text{CH}_3)\text{COO}^-$ / $\text{NH}_3^+\text{CH}_2\text{COO}^-$ e.g. $\text{H}^+ + \text{NH}_3^+\text{CH}_2\text{COO}^- \rightarrow \text{NH}_3^+\text{CH}_2\text{COOH}$ or $\text{H}^+ + \text{NH}_3^+\text{CH}(\text{CH}_3)\text{COO}^- \rightarrow \text{H}_3\text{N}^+\text{CH}(\text{CH}_3)\text{COOH}$ $\text{OH}^- + \text{NH}_3^+\text{CH}_2\text{COO}^- \rightarrow \text{NH}_2\text{CH}_2\text{COO}^- + \text{H}_2\text{O}$ or $\text{OH}^- + \text{NH}_3^+\text{CH}(\text{CH}_3)\text{COO}^- \rightarrow \text{NH}_2\text{CH}(\text{CH}_3)\text{COO}^- + \text{H}_2\text{O}$ Allow use of un-ionised amino acid structures If IP2 and 3 not scored then allow 1IP for a suitable description of acid and base behaviour Allow reference to four different atoms/groups bonded to central carbon for chiral centre 'Plane' must be stated at least once Wedges must be drawn e.g. Ignore angles and connectivity	
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Question Number	Answer	Additional Guidance	Mark
7(d)	An explanation which includes - lysine requires twice (the volume of HCl) (1) (because) lysine has two (basic) amine/NH_2 groups whereas serine has one (1)	Allow lysine requires 20.0 cm^3 and serine requires 10 cm^3 Allow lysine has one more (basic) / another amine/ NH_2 group Allow lysine can accept two protons whereas serine can only accept one	(2)

(Total Question 7 = 14 marks)



Question Number	Acceptable Answers	Additional Guidance	Mark
9(a)(i)	An explanation that makes reference to the following points: - glycinate ions / they do not contain a carbon atom with four different atoms / groups attached or the glycinate ion is superimposable on its mirror image (1) - so there will be no effect (on plane-polarised monochromatic light) (1)	An answer that states there will be an effect scores (0) Allow not chiral / achiral / has no enantiomers / has no asymmetric carbon atom Allow the carbon atom attached to NH₂ is only attached to 3 different atoms / groups / is not attached to 4 different atoms / groups Ignore glycinate ions are not optically active / do not exhibit optical isomerism Do not award it is a racemic mixture / there are equal amounts of the two isomers / four different molecules attached M2 is conditional on M1 Do not award the (monochromatic) light will not be polarised	(2)



Question Number	Acceptable Answers	Additional Guidance	Mark
9(a)(ii)	- correct formula of one of the copper species (1) - rest of equation correct (1)	<u>Example of equation</u> $(\text{CH}_3\text{COO})_2\text{Cu} + 2 \text{NH}_2\text{CH}_2\text{COOH} \rightarrow (\text{NH}_2\text{CH}_2\text{COO})_2\text{Cu} + 2\text{CH}_3\text{COOH}$ Allow $\text{Cu}(\text{CH}_3\text{COO})_2$ / $\text{Cu}(\text{NH}_2\text{CH}_2\text{COO})_2$ Allow both charges shown e.g. $(\text{CH}_3\text{COO}^-)_2\text{Cu}^{2+}$ Allow displayed / skeletal formulae for organic substances but not molecular formulae Ignore state symbols, even if incorrect Do not award M1 if covalent bond between Cu and O in any species but M2 can still score	(2)



Question Number	Acceptable Answers	Additional Guidance	Mark
9(a)(iii)	An answer that makes reference to any four of the following points: Student 1 / higher yield - the crystals were not dry / still damp when they were weighed (1) - there are impurities in the crystals (1) Student 2 / lower yield - reaction was incomplete (1) - not all of the copper(II) glycinate had crystallised / some is left in solution (1) - description of a specific handling loss (1)	Ignore reference to weighing errors for both students Allow the student did not subtract the mass of filter paper / product container Do not award the crystals contain water of crystallisation / are (partially) hydrated Allow a specific impurity e.g. glycine Allow the reaction reached equilibrium / side reactions occur / by-products form Ignore just 'the solution has not cooled enough' Allow any specific example e.g. some crystals left on the walls of the container / beaker / flask / lost during filtration / lost during transfer Ignore just 'transfer error' / lost when handling	(4)



Question Number	Acceptable Answers	Additional Guidance	Mark
9(b)	An explanation that makes reference to any TWO of the following points: - carbon monoxide replaces / takes the place of the oxygen molecule (1) (and may be toxic because) it binds strongly to the Fe^{2+} (ion) (1) - effect on the body (1)	Allow carbon monoxide displaces the oxygen molecule Allow ligand substitution / exchange reaction between oxygen and carbon monoxide Allow carbon monoxide forms a stronger bond / binds more tightly to / has a stronger affinity for Fe^{2+} Allow reduces the amount of oxygen that can bind to Fe^{2+} Allow carbon monoxide binds (almost) irreversibly / permanently to Fe^{2+} Allow CO forms a more stable complex ion with Fe^{2+} / has a larger equilibrium constant / K Ignore CO bonds more easily to Fe^{2+} Ignore just 'CO bonds more strongly to haemoglobin' Allow prevents oxygen being carried to the cells / organs / around the body / blood Allow reduces the amount of oxygen that can be carried to the cells / organs / around the body / blood	(2)

Question Number	Acceptable Answers	Additional Guidance	Mark												
9(c) *	This question assesses a student’s ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content. <table><tr><td>Number of indicative marking points seen in answer</td><td>Number of marks awarded for indicative marking points</td></tr><tr><td>6</td><td>4</td></tr><tr><td>5–4</td><td>3</td></tr><tr><td>3–2</td><td>2</td></tr><tr><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td></tr></table> The following table shows how the marks should be awarded for structure and lines of reasoning.	Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points	6	4	5–4	3	3–2	2	1	1	0	0	Guidance on how the mark scheme should be applied: The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points that is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning). If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).	(6)
Number of indicative marking points seen in answer	Number of marks awarded for indicative marking points														
6	4														
5–4	3														
3–2	2														
1	1														
0	0														



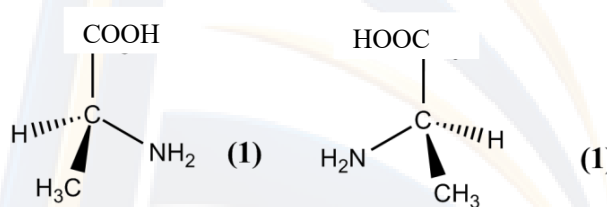
		Number of marks awarded for structure of answer and sustained line of reasoning	In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would score zero marks for reasoning.	
	Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.	2		
	Answer is partially structured with some linkages and lines of reasoning.	1		
	Answer has no linkages between points and is unstructured.	0		

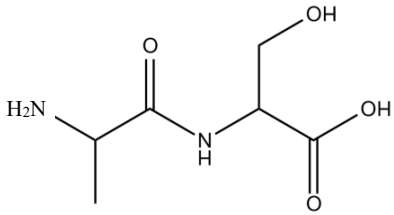
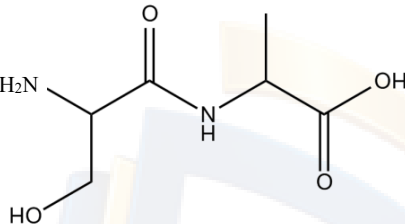
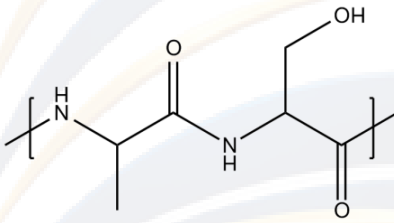
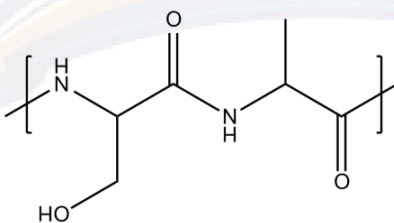
	Indicative content • IP1 - Reagents and conditions magnesium and dry ether / dry ethoxyethane / dry $(\text{CH}_3\text{CH}_2)_2\text{O}$ • IP2 - Hydrolysis of product add dilute (hydrochloric) acid / $\text{H}^+(\text{aq})$ / $\text{HCl}(\text{aq})$ (to hydrolyse the intermediate / protonate ...O–) • IP3 – Primary alcohol react with methanal to form butan-1-ol / $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ • IP4 – Secondary alcohol react with ethanal to form pentan-2-ol / $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$ • IP5 – Tertiary alcohol react with propanone to form 2-methylpentan-2-ol / $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}(\text{CH}_3)(\text{OH})\text{CH}_3$ • IP6 – Carboxylic acid react with carbon dioxide to form butanoic acid / $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$	This may be shown as part of any specific reaction. Ignore errors in an equation to make the Grignard. This only needs to be mentioned once Do not award this point if acid is clearly added at the same time as magnesium / dry ether / a reactant Allow other specific aldehydes with corresponding product Allow other specific ketones with corresponding product	
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(Total for Question 9 = 16 mark)



Question Number	Answer	Additional Guidance	Mark
8(a)(i)	An answer that makes reference to the following point: a carbon atom with four different atoms / groups (of atoms) attached	Allow resulting molecule has non-superimposable mirror images Allow a carbon atom with four different functional groups attached Ignore a carbon atom with four different species attached Do not award 'molecules' for atoms / groups	(1)

Question Number	Answer	Additional Guidance	Mark
8(a)(ii)		Allow 1 mark for 2 tetrahedral mirror images shown with only lines and no wedges / dashed lines Allow 1 mark for 2 tetrahedral mirror images shown with two similar wedges on each structure Accept dashed line for dashed wedges Ignore connectivity	(2)

Question Number	Answer	Additional Guidance	Mark
8(b)	•  (1) •  (1)	Allow 1 mark for 2 correct structures shown as structural or displayed formulae Ignore displayed NH₂, NH, or OH groups Penalise missing hydrogen atoms on amide group once only Penalise NH group shown as part of chain once only Allow 1 if both dipeptides shown as correct polymer repeat units  and 	(2)

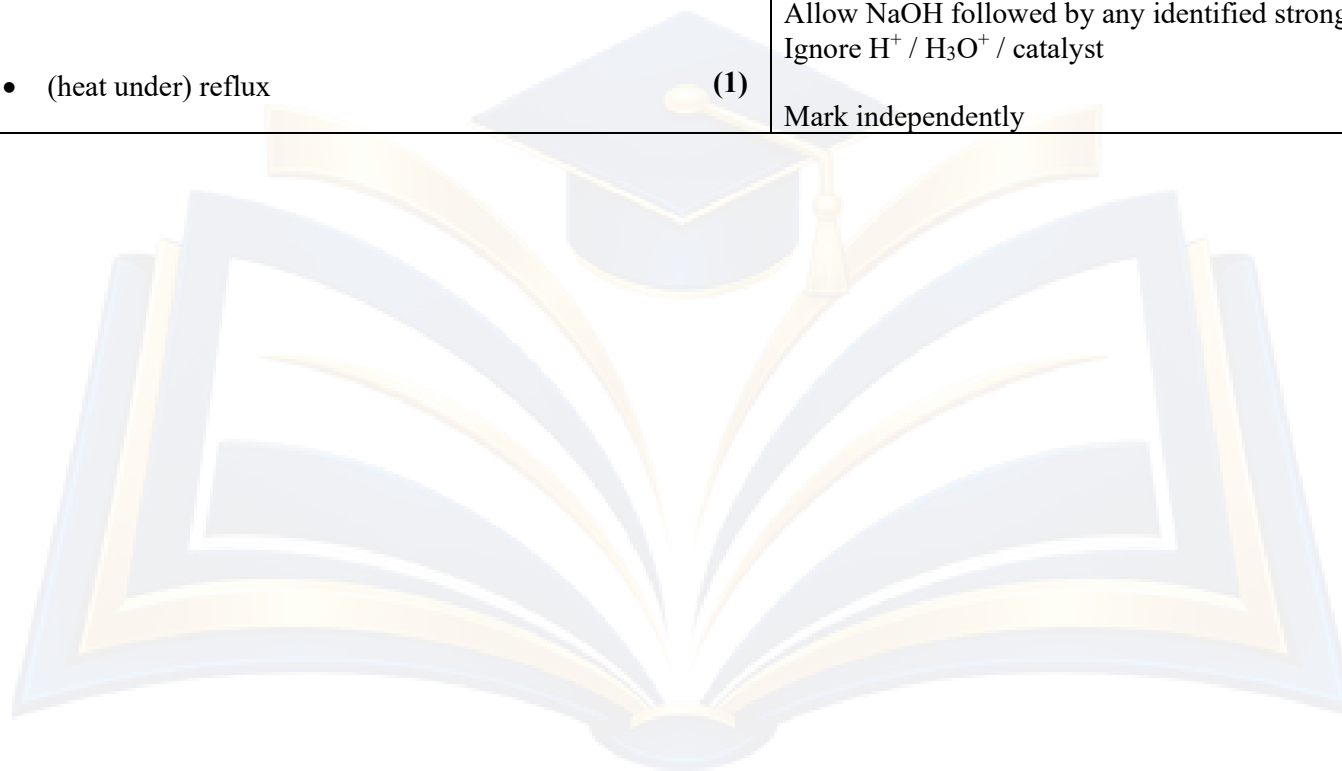
Question Number	Answer	Mark
8(c)	The only correct answer is A $\left(\begin{array}{c} \text{CH}_2\text{OH} \\ \\ \text{H}_3\text{N}^+ - \text{C} - \text{CO}_2^- \\ \\ \text{H} \end{array} \right)$ <i>B is not correct because the CO₂H group has not lost a proton</i> <i>C is not correct because the NH₂ group has not gained a proton</i> <i>D is not correct because the CH₂OH group has lost a proton</i>	(1)



Question Number	Answer	Additional Guidance	Mark
8(d)(i)	balanced equation	<u>Examples</u> $\text{C}_2\text{H}_5\text{OH} + \text{Na} \rightarrow \text{C}_2\text{H}_5\text{ONa} + \frac{1}{2}\text{H}_2$ $\text{C}_2\text{H}_5\text{OH} + \text{Na} \rightarrow \text{C}_2\text{H}_5\text{O}^-\text{Na}^+ + \frac{1}{2}\text{H}_2$ $\text{C}_2\text{H}_6\text{O} + \text{Na} \rightarrow \text{C}_2\text{H}_5\text{ONa} + \frac{1}{2}\text{H}_2$ $\text{C}_2\text{H}_6\text{O} + \text{Na} \rightarrow \text{C}_2\text{H}_5\text{O}^-\text{Na}^+ + \frac{1}{2}\text{H}_2$ Allow multiples Allow displayed / skeletal / molecular formulae Ignore state symbols even if incorrect Do not award $\text{C}_2\text{H}_5\text{OH} + \text{Na} \rightarrow \text{C}_2\text{H}_5\text{O}^\delta-\text{Na}^{\delta+} + \frac{1}{2}\text{H}_2$	(1)

Question Number	Answer	Additional Guidance	Mark
8(d)(ii)	An answer that makes reference to the following point: - ester (1) (<i>N</i>-substituted) amide (1)	If 3 answers given and 2 are correct, award 1 mark If 4 or more answers given and 2 are correct award 0 marks Ignore structures, even if incorrect	(2)

Question Number	Answer	Additional Guidance	Mark
8(d)(iii)	An answer that makes reference to the following points: - hydrochloric acid / HCl(aq) (1) (heat under) reflux (1)	Ignore references to concentrated / dilute Allow HCl Allow correct name or formulae of any strong acid e.g. HNO₃, H₂SO₄, Allow phosphoric acid / H₃PO₄ Allow NaOH followed by any identified strong acid Ignore H⁺ / H₃O⁺ / catalyst Mark independently	(2)



Question Number	Answer	Additional Guidance	Mark
8(d)(iv)	- calculation of moles of alanine (1) - scale to 100 % (1) - calculation of mass of compound X (1) OR - scale mass of alanine to 100% (1) - calculation of moles of alanine (1) - calculation of mass of compound X (1) OR - calculation of moles of alanine (1) - calculate mass of X (1) - scale to 100 % (1)	<u>Example of calculation</u> $15.0 \div 89.0 = 0.16854 \text{ (mol)}$ $0.16854 \times (100 \div 55) = 0.30644 \text{ (mol)}$ $0.30644 \times 217 = 66.496 = 66.5 \text{ g}$ $15.0 \times (100 \div 55) = 27.273 \text{ (g)}$ $27.273 \div 89.0 = 0.30644 \text{ (mol)}$ $0.30644 \times 217 = 66.496 = 66.5 \text{ g}$ $15.0 \div 89.0 = 0.16854 \text{ (mol)}$ $0.16854 \times 217 = 36.573$ $36.573 \times (100 \div 55) = 66.496 = 66.5 \text{ g}$ Correct answer no working scores 3 Ignore SF except 1 SF Allow TE throughout If no mark scored allow 1 mark for 2 correct M_r values, 89 and 217	(3)



Question Number	Answer	Additional Guidance	Mark
8(e)	An explanation that makes reference to the following points: - would move towards the positive electrode / to the left and as it will form a negative ion (1) (as basic pH means) the acid groups will both lose a proton / has two COO⁻ groups (1)	Note The negative charge on the ion and loss of both hydrogen ions from the COOH groups can both be awarded from a correct diagram of the ion Do not award zwitterion Allow the acid groups will both lose a hydrogen (ion) M2 can be awarded from diagram / amended structure in question	(2)

(Total for Question 8 = 16 marks)

