OCR A-LEVEL CHEMISTRY A

CHEMISTRY



EXAM QUESTION PACK

UNIT F324 OLD SPECIFICATION PAPERS

STEMUP

These questions belong to AQA, not to us.

The examination questions, mark schemes and examiner reports in this pack were written and published by AQA. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with AQA and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. AQA has not endorsed, approved or been involved in the production of it. AQA and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

AQA publishes its past papers, mark schemes and examiner reports free of charge. Always check the current specification at aqa.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

OCR
Oxford Cambridge and RSA

Tuesday 13 June 2017 – Afternoon

A2 GCE CHEMISTRY A

F324/01 Rings, Polymers and Analysis

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry A* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour 15 minutes

* F 3 2 4 0 1 *

* 6 7 6 5 3 1 4 3 4 2 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found inside this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means, for example, you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an Insert with this Question Paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **16** pages. Any blank pages are indicated.

© OCR 2017 [M/500/7836]
OCR is an exempt Charity

STEMUP.CO.UK

Answer **all** the questions.

1 Arenes are unsaturated hydrocarbons that undergo substitution reactions.

(a) The Kekulé model and the delocalised model have been proposed for the structure and bonding of benzene.

(i) Draw diagrams showing orbital overlap for the Kekulé model and the delocalised model.

[2]

(ii) Benzene is more resistant to reaction than expected from the Kekulé model.

Describe **two** other examples of experimental evidence which led scientists to doubt the model proposed by Kekulé.

.....

.....

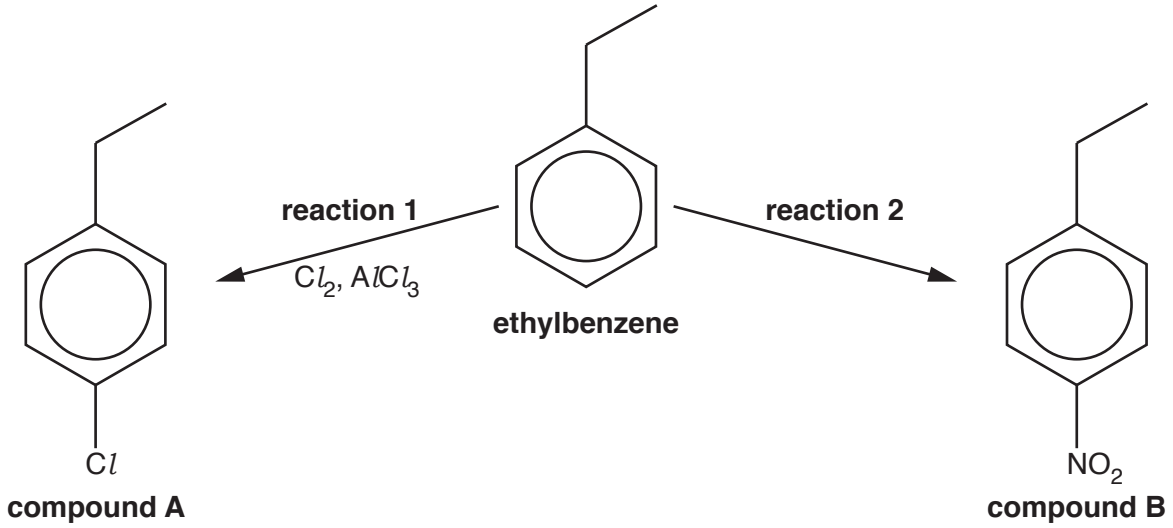
.....

.....

.....

..... **[3]**

(b) The flowchart below shows the laboratory preparation of compound **A** and compound **B** from ethylbenzene. Parts **(i)**–**(iv)** refer to structures and reactions from this flowchart.



© OCR 2017

(i) Predict the number of peaks in the carbon–13 NMR spectrum of compound **A**.

..... **[1]**

(ii) Compound **A** is formed in **reaction 1** by reacting ethylbenzene with chlorine in the presence of an $AlCl_3$ catalyst.

Explain, with the aid of curly arrows, the mechanism for the formation of compound **A** in **reaction 1**.

Your answer should show how $AlCl_3$ behaves as a catalyst.

[5]

(iii) State the reagents and conditions required for the preparation of compound **B** from ethylbenzene in **reaction 2**.

..... **[1]**

(iv) 2.65 g of ethylbenzene is converted into compound **B** in **reaction 2**.

2.31 g of compound **B** is formed.

Calculate the percentage yield of compound **B**.

Give your answer to **three** significant figures.

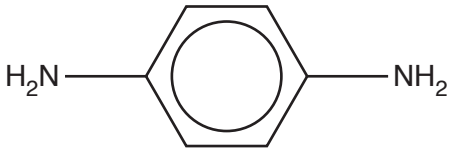
percentage yield of compound **B** = ... % **[3]**

[Total: 15]

© OCR 2017

STEMUP.CO.UK

2 Diamines such as benzene-1,4-diamine can be used to make polyamides.



benzene-1,4-diamine

(a) Benzene-1,4-diamine reacts with acids to form salts.

Explain how benzene-1,4-diamine is able to react with acids.

.....

.....

..... **[1]**

(b) Benzene-1,4-diamine can be prepared by the reduction of 1,4-dinitrobenzene.

(i) State the reagents and conditions used for this reduction.

.....

..... **[1]**

(ii) Write an equation for the formation of benzene-1,4-diamine from 1,4-dinitrobenzene.

Use **[H]** to represent the reducing agent.

[1]

© OCR 2017

STEMUP.CO.UK

(c) Kevlar™ is a polyamide that can be made by reacting benzene-1,4-diamine and benzene-1,4-dicarboxylic acid.

(i) Polyamides are condensation polymers.

State what is meant by a *condensation polymer*.

.....

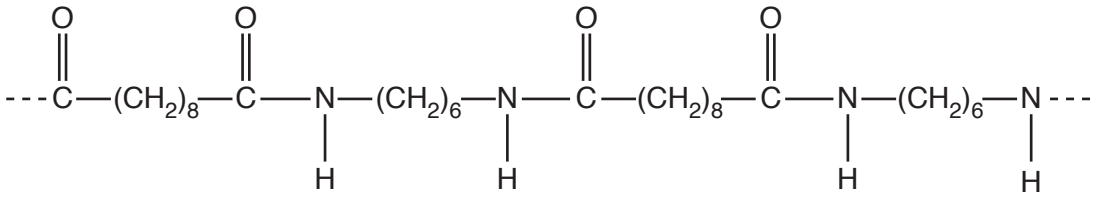
.....

..... **[1]**

(ii) Draw the structure of the repeat unit in Kevlar™.

[2]

(d) A short section of polyamide **C** is shown below.



polyamide C

(i) What is the empirical formula of the repeat unit in polyamide **C**?

..... **[1]**

(ii) Draw the structures of **two** monomers that could be used to make polyamide **C**.

[2]

[Total: 9]

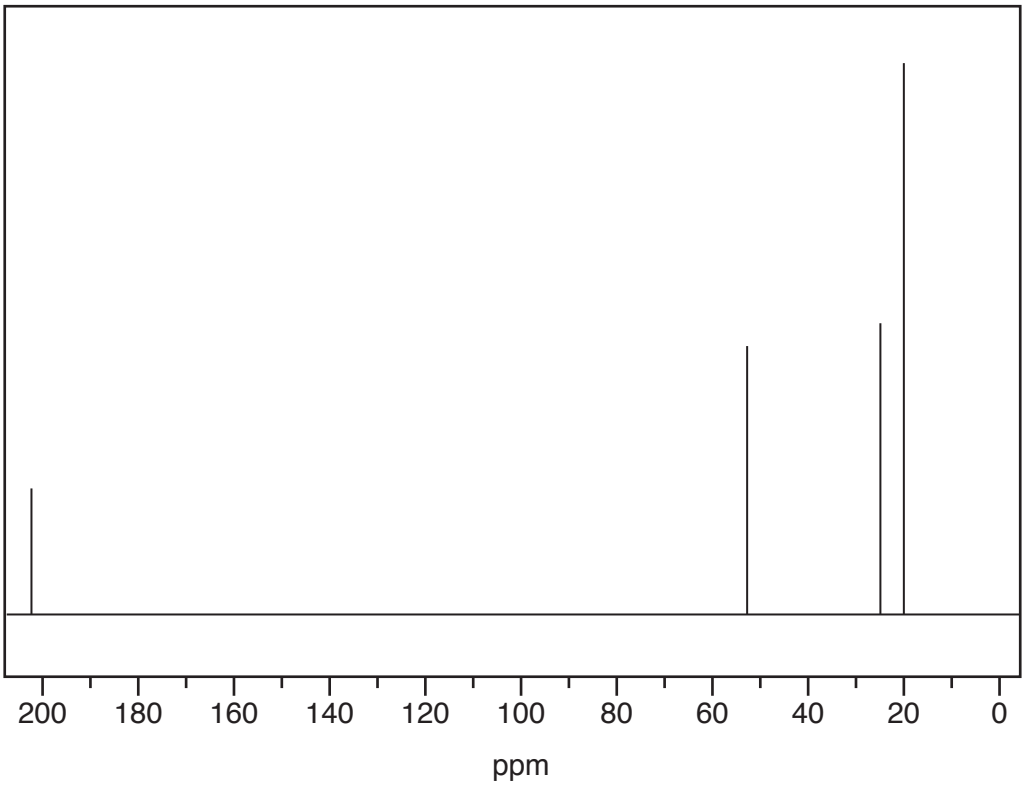
© OCR 2017

STEMUP.CO.UK

3 Compound **D** and compound **E** are carbonyl compounds with the molecular formula $C_5H_{10}O$.

(a) Compound **D** reacts with Tollens' reagent to form a silver mirror.

The ^{13}C NMR spectrum of compound **D** is shown below.



Use this information to deduce the structure of compound **D**.

Explain your reasoning.

.....

.....

.....

.....

..... **[3]**

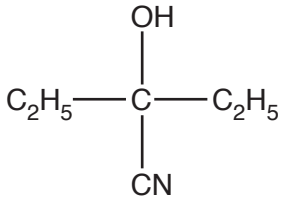
© OCR 2017

STEMUP.CO.UK

(b) Carbonyl compounds react with cyanide ions, $^{-}$**:**CN, in the presence of dilute acid.

This is a nucleophilic addition reaction in which $^{-}$**:**CN, acts as a nucleophile.

Compound **E** reacts with $^{-}$**:**CN and H^{+} to form the organic compound shown below.



Identify compound **E** and suggest the mechanism for this reaction.

Use curly arrows and show relevant dipoles.

[4]

[Total: 7]

© OCR 2017

STEMUP.CO.UK

4 The general formula of an α-amino acid is $RCH(NH_2)COOH$.

(a) Draw 3-D diagrams for the two optical isomers of the α-amino acid serine, where R is CH_2OH.

[2]

(b) Compound **F**, $C_4H_7O_2Br$, is one of two optical isomers.

Compound **F** reacts with excess ethanolic ammonia to form the α-amino acid **G**.

Compound **H** has *E/Z* isomers and can be converted into compound **F** by addition of HBr.

Compound **H** forms polymer **I**, which has the empirical formula C_2H_3O.

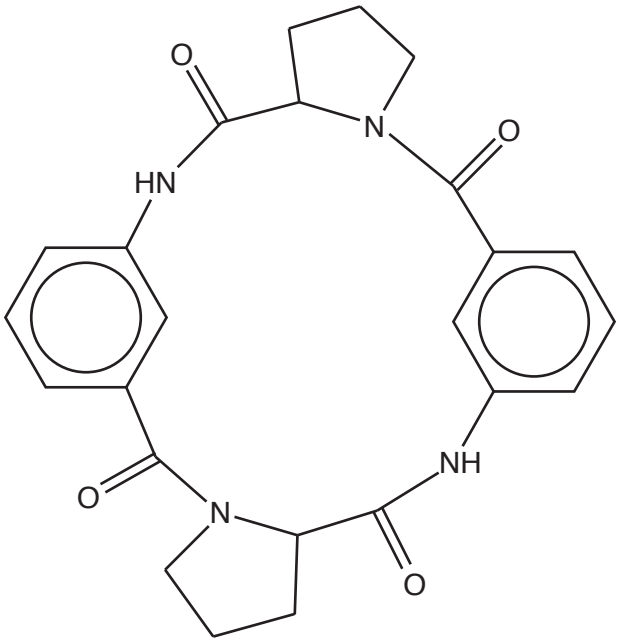
- Suggest structures for compound **F**, compound **G** and compound **H**.
- Draw a repeat unit of polymer **I**.
- State the type of reaction for the formation of **F** and for the formation of **G**.

[6]

© OCR 2017

STEMUP.CO.UK

(c) A cyclic tetrapeptide has been synthesised from 3-aminobenzoic acid and an amino acid.



cyclic tetrapeptide

The cyclic tetrapeptide is hydrolysed by heating under reflux with aqueous sodium hydroxide.

Draw the structures of **two** organic products formed by the complete alkaline hydrolysis of the cyclic tetrapeptide.

[3]

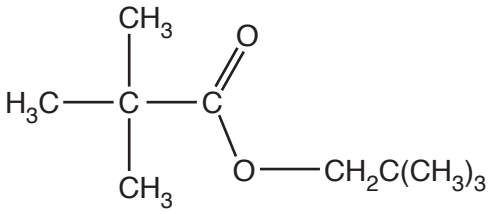
[Total: 11]

© OCR 2017

STEMUP.CO.UK

5 A chemist prepares and analyses some esters.

(a) The chemist decides to synthesise the ester shown below.



The **only** organic compound available to the chemist is 2,2-dimethylpropanal, $(CH_3)_3CCHO$.

Explain how the chemist is able to synthesise this ester using only 2,2-dimethylpropanal and standard laboratory reagents. Include conditions and relevant equations.

In your answer, you should use appropriate technical terms spelt correctly.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[7]**

© OCR 2017

STEMUP.CO.UK

(b) A mixture of esters is separated and identified using gas chromatography, GC.

Explain the possible limitations of GC in both the separation and the identification of esters.

.....

.....

.....

.....

.....

..... **[2]**

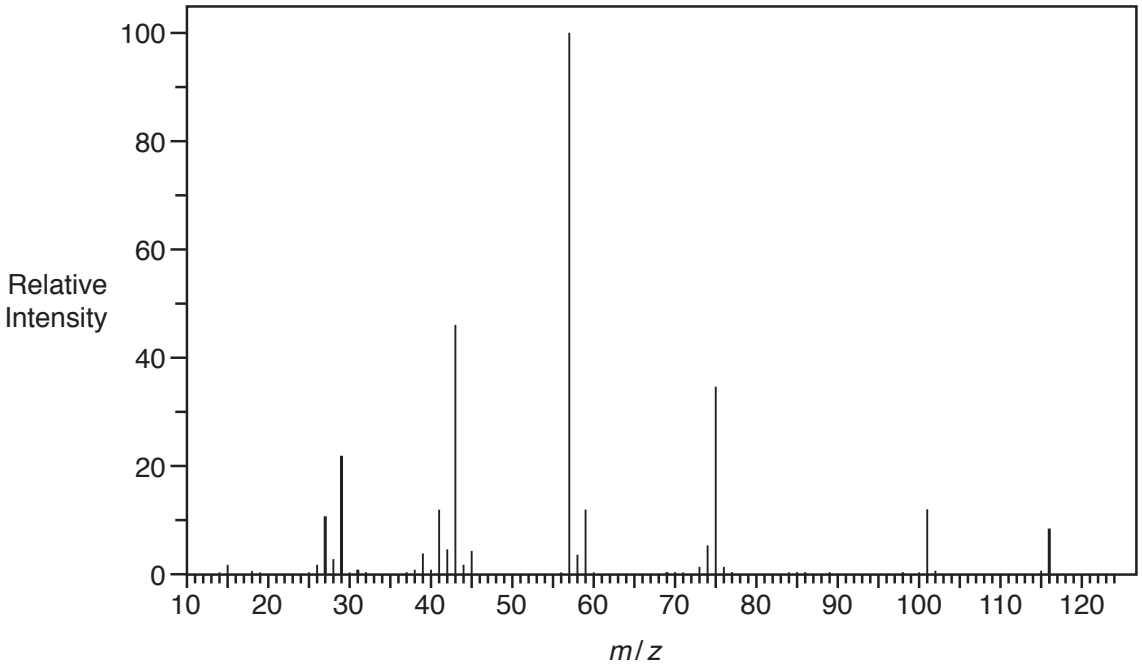
© OCR 2017

STEMUP.CO.UK

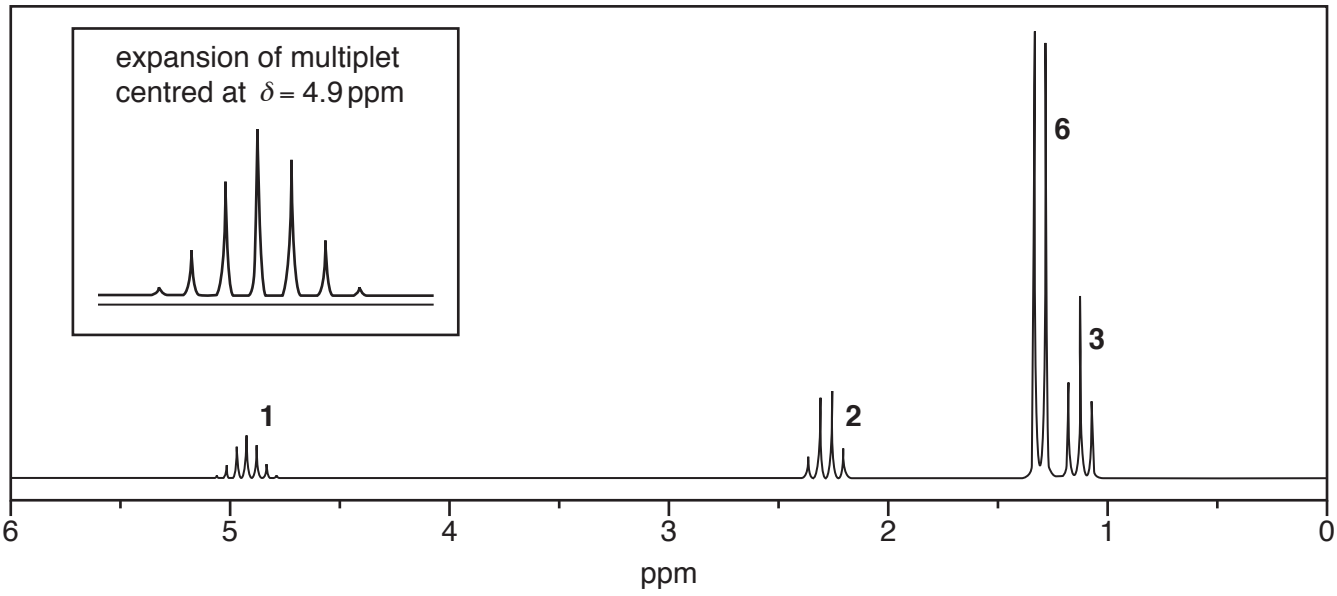
(c) The results of the analysis of an ester are shown below.

Elemental analysis by mass
C, 62.07%; H, 10.34%; O, 27.59%

Mass spectrum



Proton NMR spectrum
The numbers by each peak are the relative peak areas.



The peak centred at $\delta = 4.9$ ppm would normally be expected at a chemical shift value about 1 ppm to the right, i.e. 3.9 ppm.

© OCR 2017

Use the results to identify the ester. Show **all** your reasoning.

In your answer you should use appropriate technical terms spelled correctly.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[9]**

[Total: 18]

END OF QUESTION PAPER

© OCR 2017

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

© OCR 2017

© OCR 2017

OCR
Oxford Cambridge and RSA

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2017

OCR
Oxford Cambridge and RSA

GCE

Chemistry A

Unit **F324:** Rings, Polymers and Analysis

Advanced GCE

Mark Scheme for June 2017

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

© OCR 2017

Annotations

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

STEMUP.CO.UK

Subject-specific Marking Instructions

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

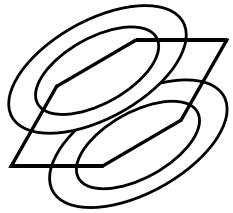
- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

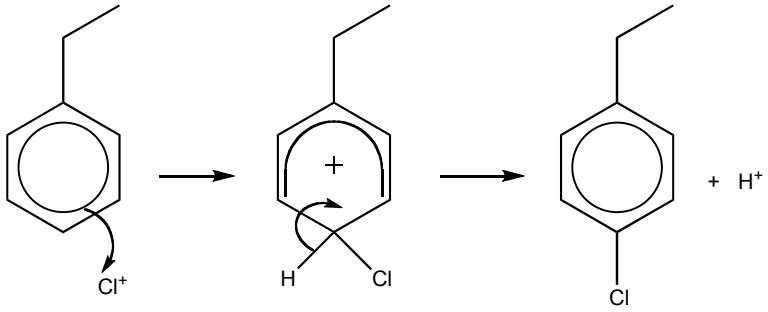
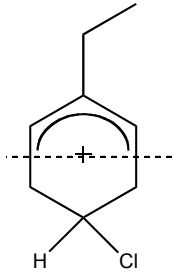
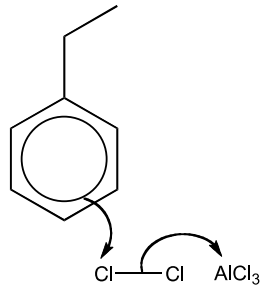
You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

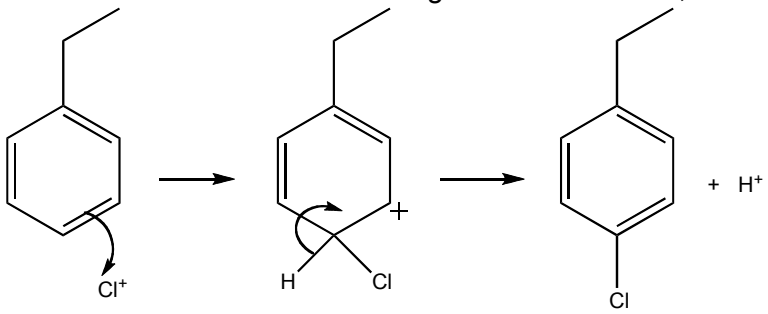
STEMUP.CO.UK

Question			Answer	Marks	AO element	Guidance
1	(a)	(i)	 ✓  ✓	2	AO1 AO1	Diagrams must show the full ring Labels not required Diagram shows correct position of localised π-bonds/π-electrons **OR** correct position of p-orbital overlap Diagram shows correct position of delocalised π-bonds/π-electrons **OR** correct position of p-orbital overlap **IGNORE** C=C in diagram **IGNORE** initial diagrams showing p-orbitals
		(ii)	**Maximum of 3 marks** **Bond lengths:** *up to 2 marks* All carbon–carbon bonds the same length ✓ Bond length intermediate/between (short) C=C and (long) C–C ✓ **Enthalpy change of hydrogenation:** *up to 2 marks* ΔH hydrogenation different from that expected ✓ ΔH less exothermic than expected (when compared to ΔH hydrogenation for cyclohexene) ✓	3	AO1 AO1 AO1	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **IGNORE** any reference to reactivity **DO NOT ALLOW** ΔH halogenation/hydration
	(b)	(i)	6 ✓	1	AO2	

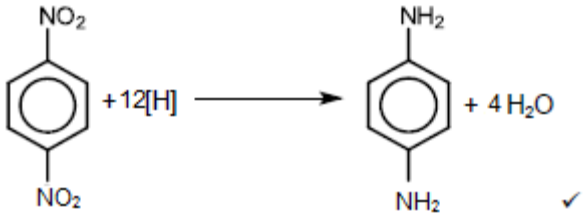
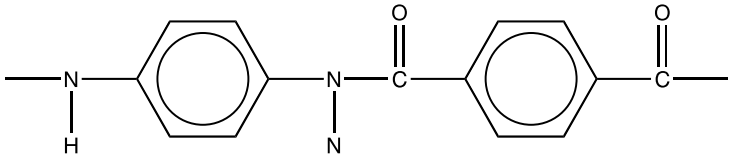
STEMUP.CO.UK

Question			Answer	Marks	AO element	Guidance
	(b)	(ii)	$AlCl_3 + Cl_2 \rightarrow AlCl_4^- + Cl^+$ ✓	5	AO1	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **NOTE**: If Br^+ is used, **DO NOT ALLOW** 1st mechanism mark but other marks available by **ECF** **NOTE** Absence of C_2H_5 OR wrong position of C_2H_5 loses intermediate mark
						
			Curly arrow from π bond to Cl^+ ✓		AO1	**DO NOT ALLOW** the following intermediate:  • π-ring must be more than halfway way down **AND** • Arc must be the right way up (i.e. gap towards C–Cl) **ALLOW** + sign anywhere within hexagon of intermediate
			Correct intermediate ✓		AO2	
			Curly arrow from C–H bond back to reform ring ✓		AO2	
			$H^+ + AlCl_4^- \rightarrow AlCl_3 + HCl$ ✓ **Note**: 1st curly arrow should start within the ring or on the ring		AO1	**ALLOW** mechanism with Cl–Cl---$AlCl_3$ for 1st two marks, i.e. 

STEMUP.CO.UK

Question			Answer	Marks	AO element	Guidance
			NOTE: **ALLOW** mechanism using Kekulé structures, i.e. 			Refer alternative mechanisms to TL for discussion.
		(iii)	HNO_3 **AND** H_2SO_4 ✓	**1**	AO3	**IGNORE** temperature **IGNORE** catalyst 'concentrated' **not** required for HNO_3 or H_2SO_4 but **DO NOT ALLOW** dilute HNO_3 or dilute H_2SO_4
		(iv)	**IF answer = 61.2% award 3 marks** moles of ethylbenzene used = 2.65/106 = 0.025(0) (mol) ✓ moles of **B** formed = 2.31/151 = 0.0153 (mol) ✓ yield = 0.0153/0.0250 × 100 = 61.2% ✓	**3**	AO2 AO2 AO2	0.0250 mol is exact calculator value 0.0153 mol must be to at least 3sf (calculator value 0.015298013) The final answer must be to 3 SF (calculator value gives 61.1920529%) (rounding of moles of **B** gives 61.2% exactly) **ALLOW ECF** from incorrect M_r or moles unless the yield is > 100%
			Total	**14**		

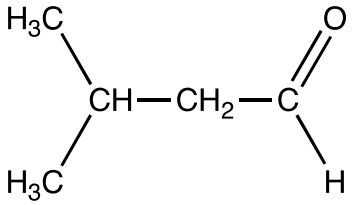
STEMUP.CO.UK

Question			Answer	Marks	AO element	Guidance
2	(a)		nitrogen electron pair **OR** nitrogen lone pair accepts a proton/H^+ ✓	1	AO1	**DO NOT ALLOW** nitrogen/N lone pair accepts hydrogen (proton/H^+ required) **ALLOW** nitrogen donates an electron pair/lone pair to H^+ **IGNORE** NH_2 group donates electron pair
	(b)	(i)	Sn **AND concentrated** HCl ✓	1	AO3	**IGNORE** temperature and reaction type/purpose of reagents
		(ii)	 ✓	1	AO2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **DO NOT ALLOW** H_2 instead of [H]
	(c)	(i)	**monomers** join/bond/add/react/form polymer/form chain **AND** form another product/small molecule/H_2O/HCl ✓	1	AO1	**IGNORE** 'two' when referring to monomers, *i.e.* (two) monomers…
		(ii)	 amide link ✓ correct structure ✓	2	AO2 AO2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** 'terminal' —NH— at other end 'End bonds' **MUST** be shown (solid or dotted) **IGNORE** brackets and/or *n* **ALLOW** CONH for amide link

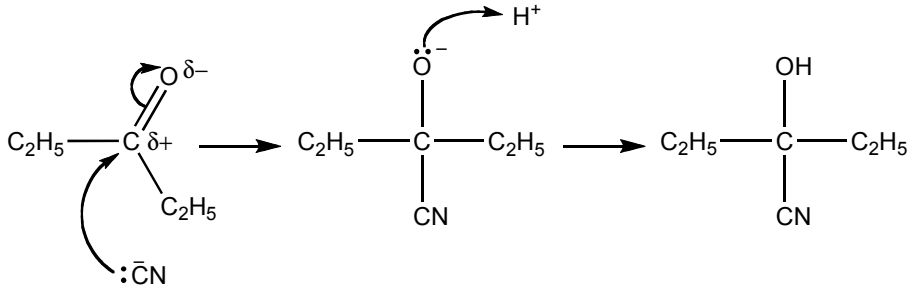
STEMUP.CO.UK

Question			Answer	Marks	AO element	Guidance
	(d)	(i)	$C_8H_{15}NO$ ✓	1	AO2	**ALLOW** any order of elements
		(ii)	$H_2N(CH_2)_6NH_2$ ✓	2	AO2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous
			$HOOC(CH_2)_8COOH$ ✓		AO2	**ALLOW** acyl chloride, $ClOC(CH_2)_8COCl$
			Total	9		

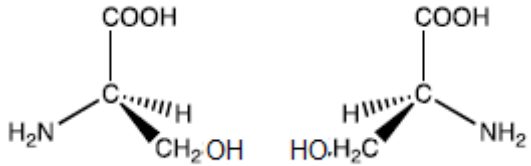
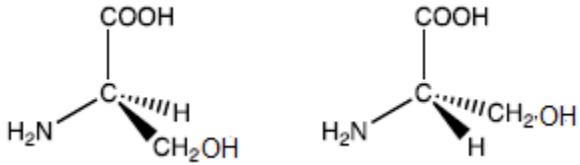
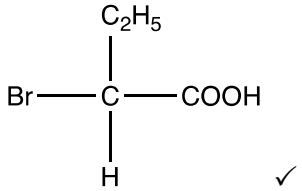
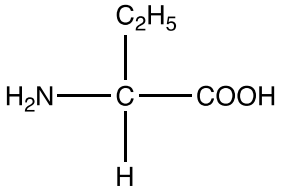
STEMUP.CO.UK

Question			Answer	Marks	AO element	Guidance
3	(a)		**M1** (^{13}C NMR spectrum indicates) four types of carbon ✓ **M2** (Tollens' test shows) compound **D** is an aldehyde ✓ **M3** Correct structure  ✓	3	AO1 AO2 AO2	**ALLOW** 4 carbon environments **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **NOTE:** Correct structure also scores **M2** *(aldehyde shown in structure)* **ALLOW** 3-methylbutanal (2 marks) **NOTE:** Ketone with four carbon environments i.e. methylbutanone (Maximum 2 marks possible: **M1** and **M3**)

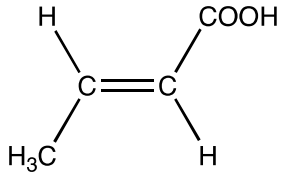
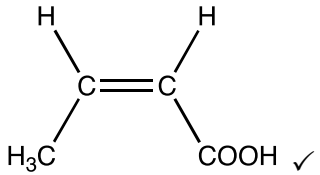
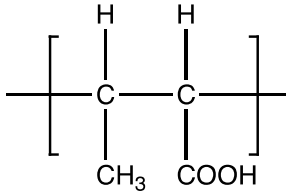
STEMUP.CO.UK

Question	Answer	Marks	AO element	Guidance
(b)	Correct structure of compound **E** (pentan-3-one) ✓	4	AO2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **IF** structure E is incorrect 3 marks can be scored for the mechanism e.g. apply **ECF** to error in structure e.g. CH_2 missing from the chain
				
	curly arrow from ^-CN to C(δ+) of C=O group ✓		AO2	First curly arrow must come from either lone pair on $^-$:CN or '–' charge on ^-CN **DO NOT ALLOW** lone pair and/or negative charge on nitrogen atom
	dipole correct **AND** curly arrow from C=O bond to O(δ–) ✓		AO1	
	Correct intermediate with negative charge on O **AND** Curly arrow from O^- to H^+ ✓		AO1	Curly arrow must come from either lone pair on O or negative charge on O **ALLOW** curly arrow from O^- to Hδ+ of H_2O Dipole on H_2O must be shown. **IGNORE** other products
	Total	7		

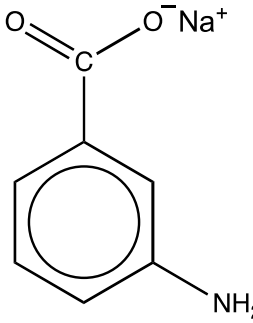
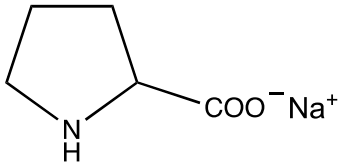
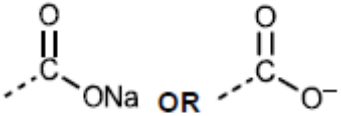
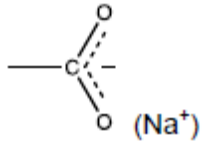
STEMUP.CO.UK

Question			Answer	Marks	AO element	Guidance
4	(a)		**M1** Mirror images around a tetrahedral carbon atom ✓  **M2** The four correct groups with correct connectivity ✓	**2**	AO1 AO2	3-D diagrams must contain 1 'out wedge' and 1 'in wedge'/dotted line **AND** 2 lines in plane of paper **ALLOW** 2 'out wedges', 1 'in wedge' and 1 line in plane of paper. **ALLOW** the same 3-D structure repeated with two groups 'swapped'. After rotation the second isomer is a mirror image of the first.  **Connectivity**: the chiral carbon must be linked to the C of the COOH **AND** the C of the CH_2OH **AND** the N of NH_2.
	(b)		**M1** Compound **F**  ✓ **M2** Compound **G**  ✓	**6**	AO2	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **IGNORE** labels for **M1**, **M2**, **M3** and **M4** **ALLOW ECF** for the following conversions: **F → G** (**F** must have correct molecular formula) **H → I** (**I** must have correct empirical formula)

STEMUP.CO.UK

Question	Answer	Marks	AO element	Guidance
	M3 Compound **H**  **OR**  ✓		AO2	C=C must be shown in **H**
	M4 Polymer **I**  ✓		AO2	**ALLOW** multiple repeat units but must be full repeat units **ALLOW** end bonds shown as ..... **DO NOT ALLOW** if structures have no end bonds **IGNORE** brackets unless they are used to pick out the repeat unit from a polymer chain **IGNORE n**
	M5 Formation of **F** is an (electrophilic) addition reaction ✓		AO1	**ALLOW** reaction with HBr is an addition reaction **DO NOT ALLOW** nucleophilic addition
	M6 Formation of **G** is a (nucleophilic) substitution reaction ✓		AO1	**ALLOW** reaction with NH_3 is a substitution reaction **DO NOT ALLOW** electrophilic substitution

STEMUP.CO.UK

Question	Answer	Marks	AO element	Guidance
(c)	 1 mark for correct structure with COOH or COO^-Na^+ ✓  1 mark for correct structure with COOH or COO^-Na^+ ✓ 1 mark for **both** structures shown with COO^- ✓	3	AO2 AO2 AO2	**For both structures,** **ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) **Note**: If there are more than two structures shown, credit any correct structures and **IGNORE** incorrect structures **DO NOT ALLOW** –COO–Na (covalent bond) (penalise once only) **ALLOW** $–COO^-$ **ALLOW** –COONa **OR**  **ALLOW** delocalised carboxylate 
	Total	**12**		

STEMUP.CO.UK

Question			Answer	Marks	AO element	Guidance
5	(a)		**Throughout, ALLOW formulae OR correct names** --- **M1** react $(CH_3)_3CCHO$ with $H_2SO_4/K_2Cr_2O_7$ **AND** heat/reflux ✓	7	AO3	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **ALLOW** $H^+/Cr_2O_7^{2-}$ or $H_2SO_4/Na_2Cr_2O_7$ **ALLOW** acidified dichromate
			M2 Equation: $(CH_3)_3CCHO + [O] \rightarrow (CH_3)_3CCOOH$ ✓		AO2	
			M3 react $(CH_3)_3CCHO$ with $NaBH_4$ ✓		AO3	**ALLOW** $LiAlH_4$ as alternative to $NaBH_4$
			M4 Equation: $(CH_3)_3CCHO + 2[H] \rightarrow (CH_3)_3CCH_2OH$ ✓		AO2	
			M5 react $(CH_3)_3CCOOH$ with $(CH_3)_3CCH_2OH$ ✓ **AND** acid catalyst/H_2SO_4		AO3	If both already correctly identified, **ALLOW** 'carboxylic acid and alcohol' **ALLOW** conc H_2SO_4 **DO NOT ALLOW** dilute or H_2SO_4(aq) **ALLOW** HCl **IGNORE** HNO_3
			M6 Equation: $(CH_3)_3CCOOH + (CH_3)_3CCH_2OH \rightarrow$ $(CH_3)_3CCOOCH_2C(CH_3)_3 + H_2O$ ✓			
			M7 <u>reflux</u> in either **(M1)** or **(M5)** or <u>catalyst</u> used in **(M5)** ✓ **QWC** must spell catalyst or reflux correctly		AO2 AO1	

STEMUP.CO.UK

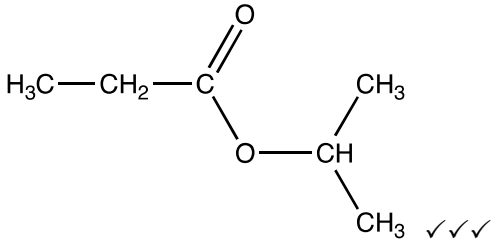
<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>5</td><td>(b)</td><td></td><td>similar compounds have similar retention times ✓

no reference values ✓</td><td>2</td><td>AO1

AO1</td><td>ALLOW same retention times
ALLOW correct description of retention time
ALLOW leave the column at the same time
ALLOW relative solubilities/partition/adsorption will be very similar
IGNORE Rf values
ALLOW no data book values (of retention times)</td></tr>
<tr><td></td><td>(c)</td><td></td><td>Elemental analysis and molecular formula (2 marks)

Use of percentages to find empirical formula = C_3H_6O ✓

Relative molecular mass from mass spectrum = 116
AND
Molecular formula = $C_6H_{12}O_2$ ✓

Ester structure (3 marks)
  ✓✓✓</td><td>2

3</td><td>AO2
×2

AO2
×3</td><td>ANNOTATE ANSWER WITH TICKS AND CROSSES ETC. CHECK SPECTRUM

<table><tr><th>Element</th><th>%</th><th>A_r</th><th>moles</th><th>ratio</th></tr><tr><td>C</td><td>62.07</td><td>12</td><td>5.173</td><td>3</td></tr><tr><td>H</td><td>10.34</td><td>1</td><td>10.34</td><td>6</td></tr><tr><td>O</td><td>27.59</td><td>16</td><td>1.724</td><td>1</td></tr></table>
Alternative method:
carbon: (116 × 62.07/100)/12 = 6
hydrogen: (116 × 10.34/100)/1 = 12
oxygen: (116 × 27.59/100)/16 = 2

ALLOW correct structural OR displayed OR skeletal formula OR mixture of the above (as long as unambiguous)

If not fully correct award marks as follows:

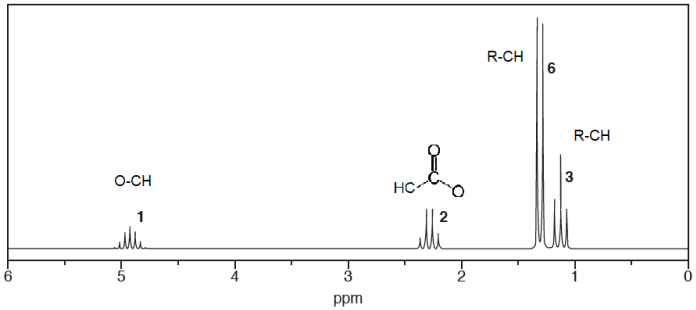
If the structure is any ester with molecular formula $C_6H_{12}O_2$, e.g. $CH_3COOCH_2CH(CH_3)_2$ (one mark)

If the ester link is reversed
i.e. $(CH_3)_2CHCOOCH_2CH_3$ (two marks)

Ignore any name</td></tr>
</table>

STEMUP.CO.UK

Question	Answer	Marks	AO element	Guidance
	NMR analysis (4 marks)	**4**		**NOTE: Each peak can be identified from:** • its δ value: ± 0.2 ppm • a range • its relative peak area • its splitting
	M1 Multiplet/heptet/peak at *δ* 4.9/3.9 is due to **H**C-O ✓		AO2	**Check annotated spectrum or table**
	M2 Quartet/peak at (*δ*) 2.3 is due to **H**C-C=O ✓		AO2	



Chemical shift/ppm	Relative peak area	Splitting pattern	Type of proton	Adjacent protons
1.2	3	triplet	R-C**H**	2
1.3	6	doublet	R-C**H**	1
2.3	2	quartet	**H**C-C=O	3
4.9	1	multiplet	O-C**H**	6

STEMUP.CO.UK

Question			Answer	Marks	AO element	Guidance
			M3 (CH_2CH_3) Triplet/peak (at δ 1.2) **AND** quartet/peak (at δ 2.3) = CH_2CH_3 **OR** Triplet/peak (at δ 1.2) shows 2 adjacent Hs/protons = CH_2CH_3 **OR** Quartet/peak (at δ 2.3) shows 3 adjacent Hs/protons = CH_2CH_3 **NOTE: QWC** – **triplet** or **quartet must** be spelled correctly in the correct context for **M3** ✓ **M4** Multiplet/heptet/peak (at δ 4.9/3.9) shows 6 adjacent H/two CH_3 groups **OR** Doublet/peak (at δ 1.3) shows one adjacent H ✓		AO2 AO2	**ALLOW** CH_3CH_2 described as CH_3 and 2 adjacent H **OR** CH_2 and 3 adjacent H **For QWC, ALLOW** quadruplet for quartet
			Total	**18**		

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2017

PART OF THE CAMBRIDGE ASSESSMENT GROUP

LLOYD'S REGISTER QUALITY ASSURANCE ISO9001 UKAS MANAGEMENT SYSTEMS 001

OCR
Oxford Cambridge and RSA

Tuesday 14 June 2016 – Afternoon

A2 GCE CHEMISTRY A

F324/01 Rings, Polymers and Analysis

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry A* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour 15 minutes

* F 3 2 4 0 1 *

* 5 8 7 8 6 0 9 4 2 1 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found inside this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means, for example, you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an Insert with this Question Paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.

© OCR 2016 [M/500/7836]
OCR is an exempt Charity

STEMUP.CO.UK

Answer **all** the questions.

1 Stearic acid, oleic acid and linoleic acid are examples of naturally occurring fatty acids.

Traditional name	Structure	Systematic name
Stearic acid	$C_{17}H_{35}COOH$	Octadecanoic acid
Oleic acid	$C_{17}H_{33}COOH$	Octadec-9-enoic acid
Linoleic acid	$C_{17}H_{31}COOH$	Octadeca-9,12-dienoic acid

(a) Suggest which fatty acid in the table is most likely to be linked with concerns about heart disease and obesity.

Explain your choice.

.....

..... **[1]**

(b) Sodium stearate is the salt formed when stearic acid reacts with sodium hydroxide solution.

Write an equation for the formation of sodium stearate.

..... **[1]**

(c) A triglyceride formed from stearic acid can be found in some types of food.

Draw the structure of this triglyceride with any functional groups fully displayed.

[2]

© OCR 2016

STEMUP.CO.UK

(d) Partial hydrogenation of linoleic acid may result in the formation of *trans*-octadec-12-enoic acid.

(i) Draw the **skeletal** formula of *trans*-octadec-12-enoic acid.

[2]

(ii) Some fatty acids show *cis-trans* isomerism because there is restricted rotation about a C=C double bond.

State **one** other feature of these molecules that enables them to show *cis-trans* isomerism.

.....

..... **[1]**

[Total: 7]

© OCR 2016

STEMUP.CO.UK

2 Some organic compounds contain nitrogen atoms. Examples include condensation polymers and azo dyes.

(a) A section of a condensation polymer is shown below.

$$–CO(CH_2)_4CONH(CH_2)_6NHCO(CH_2)_4CONH(CH_2)_6NH–$$

(i) In the boxes below, draw the structures of the two monomers that form this condensation polymer.

[2]

(ii) Name the type of condensation polymer and give a use for this polymer.

Type .....

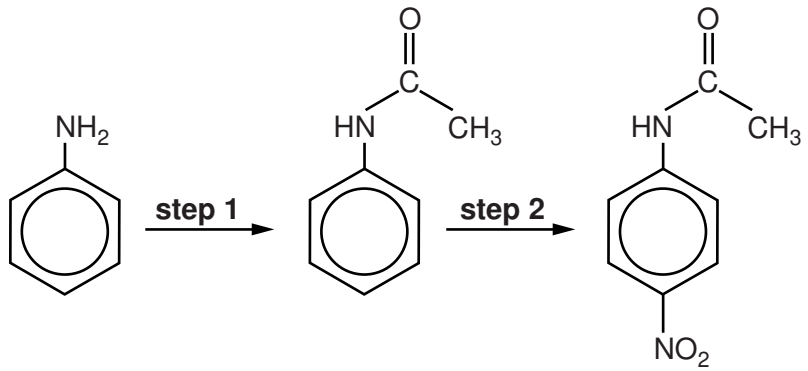
Use ..... **[1]**

© OCR 2016

STEMUP.CO.UK

(b) A student plans a two-step synthesis starting with phenylamine.

The steps of the synthesis are shown below.



phenylamine **compound A** **compound B**

(i) In **step 1**, phenylamine reacts with ethanoic anhydride to make compound **A** and one other organic product.

Draw the structure of ethanoic anhydride, with the functional group displayed, and suggest the structure of the other organic product formed in **step 1**.

ethanoic anhydride

other organic product

[2]

(ii) Calculate the mass of compound **A** that can be synthesised from 3.00 g of phenylamine in **step 1**. The percentage yield of this reaction is 61.0%.

M_r (phenylamine) = 93.0

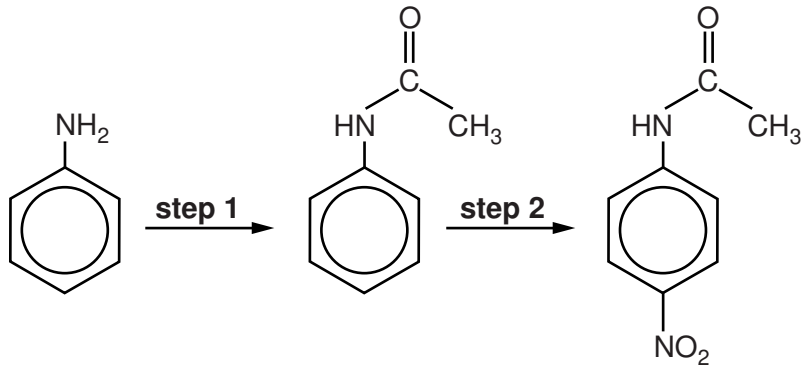
Give your answer to **three** significant figures.

mass of compound **A** = ... g **[3]**

© OCR 2016

STEMUP.CO.UK

The steps of the synthesis are shown again below.



phenylamine **compound A** **compound B**

(iii) In **step 2**, compound **A** is converted into compound **B** using a mixture of concentrated nitric acid and concentrated sulfuric acid.

Outline, with the aid of curly arrows, the mechanism for the conversion of compound **A** into compound **B**.

Use equations to explain how sulfuric acid acts as a catalyst in this reaction.

[5]

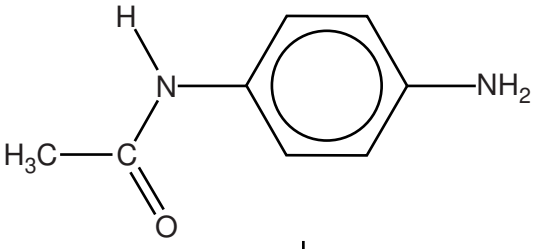
© OCR 2016

STEMUP.CO.UK

(c) An azo dye is synthesised in two steps. In **step 2** the diazonium ion is reacted with compound **C** to form the azo dye.

Complete the flowchart for this synthesis.

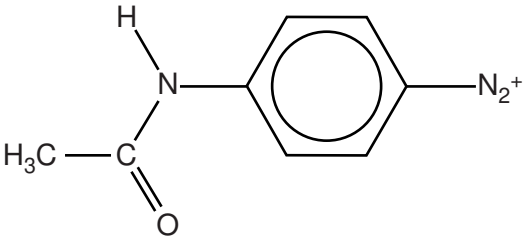
Write your answers in the boxes.



step 1

Reagents.....

Conditions.....

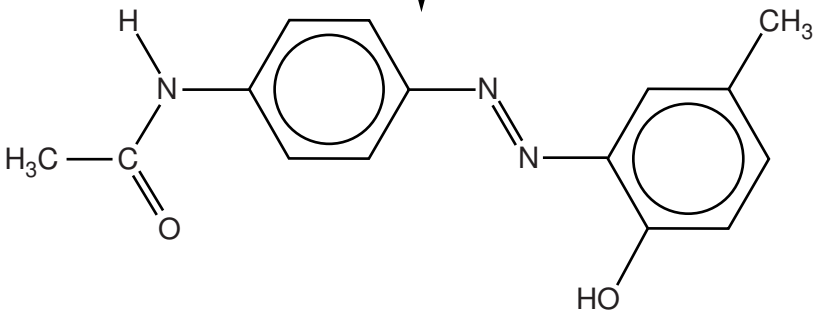


diazonium ion

step 2

Conditions.....

Structure of compound **C**



azo dye

[4]

[Total: 17]

© OCR 2016

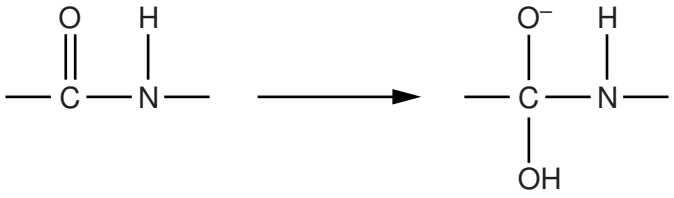
STEMUP.CO.UK

3 The building blocks of peptides and proteins are α-amino acids.

A tripeptide is hydrolysed to form a mixture of three different α-amino acids.

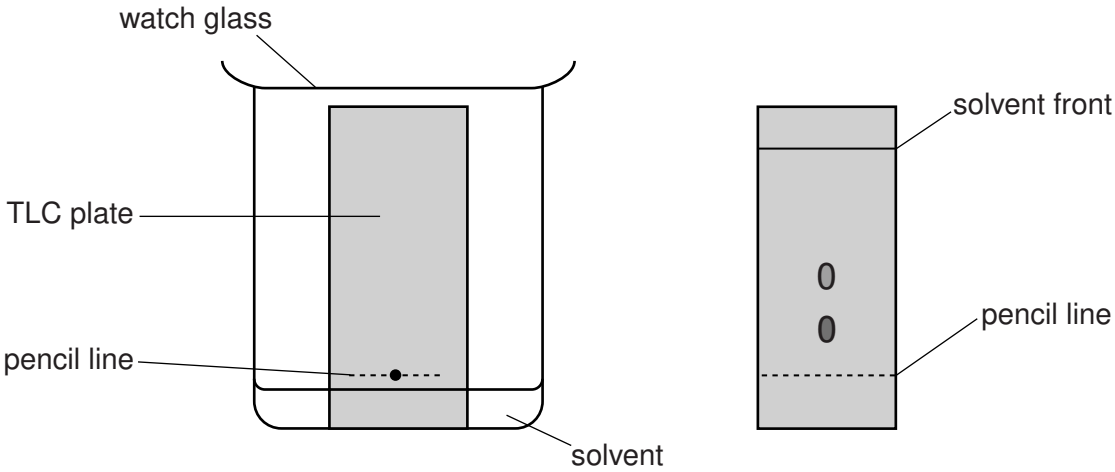
(a) The first step of an incomplete mechanism for the alkaline hydrolysis of the tripeptide is shown below.

Add curly arrows and relevant dipoles to the diagram to suggest how the hydroxide ion takes part in the first step of this mechanism.



[2]

(b) The tripeptide is hydrolysed and the resulting mixture containing the three amino acids is neutralised.
A student tries to separate and identify the three amino acids in the mixture using thin-layer chromatography (TLC). The diagram below shows the apparatus for the experiment and the chromatogram produced.



Chromatogram

Explain how the chromatogram can be used to identify amino acids.
The student thinks that there should be three spots on the chromatogram.

Suggest why there are only two spots.

.....

.....

.....

.....

.....

..... **[3]**

© OCR 2016

STEMUP.CO.UK

(c) The three α-amino acids in the tripeptide are aspartic acid, glycine and isoleucine.

The general formula for an α-amino acid is $RCH(NH_2)COOH$.

α-amino acid	**R-group**
aspartic acid	$–CH_2COOH$
glycine	–H
isoleucine	$–CH(CH_3)CH_2CH_3$

(i) Aspartic acid has an isoelectric point of 2.77.

What is meant by the term *isoelectric point*?

In your answer you should use the appropriate technical terms spelled correctly.

.....

.....

..... **[1]**

(ii) Draw the structure of aspartic acid when it is dissolved in a solution with a high pH.

[1]

(iii) Suggest a structure for the tripeptide.

On your structure, mark each chiral centre with an asterisk (*).

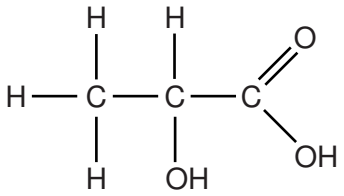
[2]

[Total: 9]

© OCR 2016

STEMUP.CO.UK

4 This question is about the preparation, properties and uses of lactic acid.



lactic acid

(a) What is the systematic name of lactic acid?

..... **[1]**

(b) Lactic acid can be produced by chemical synthesis or by the fermentation of sugars using bacteria.

Describe **one** important difference between lactic acid manufactured by chemical synthesis and lactic acid manufactured by the fermentation of sugars.

.....

.....

.....

..... **[1]**

(c) When heated strongly, lactic acid forms a cyclic 'diester'.
The diester has the molecular formula, $C_6H_8O_4$.

Draw the structure of the cyclic diester.

[1]

© OCR 2016

STEMUP.CO.UK

(d) Poly(lactic acid), PLA, is used to make 'dissolvable' stitches (for holding wounds together). PLA breaks down into smaller molecules after one or two weeks.

(i) Draw the structure of **one** repeat unit in PLA.

[1]

(ii) Explain how PLA breaks down and why the stitches 'dissolve'.



In your answer you should use the appropriate technical terms spelled correctly.

.....

.....

.....

.....

.....

..... **[3]**

[Total: 7]

© OCR 2016

STEMUP.CO.UK

5 A chemistry teacher carries out an experiment to synthesise 2-aminopropan-1-ol, $CH_3CH(NH_2)CH_2OH$.

(a) The teacher asks a university chemistry department to test the 2-aminopropan-1-ol using proton NMR spectroscopy and mass spectrometry.

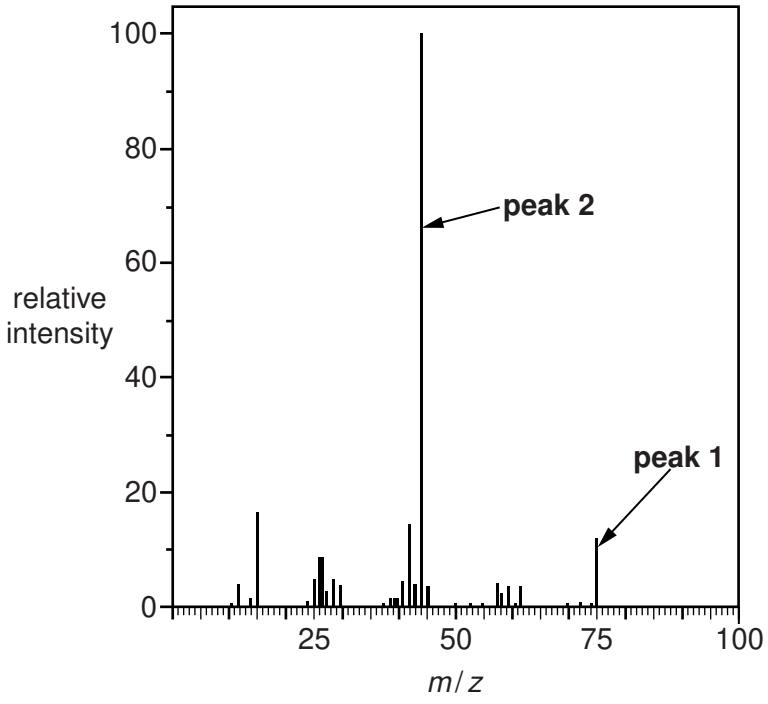
(i) For the ^1H NMR analysis, the sample was dissolved in D_2O.

Complete the table to predict the ^1H NMR spectrum of $CH_3CH(NH_2)CH_2OH$ after dissolving in D_2O.

^1H NMR spectrum for $CH_3CH(NH_2)CH_2OH$, dissolved in D_2O		
Chemical shift, δ / ppm	**Relative peak area**	**Splitting pattern**

[3]

(ii) The mass spectrum for $CH_3CH(NH_2)CH_2OH$ is shown below.



© OCR 2016

STEMUP.CO.UK

Give the formulae for the species responsible for **peak 1** and **peak 2** in the mass spectrum.

peak 1

peak 2

[2]

(b) The teacher synthesises 2-aminopropan-1-ol, $CH_3CH(NH_2)CH_2OH$, from 2-chloropropan-1-ol, $CH_3CHClCH_2OH$.

(i) State the reagents and conditions required for this synthesis.

.....

..... **[1]**

(ii) The sample prepared by the teacher from 2-chloropropan-1-ol is not pure. It also contains compound **D**.

Compound **D** has a molecular formula of $C_6H_{15}NO_2$.

Suggest the structure of compound **D**.

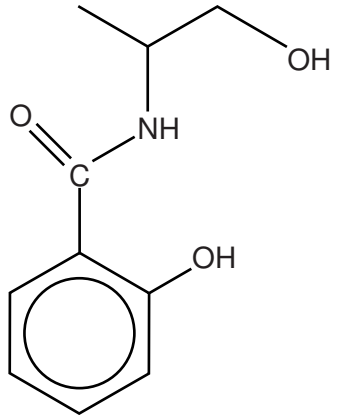
Compound **D**

[1]

© OCR 2016

STEMUP.CO.UK

(c) In a separate experiment, the chemistry teacher prepares compound **E** from 2-aminopropan-1-ol.



compound E

(i) One of the functional groups in compound **E** is a phenol.

Name the other functional groups in compound **E**.

.....

..... **[1]**

(ii) Draw the structures of the **two** organic products formed when compound **E** is heated under reflux with dilute hydrochloric acid.

[2]

[Total: 10]

© OCR 2016

STEMUP.CO.UK

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Turn over for the next question

© OCR 2016

STEMUP.CO.UK

6 There are several isomeric alcohols with the formula $C_5H_{11}OH$.

(a) Pentan-1-ol, $CH_3(CH_2)_3CH_2OH$, can be prepared in the laboratory by the reduction of an aldehyde.

State a suitable reducing agent for this reaction and write an equation to show the preparation of pentan-1-ol.
Use [H] to represent the reducing agent in the equation.

Reducing agent .....

Equation .....

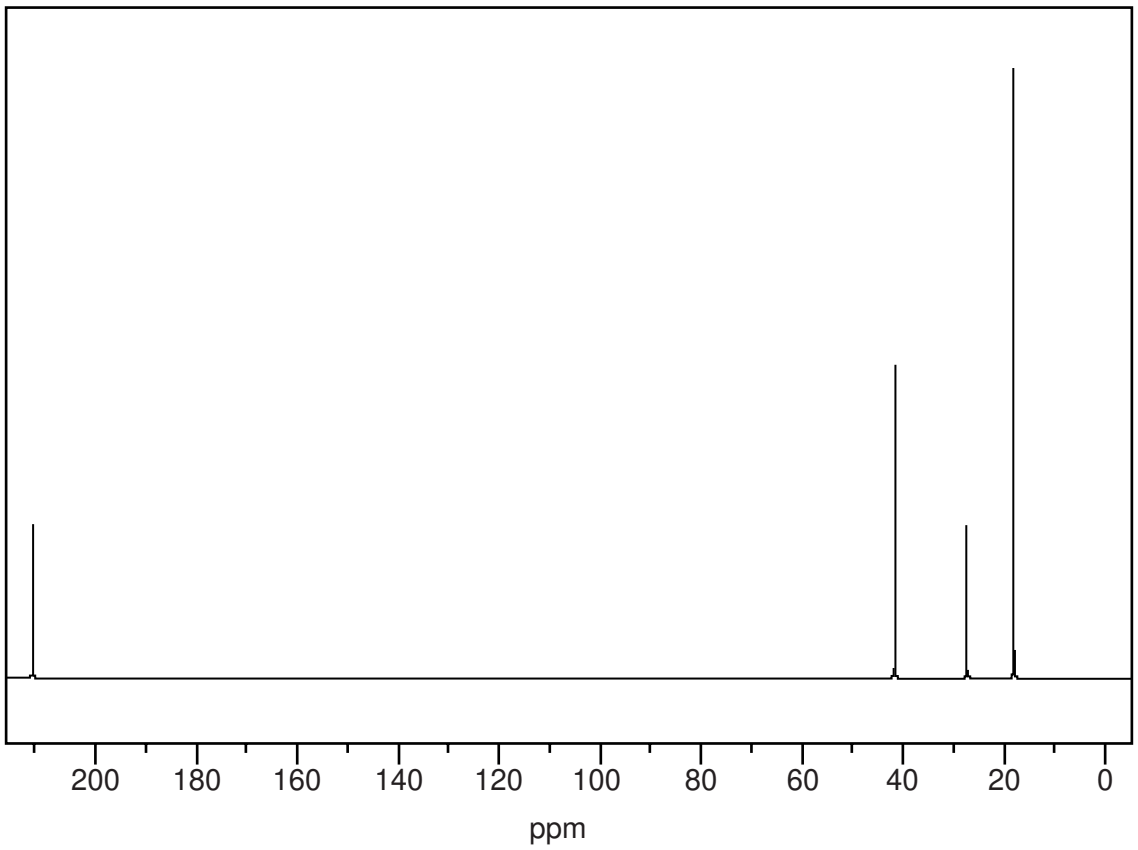
[2]

(b) Compound **F** is a structural isomer of $C_5H_{11}OH$.

Compound **F** is converted to compound **G** when heated under reflux with acidified potassium dichromate(VI) solution.

Compound **G** reacts with 2,4-dinitrophenylhydrazine to form an orange solid but compound **G** does not react with Tollens' reagent.

The ^{13}C NMR spectrum of compound **G** is shown below.



Compound **H** is a carboxylic acid. In a titration, 0.211 g of carboxylic acid **H** requires 22.8 cm^3 of 0.125 mol dm^{-3} NaOH for neutralisation.

Compound **F** reacts with compound **H** in the presence of concentrated sulfuric acid to form organic compound **I**.

© OCR 2016

STEMUP.CO.UK

17

Identify compounds **F**, **G**, **H** and **I** and draw their structures in the boxes below.

Show your working **only** for the identification of compound **H**.

.....

.....

.....

.....

.....

.....

.....

F

G

H

I

[7]

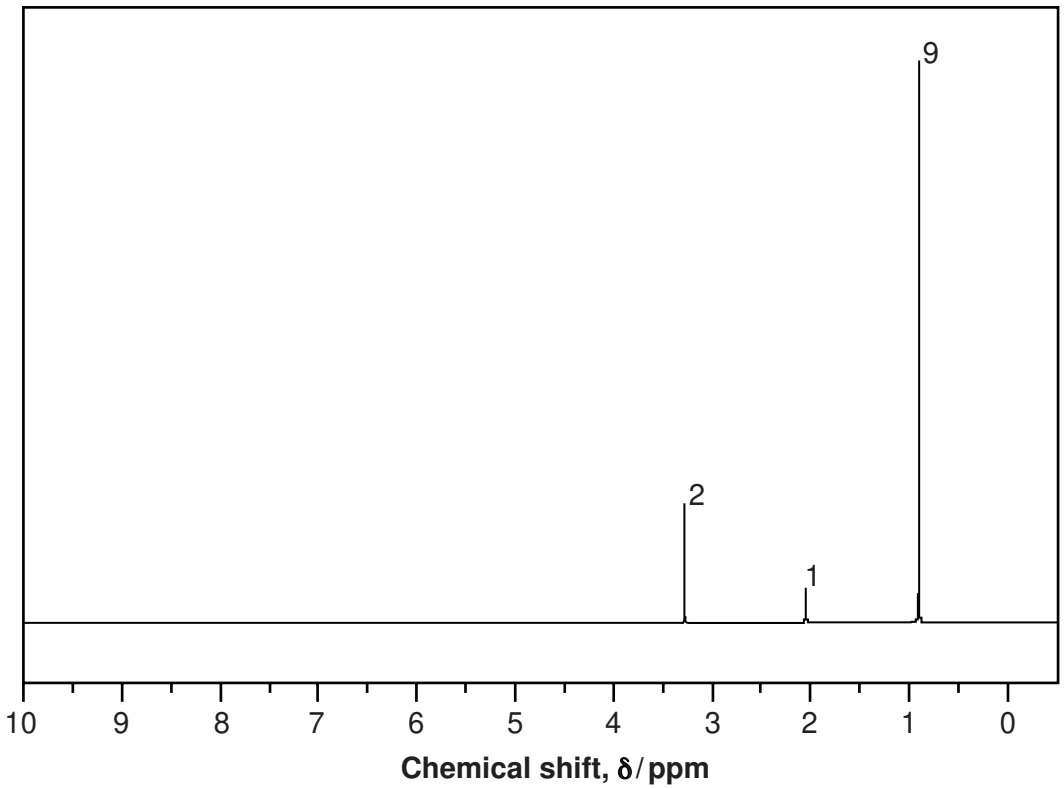
© OCR 2016

STEMUP.CO.UK

(c) Compound **J** is another structural isomer of $C_5H_{11}OH$.

The ^1H NMR spectrum of **J** is shown below.

The numbers next to each peak are the relative peak areas.



Identify compound **J** and draw its structure in the box below.

J

[1]

[Total: 10]

END OF QUESTION PAPER

© OCR 2016

STEMUP.CO.UK

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

© OCR 2016

OCR
Oxford Cambridge and RSA

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2016

OCR
Oxford Cambridge and RSA

GCE

Chemistry A

Unit **F324:** Rings, Polymers and Analysis

Advanced GCE

Mark Scheme for June 2016

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

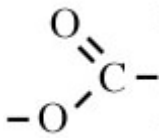
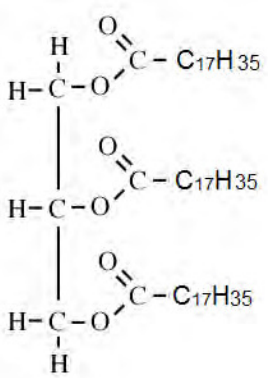
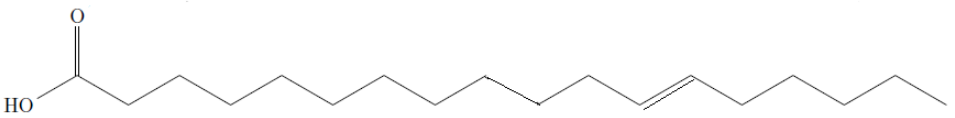
OCR will not enter into any discussion or correspondence in connection with this mark scheme.

© OCR 2016

Abbreviations, annotations and conventions

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

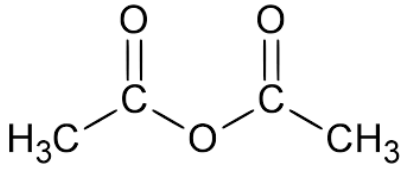
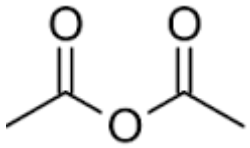
STEMUP.CO.UK

Question			Answer	Mark	Guidance
1	(a)		Stearic acid/octadecanoic acid **AND** Saturated (fat) ✓	1	**ALLOW** stearic acid **AND** no C=C double bonds **IGNORE** comments about LDL and cholesterol **DO NOT ALLOW** stearic acid is a trans fatty acid
	(b)		$C_{17}H_{35}COOH + NaOH \rightarrow C_{17}H_{35}COO^{-}Na^{+} + H_2O$ ✓	1	**ALLOW** $C_{17}H_{35}COONa$ **IGNORE** state symbols
	(c)		At least one ester link fully displayed in a triglyceride structure ✓  Correct triglyceride structure ✓	2	 **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above for the rest of the structure
	(d)	(i)	**M1** Correct structure of a mono unsaturated fatty acid with 18 C ✓ **M2** Correct position of double bond (12) in a mono unsaturated fatty acid **AND** trans arrangement ✓	2	Must be skeletal formula for M1  **DO NOT ALLOW** cis isomer for M2

STEMUP.CO.UK

Question			Answer	Mark	Guidance
		(ii)	**Each** carbon atom <u>in the double bond</u> is attached to (two) different group**s**/atoms ✓	1	**ALLOW Each** carbon atom of the double bond is attached to a H atom **DO NOT ALLOW** functional group for group **DO NOT ALLOW** the carbon atoms are attached to different groups **IGNORE** two of the substituent groups are the same
			Total	**7**	

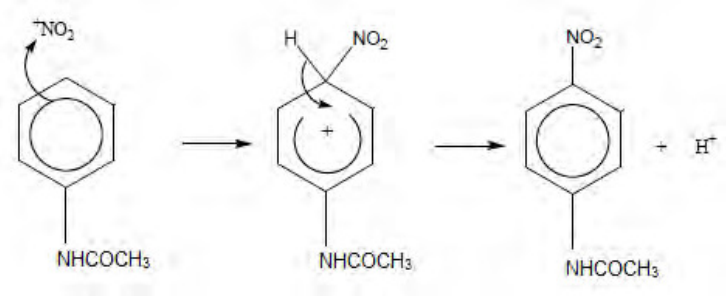
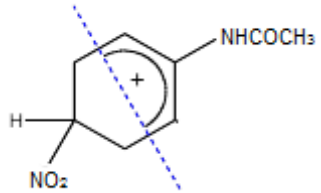
STEMUP.CO.UK

Question			Answer	Mark	Guidance
2	(a)	(i)	$H_2N(CH_2)_6NH_2$ ✓ $HOOC(CH_2)_4COOH$ ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **ALLOW** acid chloride, $ClOC(CH_2)_4COCl$
		(ii)	<u>Type of condensation polymer</u> Polyamide **AND** <u>Use of condensation polymer</u> Fibres in clothing ✓	1	Both answers required for one mark **ALLOW** nylon **IGNORE** numbers **IGNORE** polypeptide **DO NOT ALLOW** kevlar **ALLOW** any common use for nylon e.g. fibre, clothing, rope, fishing net, bristles, brushes, bags, cable ties etc. **DO NOT ALLOW** distinctive uses associated with kevlar or other polymers e.g. bullet-proof vests, crash helmets, bottles, cups **IGNORE** plastic
	(b)	(i)	<u>Ethanoic anhydride</u>  ✓ <u>Other organic compound</u> CH_3COOH ✓	2	**ALLOW** skeletal formula  **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **IGNORE** names

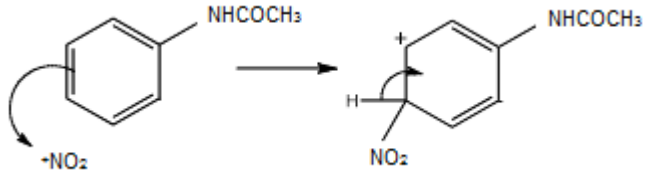
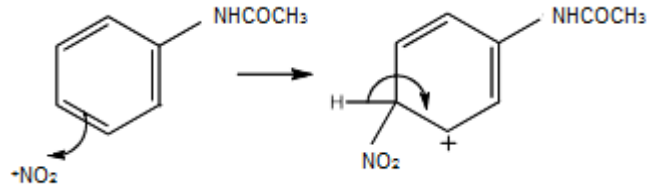
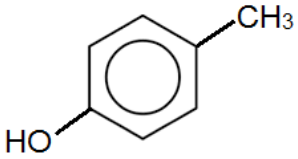
STEMUP.CO.UK

Question			Answer	Mark	Guidance
		(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **IF** answer = 2.66 (g) award 3 marks **IF** answer = 4.36 (g) award 2 marks (% yield not used) **IF** answer = 7.14 (g) award 2 marks (% yield used incorrectly) n(phenylamine) (= 3.00/93.0) = 0.0323 mol ✓ n(compound A) = (0.0323 x 0.61) = 0.0197 mol ✓ Mr (compound A) = 135 **AND** Mass of compound A = (135)(0.0197) = 2.66 g ✓ **OR** n(phenylamine) (= 3.00/93.0) = 0.0323 mol ✓ Mr (compound A) = 135 **AND** Theoretical mass of compound A = (0.0323 x 135) = 4.36 ✓ Actual mass of compound A = (4.36 x 0.61) = 2.66 g ✓	3	**ANNOTATE WITH TICKS AND CROSSES ETC.** **ALLOW 3 SF:** 0.0323 up to calculator value of 0.032258064 correctly rounded **ALLOW 3 SF** up to calculator value Penalise rounding to 2 SF once **ALLOW ECF** on incorrectly rounded values Final answer must be expressed to 3 significant figures **ALLOW** ecf from incorrect Mr **IF** answer = 2.65 (g) award 2 marks unless this alternative method is used (3 marks) 93 g gives 135 g 3.00 g gives 135/93 x 3.00 = 4.35 g 4.35 x 0.61 = **2.65** g

STEMUP.CO.UK

Question			Answer	Mark	Guidance
		(iii)	**M1** $H_2SO_4 + HNO_3 \rightarrow HSO_4^- + H_2O + NO_2^+$ ✓ **M2** curly arrow from π ring **OR** from within the ring to $^+NO_2$ ✓  **M3** correct intermediate (with charge) ✓ **M4** curly arrow from C-H to reform ring **AND** correct products ✓	5	**ANNOTATE WITH TICKS AND CROSSES ETC.** Equation to show formation of the electrophile **ALLOW** $2H_2SO_4 + HNO_3 \rightarrow 2HSO_4^- + H_3O^+ + NO_2^+$ **ALLOW** $H_2SO_4 + HNO_3 \rightarrow HSO_4^- + H_2NO_3^+$ **AND** $H_2NO_3^+ \rightarrow H_2O + NO_2^+$ Penalise missing or incorrect $-NHCOCH_3$ on intermediate only (**M3**) **DO NOT ALLOW** intermediate with the π-system covering less than half the ring  **ALLOW** + charge anywhere inside the 'horseshoe' Horseshoe must have open end towards NO_2 **ALLOW** Kekulé mechanism

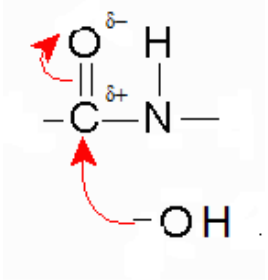
STEMUP.CO.UK

Question			Answer	Mark	Guidance
			M5 Regeneration of the catalyst: $H^+ + HSO_4^- \rightarrow H_2SO_4$ ✓		 **OR**  **ALLOW** $H_3O^+ + HSO_4^- \rightarrow H_2SO_4 + H_2O$
		(c)	<u>reagents for **step 1**</u> **Nitrous acid/HNO_2** (and HCl) ✓ <u>conditions for **step 1**</u> **≤10 °C** ✓ <u>compound C</u>  ✓	4	**ALLOW** $NaNO_2$ + HCl **IGNORE** reference to concentration **ALLOW** –OH ionised as $–O^-$ **ALLOW** KOH**(aq)**/NaOH**(aq)**/OH^-**(aq)**

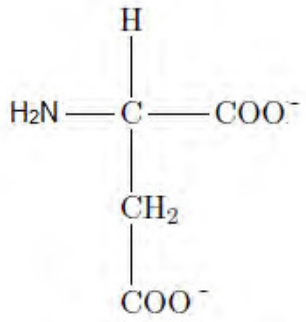
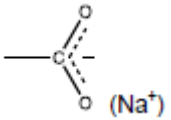
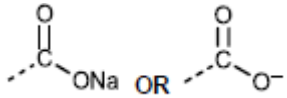
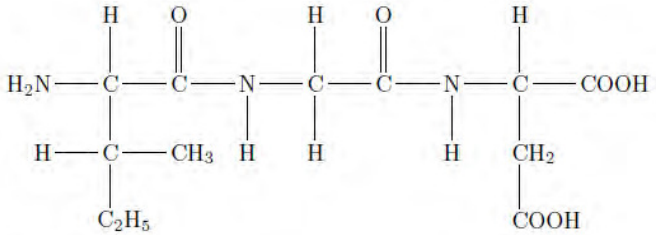
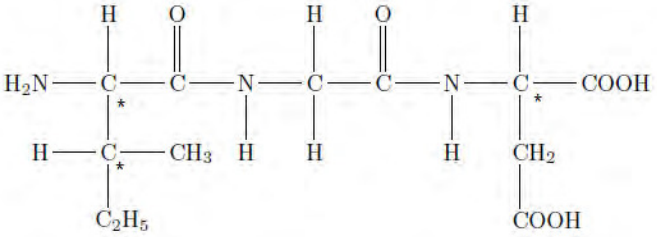
STEMUP.CO.UK

Question			Answer	Mark	Guidance
			conditions for **step 2** alkaline/alkali ✓		**ALLOW** dilute NaOH or stated concentration **IGNORE** NaOH/KOH (must be aqueous) If temperature stated must be below 10°C **DO NOT ALLOW** heat/boil/warm
			Total	**17**	

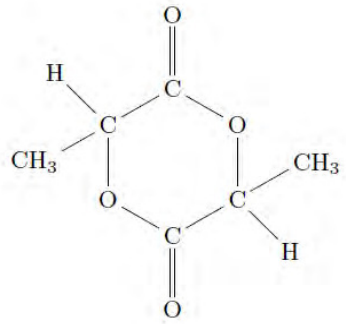
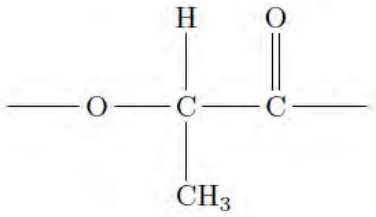
STEMUP.CO.UK

Question			Answer	Mark	Guidance
3	(a)		 Curly arrow from OH^- to C(δ+) ✓ Dipole correct **AND** curly arrow from C=O bond to O(δ-) ✓	2	First curly arrow must come from either a lone pair on O or negative charge on O
	(b)		Measure distance moved by spot / distance moved by solvent ✓ Compare (R_f) value with data book values/known values ✓ Two amino acids have the same/similar R_f value **OR** similar adsorption **OR** move the same/similar distance ✓	2 1	**ALLOW** attempt at calculation of R_f value using distances measured on the chromatogram **IGNORE** explanation of how chromatography works **ALLOW** One spot contains two amino acids **ALLOW** Two amino acids have not separated **IGNORE** relative solubility **ALLOW** two of the amino acids have similar structures
	(c)	(i)	The **pH** at which the amino acid exists as a <u>zwitterion</u> ✓ ✎ **QWC**: **zwitterion** spelled correctly in the correct context	1	**DO NOT ALLOW** PH/ph **ALLOW** zwitter ion

STEMUP.CO.UK

Question			Answer	Mark	Guidance
		(ii)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **Two** COO^- groups are required in the structure **ALLOW** $–COO^-Na^+$ **OR** -COONa  **ALLOW** delocalised carboxylate **ALLOW**  **DO NOT ALLOW** -COO-Na **OR** -O-Na (covalent bond)
		(iii)	**M1** structure  ✓ **M2** correct structure has three chiral centres  ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **ALLOW** tripeptide with the 3 amino acids in any order **ALLOW** cyclic tripeptide Isoleucine has two chiral centres, aspartic acid has one chiral centre and glycine has none. **ALL three** correct for one mark **ALLOW** chiral centres correctly identified if the three amino acids are part of a polypeptide chain
			Total	**9**	

STEMUP.CO.UK

Question			Answer	Mark	Guidance
4	(a)		2(-)hydroxypropanoic acid ✓	1	**DO NOT ALLOW** 2-hydroxylpropanoic acid **IGNORE** other dashes, commas and spaces
	(b)		Lactic acid synthesised in the laboratory will contain optical isomers/two optical isomers **OR** Lactic acid produced by bacteria will be present as one optical isomer ✓	1	**ALLOW** enantiomer for optical isomer **ALLOW** racemic mixture **IGNORE** stereoisomer
	(c)		 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous
	(d)	(i)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **DO NOT ALLOW** more than one repeat unit **DO NOT ALLOW** if structure has no end bonds **IGNORE** brackets unless they are used to pick out the repeat unit from a polymer chain **IGNORE** n

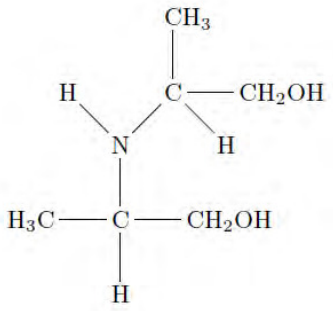
STEMUP.CO.UK

Question			Answer	Mark	Guidance
		(ii)	(Ester links in PLA are) **hydrolysed** ✓ Any two from: • Ester (links in the polymer) **OR (**PLA is a) polyester • Monomer/lactic acid/product (is soluble because it) forms hydrogen bonds to water • polymer is photodegradable • the C=O bond absorbs radiation/uv/light ✓✓ ✎ **QWC**: **hydrolysed/hydrolysis/hydrolyses** spelled correctly in the correct context	3	**ANNOTATE WITH TICKS AND CROSSES ETC.** **ALLOW** (ester) **hydrolysis/**(ester) **hydrolyses** **IGNORE** acid/alkaline (hydrolysis) **IGNORE** PLA forms hydrogen bonds to water **IGNORE** biodegradable **IGNORE** infrared radiation Maximum of 2 marks if hydrolysed/hydrolysis/hydrolyses does not appear in the answer **ALLOW** (ester) hydrolyzed
			Total	**7**	

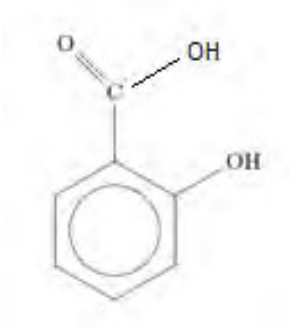
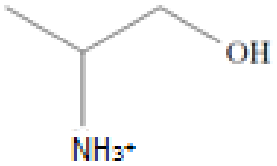
STEMUP.CO.UK

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>5</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><th colspan="3">^{1}H NMR spectrum for 2-aminopropan-1-ol</th></tr>
<tr><th>Chemical shift, δ/ppm</th><th>Relative peak area</th><th>Splitting pattern</th></tr>
<tr><td>0.8 – 2.0</td><td>3</td><td>doublet</td></tr>
<tr><td>2.3 – 3.0</td><td>1</td><td>multiplet</td></tr>
<tr><td>3.3 – 4.2</td><td>2</td><td>doublet</td></tr>
</table>
✓✓✓</td><td>3</td><td>One mark for each correct row
ALLOW δ values as a range or a value within the specified range.
ALLOW δ values +/- 0.2 ppm.
ALLOW a response that implies a splitting into two for a doublet etc.
ALLOW sextet/hextet/six (or more than 5) as alternative to multiplet
Relative peak area = CH_3/3H etc. penalise once</td></tr>
<tr><td></td><td></td><td>(ii)</td><td><u>M^+ peak at 75</u> (peak 1)
$CH_3CH(NH_2)CH_2OH^+/C_3H_9NO^+$
✓

<u>Fragment peak at 44</u> (peak 2)
$CH_3CH(NH_2)^+/C_2H_6N^+$
✓</td><td>2</td><td>ALLOW correct structural OR displayed OR skeletal formulae OR a combination of above as long as unambiguous

Positive charge is essential but ALLOW maximum of one mark if both formulae are correct AND neither species has a positive charge</td></tr>
<tr><td>5</td><td>(b)</td><td>(i)</td><td>Ethanolic ammonia
OR ammonia/NH_3 AND ethanol
✓</td><td>1</td><td>ALLOW ammonia in a sealed tube
ALLOW dilute ethanolic ammonia/NH_3
IGNORE heat
ALLOW alcohol for ethanol
DO NOT ALLOW any reference to water or hydroxide ions</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>(compound D)
 
✓</td><td>1</td><td>ALLOW correct structural OR displayed OR skeletal formulae OR a combination of above as long as unambiguous</td></tr>
</table>

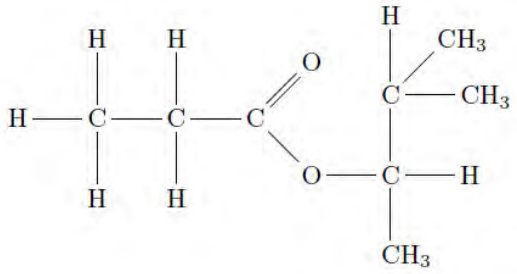
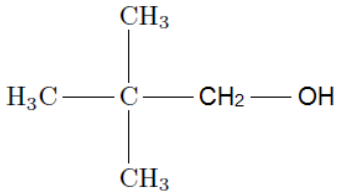
STEMUP.CO.UK

Question			Answer	Mark	Guidance
	(c)	(i)	Alcohol **AND** Amide/peptide ✓	1	**IGNORE** phenol **IGNORE** hydroxyl/hydroxy **IGNORE** attempts to classify alcohol or amide as primary, secondary or tertiary **DO NOT ALLOW** hydroxide
		(ii)	 ✓  ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** + on N or H i.e. $^{+}NH_3$ or NH_3^{+} **ALLOW** $NH_3^{+}Cl^{-}$
			Total	**10**	

STEMUP.CO.UK

Question			Answer	Mark	Guidance
6	(a)		Reducing agent $NaBH_4$ / sodium tetrahydridoborate(III) / sodium borohydride ✓ Equation $CH_3(CH_2)_3CHO + 2[H] \rightarrow CH_3(CH_2)_3CH_2OH$ ✓	2	**ALLOW** $LiAlH_4$ / lithium tetrahydridoaluminate(III)/lithium aluminium hydride **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above **ALLOW** $C_4H_9CHO + 2[H] \rightarrow C_5H_{11}OH$ **ALLOW** molecular formulae: $C_5H_{10}O + 2[H] \rightarrow C_5H_{12}O$ **DO NOT ALLOW** –COH for aldehyde
	(b)		**M1** Compound **F** structure is a secondary alcohol with the formula $C_5H_{11}OH$ ✓ **M2** Compound **F** = $CH_3CH(OH)CH(CH_3)CH_3$ ✓ **M3** Compound **G** = $CH_3COCH(CH_3)CH_3$ ✓	7	**ANNOTATE WITH TICKS AND CROSSES ETC.** **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **IGNORE** names if structures are given **ALLOW** 3-methylbutan-2-ol if structure not given **ALLOW ECF** from an incorrect secondary alcohol for **M3** e.g. pentan-2-ol → pentan-2-one e.g. pentan-3-ol → pentan-3-one **ALLOW** (3-)methylbutanone if structure not given **IGNORE** any discussion of the reactions of compound **G** with 2,4-dinitrophenylhydrazine and/or Tollens' reagent. **ALLOW 3 SF** up to calculator value correctly rounded

STEMUP.CO.UK

Question			Answer	Mark	Guidance
			M4 n(NaOH) = (0.125 x 22.8/1000) = 0.00285 (mol) ✓ **M5** M(compound H) = (0.211/0.00285 =) 74(.0) (g mol^{-1}) ✓ **M6** Compound **H** = / CH_3CH_2COOH ✓ **M7** Compound **I** =  ✓		**IF** M(compound H) = 74 award 2 marks (M4 + M5) **ALLOW ECF** from incorrect calculation of amount of NaOH **ALLOW** propanoic acid if structure not given **ALLOW ECF** from incorrect compound **F** (alcohol) and/or incorrect compound **H** (carboxylic acid) to form compound **I** (ester). Compounds **F**, **G**, **H** and **I** must be placed in the correct box or correctly labelled for **M2**. **M3**, **M6** and **M7**
	(c)		The structural isomer is:  ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **ALLOW** 2,2-dimethylpropan-1-ol
			Total	**10**	

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2016

PART OF THE CAMBRIDGE ASSESSMENT GROUP

UKAS MANAGEMENT SYSTEMS 001

STEMUP.CO.UK

OCR
Oxford Cambridge and RSA

Wednesday 10 June 2015 – Afternoon

A2 GCE CHEMISTRY A

F324/01 Rings, Polymers and Analysis

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry A* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour 15 minutes

* F 3 2 4 0 1 *

* 4 9 8 9 3 3 7 5 1 9 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found inside this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means, for example, you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an Insert with this Question Paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.

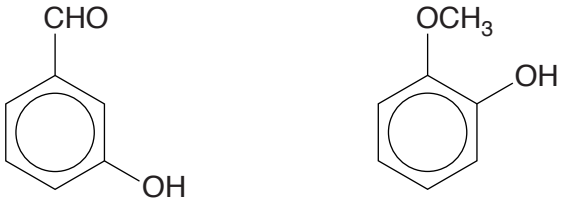
© OCR 2015 [M/500/7836]
OCR is an exempt Charity

STEMUP.CO.UK

Answer **all** the questions.

1 A student analysed a mixture of compounds found in red wine using gas chromatography followed by mass spectrometry (GC-MS).

Two of the compounds found to be present in the mixture are shown below.



compound A **compound B**

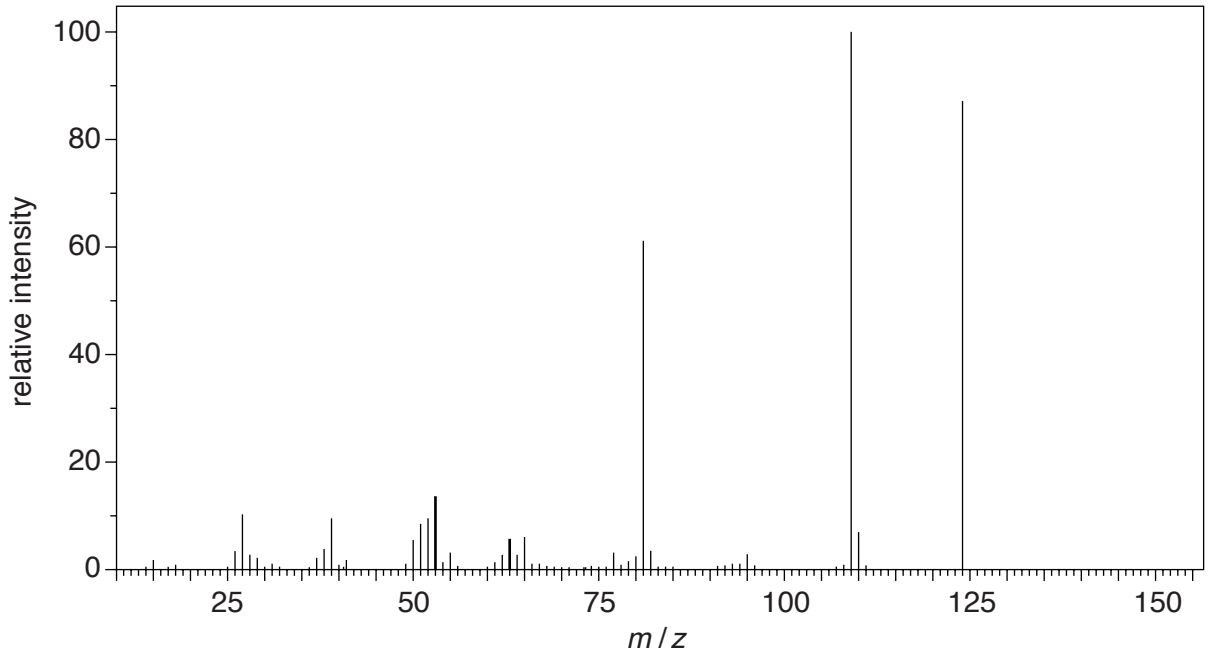
(a) The column in the gas chromatogram is packed with solid beads coated with a liquid polymer.

How does gas chromatography (GC) separate the compounds in the mixture?

.....

..... **[1]**

(b) The mass spectrum (MS) of the **first** compound to emerge from the column is shown below.



(i) Identify the compound responsible for this spectrum.

Give a reason for your answer.

.....

..... **[1]**

© OCR 2015

(ii) What does your answer to **(b)(i)** suggest about the interaction of this compound with the phases present in the column?

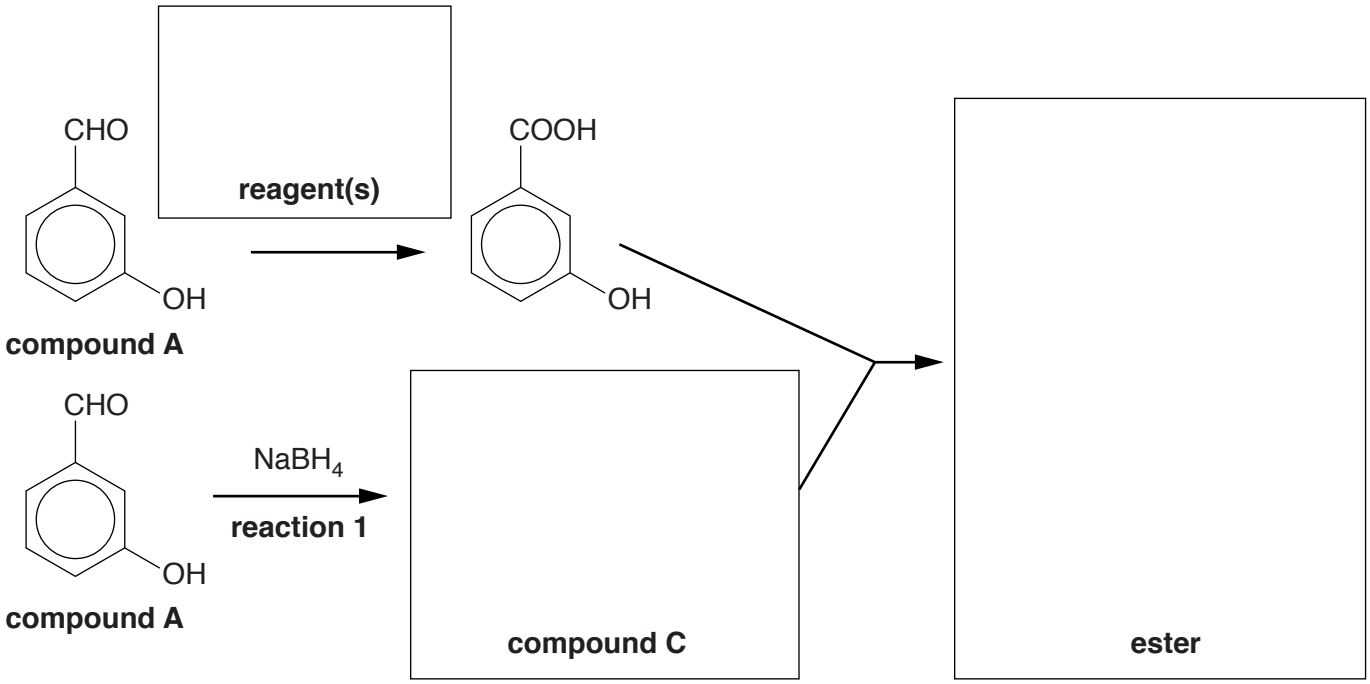
.....

..... **[1]**

(c) In red wine, compound **A** slowly forms an ester.

The formation of the ester can also be done in the laboratory, as shown in the flowchart below. Separate portions of compound **A** are used in the formation of the ester.

(i) Complete the boxes in the flowchart below.



[3]

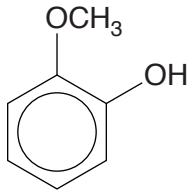
(ii) Give the mechanism to show the formation of compound **C** in **reaction 1**.
Use curly arrows and relevant dipoles.

[3]

© OCR 2015

STEMUP.CO.UK

(d) 1 mol of compound **B** reacts with 2 mol of bromine, Br_2 by electrophilic substitution.



compound B

Write a balanced equation for this reaction, showing clearly the structure of the organic compound.

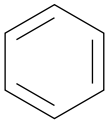
[1]

[Total: 10]

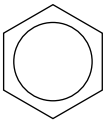
© OCR 2015

STEMUP.CO.UK

2 Chemists often use two different structures to represent a molecule of benzene, as shown below.



structure A



structure B

(a) (i) Describe, with the aid of suitable diagrams showing orbital overlap, the difference in bonding between structure **A** and structure **B**.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

© OCR 2015

STEMUP.CO.UK

(ii) The table below shows the enthalpy changes for the reactions of cyclohexene, C_6H_{10}, and benzene, C_6H_6, with hydrogen.

reaction	enthalpy change / kJ mol^{-1}
$C_6H_{10} + H_2 \rightarrow C_6H_{12}$	−119
$C_6H_6 + 3H_2 \rightarrow C_6H_{12}$	−208

Using this information, suggest and explain whether structure **A** or structure **B** is a better representation of benzene.

.....

.....

.....

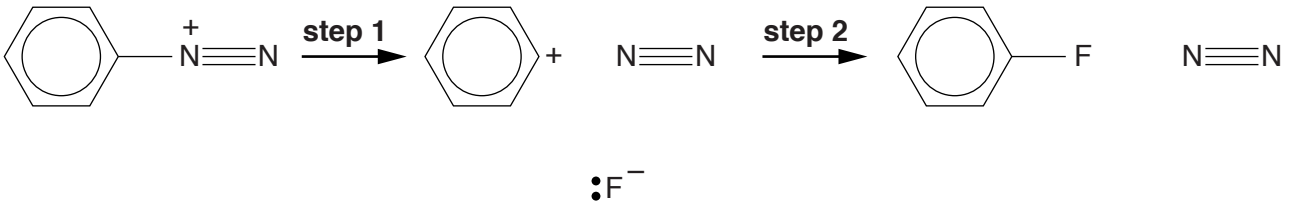
.....

.....

..... **[2]**

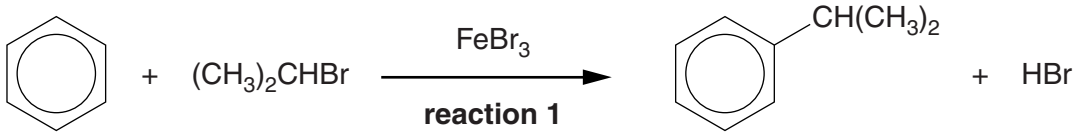
(b) Benzene compounds can undergo nucleophilic substitution reactions.

Add curly arrows to the diagram below to show the two-step mechanism of $C_6H_5N_2^+$ with F^-.



[2]

(c) Benzene can react with halogenoalkanes in the same way as with bromine, as shown in **reaction 1** below.



Write an equation to show the formation of the electrophile that reacts with benzene in **reaction 1**.

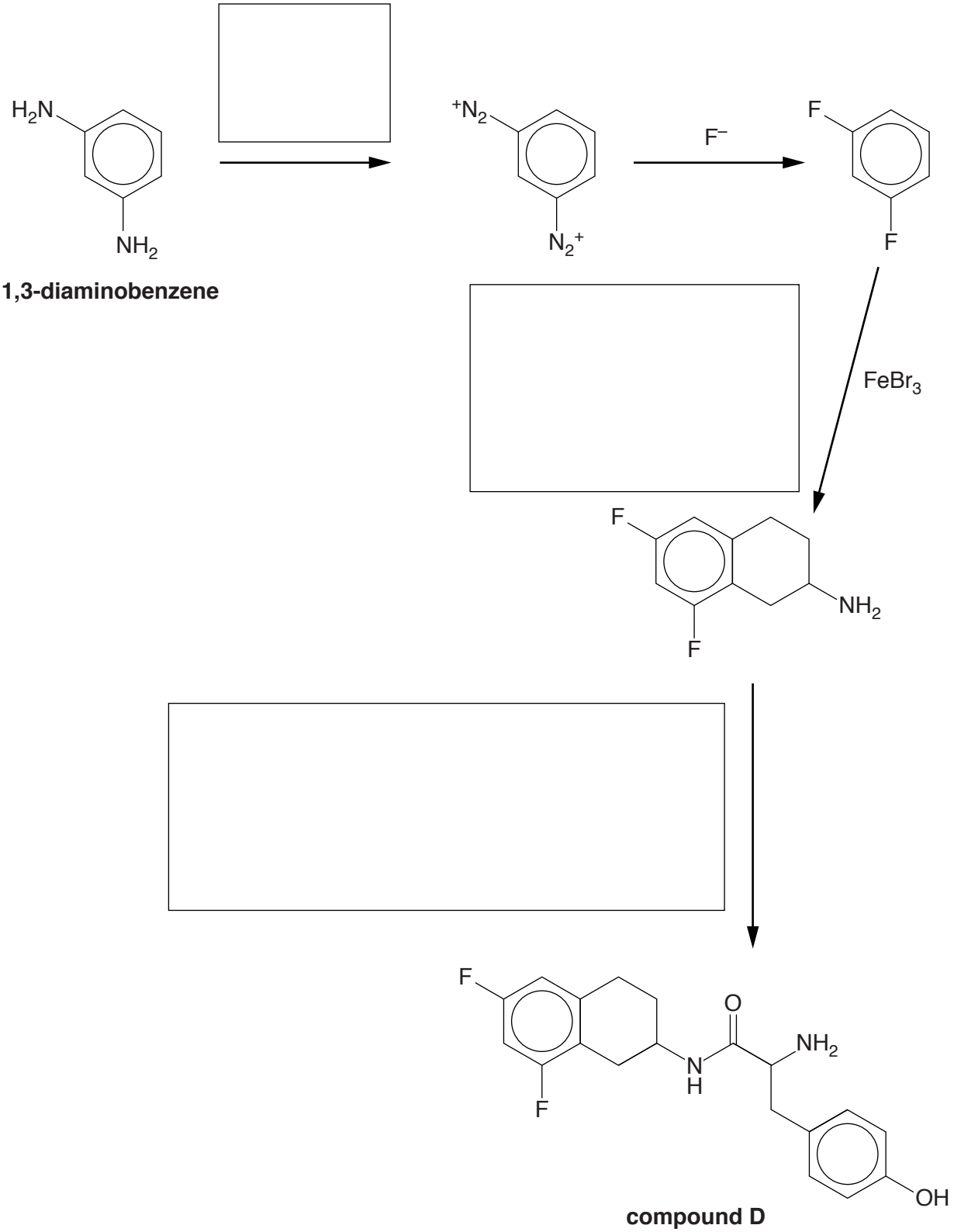
[1]

© OCR 2015

STEMUP.CO.UK

(d) The types of reaction in **(b)** and **(c)** can be used to synthesise compound **D**, as shown in the flowchart below.

(i) Complete the boxes below to suggest formulae for the reactants involved in the synthesis of compound **D**.
Give structures for organic compounds.



1,3-diaminobenzene

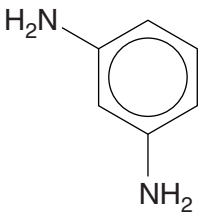
compound D

[3]

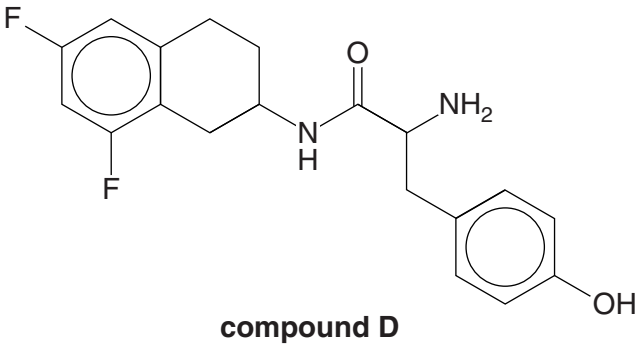
© OCR 2015

STEMUP.CO.UK

(ii) In a synthesis of compound **D** from 1,3-diaminobenzene shown in the flowchart, 1.73 g of compound **D** was prepared. These structures have been repeated below:



1,3-diaminobenzene



compound D

The overall percentage yield of compound **D** was 40.0%.

M_r of compound **D** = 346.0

Calculate the mass of 1,3-diaminobenzene needed for this synthesis.

mass = ... g **[3]**

© OCR 2015

STEMUP.CO.UK

(iii) Compound **D** has been developed for possible use as a drug to treat heart conditions. When compound **D**, prepared in this synthesis, was given to patients, only 25% of the dose was effective in treating their heart conditions.

Explain why only 25% of the dose was effective. Suggest how the synthesis of compound **D** might be changed to make the dose more effective.

.....

.....

.....

.....

..... **[3]**

[Total: 18]

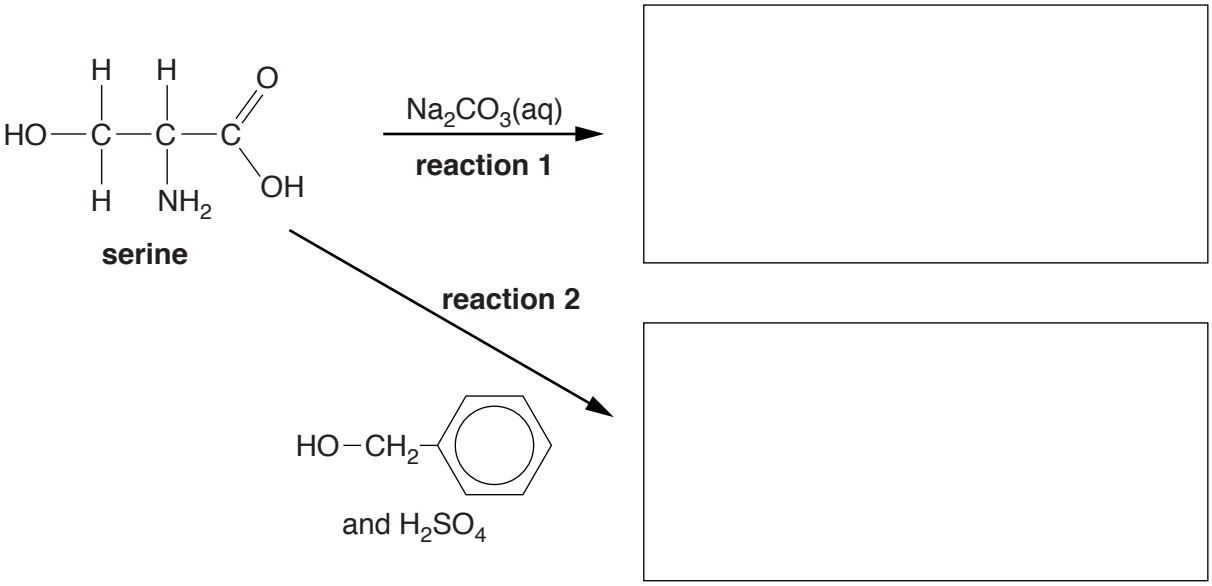
© OCR 2015

STEMUP.CO.UK

3 Many α-amino acids have several functional groups.

(a) Serine, shown below, is a naturally occurring α-amino acid.

(i) In the boxes below, draw the structure of the organic compounds formed by each reaction.



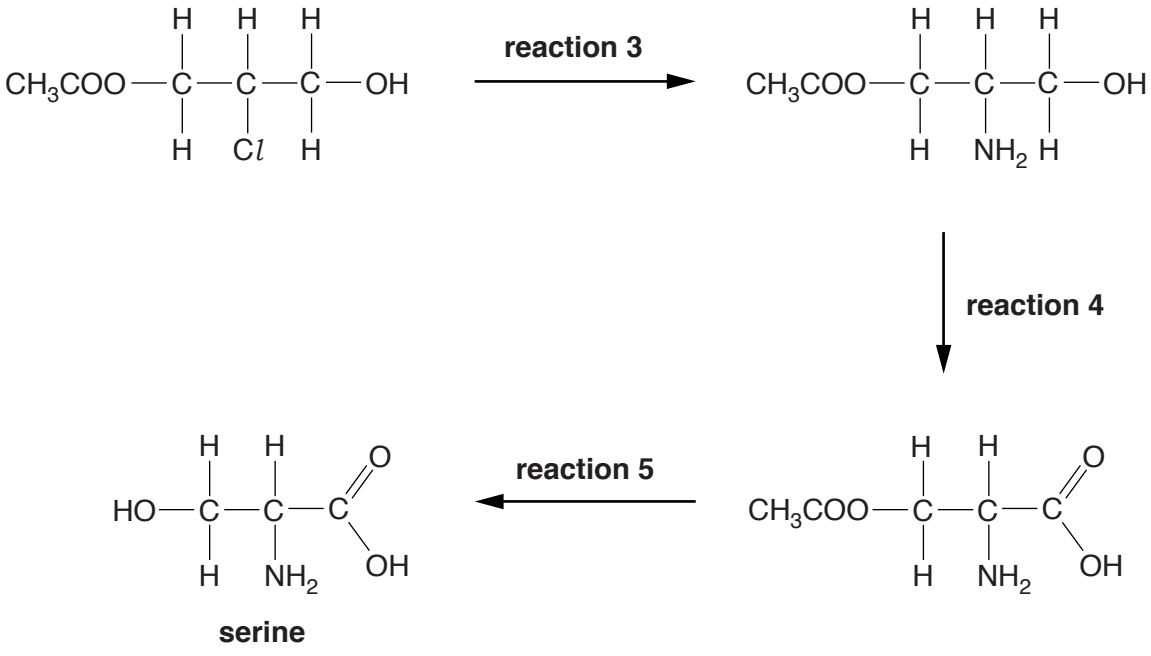
[3]

(ii) Suggest a use for the organic compound formed by **reaction 2**.

..... **[1]**

(iii) Serine is commonly used in organic synthesis.

One possible method of synthesising serine is shown below.



© OCR 2015

STEMUP.CO.UK

Complete the following:

Reagent and conditions used for **reaction 3**.

.....

Type of reaction for:

reaction 4 .....

reaction 5 .....

[3]

(b) Compound **E**, C_4H_7NO, is one of two optical isomers. It can be oxidised by Tollens' reagent to an α-amino acid, **F**.

The α-amino acid **F** forms two different polymers, **G** and **H**.
Polymer **G** has the empirical formula $C_4H_7NO_2$.
Polymer **H** has the empirical formula C_4H_5NO.

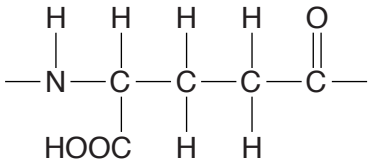
- Suggest structures for compound **E** and compound **F**.
- Draw repeat units of polymer **G** and polymer **H**.
- Describe how **F** forms **G** and **H**.

[6]

© OCR 2015

STEMUP.CO.UK

(c) Poly(glutamic acid) is a polymer of the amino acid, glutamic acid.



repeat unit of poly(glutamic acid)

(i) Draw the structure of glutamic acid.

[1]

(ii) A student tried to prepare poly(glutamic acid) from glutamic acid. No polymer was found in the product mixture.

The student isolated the two major compounds in the mixture. The mass spectra of these two compounds showed molecular ion (M^+) peaks at $m/z = 129$ and $m/z = 258$.

Suggest structures for these two compounds.

[2]

© OCR 2015

STEMUP.CO.UK

(d) Polymer **J** has been recently developed by scientists. The repeat unit of polymer **J** is shown below.

$$—CO(CH_2)_4CONHC(CH_3)_2CH_2O—$$

polymer J

(i) What are the functional groups in polymer **J**?

..... **[1]**

(ii) Two different monomers react to form polymer **J**.

Draw the structures of the two monomers in the boxes below.

Display the functional groups in each monomer.

[2]

(iii) Polymer **J** is used in hair spray. It can be washed away easily with hot water.

Suggest why polymer **J** is able to be washed away easily with hot water.

.....

..... **[1]**

[Total: 20]

© OCR 2015

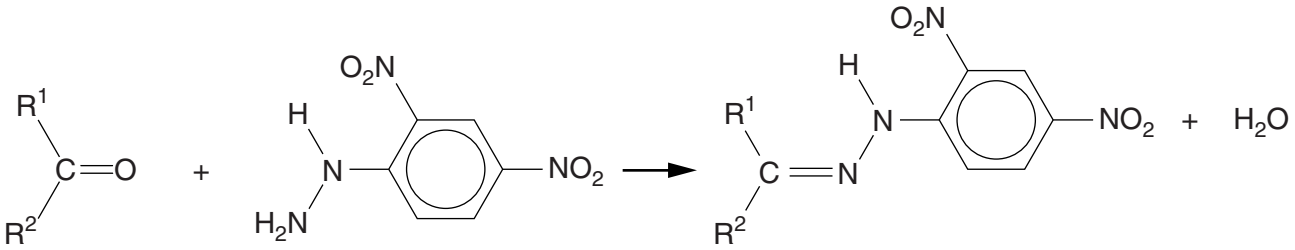
STEMUP.CO.UK

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© OCR 2015

4 A student reacts compound **K** with 2,4-dinitrophenylhydrazine. An orange precipitate, **L**, was formed.



compound K **2,4-dinitrophenylhydrazine** **orange precipitate L**

The student purifies the orange precipitate, **L**, and sends the sample for analysis using ^{1}H NMR and ^{13}C NMR spectroscopy.

(a) Describe a use for NMR spectroscopy in medicine.

.....

..... **[1]**

(b) **(i)** State the region of the electromagnetic spectrum used in ^{1}H NMR spectroscopy.

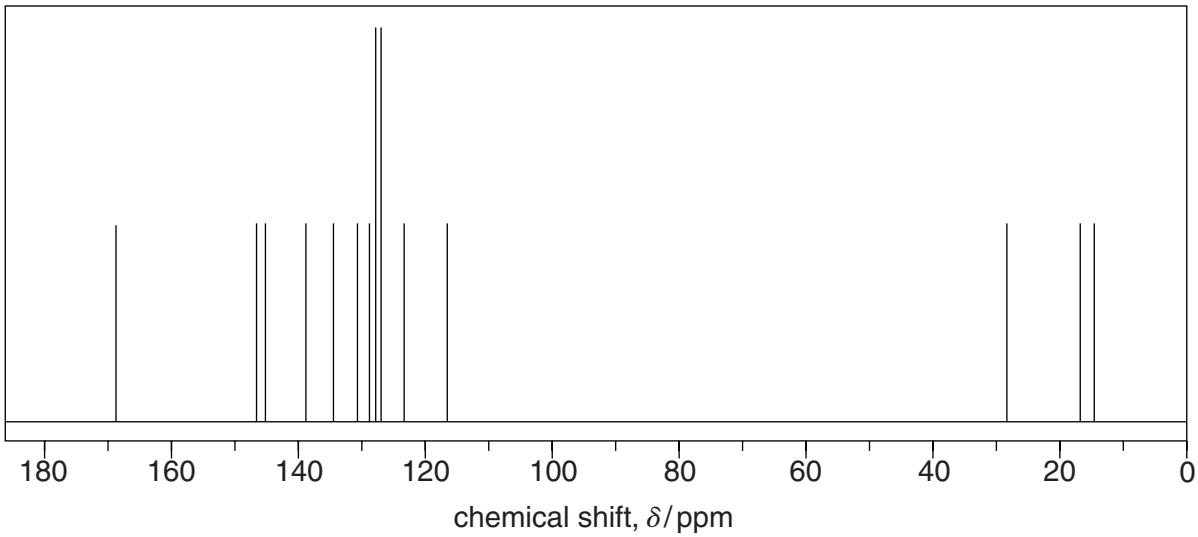
..... **[1]**

(ii) Explain why $CDCl_3$ is used as a solvent in ^{1}H NMR spectroscopy.

.....

..... **[1]**

(c) The ^{13}C NMR spectrum of **L** is shown below.



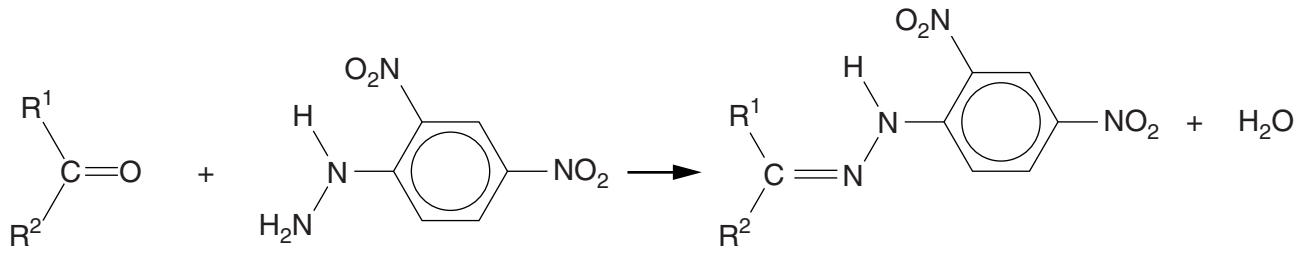
How many different carbon environments (types of carbon) are present in a molecule of compound **L**?

..... **[1]**

© OCR 2015

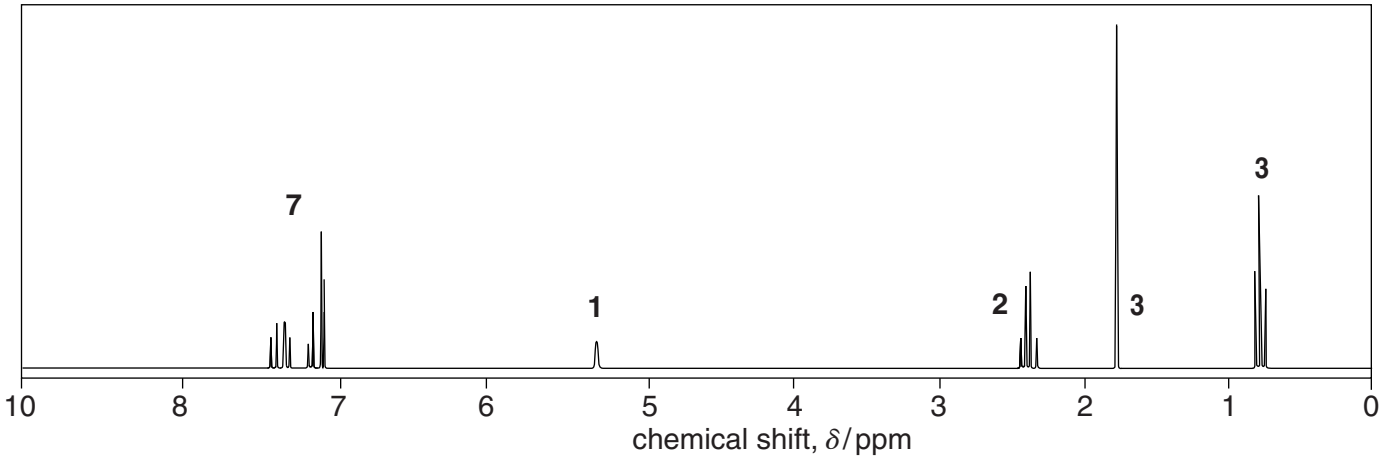
STEMUP.CO.UK

(d) The reaction of **K** to form **L** is repeated below.



compound K **2,4-dinitrophenylhydrazine** **orange precipitate L**

The ^{1}H NMR spectrum of **L** is shown below.



Use your answer to **(c)** and the data given to identify R^1, R^2 and the structure of compound **L**.

Explain how you used the chemical shifts and splitting patterns in the ^{1}H NMR spectrum and any evidence from the ^{13}C NMR spectrum.

In the ^{1}H NMR spectrum, HC–C=N– would have a peak in the range δ = 1.6–2.2 ppm.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

.....

.....

© OCR 2015

STEMUP.CO.UK

.....

.....

.....

.....

.....

.....

.....

.....

.....

structure of compound **L**

[7]

(e) Draw the structure of compound **K**.

structure of compound **K**

[1]

[Total: 12]

END OF QUESTION PAPER

© OCR 2015

STEMUP.CO.UK

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin.

© OCR 2015

© OCR 2015

OCR
Oxford Cambridge and RSA

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2015

OCR
Oxford Cambridge and RSA

GCE

Chemistry A

Unit **F324:** Rings, Polymers and Analysis

Advanced GCE

Mark Scheme for June 2015

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

© OCR 2015

Annotations available in Scoris.

Annotation	Meaning
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
I	Ignore
NAQ	Not answered question
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
RE	Rounding error
SF	Error in number of significant figures
	Correct response

STEMUP.CO.UK

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

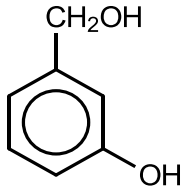
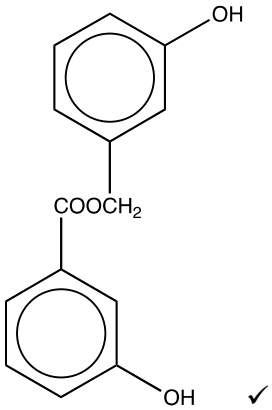
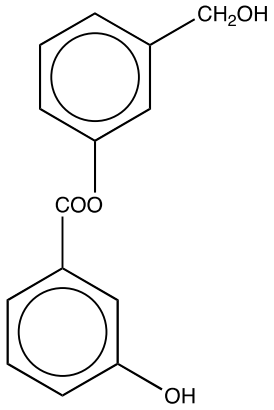
The following questions should be annotated with ticks to show where marks have been awarded in the body of the text:

1(c)(ii), 2(a)(i), 2(d)(ii), 3(b) and 4(d)

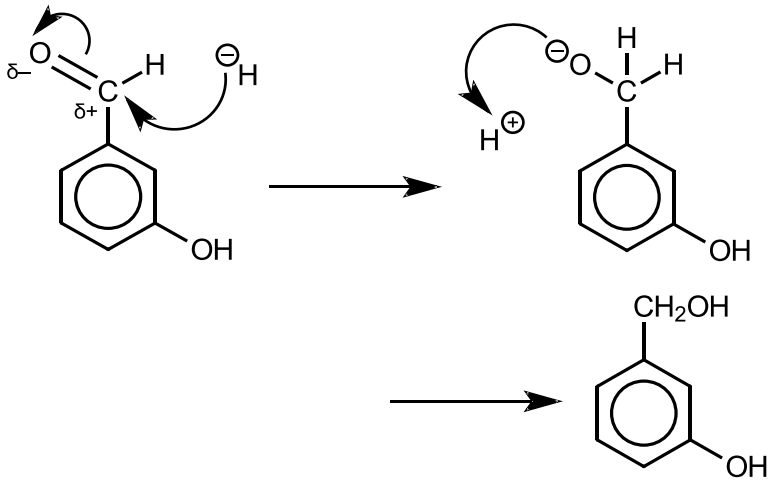
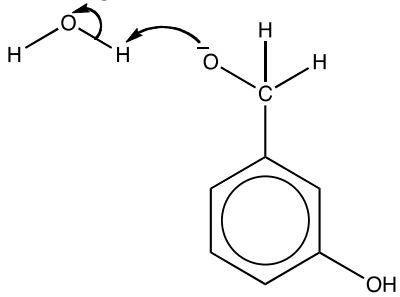
STEMUP.CO.UK

Question			Answer	Mark	Guidance
1	(a)		(Relative) solubility (in stationary phase) ✓	1	**ALLOW** how well the compound dissolves **IGNORE** retention time **AND** partition **DO NOT ALLOW** adsorption **OR** absorption
	(b)	(i)	Compound **B** **AND** M^+/molecular ion peak (at *m*/*z*) = 124 ✓	1	**ALLOW** Mr = 124 **IGNORE** compound B because *m*/*z* = 124 **ALLOW** $C_7H_8O_2^+$ = 124 **OR** $C_7H_8O_2$ = 124 **ALLOW** peak at (m/z =) 109 due to $HOC_6H_4O^+$ **ALLOW** peak at (m/z =) 109 due to loss of CH_3 **IGNORE** reference to other peaks in the spectrum
		(ii)	Compound (B) is less soluble in the stationary phase/ liquid	1	**ORA** Answer refers to the first compound to emerge from the column **ALLOW** compound (B) is more soluble in mobile phase/gas **ALLOW** compound interacts less with stationary phase/liquid **OR** compound interacts more with mobile phase/gas **IGNORE** compound adsorbs less **IGNORE** compound is not very soluble (comparison needed) **IGNORE** volatility **OR** reactivity

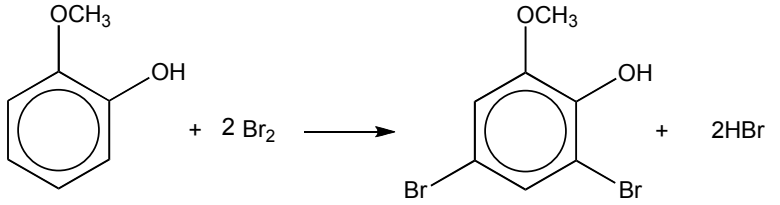
STEMUP.CO.UK

Question			Answer	Mark	Guidance
	(c)	(i)	reagent = $K_2Cr_2O_7$ **AND** H_2SO_4 ✓	3	**ALLOW** acidified dichromate **ALLOW** H^+/any acid **IGNORE** concentration of acid **ALLOW** $Na_2Cr_2O_7$ /$Cr_2O_7^{2-}$ /(potassium **OR** sodium) dichromate((VI)) **ALLOW** acidified MnO_4^- **ALLOW** Tollens' reagent/ammoniacal silver nitrate **IGNORE** conditions
			compound C =  ✓		**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **ALLOW ECF** from incorrect **compound C** Check positions of OH groups
			ester =  ✓		**ALLOW** esterification of phenol group 

STEMUP.CO.UK

Question	Answer	Mark	Guidance
(ii)	curly arrow from H^- to $C^{\delta+}$ ✓ dipole **AND** curly arrow from C=O bond to O ✓ correct intermediate **AND** curly arrow to H^+ ✓ 	3	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** curly arrow must come from lone pair on H or negative charge on H curly arrow must come from the bond, not the carbon atom curly arrow must come from lone pair on O or negative charge on O and go to H or positive charge on H **Where circles have been placed round charges, this is for clarity only and does not indicate a requirement** **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **ALLOW** for second stage  **IF** H_2O is used it **MUST** show the curly arrow from the negative charge or lone pair on the oxygen atom of the intermediate to H in H_2O **AND** from the O—H bond to the O in H_2O. **Dipole not required on water molecule** Penalise missing –OH on intermediate only **IGNORE** product – already given credit in part (i)

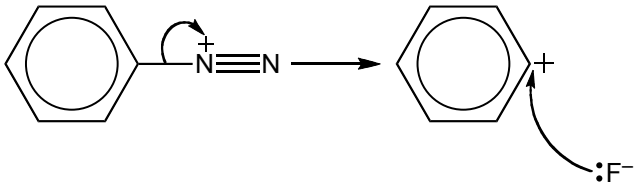
STEMUP.CO.UK

Question			Answer	Mark	Guidance
	(d)		 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **ALLOW** disubstitution at any positions on benzene ring
			Total	**10**	

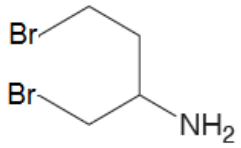
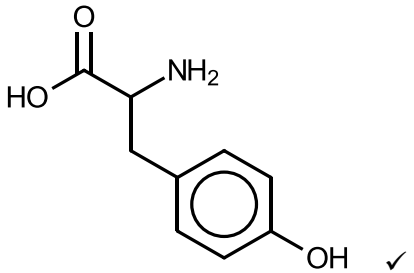
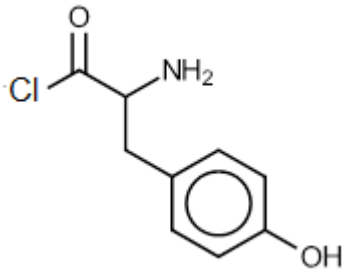
STEMUP.CO.UK

Question			Answer	Mark	Guidance
2	(a)	(i)	**M1** p-orbitals overlap (to form pi/π-bonds) ✓ **M2** π-bond(s) are <u>delocalised</u> in **structure B** ✓ **M3** π-bonds are localised/between two carbons in **structure A** ✓ **M4**  **AND** **Diagrams** show correct **position** of delocalised and localised π-bonds/π-electrons **OR** correct position of p-orbital overlap ✓ ✎ **QWC** requires delocalised/delocalized **spelled correctly** and used in correct context	4	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **IGNORE** p-orbitals overlap to form sigma bonds **ALLOW** electrons are delocalised in structure B **IGNORE B** has delocalised structure or ring (must be electrons or π-bonds) **ALLOW π**-electrons/p-orbital overlap localised/between two carbons in structure A **ALLOW** p-orbitals overlap with one other carbon **IGNORE** electrons are localised **OR structure A** has localised structure (must be π-bonds/π-electrons/p-orbital overlap) **ALLOW** labelled diagram showing overlap of p-orbitals between two carbon atoms **DO NOT ALLOW** C=C in this diagram Diagram for structure A must show the full ring for **M4** **IGNORE** C=C in **M4** diagram **IGNORE** charge density **DO NOT ALLOW** electronegativity Structures do not need to be labelled A and B if the description matches the structure

STEMUP.CO.UK

Question			Answer	Mark	Guidance
		(ii)	**structure B/**delocalised structure is (more) stable ✓ **structure B** is a better because (enthalpy change of hydrogenation for benzene is) less (exothermic) than (-) 357 (kJ mol^{-1}) ✓	2	**ALLOW** structure **B** is low in energy **IGNORE** structure **B** is less reactive **ALLOW** enthalpy change/hydrogenation for benzene is less (negative) than 3 × (–)119 **IGNORE** more positive than (-)357 kJ mol^{-1} **ALLOW** enthalpy change is less than 3x enthalpy change for cyclohexene **ALLOW** structure **B** is more stable by 149 kJ mol^{-1} (2 marks) **DO NOT ALLOW** more/less energy needed for the reaction Answer must refer to data given in the question and must be a comparison **IGNORE** 360 kJ mol^{-1} No marks can be awarded if structure **A** is selected
	(b)		 curly arrow from C–N bond to N^+ ✓ curly arrow from lone pair on fluoride ion to positive charge on benzene ring ✓	2	First curly arrow must come from bond not from C atom **ALLOW** first curly arrow to nitrogen atom **OR** to positive charge on nitrogen atom **ALLOW** second curly arrow from negative charge on fluoride ion **ALLOW** second curly arrow to carbon atom with positive charge

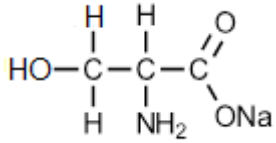
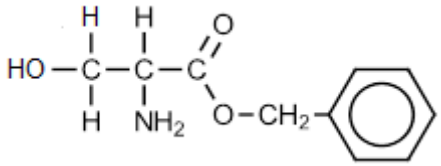
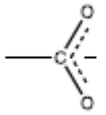
STEMUP.CO.UK

Question			Answer	Mark	Guidance
	(c)		$(CH_3)_2CHBr + FeBr_3 \rightarrow (CH_3)_2CH^+ + FeBr_4^-$	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **ALLOW** positive charge anywhere on the electrophile **IGNORE** $AlCl_3$ **OR** $AlBr_3$
	(d)	(i)	First reactant = HNO_2 ✓ Second reactant =  ✓ Third reactant =  ✓	3	**ALLOW** $NaNO_2$ + HCl **OR** HNO_2 + HCl **IGNORE** conditions/concentration **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **ALLOW** 

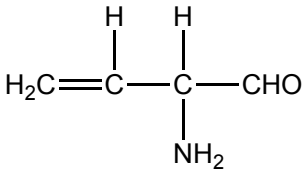
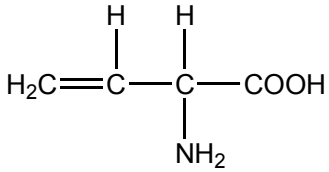
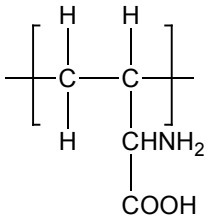
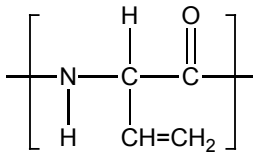
STEMUP.CO.UK

Question			Answer	Mark	Guidance
		(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **IF** answer = 1.35 (g) award 3 marks **IF** answer = 0.54 (g) award 2 marks (no scale-up) **IF** answer = 0.216 (g) award 2 marks (incorrect scale-up) *n*(compound D) = 1.73/346 = 0.00500 mol ✓ *n*(1,3-diaminobenzene) required = 100/40 x 0.005 = 0.0125 mol ✓ Molar mass of 1,3-diaminobenzene = 108 (g mol^{-1}) **AND** Mass of 1,3-diaminobenzene = (108)(0.0125) = 1.35 g ✓	3	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **If there is an alternative answer, check to see if there is any ECF credit possible** **ALLOW ECF** from incorrect amount, scale-up or molar mass **Alternative 1** n(compound D) = 1.73/346 = 0.00500 mol Molar mass of 1,3-diaminobenzene = 108 (g mol^{-1}) **AND** Mass of 1,3-diaminobenzene = (0.00500)(108) = 0.540 g Mass of 1,3-diaminobenzene required = (0.540)(100/40) = 1.35 g **Alternative 2** 346 g gives 108 g 1.73 g gives 108/364 x 1.73 = 0.54 g 0.54/40 x100 = 1.35 g
		(iii)	(compound D has) **two** chiral centres ✓ Four optical isomers exist ✓ (Synthesis could) use enzymes **OR** bacteria **OR** use (chemical) chiral synthesis **OR** chiral catalysts **OR** use natural chiral molecules **OR** single isomers (as starting materials) ✓	3	**ALLOW** (Compound **D**) has two asymmetric carbons **OR** has two stereocentres **ALLOW** four enantiomers **OR** two pairs of enantiomers **INDEPENDENT MARK** **ALLOW** biological catalysts **ALLOW** chiral transition metal complex/catalyst **OR** stereoselective transition metal complex/catalyst **ALLOW** 'chiral pool'/chiral auxiliary
			Total	**18**	

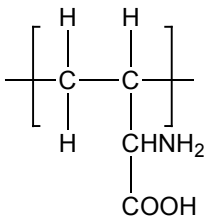
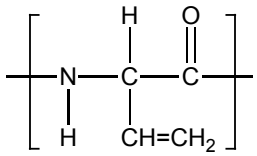
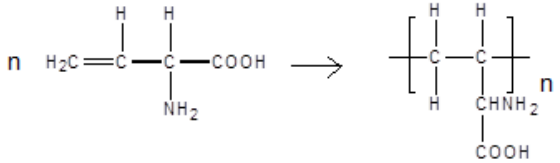
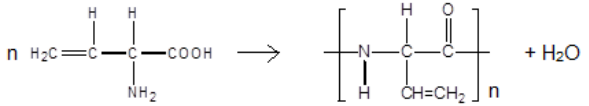
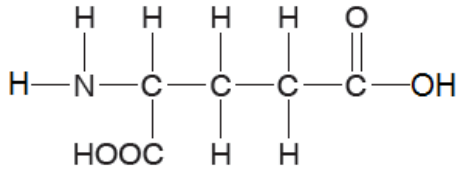
STEMUP.CO.UK

Question			Answer	Mark	Guidance
3	(a)	(i)	 ✓  ✓ $—NH_3^+$ in second product ✓	3	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **ALLOW** $—O^-Na^+$ **OR** $—O^-$ (cation not required) **DO NOT ALLOW** —O—Na (covalent bond) **DO NOT ALLOW** –O (without the sodium) **ALLOW** delocalised carboxylate 
		(ii)	perfume/fragrance/flavouring ✓	1	**IGNORE** solvent **OR** food additive
		(iii)	Reaction 3: (hot) ethanolic ammonia ✓ Reaction 4: oxidation ✓ Reaction 5: hydrolysis ✓	3	**ALLOW** NH_3 (dissolved) in ethanol **IGNORE** other conditions **ALLOW** oxidisation/oxidised **DO NOT ALLOW** redox **ALLOW** nucleophilic addition-elimination **DO NOT ALLOW** nucleophilic substitution **IGNORE** acid/base

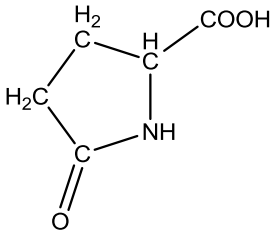
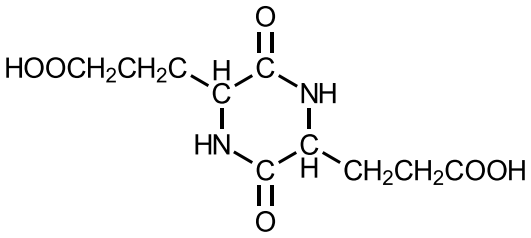
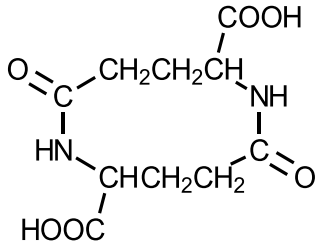
STEMUP.CO.UK

Question	Answer	Mark	Guidance
(b)	**M1** Compound **E**  ✓ **M2** Compound **F**  ✓ **M3** Compound **G**  ✓ **M4** Compound **H**  ✓	6	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous Labels are not required for compound E, F, G or H **IGNORE** labels for **M1**, **M2**, **M3** and **M4** CH_2=CH must be shown in **E** **ALLOW** C_2H_3 **OR** $CHCH_2$ for $CH=CH_2$ in **F** **ALLOW ECF** from error in structure of <u>aldehyde</u> E **ALLOW** multiple repeat units but must be full repeat units **ALLOW** end bonds shown as ..... **DO NOT ALLOW** if structures have no end bonds **IGNORE** brackets unless they are used to pick out the repeat unit from a polymer chain **IGNORE** n **ALLOW** $C_2H_4NO_2$ for $CH(NH_2)COOH$ in polymer **G** **ALLOW** C_2H_3 **OR** $CHCH_2$ for $CH=CH_2$ in polymer **H** **ALLOW ECF** from $NH_2CH_2CH=CHCOOH$ for the formation of compound G or compound H

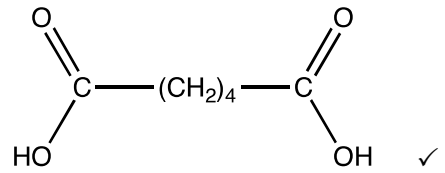
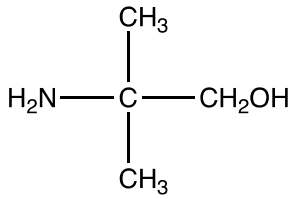
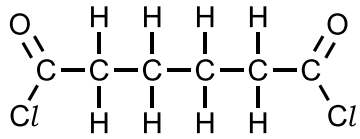
STEMUP.CO.UK

Question			Answer	Mark	Guidance
			M5 Compound **G** **OR**  Is an addition polymer ✓ **M6** Compound **H** **OR**  is a condensation polymer ✓		**ALLOW** alkene forms addition polymer/polymer with same empirical formula as monomer **ALLOW** equation for reaction  **ALLOW** amino acid forms condensation polymer **OR** (molecules of) compound **F** join/bond/add/react/form polymer and water/small molecule **ALLOW** equation for reaction 
	(c)	**(i)**	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous

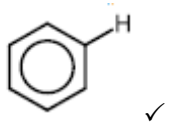
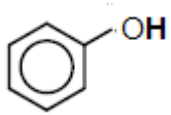
STEMUP.CO.UK

Question	Answer	Mark	Guidance
(ii)	 ✓  ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **ALLOW** a cyclic amide with a 3 membered ring **ALLOW**  **OR** a structure obtained by condensation of a glutamic acid molecule with the first cyclic amide

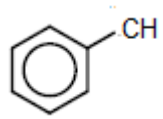
STEMUP.CO.UK

Question			Answer	Mark	Guidance
	(d)	(i)	Ester **AND** amide ✓	1	**ALLOW** peptide for amide
		(ii)	 ✓  ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous Functional groups do not need to be fully displayed **ALLOW** structures as shown; the O-H bond and the N-H bonds in the functional groups **do not** need to be displayed **DO NOT ALLOW** -COOH **ALLOW**  Penalise incorrect connectivity to OH once in this question
		(iii)	(The molecule/amide/ester) can be <u>hydrolysed</u> ✓	1	**ALLOW** (the molecule/amide/ester) can form hydrogen/H-bonds <u>with water</u> **IGNORE** acid/base
			Total	**20**	

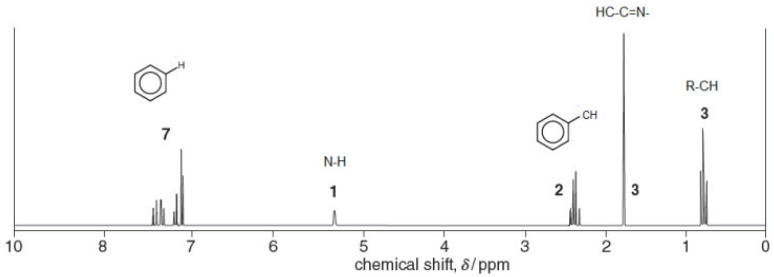
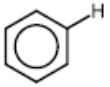
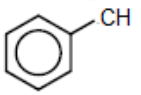
STEMUP.CO.UK

Question			Answer	Mark	Guidance
4	(a)		magnetic resonance imaging/providing diagnostic information/body scanners. ✓	1	**ALLOW** MRI/scanning internal structures e.g. brain **ALLOW** detection of tumours/cancer/haemorrhage/aneurysm **IGNORE** reference to drugs, chemicals or functional groups **IGNORE** analysis of blood **DO NOT ALLOW** CT scan/CAT scan
	(b)	(i)	Radio (waves) ✓	1	**ALLOW** a value in the range 60 – 900 MHz
		(ii)	The solvent does not have any hydrogen/H/protons ✓	1	**ALLOW** to prevent (^{1}H nuclei from) the solvent from interfering with the NMR spectrum **ALLOW** does not show on the spectrum **ALLOW** no peak/signal (from solvent) **IGNORE** volatility
4	(c)		14 ✓	1	
	(d)		**NMR analysis** (5 marks) **M1** Peaks between (δ) 7.1 and 7.5 (ppm) **OR** Relative peak area of 7 **OR** Multiplet =  ✓ **M2** Peak at 5.2/5.3	7	**ANNOTATE ANSWER WITH TICKS AND CROSSES ETC** **IGNORE** analysis of ^{13}C spectrum Each peak can be identified from its δ value ± 0.2 ppm **ALLOW** (seven) benzene ring protons **OR** aromatic protons **DO NOT ALLOW** benzene ring without reference to protons **ALLOW** C_6H_6 **IGNORE** 

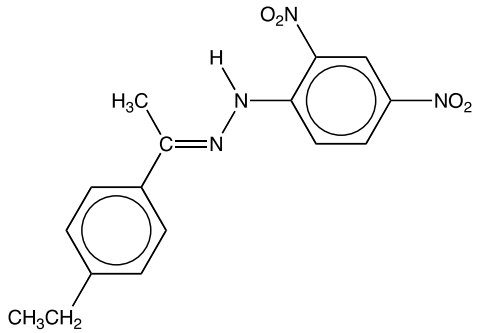
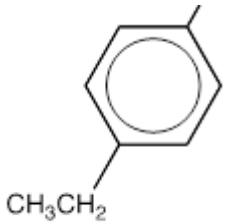
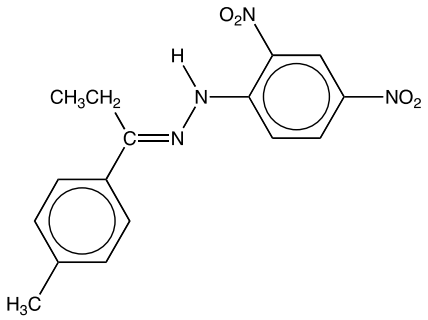
STEMUP.CO.UK

Question	Answer	Mark	Guidance
	OR Relative peak area of 1 = N-**H** ✓		**IGNORE** O-**H** , CON**H** **AND** C=C**H**
	M3 Peak at 2.3/2.4 **OR** Relative peak area of 2 **OR** Quartet =  **OR** $C_6H_5CH_2$ ✓		**ALLOW** quadruplet **IGNORE** C**H**C=O **AND** **H**C-N
	M4 Peak at 0.7/0.8 **OR** Triplet = R-CH **OR** R-CH_3 ✓		**DO NOT ALLOW** triplet = CH_3 **OR** CH_2CH_3
	M5 Triplet (at δ 0.7) **AND** quartet (at δ 2.3) = CH_2CH_3 **OR** triplet at (δ) 0.7 shows (C with) 2 adjacent Hs/protons = CH_2CH_3 **OR** quartet (at δ 2.3) shows (C with) 3 adjacent Hs/protons = CH_2CH_3 ✓		This also scores **M4** if triplet is linked to R-CH_3 **ALLOW** CH_3CH_2 described as R-CH_3 and 2 adjacent H **OR** –CH_2- and 3 adjacent H The information can be presented on the spectrum or in a table.

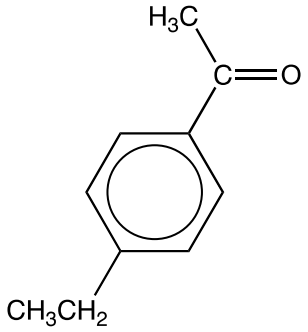
STEMUP.CO.UK

Question	Answer	Mark	Guidance
	✎ **QWC**: **triplet** or **quartet** spelled correctly in the correct context for **M5**		 Chemical shift/ppm / Relative peak area / Splitting pattern / Type of proton 7.1 – 7.5 / 7 / Multiplet /  5.3 / 1 / Singlet / N-H 2.3/2.4 / 2 / Quartet /  1.7/1.8 / 3 / Singlet / HC-C=N- 0.7/0.8 / 3 / triplet / R-CH/R-CH_3 **IGNORE** peak in the range 1.6–2.2 = HC–C=N– because this information is given in the question. H_3C-C=N- scores one mark for the identification of $\mathbf{R^1}$ or $\mathbf{R^2}$ (see below)

STEMUP.CO.UK

Question	Answer	Mark	Guidance
	Identification of R^1 and R^2 (2 marks) **Orange precipitate L** Correct structure scores 2 marks  **R^1** or **R^2** = $-CH_3$ ✓ **R^1** or **R^2** =  ✓		**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous Marks are for structure of R^1 and R^2 **IGNORE** errors in the rest of the structure **ALLOW** 1 mark for CH_3 and CH_3CH_2 swapped, i.e. the following structure  **ALLOW** H_3C-C=N- **MUST BE** 1,4-disubstituted (14 carbon environments in the ^{13}C NMR spectrum

STEMUP.CO.UK

Question			Answer	Mark	Guidance
	(e)		**Carbonyl compound K**  ✓	1	**ALLOW ECF** from incorrect compound **L** Must be a correct carbonyl structure
			Total	**12**	

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2015

PART OF THE CAMBRIDGE ASSESSMENT GROUP

LLOYD'S REGISTER QUALITY ASSURANCE ISO9001 UKAS MANAGEMENT SYSTEMS 001

STEMUP.CO.UK

Monday 9 June 2014 – Afternoon

A2 GCE CHEMISTRY A

F324/01 Rings, Polymers and Analysis

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry A* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour 15 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found inside this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

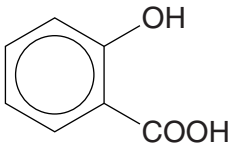
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means, for example, you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an Insert with this Question Paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.

© OCR 2014 [M/500/7836]
OCR is an exempt Charity

STEMUP.CO.UK

Answer **all** the questions.

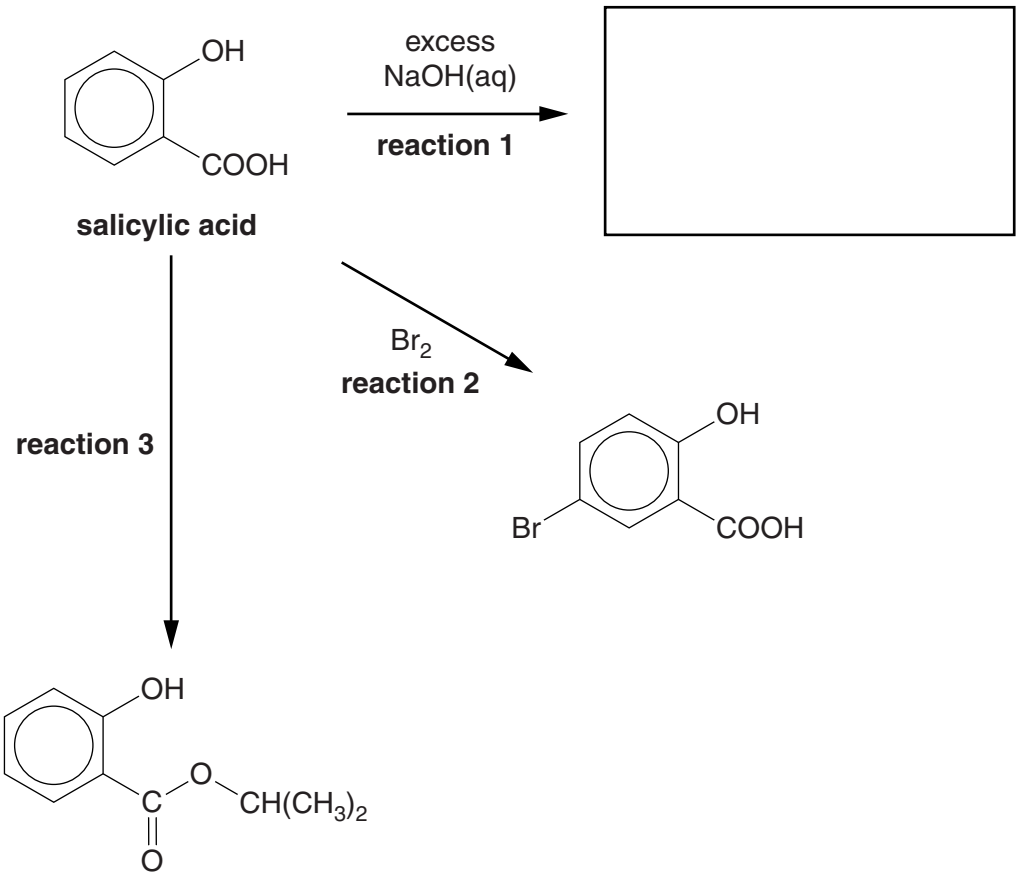
1 Salicylic acid is a naturally occurring carboxylic acid, widely used in organic synthesis.



salicylic acid

(a) The flowchart below shows some reactions of salicylic acid.

(i) In the box below, draw the structure of the organic compound formed by **reaction 1**. **[1]**



© OCR 2014

STEMUP.CO.UK

(ii) Describe what would be **observed** during **reaction 2**.

.....

..... **[1]**

(iii) Write a chemical equation to represent **reaction 2**.

[1]

(iv) State the reagents and conditions in **reaction 3**.

.....

..... **[1]**

(b) Bromine reacts more readily with salicylic acid than with benzene.

(i) Outline the mechanism for the bromination of salicylic acid shown in **reaction 2** in the flowchart.

A halogen carrier is not required for this reaction.

The electrophile is Br_2.

[4]

© OCR 2014

STEMUP.CO.UK

(ii) Explain why bromine reacts more readily with salicylic acid than with benzene.



In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

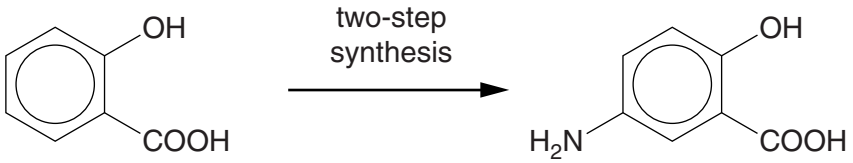
.....

.....

..... **[3]**

© OCR 2014

(c) Mesalazine is a drug that can be synthesised from salicylic acid in two steps.



salicylic acid **mesalazine**

(i) Suggest a **two-step** synthesis to prepare mesalazine from salicylic acid.

For **each** step

- state the reagents used,
- write a chemical equation.

[4]

(ii) Mesalazine reacts with acids to form salts.

Explain how mesalazine is able to react with acids.

.....

.....

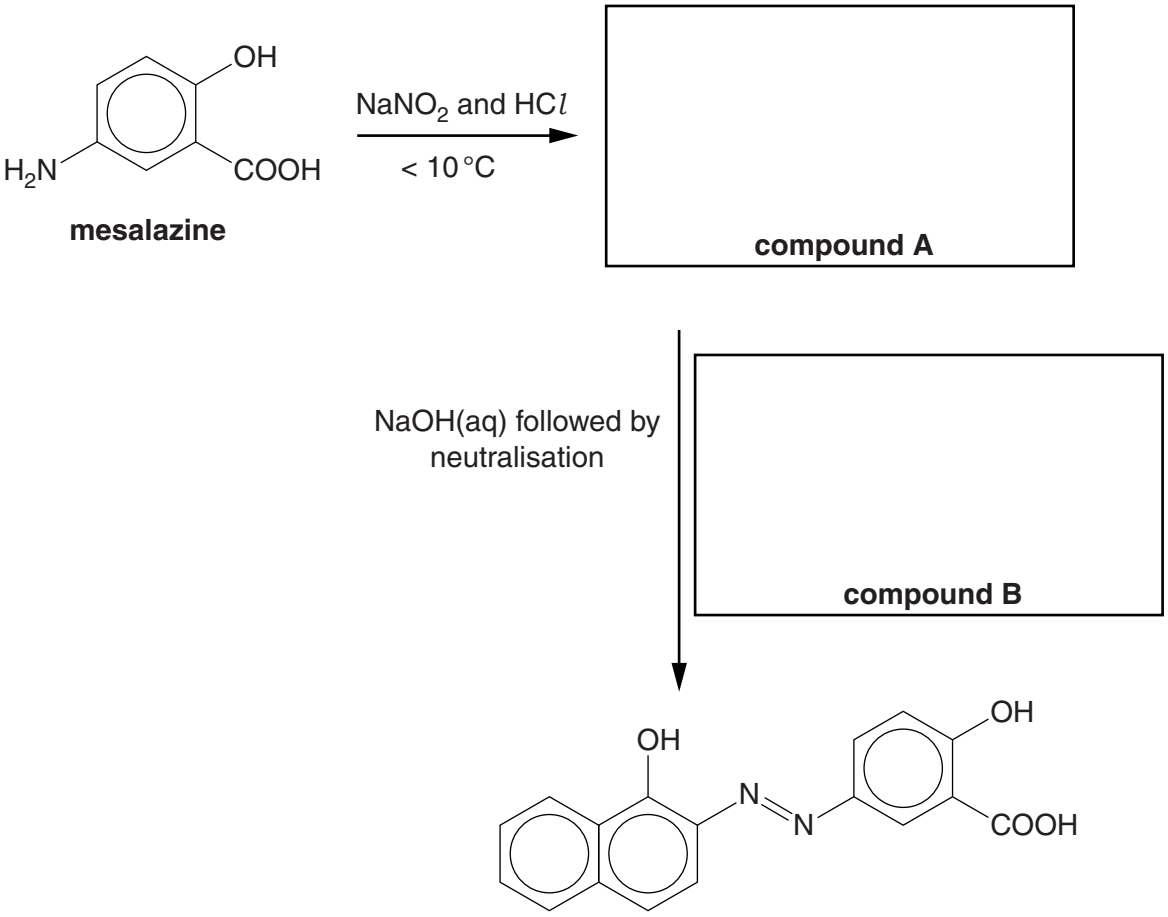
..... **[1]**

© OCR 2014

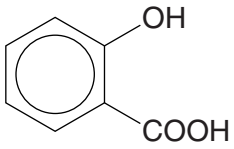
STEMUP.CO.UK

(iii) Mesalazine reacts in another two-stage process as shown below.

In the boxes, draw the structures of organic compounds **A** and **B**. **[2]**



(d) Salicylic acid can be used to form a condensation polymer similar to Terylene®.



salicylic acid

(i) Explain what is meant by the term *condensation polymer*.

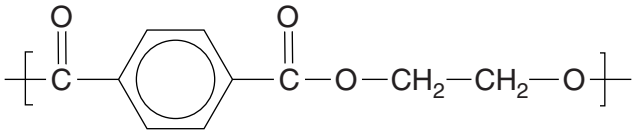
.....

..... **[1]**

© OCR 2014

STEMUP.CO.UK

(ii) The repeat unit of Terylene® is shown below.



Terylene®

Draw the skeletal formulae of **two** monomers that can be used to form Terylene®.

[2]

(iii) Salicylic acid reacts with 3-hydroxypropanoic acid to form a mixture of condensation polymers.

To form one polymer, the two monomers react in equal quantities.

Draw the repeat unit of this polymer, displaying the link between the monomer units.

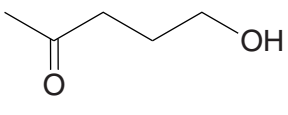
[1]

[Total: 22]

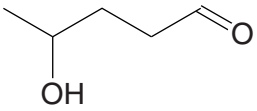
© OCR 2014

STEMUP.CO.UK

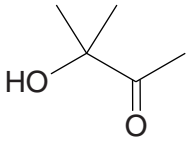
2 The following three carbonyl compounds are structural isomers of $C_5H_{10}O_2$.



compound C



compound D



compound E

(a) Describe chemical tests that you could carry out in test-tubes to distinguish between compounds **C**, **D** and **E**.

Include appropriate reagents and any relevant observations. Also include equations showing structures for the organic compounds involved.

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

© OCR 2014

STEMUP.CO.UK

(b) Aldehydes and ketones are both reduced by $NaBH_4$. When used in the presence of a $CeCl_3$ catalyst, $NaBH_4$ only reduces ketones.

Compound **F** has the structural formula $CH_3COCH_2CH_2CHO$. It is reduced by $NaBH_4$ in the presence of a $CeCl_3$ catalyst to form one of the compounds **C**, **D** or **E**.

Show the mechanism for this reduction of compound **F** and identify the product that is formed.

Use curly arrows and show relevant dipoles.

You do not need to show the role of the $CeCl_3$ catalyst.

[4]

(c) Predict the number of peaks in the ^{13}C NMR spectra of compounds **C**, **D** and **E**.

Compound	**C**	**D**	**E**
Number of peaks			

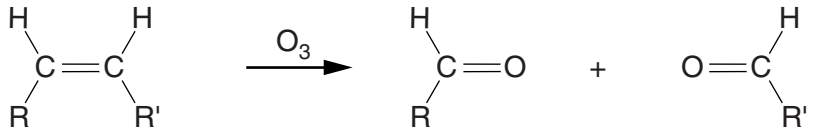
[1]

© OCR 2014

STEMUP.CO.UK

(d) 'Ozonolysis' is a technique used in organic chemistry to break open a C=C double bond.

During ozonolysis, an alkene reacts with ozone, O_3. The products are carbonyl compounds, as shown below.



(i) Draw the structures of the products you would expect from the complete ozonolysis of the following alkenes.

- pent-2-ene

- hexa-2,4-diene

[3]

(ii) In another ozonolysis reaction, organic compound **G** reacted to form **only** hexane-1,6-dial.

Compound **G** has six carbon atoms.

Draw the structure of compound **G**.

[1]

[Total: 13]

© OCR 2014

STEMUP.CO.UK

BLANK PAGE

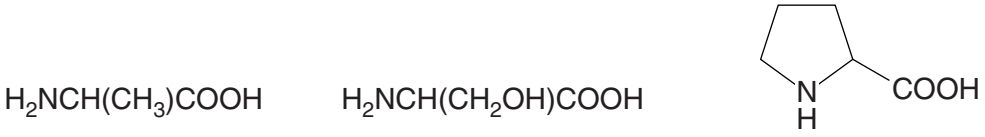
Question 3 begins on page 12

PLEASE DO NOT WRITE ON THIS PAGE

© OCR 2014

STEMUP.CO.UK

3 Alanine, serine and proline are α-amino acids.



alanine **serine** **proline**

(a) (i) Alanine and serine react together to form two different dipeptides.

Draw the structures of the **two** dipeptides that can form when alanine and serine react together.

[2]

(ii) The isoelectric points of alanine and serine are shown below.

alanine, pH = 6.0

serine, pH = 5.6

Draw the structures of the ions formed at the following pH values.

structure of **alanine** ion at **pH 6.0**

structure of **serine** ion at **pH 10.0**

[2]

© OCR 2014

(iii) Proline can polymerise to form poly(proline).

Draw the structure of the repeat unit in poly(proline).

[1]

(b) A solution of serine was shaken with a few drops of D_2O. The solution was then analysed using ^1H NMR spectroscopy.

Complete the table to predict the ^1H NMR spectrum of serine after the addition of D_2O.

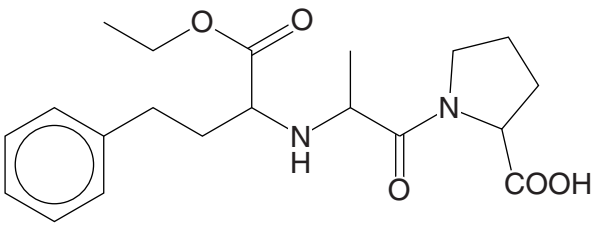
^1H NMR spectrum for serine		
Chemical shift, δ/ppm	**Relative peak area**	**Splitting pattern**

[2]

© OCR 2014

STEMUP.CO.UK

(c) Enalapril is a drug used in the treatment of high blood pressure.



enalapril

(i) **On the structure above**, mark each chiral centre with an asterisk (*). **[1]**

(ii) Suggest **two** benefits of using single stereoisomers in the synthesis of drugs such as enalapril.

.....

.....

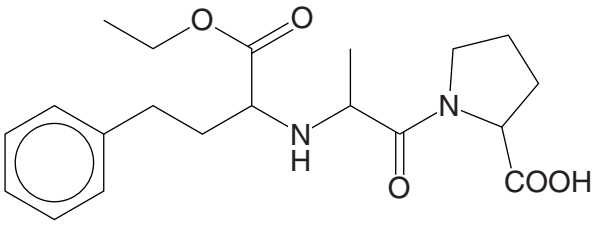
.....

..... **[2]**

© OCR 2014

STEMUP.CO.UK

(iii) Enalapril is broken down in the body by acid hydrolysis.



enalapril

Draw the structures of the **three** organic products of the **acid hydrolysis** of enalapril.

[4]

(iv) A scientist hydrolysed enalapril in the laboratory. The scientist then analysed the mixture of products using GC–MS.

Explain how GC–MS enables the products to be identified.

.....

.....

..... **[1]**

[Total: 15]

© OCR 2014

STEMUP.CO.UK

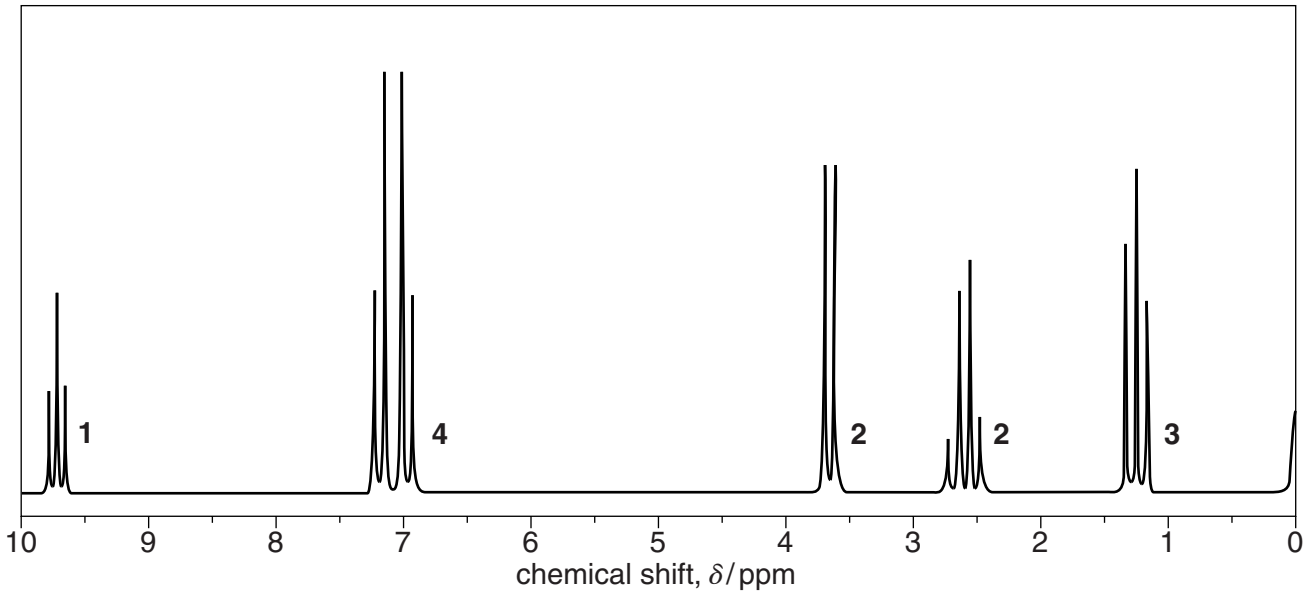
4 A chemist isolates compound **H** from a mixture and sends it for analysis.

Initial analysis shows that the molecular formula of compound **H** is $C_{10}H_{12}O$.

The ^{13}C NMR spectrum of compound **H** contained eight separate peaks.

The ^{1}H NMR spectrum of compound **H** is shown below.

^{1}H NMR spectrum
The numbers by each peak are the relative peak areas.



(a) The ^{1}H NMR spectrum contains a peak at $\delta = 0$ ppm resulting from a chemical added to the sample.

State the chemical responsible for the peak at $\delta = 0$ ppm, and state why this chemical was added to the sample.

.....

.....

..... **[1]**

© OCR 2014

STEMUP.CO.UK

(b) In the ^{1}H NMR spectrum, the peak at $\delta = 3.7$ ppm would normally be expected at a chemical shift value about 1 ppm to the right, ie at 2.7 ppm.

Use the information in this question to determine the structure of compound **H**.

Show all your reasoning.

In your answer, you should use the appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

© OCR 2014

STEMUP.CO.UK

[9]

[Total: 10]

END OF QUESTION PAPER

© OCR 2014

STEMUP.CO.UK

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.

© OCR 2014

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2014

OCR
Oxford Cambridge and RSA

GCE

Chemistry A

Unit **F324:** Rings, Polymers and Analysis

Advanced GCE

Mark Scheme for June 2014

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

© OCR 2014

Annotations available in Scoris.

Annotation	Meaning
BP	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
I	Ignore
NAQ	Not answered question
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
RE	Rounding error
SF	Error in number of significant figures
	Correct response

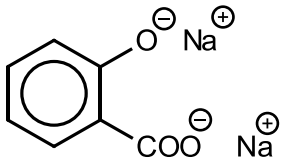
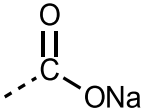
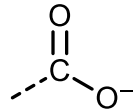
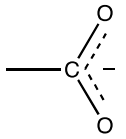
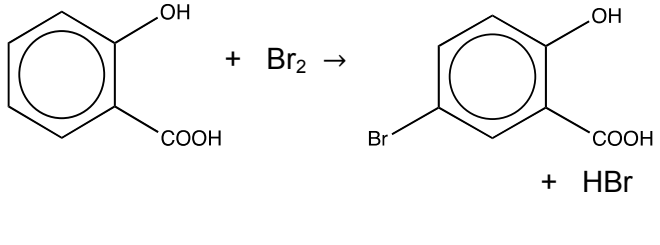
STEMUP.CO.UK

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

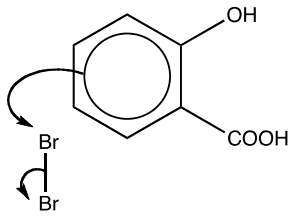
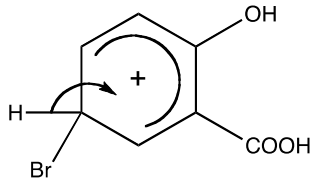
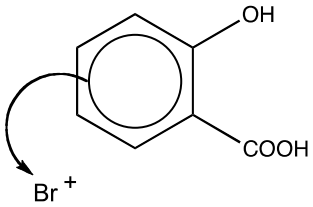
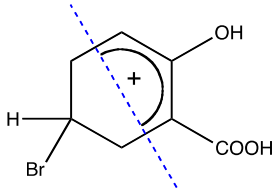
Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

The following questions should be annotated with ticks to show where marks have been awarded in the body of the text:

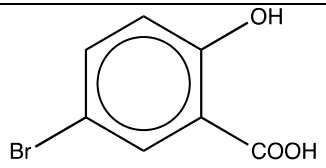
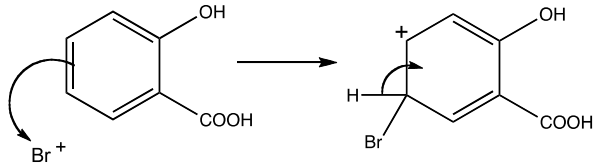
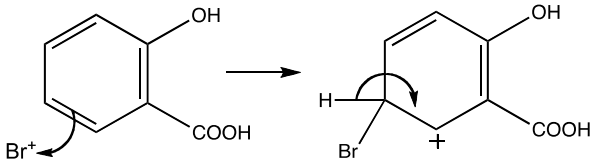
STEMUP.CO.UK

Question			Answer	Mark	Guidance
Where circles have been placed round charges, this is for clarity only and does not indicate a requirement					
1	(a)	(i)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **DO NOT ALLOW** —O—Na **OR** -COO-Na (covalent bond) **ALLOW** $-O^-$ **ALLOW** —ONa **ALLOW** —COONa **OR**  **OR**  **ALLOW** delocalised carboxylate  (Na^+)
1	(a)	(ii)	(Bromine) would be decolourised/turn (from orange/red/yellow/brown) to colourless **OR** white precipitate/solid/emulsion (formed) ✓	1	**IGNORE** goes clear **DO NOT ALLOW** other colours for bromine **IGNORE** cream precipitate **DO NOT ALLOW** salicylic acid turns colourless/decolourised **IGNORE** temperature/fumes
1	(a)	(iii)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **MUST** be all correct to score mark **ALLOW** molecular formulae, i.e. $C_7H_6O_3 + Br_2 \rightarrow C_7H_5O_3Br + HBr$

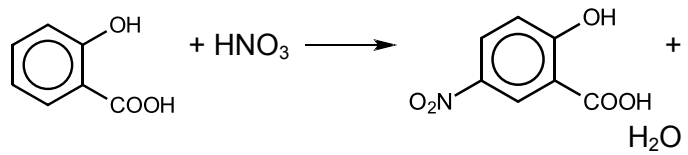
STEMUP.CO.UK

Question			Answer	Mark	Guidance
1	(a)	(iv)	$(CH_3)_2CHOH$/$CH_3CH(OH)CH_3$/propan(-)2(-)ol **AND** acid/H^+/H_2SO_4 (catalyst) ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** 2-propanol **DO NOT ACCEPT** incorrect name or incorrect formula of alcohol **IGNORE** reflux/concentrated (acid)
1	(b)	(i)	 No Br_2 dipole needed Curly arrow to Br from ring **OR** from within the ring **AND** curly arrow Br-Br bond to Br ✓  ✓ correct intermediate (with charge) ✓ curly arrow from C—H to reform ring	4	**ALLOW** mechanism with Br^+ electrophile (Maximum 3 marks)  **IGNORE** any equations involving a halogen carrier **BUT DO NOT ALLOW** intermediate with π-system covering less than half of ring:  **ALLOW** + charge anywhere inside the 'horseshoe' Horseshoe must have open end towards Br Apply ecf to error in structure of intermediate (M2)

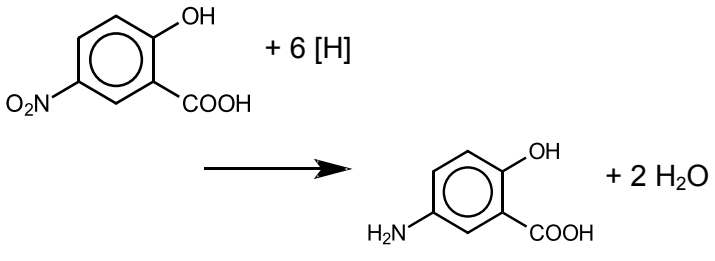
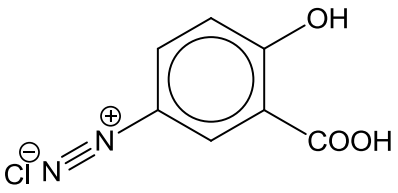
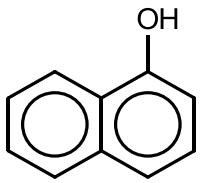
STEMUP.CO.UK

Question	Answer	Mark	Guidance
	 + HBr /H^++ Br^- ✓ Correct products (Br^- may be shown in the first step)		**ALLOW** Kekulé mechanism as shown (Maximum 3 marks if Br^+ is the electrophile)  **ALLOW** double bonds in alternate arrangement 

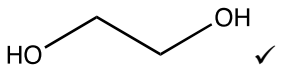
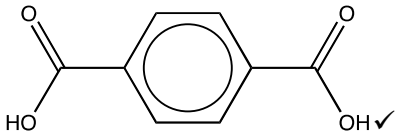
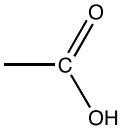
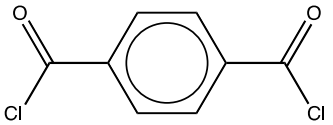
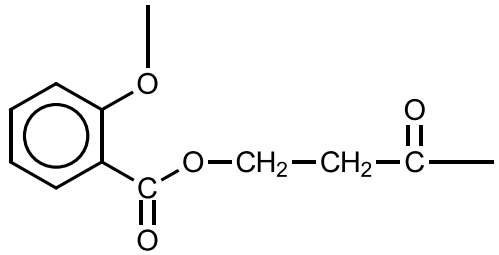
STEMUP.CO.UK

Question			Answer	Mark	Guidance
1	(b)	(ii)	(In salicylic acid) lone pair/pair of electrons on O(H)/phenol is ~ (partially) **delocalised** into the ring ✓ electron density increases/is high **ORA** ✓ Br_2/electrophile is (more) polarised **ORA** ✓ ✎ **QWC**: delocalised/delocalized/delocalise *etc*. must be spelled correctly in the correct context at least once	3	**ALLOW** diagram to show movement of lone pair into ring but delocalised ring must be mentioned **ALLOW** lone pair/pair of electrons on O(H)/phenol is (partially) drawn/attracted/pulled into **delocalised** ring **IGNORE** 'activates the ring' **ALLOW** more electron rich **DO NOT ALLOW** charge density or electronegativity **ALLOW** (salicylic acid) attracts electrophiles more/more susceptible to electrophilic attack **ALLOW** Br_2 is (more) attracted **OR** Br_2 is not polarised by benzene **OR** induces dipoles (in bromine/electrophile) Delocalise(d) needed to score the first marking point
1	(c)	(i)	**Step 1** Add HNO_3 ✓  ✓	4	**ALLOW** reagent mark if HNO_3 in equation **IGNORE** H_2SO_4 (**NOTE**: H_2SO_4 not required with phenols) **IGNORE** concentrations of acids/temperature **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous Equations **MUST** be completely correct for **one** mark each

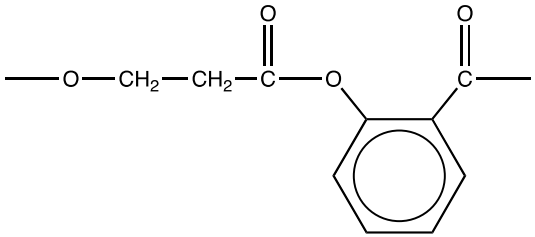
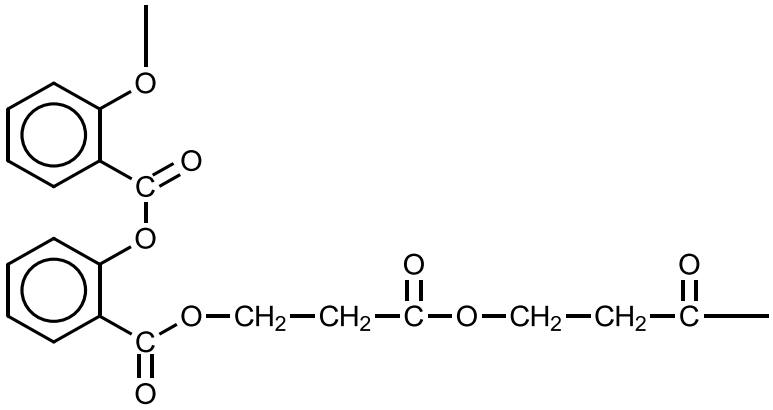
STEMUP.CO.UK

Question			Answer	Mark	Guidance
			Step 2 Tin **AND concentrated** HC*l* ✓  ✓		**DO NOT ALLOW** $3H_2$
1	(c)	(ii)	Nitrogen electron pair **OR** nitrogen lone pair accepts a proton/H^+ ✓	1	**DO NOT ALLOW** nitrogen/N lone pair accepts hydrogen (proton/H^+ required) **ALLOW** nitrogen donates an electron pair/lone pair to H^+ **IGNORE** NH_2 group donates electron pair
1	(c)	(iii)	compound **A** ✓  compound **B**  ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** —N_2Cl **OR** —$N_2^+Cl^-$ **DO NOT ALLOW** —N≡N^+ **OR** —N≡N^+ Cl^- **DO NOT ALLOW** –N_2-Cl (covalent bond)

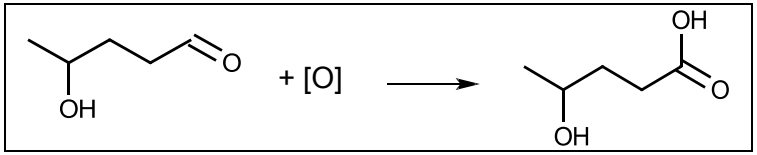
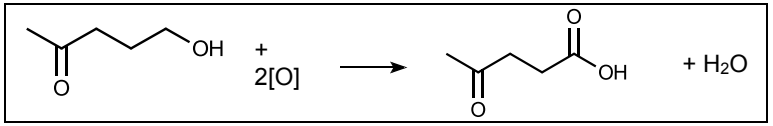
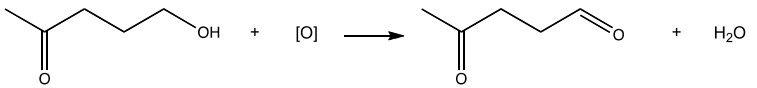
STEMUP.CO.UK

Question			Answer	Mark	Guidance
1	(d)	(i)	**monomers** join/bond/add/react/form polymer/form chain **AND** another product/small molecule/H_2O/HCl ✓	1	**IGNORE** specific reference to number of molecules
1	(d)	(ii)	  Connectivity is penalised only in this question	2	**DO NOT ALLOW** –HO (penalise connectivity once only) Both structures must be skeletal **DO NOT ALLOW** stray sticks (skeletal means CH_3 attached) **DO NOT ALLOW** structure with a C shown, e.g.  **ALLOW** 
1	(d)	(iii)	 ester link **MUST** be fully displayed ✓ **OR**	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous

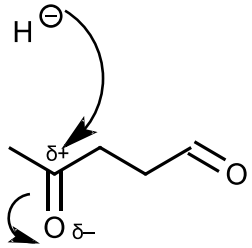
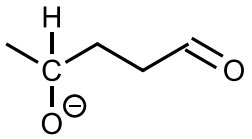
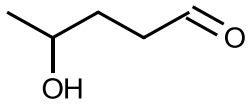
STEMUP.CO.UK

Question	Answer	Mark	Guidance
			**ALLOW**  **IGNORE** bond angles **DO NOT ALLOW** more than one repeat unit unless correct repeat unit is indicated **IGNORE** brackets with *n* **ALLOW** any correct repeat unit **ALLOW** end bonds shown as - - - - - **DO NOT ALLOW** if structure has no end bonds
	Total	**22**	

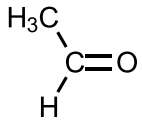
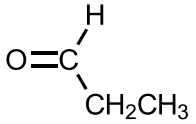
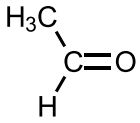
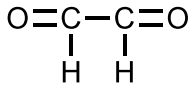
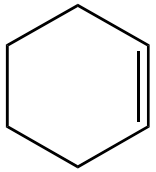
STEMUP.CO.UK

Question			Answer	Mark	Guidance
2	(a)		**FIRST** react **all** with Tollens' reagent **AND** silver mirror/ppt/solid (formed) with compound **D** **OR** with Fehling's/Benedict's solutions **AND** (brick-red/orange) solid/precipitate (formed) with compound **D** ✓ ***NOTE**: eliminates **D***  ✓ **THEN** react **C** and **E** with H_2SO_4/H^+ **AND** $K_2Cr_2O_7$/ $Cr_2O_7^{2-}$/$Na_2Cr_2O_7$ **AND** colour change **OR** green colour with compound **C** **OR** no change **OR** no reaction **OR** no green colour with compound **E** ✓  ✓	4	**ALLOW** ammonia + silver nitrate for reagent **ALLOW** black solid/ppt **ALLOW** 'the aldehyde gives a silver mirror' **ALLOW** solid **OR** crystals **OR** ppt as alternatives for precipitate **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **DO NOT ALLOW** molecular formulae for organic structures **IGNORE** all references to 2,4-dinitrophenylhydrazine/Brady's **ACCEPT** acidified dichromate **ALLOW** blue/green blue **IGNORE** equation for oxidation of **D** **ALLOW** equation for partial oxidation 

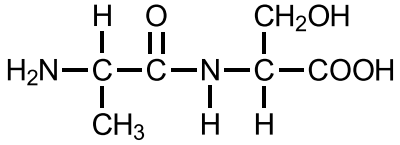
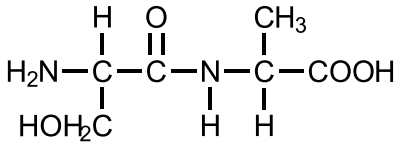
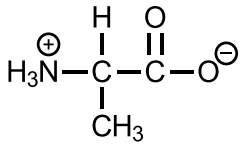
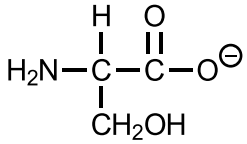
STEMUP.CO.UK

Question			Answer	Mark	Guidance
					ALLOW alternative sequences e.g. **FIRST** react **all** with H_2SO_4 **AND** $K_2Cr_2O_7$ colour change with **C** and **D** *eliminates **E*** At least one correct equation and structure of one product from either reaction required for the second mark. **NB** several possible products for the oxidation of **D** **THEN** react **C** and **D** with Tollens' …… *distinguishes between **C** and **D***
2	**(b)**		 curly arrow from H^- to $C^{(\delta+)}$ of correct C=O group ✓ dipole correct **AND** curly arrow from C=O bond to $O^{(\delta-)}$ ✓  correct intermediate with negative charge on O ✓  correct product ✓	**4**	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous First curly arrow must come from either a lone pair on H or negative charge on H **IF** aldehyde reduced **OR** both carbonyls reduced **DO NOT AWARD** first mark (second, third and fourth marks can be awarded **ECF**) **IGNORE** lack of C—H if entirely skeletal **IGNORE** curly arrows in second stage Apply ecf to error in structure e.g. CH_2 missing from the chain or –COOH/-COH instead of –CHO **IGNORE** other products

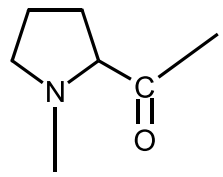
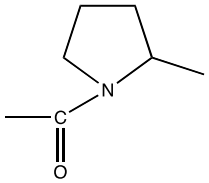
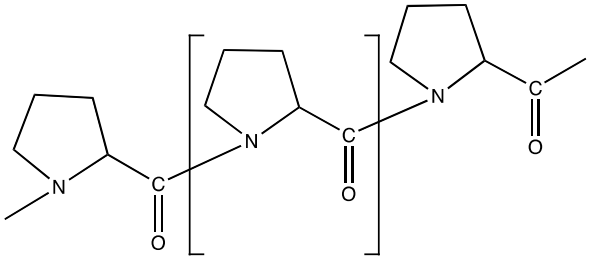
STEMUP.CO.UK

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>2</td><td>(c)</td><td></td><td>
<table>
<tr><td>Compound</td><td>C</td><td>D</td><td>E</td></tr>
<tr><td>Number of peaks</td><td>5</td><td>5</td><td>4</td></tr>
</table>
all correct ✓</td><td>1</td><td></td></tr>
<tr><td>2</td><td>(d)</td><td>(i)</td><td>• pent-2-ene  AND  ✓
• hexa-2,4-diene  ✓  ✓</td><td>3</td><td>ALLOW correct structural OR displayed OR skeletal formulae OR combination of above as long as unambiguous
ALLOW C_2H_5CHO and CH_3CHO</td></tr>
<tr><td>2</td><td>(d)</td><td>(ii)</td><td>  ✓</td><td>1</td><td>ALLOW correct structural OR displayed OR skeletal formulae OR combination of above as long as unambiguous</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>13</td><td></td></tr>
</table>

STEMUP.CO.UK

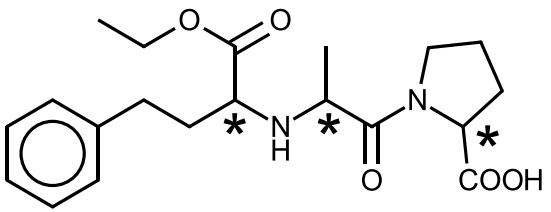
Question			Answer	Mark	Guidance
3	(a)	(i)	 ✓  ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **DO NOT ALLOW** peptide chains
3	(a)	(ii)	alanine at pH 6.0  ✓ serine at pH 10.0  ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** + charge on N or H: *i.e.* $^{+}NH_3$ or NH_3^{+} **DO NOT ALLOW** '–' charge on C *i.e.* ^{-}COO **DO NOT ALLOW** if structure is incomplete

STEMUP.CO.UK

Question			Answer	Mark	Guidance
3	(a)	(iii)	 ✓ **OR** 	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **IGNORE** bond angles **DO NOT ALLOW** more than one repeat unit **ALLOW** end bonds shown as - - - - - **DO NOT ALLOW** if structure has no end bonds **IGNORE** brackets unless they are used to pick out the repeat unit from a polymer chain **IGNORE** *n* 

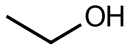
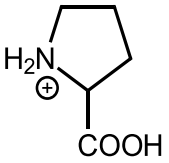
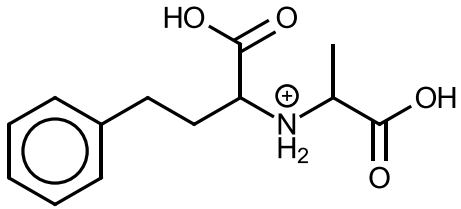
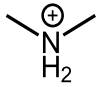
STEMUP.CO.UK

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>3</td><td>(b)</td><td></td><td>
<table>
<tr><th colspan="3">^{1}H NMR spectrum for serine</th></tr>
<tr><th>chemical shift, δ /ppm</th><th>relative peak area</th><th>splitting pattern</th></tr>
<tr><td>2.0 to 3.0</td><td>1</td><td>triplet</td></tr>
<tr><td>3.3 to 4.2</td><td>2</td><td>doublet</td></tr>
</table>
One mark for each correct row ✓✓</td><td>2</td><td>ALLOW δ values ± 0.2 ppm, as a range or a value within the range

ALLOW a response that implies a splitting into three for a triplet/into two for a doublet</td></tr>
<tr><td>3</td><td>(c)</td><td>(i)</td><td> 

✓</td><td>1</td><td>ALL correct for one mark</td></tr>
<tr><td>3</td><td>(c)</td><td>(ii)</td><td>any two from:
no/fewer side effects
increases the (pharmacological) activity/effectiveness
Reduces/stops the need for/cost/difficulty in separating stereoisomers/optical isomers
✓✓</td><td>2</td><td>IGNORE toxic/harmful
IGNORE a response that implies a reduced dose
IGNORE “it takes (less) time to separate”</td></tr>
</table>

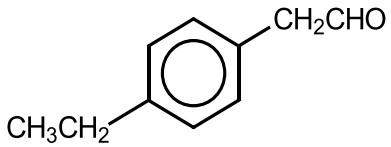
STEMUP.CO.UK

Question			Answer	Mark	Guidance
3	(c)	(iii)	 ✓ one mark for ethanol  ✓ one mark for proline with NH **OR** NH_2^+  ✓ one mark for remaining fragment with  or  ✓ **Fourth** mark for structure of **both** ions shown correctly with NH_2^+	4	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** + charge on H of NH_2 groups, *i.e.* NH_2^+ **IGNORE** negative (counter) ions
3	(c)	(iv)	idea of separating (the components/compounds) **AND** idea of (identifying compounds by) comparison with a (spectral) database ✓	1	**ALLOW** (identifies compounds) using fragmentation (patterns)/fragment ions (but **IGNORE** molecular ions) **IGNORE** retention times
			Total	15	

STEMUP.CO.UK

Question			Answer	Mark	Guidance
4	(a)		TMS/tetramethylsilane (which is the) standard (for chemical shift measurements) ✓	1	**ALLOW** $(CH_3)_4Si$ **ALLOW** TMS is the reference **OR** TMS has δ = 0 (ppm) **OR** for calibration **OR** for comparison **IGNORE** solvent, unreactive, volatile, it gives a sharp peak
4	(b)		**NMR analysis = 5 marks** **M1:** Peak(s) at (δ) 9.7 = CHO ✓ **M2:** Peak(s) at (δ) 7.1 = C_6H_4 ✓ **M3:** Triplet at (δ) 1.3/peak at 1.3 **AND** quartet (at δ 2.6)/ peak at 2.6 = CH_2CH_3 ✓ **M4:** Triplet at (δ) 9.7/peak at 9.7 **AND** doublet (at δ 3.7)/peak at 3.7 = CH_2CHO ✓	9	**NOTE**: Each peak can be identified from: • its δ value • a range, *e.g.* "the peak between 0.8 and 2.0" • its relative peak area (beware two peaks with 2 protons) • its splitting (beware two triplets) • labelling on the spectrum **ALLOW** CH_2CHO/aldehyde **IGNORE** reference to phenol **ALLOW** (four) benzene ring proton(s) **IGNORE** reference to phenol **M3** and **M4** Look for a clear link (using words or diagrams) between the two peaks

STEMUP.CO.UK

Question			Answer	Mark	Guidance
			M5: **(**n+1 rule) Any one of the following • triplet at (δ) 1.3 shows (C with) 2 adjacent Hs/protons **OR** adjacent CH_2 *(because of splitting: so triplet)* • quartet at (δ 2.6 shows) (C with) 3 adjacent Hs/protons **OR** adjacent CH_3 • triplet at (δ) 9.7 shows (C with) 2 adjacent Hs/protons **OR** adjacent CH_2 • doublet at (δ 3.7 shows) (C with) 1 adjacent H/proton **OR** adjacent CH ✓ ✎ **QWC**: **triplet** spelled correctly in the correct context once		**ALLOW** a response that implies a splitting into three for a triplet/into two for a doublet etc. **ALLOW** "neighbouring" Hs for "adjacent to" Hs **IGNORE** other comments about splitting once **M5** has been awarded **DO NOT ALLOW** one of **M3** or **M4 or M5** if triplet not seen
			Aldehyde structure = 4 marks  ✓✓✓✓		**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **IF** structure contains C_6H_4 ✓ **IF** structure contains C_6H_4 **AND** the organic structure contains CH_3CH_2 directly attached to the benzene ring **OR** contains CH_2CHO directly attached to the benzene ring ✓✓ **IF** structure has formula $C_{10}H_{12}O$ **AND** structure contains C_6H_4 **AND** the structure contains CH_3CH_2 **AND** contains CH_2CHO **AND** 1,2 **OR** 1,3 substituted ✓✓✓

STEMUP.CO.UK

Question			Answer	Mark	Guidance
					IF structure has formula $C_{10}H_{12}O$ **AND** structure contains C_6H_4 **AND** the structure contains CH_3CH_2 **AND** contains CH_2CHO **AND** 1,4 substituted ✓✓✓✓ (use of ^{13}C data)
			Total	**10**	

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2014

STEMUP.CO.UK

OCR
RECOGNISING ACHIEVEMENT

Wednesday 19 June 2013 – Morning

A2 GCE CHEMISTRY A

F324/01 Rings, Polymers and Analysis

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry A* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour 15 minutes

F 3 2 4 0 1

F3147306133

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an Insert with this Question Paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.

© OCR 2013 [M/500/7836]
OCR is an exempt Charity

STEMUP.CO.UK

BLANK PAGE

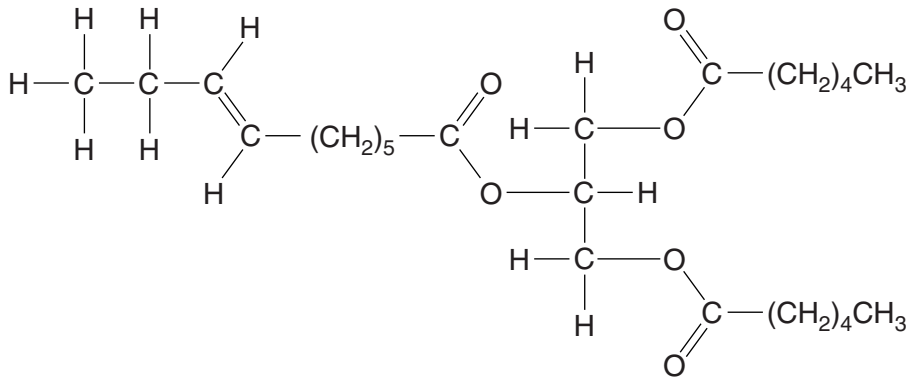
PLEASE DO NOT WRITE ON THIS PAGE

© OCR 2013

Answer **all** the questions.

1 Triglycerides are triesters and are found in fats and oils.

The structure of a triglyceride found in some goats' milk is shown below.



(a) This triglyceride is hydrolysed with hot aqueous sodium hydroxide.

(i) Give the systematic name of the alcohol that is formed by this hydrolysis.

..... **[1]**

(ii) Draw the structures of the other organic products of this hydrolysis.

[3]

(b) Suggest why people who consume a large quantity of this type of goats' milk might be more at risk of suffering from coronary heart disease.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

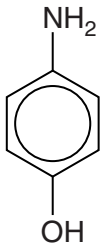
..... **[2]**

[Total: 6]

© OCR 2013

STEMUP.CO.UK

2 4-Aminophenol is an organic compound that can behave as an acid and a base.



4-aminophenol

(a) State how 4-aminophenol can behave as a base.

.....

..... **[1]**

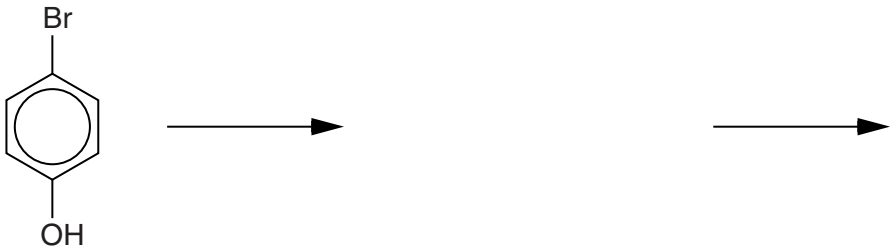
(b) 4-Aminophenol is produced by the reduction of 4-nitrophenol.

Write an equation to show the production of 4-aminophenol from 4-nitrophenol.
Use **[H]** to represent the reducing agent.

[1]

(c) 4-Nitrophenol can be produced from 4-bromophenol.

- Complete the mechanism for this reaction.
- Use $^{+}NO_2$ as the electrophile. Include any intermediate and the products.
- In the mechanism for this reaction, NO_2 substitutes for Br on the ring.

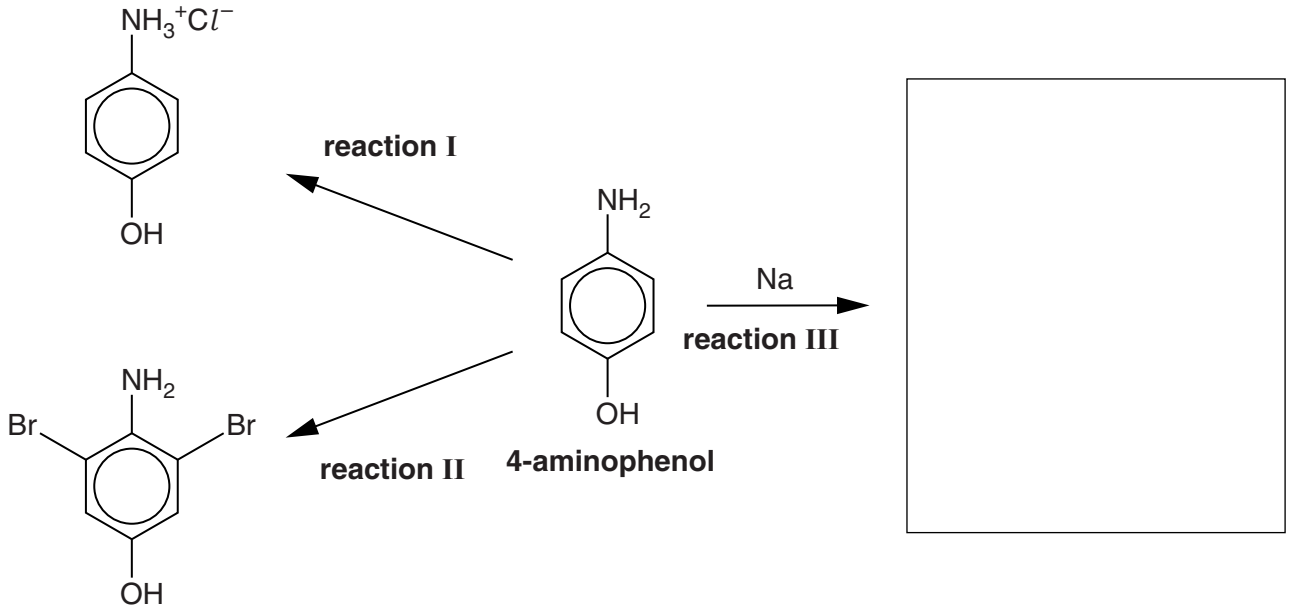


[4]

© OCR 2013

STEMUP.CO.UK

(d) The flowchart below shows some reactions of 4-aminophenol.



(i) Identity the reagent in **reaction I**.

..... **[1]**

(ii) Name the organic product of **reaction II**.

..... **[1]**

(iii) Write the equation for **reaction II**.

[1]

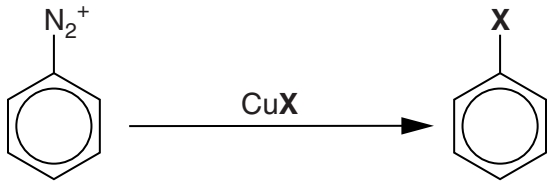
(iv) In the box on the flowchart, draw the structure of the organic compound formed by **reaction III**. **[1]**

© OCR 2013

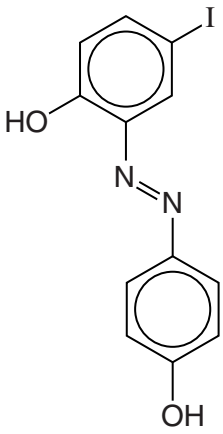
STEMUP.CO.UK

(e) The Sandmeyer reaction can be used to replace a diazonium group, N_2^+, with a halogen atom, **X**, on an aromatic ring.

The reagent used for the reaction is a copper(I) halide, Cu**X**.



Compound **C**, shown below, can be synthesised using **only** 4-aminophenol and other standard laboratory reagents. The flowchart on the next page shows this synthesis.



compound C

(i) State a possible use for compound **C**.

..... **[1]**

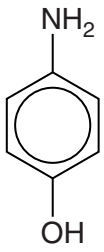
(ii) On the flowchart on the next page:

- state the reagents and conditions used for **reaction 1**
- suggest the structure of compound **B**
- suggest the reagent used for **reaction 2**
- state the conditions used for **reaction 3**.

[5]

© OCR 2013

STEMUP.CO.UK

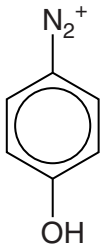


4-aminophenol

reaction 1

reagents .....

conditions .....



compound A

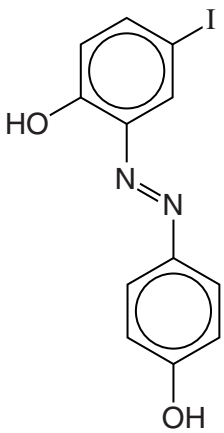
reaction 2

reagent .....

compound B

reaction 3

conditions .....



compound C

[Total: 16]

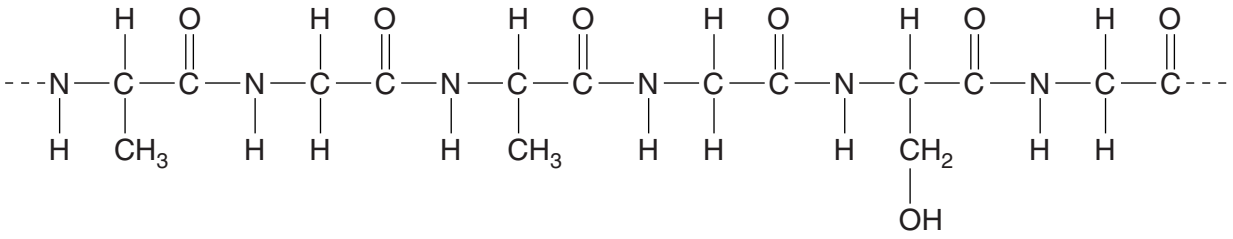
© OCR 2013

STEMUP.CO.UK

3 Many modern textiles are created using a mixture of natural and synthetic polymers.

(a) Silk is a natural fibre. It is made up of two main proteins, fibroin and sericin.

A section of a **fibroin** strand is shown below.



(i) Proteins are natural condensation polymers.

State what is meant by a *condensation polymer*.

.....

..... **[1]**

(ii) A student hydrolysed a sample of fibroin protein. She analysed the amino acids that were formed from the hydrolysis. She found that fibroin contained the amino acid glycine, H_2NCH_2COOH.

Draw the structures of the **two** other amino acids that make up the section of fibroin shown in the diagram above.

[2]

(iii) The isoelectric point of glycine is 5.8.

Define the term *isoelectric point* and draw the structure of glycine at its isoelectric point.

isoelectric point .....

.....

[2]

© OCR 2013

STEMUP.CO.UK

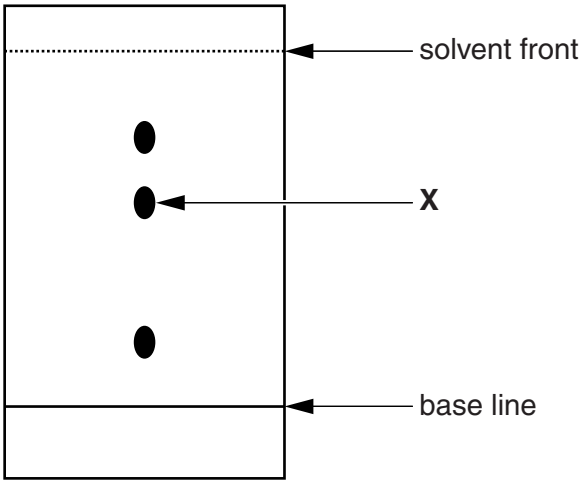
(b) The student then hydrolysed a section of sericin protein. She analysed the amino acids formed using Thin-Layer Chromatography (TLC).

(i) Name the process by which TLC separates amino acids.

..... **[1]**

(ii) The chromatogram the student obtained, and a table of R_f values for amino acids, are shown below.

Estimate the R_f value for the amino acid found at **X**. Hence identify the amino acid found at **X**.



Amino acid	R_f value
alanine	0.38
aspartic acid	0.15
glycine	0.26
leucine	0.75
methionine	0.58
threonine	0.35

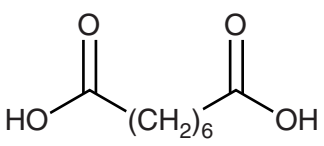
.....

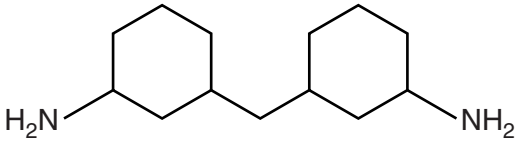
.....

..... **[2]**

(c) *Quiana* is a synthetic polymer that can be spun into a soft, silky fabric.

The monomers used to make *Quiana* are shown below.





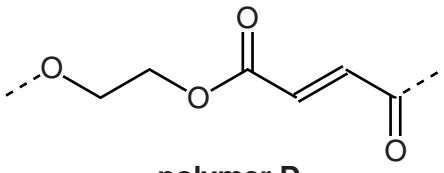
Draw the repeat unit of the polymer formed from these two monomers.

[2]

© OCR 2013

STEMUP.CO.UK

(d) Polymer **D** has been developed by the textile industry. The repeat unit of polymer **D** is shown below.



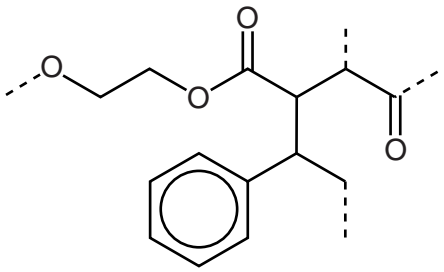
polymer D

(i) Polymer **D** is a condensation polymer.

Draw the structure of each of the monomers that make up polymer **D**.

[2]

(ii) Polymer **D** reacts with a third monomer to form an addition polymer. The repeat unit of this polymer is shown below.



addition polymer

Draw the structure of the third monomer.

[1]

[Total: 13]

© OCR 2013

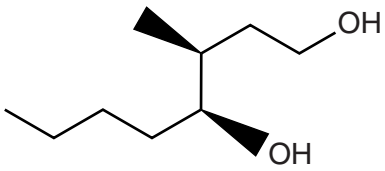
BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© OCR 2013

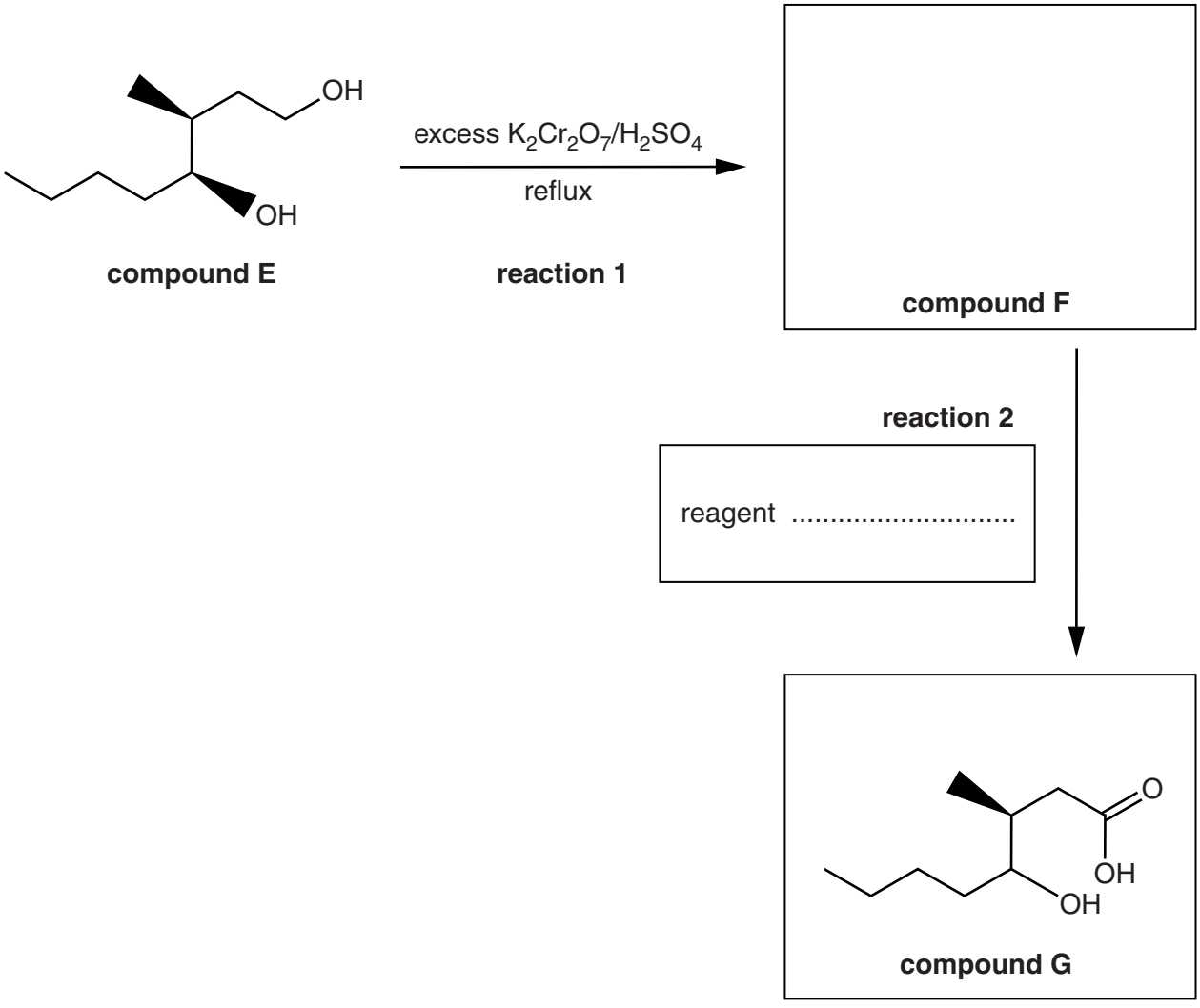
STEMUP.CO.UK

4 Compound **E**, shown below, is an alcohol that is found in oak wood. It is formed by the breakdown of cellulose.



compound E

Compound **E** can be converted into compound **G** as shown in the flowchart below.



(a) (i) Complete the flowchart to show the structure of the organic compound **F** and the reagent needed for **reaction 2**. **[1]**

© OCR 2013

(ii) What would you observe during **reaction 1**?

.....

..... **[1]**

(iii) In **reaction 1**, compound **E** was heated under reflux with excess $K_2Cr_2O_7/H_2SO_4$.

Suggest why these conditions were used, rather than the reaction mixture being distilled during the process.

.....

.....

..... **[1]**

(iv) Name the type of reaction taking place in **reaction 2**.

..... **[1]**

(b) Describe a chemical test that you could use to detect the presence of a carbonyl group in an organic compound.

Reagent .....

Observation .....

.....

..... **[2]**

(c) Compound **E** is a single stereoisomer.

(i) Draw the skeletal formula of one other stereoisomer of compound **E** and state the type of stereoisomerism.

type of stereoisomerism ..... **[2]**

© OCR 2013

STEMUP.CO.UK

(ii) 4.56 g of compound **E** was converted into compound **G** using the method shown in the flowchart on page 12.

3.15 g of compound **G** was formed.

Calculate the percentage yield of compound **G**.

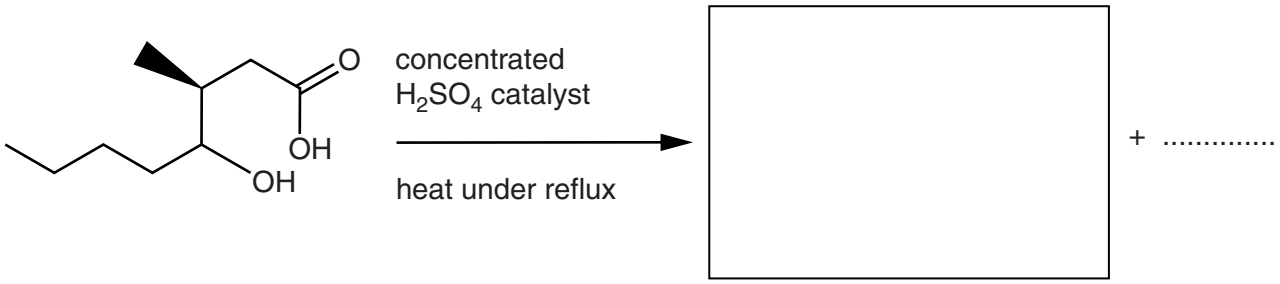
Give your answer to **three** significant figures.

The M_r of compound **E** is 160.0.

percentage yield of compound **G** = ... % **[3]**

(iii) Compound **G** is heated for several hours under reflux, in the presence of a concentrated sulfuric acid catalyst. An ester and a small inorganic molecule are formed.

Complete the equation below to show the **two** products formed by this reaction.



[2]

[Total: 13]

© OCR 2013

STEMUP.CO.UK

5 A chemist isolated compound **L** from the leaves of a common garden herb. He analysed the compound using a number of techniques.

(a) Compound **L** contains C, H and O only. Elemental analysis shows that **L** has the percentage composition by mass: C, 73.15%; H, 7.37%.

The mass spectrum of **L** has a molecular ion peak at $m/z = 164$.

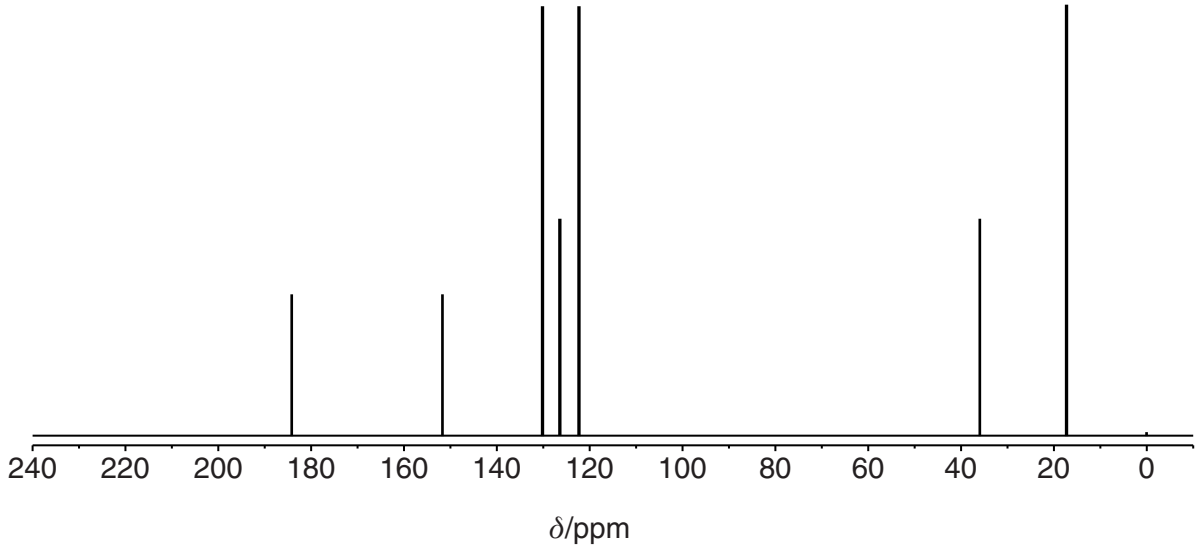
Show that the molecular formula of **L** is $C_{10}H_{12}O_2$.

[2]

© OCR 2013

STEMUP.CO.UK

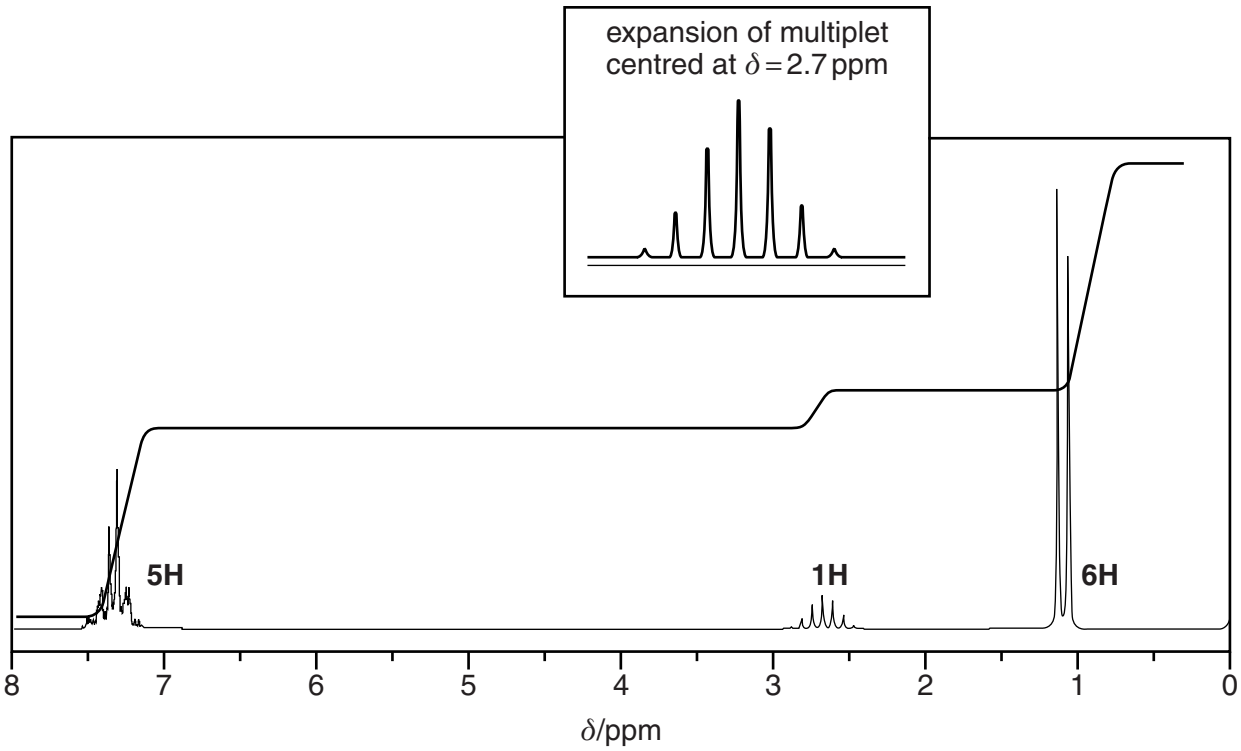
(b) The ^{13}C NMR spectrum of compound **L** is shown below.



How many different carbon environments (types of carbon) are present in a molecule of compound **L**?

..... **[1]**

(c) The ^{1}H NMR spectrum of compound **L**, $C_{10}H_{12}O_2$, is shown below. One of the signals has been enlarged to help its analysis.



© OCR 2013

STEMUP.CO.UK

(i) A signal at δ = 0 ppm results from tetramethylsilane (TMS). TMS had been added to the sample of compound **L** before the NMR spectrum was run.

State why TMS was added.

..... **[1]**

(ii) The ^{1}H NMR spectrum includes an integration trace.

What information can be deduced about compound **L** from the integration trace?

..... **[1]**

(iii) Using the information given in parts **(a)**, **(b)** and **(c)** of this question, determine the structure of compound **L**.

Show all your reasoning.



In your answer, you should use appropriate technical terms, spelled correctly.

structure of compound L

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

© OCR 2013

STEMUP.CO.UK

[7]

[Total: 12]

END OF QUESTION PAPER

© OCR 2013

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.

© OCR 2013

OCR
RECOGNISING ACHIEVEMENT

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2013

OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Advanced GCE

Unit **F324:** Rings, Polymers and Analysis

Mark Scheme for June 2013

Oxford Cambridge and RSA Examinations

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

© OCR 2013

Annotations

Annotations available in Scoris.

Annotation	Meaning
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
I	Ignore
NAQ	Not answered question
NBUD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
RE	Rounding error
SF	Error in number of significant figures
	Correct response
SEEN	Noted but no credit given
REP	Repeat

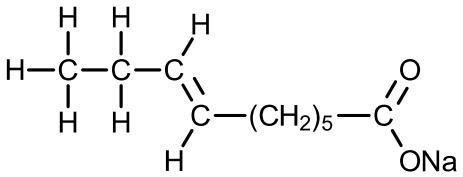
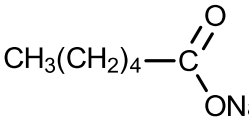
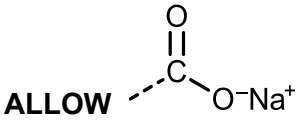
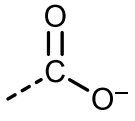
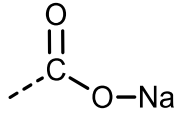
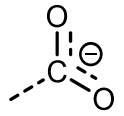
STEMUP.CO.UK

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

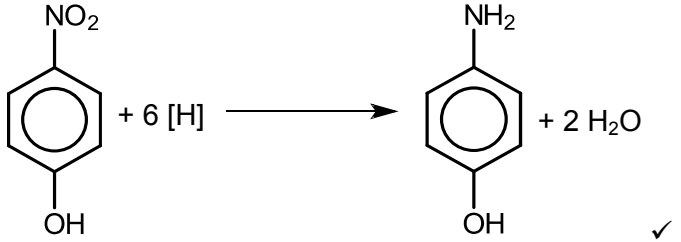
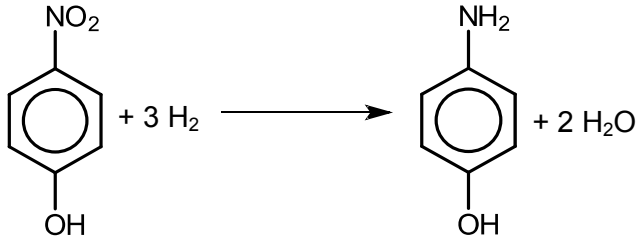
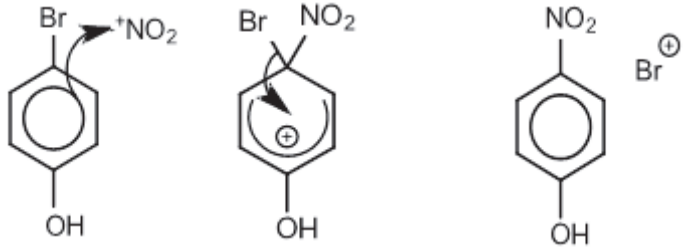
Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

All questions should be annotated with ticks to show where marks have been awarded in the body of the text.
All questions where an ECF has been applied should also be annotated with the ECF annotation.

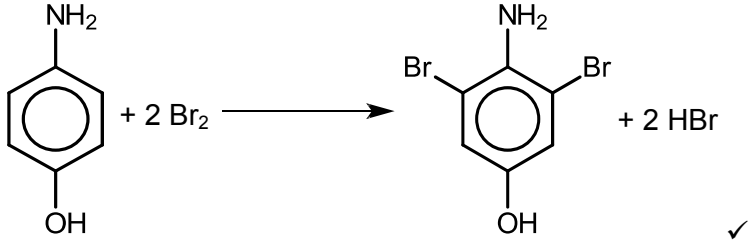
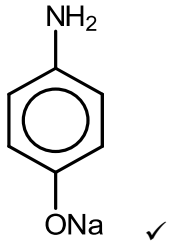
STEMUP.CO.UK

Question			Answer	Marks	Guidance
1	(a)	(i)	propane-1,2,3-triol ✓	1	**ALLOW** absence of 'e' after 'propan' **ALLOW** 1,2,3-propanetriol **ALLOW** absence of hyphens 1, 2 and 3 must be clearly separated: **ALLOW** full stops: 1.2.3 **OR** spaces: 1 2 3 **DO NOT ALLOW** 123 **IGNORE** glycerol
		(ii)	  One mark for decenoate salt **OR** decenoic acid ✓ One mark for hexanoate salt **OR** hexanoic acid ✓ One mark for **BOTH correct** products shown as salts (with or without Na^+) ✓	3	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **DO NOT ALLOW** *cis* structure **ALLOW**  **OR**  **DO NOT ALLOW**  (covalent bond) **ALLOW** delocalised carboxylate  **IGNORE** glycerol
	(b)		one of the fatty acids is *trans* ✓ which may increase / cause / produce (the level of) 'bad'/LDL cholesterol ✓ **QWC** cholesterol MUST be spelt correctly	2	**ALLOW** one of the products is TRANS **ALLOW** reduces (the level of) 'good'/HDL cholesterol
			Total	**6**	

STEMUP.CO.UK

Question			Answer	Marks	Guidance
2	(a)		**Nitrogen** lone pair accepts a proton/H^+ ✓ *Requires position of lone pair on N*	1	**DO NOT ALLOW** Nitrogen/N lone pair accepts hydrogen *Proton/H^+ is required* **ALLOW nitrogen** donates a lone pair **IGNORE** NH_2 group donates a lone pair
	(b)		 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **DO NOT ALLOW** 
	(c)		 ✓ curly arrow from ring to $^+NO_2$ ✓ correct intermediate ✓ curly arrow from C–Br to reform ring ✓ correct products **MUST HAVE** Br^+	4	**ALLOW** $^+NO_2$ **OR** NO_2^+ **ALLOW** first curly arrow from the ring **OR** from within the ring to any part of the NO_2^+ including the + charge **DO NOT ALLOW** intermediate with broken ring covering less than half the ring or incorrect orientation of broken ring + must be within the broken ring **ALLOW** non-delocalized (Kekulé) structures with carbocation on either side of Br/NO_2 substituents **DO NOT ALLOW** M1 if a second arrow used on the diagram **DO NOT ALLOW** M3 ecf if arrow does not come from C-Br bond If OH missing on intermediate **do not** award M2. If OH missing on final product **do not** award M4
	(d)	(i)	hydrochloric acid/HC*l* ✓	1	**ALLOW** conc / dilute HC*l*

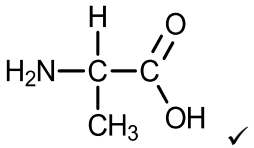
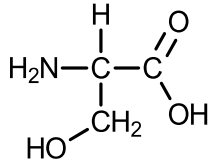
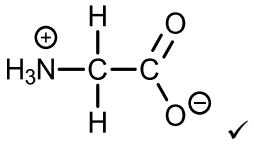
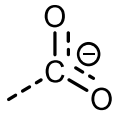
STEMUP.CO.UK

Question			Answer	Marks	Guidance
		(ii)	4-amino-3,5-dibromophenol ✓	1	**ALLOW** 3,5-dibromo-4-aminophenol **ALLOW** 2,6-dibromo-4-hydroxyphenylamine **ALLOW** 2,6-dibromo-4-hydroxy(-1-)aminobenzene **OR** (1-)amino-2,6-dibromo-4-hydroxybenzene **ALLOW** absence of hyphens numbers must be clearly separated **ALLOW** full stops **OR** spaces
		(iii)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous
		(iv)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** $-O^-Na^+$ **OR** $-O^-$ **DO NOT ALLOW** –O-Na
	(e)	(i)	dyes/dyestuffs/pigments/food colourings ✓	1	**ALLOW** indicators / biological stains **DO NOT ALLOW** unqualified paint or food

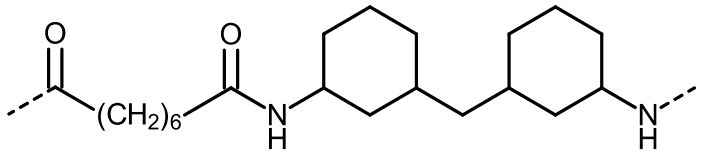
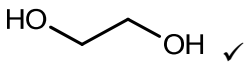
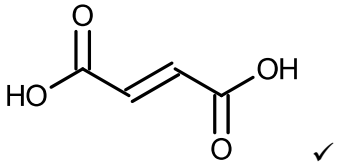
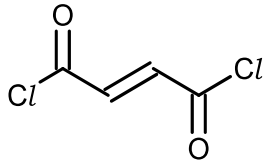
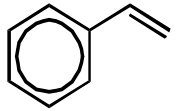
STEMUP.CO.UK

Question			Answer	Marks	Guidance
		(ii)		5	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous *No alternative pathway possible*
			reaction **1** HNO_2 (with or without HC*l*) **OR** $NaNO_2$ + HC*l* ✓		**ALLOW dilute** H_2SO_4 but **NOT** conc H_2SO_4 **ALLOW** conc HC*l*
			temp **<**10 °C ✓		
			compound **B** =  ✓		
			reaction **2** CuI ✓		
			reaction **3** alkali(ne) ✓		**ALLOW** KOH**(aq)**/NaOH**(aq)**/OH^-**(aq)** **IGNORE** temp < 10°C **DO NOT ALLOW** heat/boil/warm **DO NOT ALLOW** use of phenol in M5
			Total	**16**	

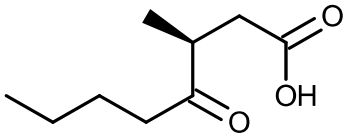
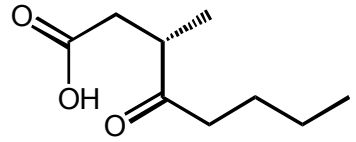
STEMUP.CO.UK

Question			Answer	Marks	Guidance
3	(a)	(i)	**monomers** join/bond/add/react/form polymer/form chain **AND** another product/small molecule *e.g.* H_2O/HC*l* ✓	1	**IGNORE** 'two' when referring to monomers, *i.e.* (two) monomers…
		(ii)	 ✓  ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** zwitterions
		(iii)	The pH at which the zwitterion exists ✓  ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** pH at which there is no **overall**/**net** charge **IGNORE** pH at which there is no charge/ neutral charge *ie overall/net is required* **ALLOW** pH at which contains COO^- **AND** NH_3^+  **ALLOW** delocalized carboxylate **ALLOW** + on N or H; - must be on O
	(b)	(i)	Adsorption ✓	1	**DO NOT ALLOW** absorption **ALLOW** partition **ALLOW** adsorbtion
		(ii)	R_f = 0.53 to 0.62 ✓ Amino acid is methionine ✓	2	Values vary if distance measured to middle or top of spot Independent marks. No need to show working as question asks for estimate of R_f

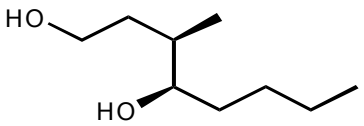
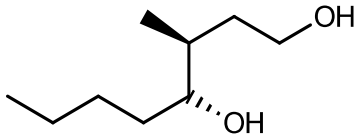
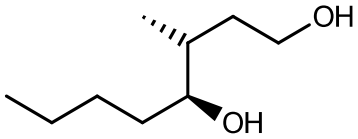
STEMUP.CO.UK

Question			Answer	Marks	Guidance
	(c)		 amide link ✓ correct structure ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** 'terminal' —NH— at other end 'End bonds' **MUST** be shown (solid or dotted) **IGNORE** brackets and/or *n* **DO NOT ALLOW** aromatic rings in amine residue **ALLOW** CONH for amide link
	(d)	(i)	 ✓  ✓ Penalise connectivity once (i.e. not –HO)	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous For dicarboxylic acid: **ALLOW** dioyl chloride  **DO NOT ALLOW** the CIS monomer
		(ii)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous
			Total	**13**	

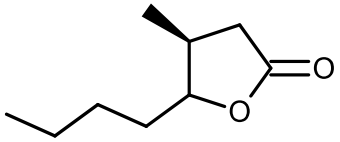
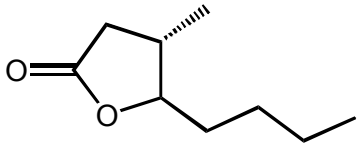
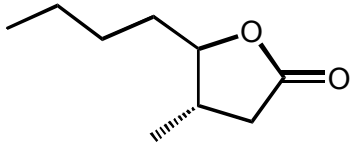
STEMUP.CO.UK

Question			Answer	Marks	Guidance
4	(a)	(i)	**F =**  **AND** reagent $NaBH_4$ ✓ **NB One mark for BOTH**	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous Wedge out of the paper is required i.e.( or  or ) **DO NOT ALLOW** dashed wedge on methyl group in this orientation ( or  or  or ) **ALLOW** 
		(ii)	Colour changes from orange to green / blue / green blue ✓	1	
		(iii)	to ensure carboxylic acid is formed **OR** prevents formation of aldehyde **OR** distillation only makes the aldehyde ✓	1	
		(iv)	(nucleophilic) addition ✓	1	**ALLOW** redox **OR** reduction
	(b)		2,4-DNP(H) ✓ orange precipitate ✓	2	**ALLOW** Brady's (reagent) **ALLOW** orange/red/yellow for colour of the 2,4-DNP(H) precipitate **ALLOW** solid/crystals in place of precipitate **IGNORE** any reference to recrystallising/melting points

STEMUP.CO.UK

Question			Answer	Marks	Guidance
4	(c)	(i)	One of:  **OR**  **OR**  for one mark ✓ optical (isomerism) ✓	2	For bold wedge **ALLOW**  or  or  For dashed wedge **ALLOW**  or  or  or  **DO NOT ALLOW** any other representation of the structure, *i.e.* anything not skeletal **ALLOW** open wedges **ALLOW** isomers shown in any alternative correct orientation
		(ii)	If answer = 63.5 award 3 marks moles of **E** used = 4.56/160(.0) / 0.0285 (mol) ✓ moles of **G** formed = 3.15/174(.0) / 0.0181 (mol) ✓ yield = 0.0181/0.0285 × 100% / 63.5% ✓	3	0.0285 mol is exact calculator value 0.0181 mol is to 3sf (calculator value 0.0181034…) **IGNORE** trailing numbers in this answer **ALL ANSWERS MUST** be to a minimum of 3sf, the final answer must be to 3 sf (calculator value gives 63.520871%) (rounding of moles of **G** gives 63.508772%) **ALLOW** ecf from incorrect Mr or moles unless the yield is >100%

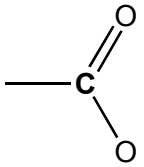
STEMUP.CO.UK

Question	Answer	Marks	Guidance
(iii)	 for first mark ✓ Other product = H_2O for second mark ✓	2	**ALLOW** abbreviation of alkyl chain Wedge out of the paper is required i.e.( or  or ) **DO NOT ALLOW** dashed wedge on methyl group in this orientation ( or  or  or ) **ALLOW**  Be careful with orientation of lactone: **ALLOW** 
	Total	**13**	

STEMUP.CO.UK

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>5</td><td>(a)</td><td></td><td>
<table>
<tr><td></td><td>C</td><td>H</td><td>O</td></tr>
<tr><td>%</td><td>73.15%</td><td>7.37%</td><td>19.48%</td></tr>
<tr><td>mol</td><td>6.10</td><td>7.37</td><td>1.22</td></tr>
<tr><td>ratio</td><td>5</td><td>6</td><td>1</td></tr>
</table>
molar ratio (C:H:O) = 6.10 : 7.37 : 1.22 OR = 5:6:1
OR empirical formula = C_5H_6O ✓
M_r is 164 so molecular formula = $C_{10}H_{12}O_2$ ✓
</td><td>2</td><td>ALLOW alternative method
73.15% × 164 = 120 } ratio = 10 OR 5
7.37% × 164 = 12.1 } 12 OR 6
19.48% × 164 = 31.9 } 2 OR 1
✓ ✓

This mark is for some evidence of using M_r, which is twice the value that you would obtain from the empirical formula</td></tr>
<tr><td></td><td>(b)</td><td></td><td>seven ✓</td><td>1</td><td></td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>TMS is the standard (for chemical shift measurements) ✓</td><td>1</td><td>ALLOW TMS is the reference OR for calibration
IGNORE unreactive / volatile / it gives a sharp peak
ALLOW TMS = 0 ppm / TMS is used for comparison</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>(relative) number of protons/hydrogens in each environment / peak / region
OR three proton environments with protons in ratio 5:1:6 ✓</td><td>1</td><td>ALLOW (relative) number of each type of proton/hydrogen
IGNORE number of protons in the compound</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>^{13}C NMR Analysis (1 mark)

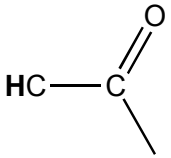
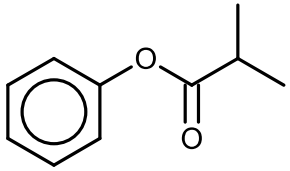
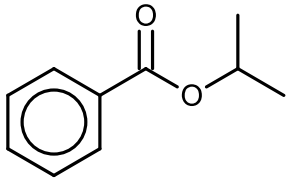
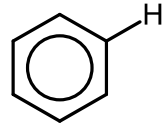
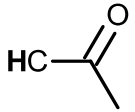
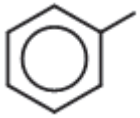
The peak at 185ppm suggests an ester group /
 

AND one of the following:

The peaks between 120ppm and 160ppm indicate a benzene ring
OR the peaks at 18ppm AND 36ppm suggest C-C ✓</td><td>7</td><td>FULL ANNOTATIONS WITH TICKS, CROSSES,CON ETC MUST BE USED

Inclusion of an incorrectly assigned ^{13}C peak CONS M1</td></tr>
</table>

STEMUP.CO.UK

Question	Answer	Marks	Guidance
	^{1}H ANALYSIS (4 marks) Doublet / peak at 1.2 shows R-C**H AND** 6 H's / 2 CH_3 (in this environment) ✓ Multiplet / septet / heptet / peak split into 7 / peak at 2.7ppm indicates  ✓ The doublet suggests that two CH_3 groups are attached to a CH **OR** the multiplet / septet / heptet suggests that the CH group is attached to two CH_3 groups ✓ ✎ **QWC** must spell **one** of *multiplet*, *septet*, *heptet* **OR** *doublet correctly* Peak at 7.3ppm indicates a benzene ring **AND** 5 H's ✓ **Compound identification (2 marks)** **IF** identified as  then **two** marks ✓✓ **IF** identified as  then **one** mark ✓		Candidates may quote δ values as ranges taken from Data Sheet, so **ALLOW** tolerance (ppm) eg  6.5–8 aromatic  2.0–2.9 carboxyl 0.7–2.0 alkyl R—C**H** **ALLOW** peaks labelled on the spectrum If **QWC** word is not used, MAX 3 for proton NMR **ALLOW** C_6H_5 **IGNORE** reference to phenol Allow  as C_6H_5 if they state that the benzene ring has 5 H's
	Total	**12**	

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2013

STEMUP.CO.UK

OCR
RECOGNISING ACHIEVEMENT

Monday 14 January 2013 – Afternoon

A2 GCE CHEMISTRY A

F324/01 Rings, Polymers and Analysis

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry A* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour 15 minutes

F 3 1 4 4 6 0 1 1 3

F 3 2 4 0 1

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

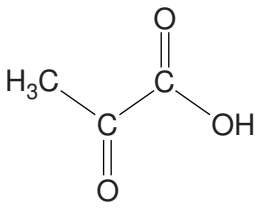
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an Insert with this Question Paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.

© OCR 2013 [M/500/7836]
OCR is an exempt Charity

STEMUP.CO.UK

Answer **all** the questions.

1 Pyruvic acid, shown below, is an organic compound that has a smell similar to ethanoic acid. It is extremely soluble in water.



pyruvic acid

(a) Explain why pyruvic acid is soluble in water.

Use a labelled diagram to support your answer.

.....

.....

..... **[2]**

(b) Pyruvic acid can be prepared in the laboratory by reacting propane-1,2-diol with excess acidified potassium dichromate(VI). The reaction mixture is heated under reflux.

Write an equation for this oxidation.

Use **[O]** to represent the oxidising agent and show structural formulae for organic compounds.

[2]

© OCR 2013

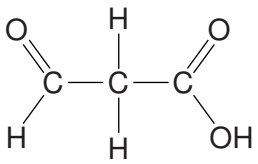
(c) Pyruvic acid can also be reduced by $NaBH_4$ to form $CH_3CH(OH)COOH$.

Outline the mechanism for this reduction.

Use curly arrows and show relevant dipoles.

[4]

(d) Compound **A**, shown below, is a structural isomer of pyruvic acid.



compound A

Describe a chemical test that could be carried out in a laboratory to distinguish between samples of pyruvic acid and compound **A**.

Your answer should include reagents, observations, the type of reaction and the organic product formed.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

..... **[3]**

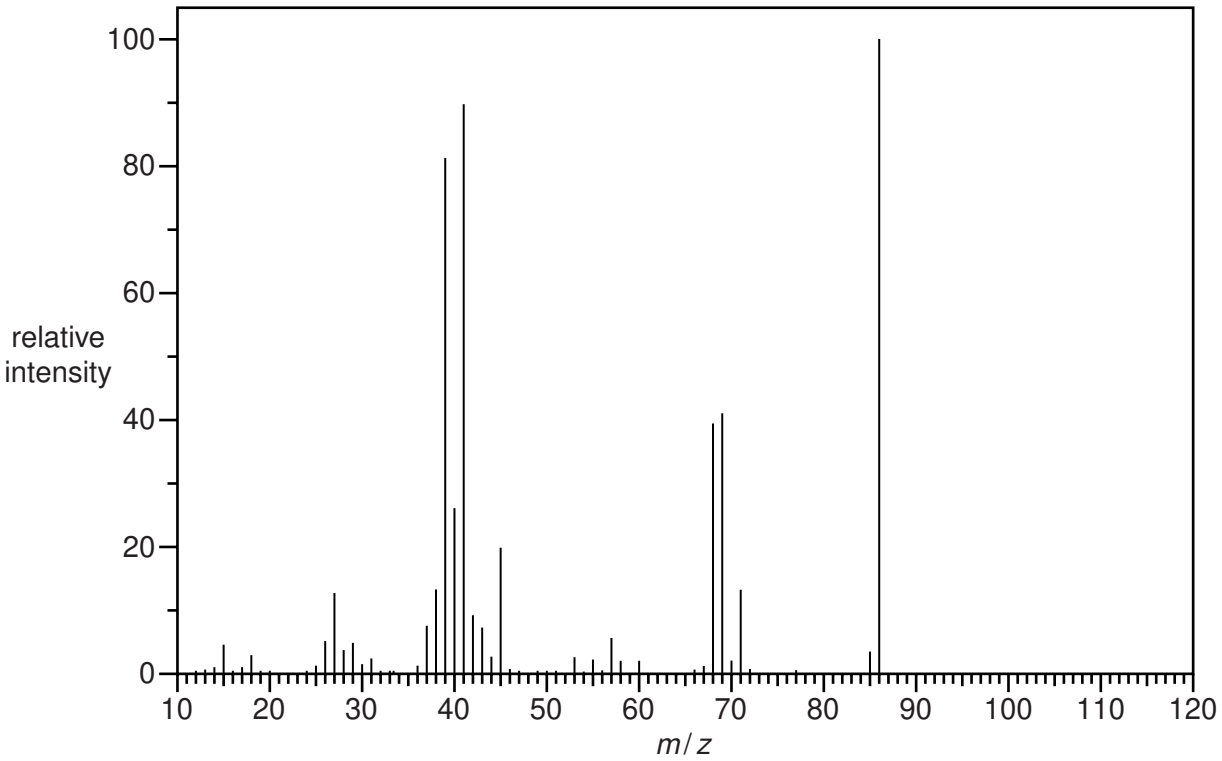
© OCR 2013

STEMUP.CO.UK

(e) Compound **B** is an organic compound used to make some cosmetics.

Compound **B** contains C, H and O only. Elemental analysis shows that **B** has the percentage composition by mass: C, 55.81%; H, 7.02%; O, 37.17%.

The mass spectrum of compound **B** is shown below.



(i) Determine the **molecular** formula of compound **B**.

Show all of your working.

molecular formula of compound **B** = ... **[2]**

© OCR 2013

STEMUP.CO.UK

(ii) Compound **B** is an *E*-stereoisomer.

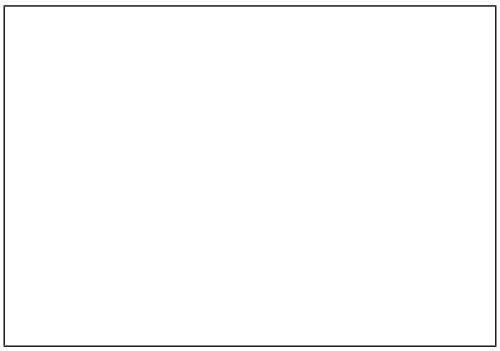
Compound **B** effervesces with aqueous Na_2CO_3 to form organic compound **C**.

Compound **B** decolourises Br_2 to form compound **D**.

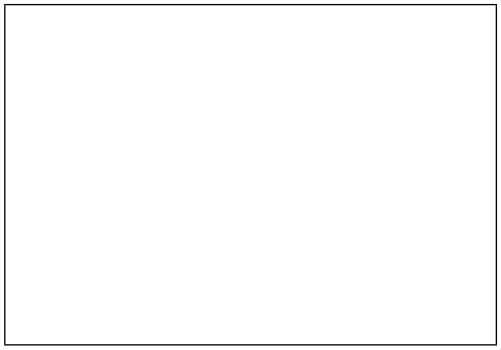
Compound **B** polymerises to form polymer **E**.

In the boxes below:

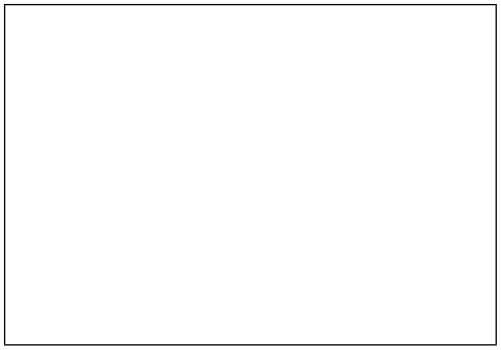
- draw structures for compounds **B**, **C** and **D**.
- draw **one** repeat unit for polymer **E**.



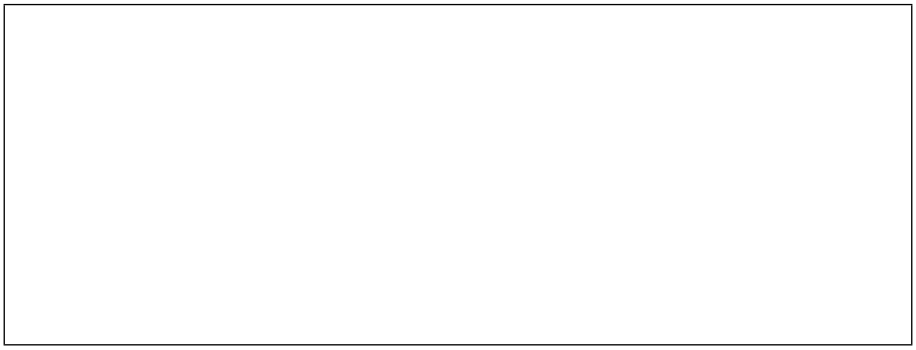
compound B



compound C



compound D



one repeat unit of polymer E

[4]

[Total: 17]

© OCR 2013

STEMUP.CO.UK

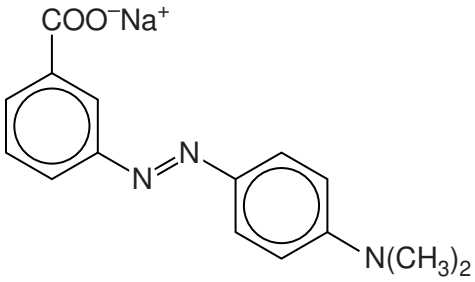
6

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© OCR 2013

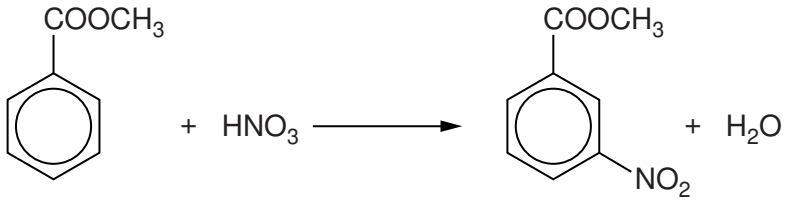
2 A chemist is developing a new azo dye. The structure of this dye is shown below.



azo dye

(a) In the first stage of the synthesis of this dye, methyl 3-nitrobenzoate is formed.

In this stage, methyl benzoate is nitrated by concentrated nitric acid, in the presence of concentrated sulfuric acid as a catalyst.



methyl benzoate **methyl 3-nitrobenzoate**

(i) Outline the mechanism for this nitration of methyl benzoate.

Show how H_2SO_4 behaves as a catalyst.

[5]

(ii) State the name for this type of mechanism.

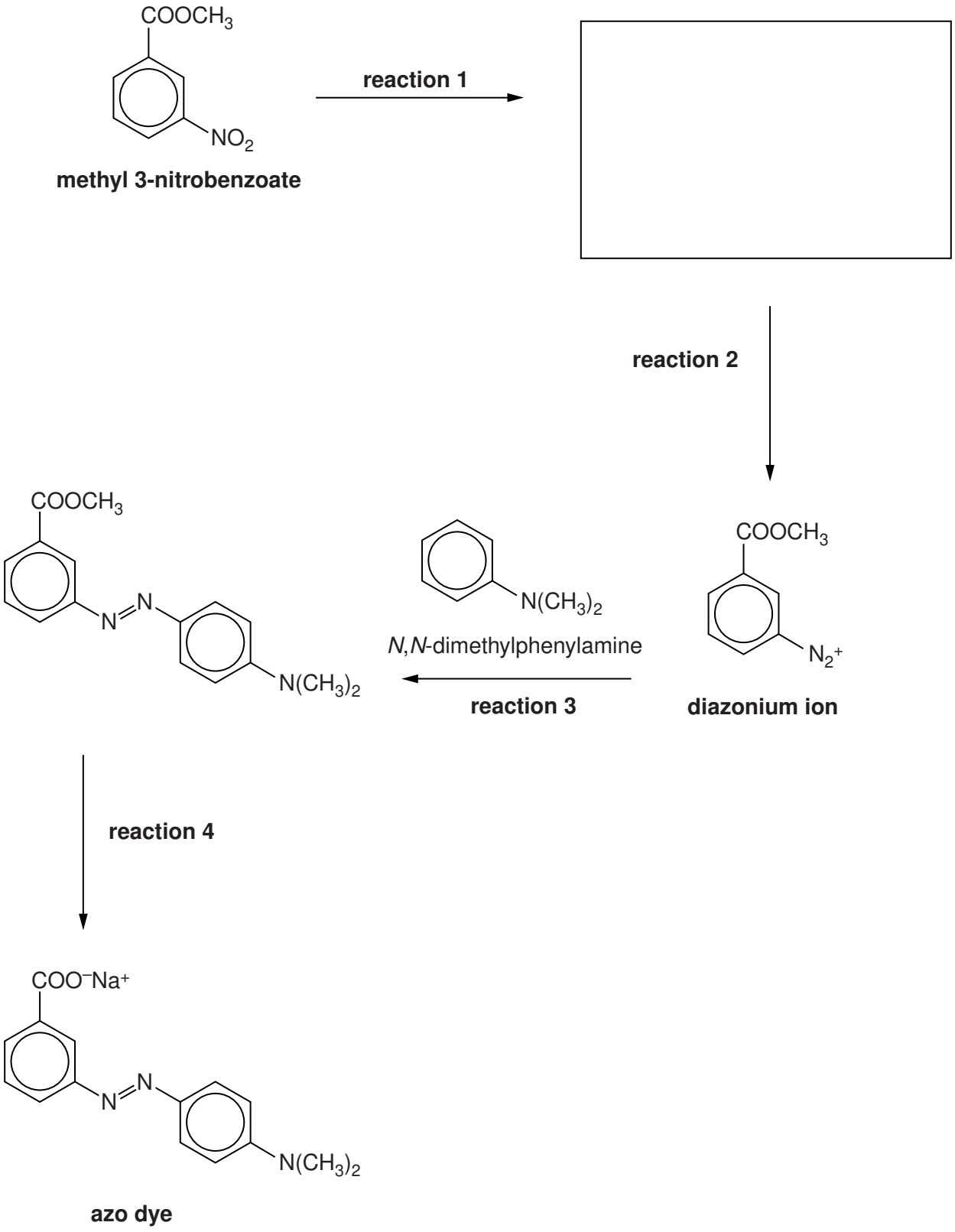
..... **[1]**

© OCR 2013

STEMUP.CO.UK

(b) Methyl 3-nitrobenzoate can be converted into the azo dye in a multi-step synthesis.

The multi-step synthesis is shown in the flowchart below.



© OCR 2013

STEMUP.CO.UK

(i) In the flowchart on page 8, draw the structure of the organic product of **reaction 1**. **[1]**

(ii) Suggest the reagents for **reaction 1**, and the reagents and conditions for **reactions 2** and **4**.

reaction 1 .....

.....

reaction 2 .....

.....

.....

reaction 4 .....

.....

[4]

(iii) The reactions of aromatic amines with bromine and with diazonium ions are similar to those of phenol with bromine and with diazonium ions.

In **reaction 3**, suggest why *N,N*-dimethylphenylamine reacts with the diazonium ion, but benzene would **not** react.

Explain your answer.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[3]

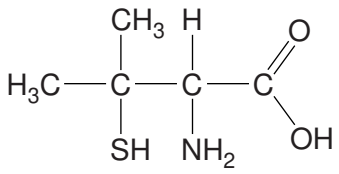
[Total: 14]

© OCR 2013

STEMUP.CO.UK

3 Penicillamine is an α-amino acid that is used as a drug to treat rheumatoid arthritis.

The structure of penicillamine is shown below.



penicillamine

(a) Explain why penicillamine is described as an *α-amino acid.*

.....

..... **[1]**

(b) Penicillamine exists as a zwitterion in aqueous solution.

(i) Draw the structure of this zwitterion.

[1]

(ii) Dilute aqueous acid is added to an aqueous solution of penicillamine.

Draw the structure of the ion that forms.

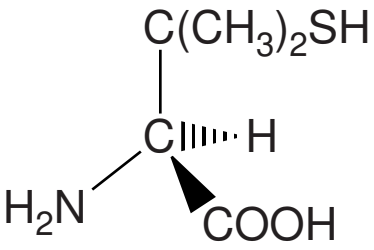
[1]

© OCR 2013

STEMUP.CO.UK

(c) Penicillamine exists as optical isomers. Only one isomer is pharmacologically active. Its 3-D structure is shown below.

In the box below, draw a 3-D diagram to show the structure of the other optical isomer of penicillamine.



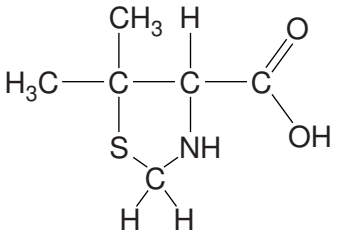
pharmacologically active isomer of penicillamine

[1]

(d) The –SH (thiol) group shows similar chemical properties to –OH.

(i) The –SH and $-NH_2$ groups in penicillamine react with halogenoalkanes by nucleophilic substitution.

Penicillamine reacts with a dihalogenoalkane to form the compound shown below.



Suggest the formula of a dihalogenoalkane that will react with penicillamine to form this compound.

..... **[1]**

© OCR 2013

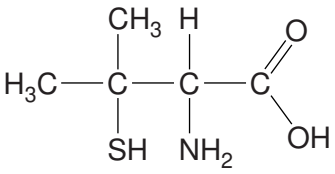
STEMUP.CO.UK

(ii) Penicillamine is able to undergo condensation polymerisation to form polypeptide chains.

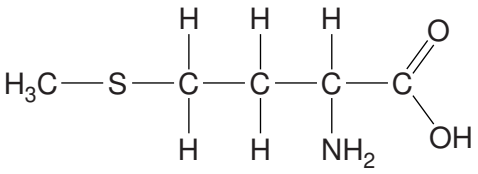
Draw **two** repeat units of a polypeptide chain of penicillamine.

[2]

(e) Penicillamine is a structural isomer of methionine, which is also an α-amino acid.



penicillamine



methionine

NMR spectroscopy can be used to distinguish samples of the two isomers.

(i) Predict the number of peaks in the ^{13}C NMR spectrum of **each** of these α-amino acids.

penicillamine .....

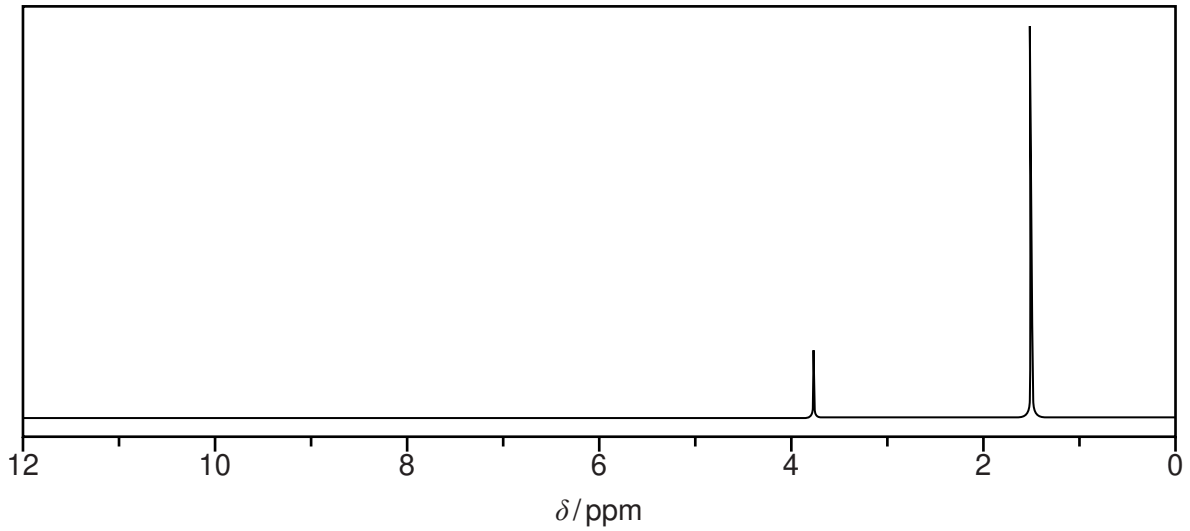
methionine ..... **[2]**

© OCR 2013

STEMUP.CO.UK

(ii) A ^{1}H NMR spectrum of **penicillamine** showed five peaks.

A solution of penicillamine was shaken with a few drops of D_2O and a second ^{1}H NMR spectrum was run. The second ^{1}H NMR spectrum is shown below.



- Identify the **three** types of protons in penicillamine responsible for the peaks that disappeared in the second ^{1}H NMR spectrum.

- Explain why these peaks were **not** seen in the second spectrum.

.....

.....

.....

.....

.....

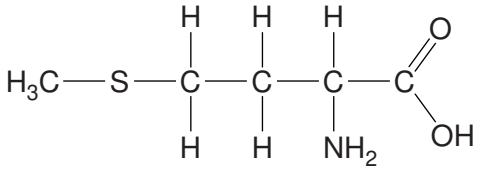
..... **[2]**

© OCR 2013

STEMUP.CO.UK

(iii) ^{1}H NMR spectroscopy can be used to distinguish between penicillamine and methionine.

Complete the table below to predict the ^{1}H NMR spectrum of **methionine**, which is shown below. The actual chemical shifts for three types of proton in methionine have been added for you.



methionine

^{1}H NMR spectrum for methionine			
Type of proton(s)	**Chemical shift, δ /ppm**	**Splitting pattern**	**Relative peak area**
$N\mathbf{H}_2$	4.5	Singlet	2
$\mathbf{H}_3C$—S—	2.1		
—S—C$\mathbf{H}_2$—	2.4		

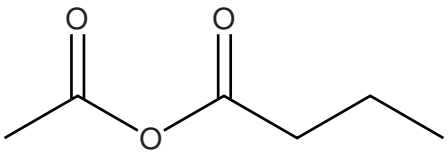
[5]

[Total: 16]

© OCR 2013

4 Acid anhydrides are organic compounds that can be reacted with alcohols to form esters and carboxylic acids.

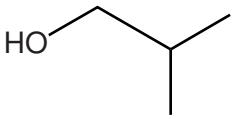
Compound **F**, shown below, is an acid anhydride used in the perfume industry as a starting material in the production of esters.



compound F

Compound **F** is a 'mixed' acid anhydride, formed from two different carboxylic acids.

(a) A chemist reacts compound **F** with an alcohol, **G**.



alcohol G

(i) Name alcohol **G**.

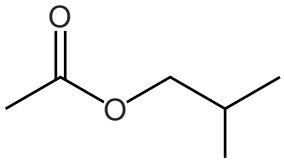
..... **[1]**

(ii) The reaction between **F** and **G** forms a mixture of four organic compounds.

Two of the compounds are esters, and two are carboxylic acids.

One of the esters is shown below.

Draw the structures of the other three organic compounds formed.



[3]

© OCR 2013

STEMUP.CO.UK

(b) After the reaction in part **(a)**, the chemist wished to analyse the mixture by separating the compounds using gas chromatography (GC), and measuring their retention times.

(i) State what is meant by *retention time*.

.....

..... **[1]**

(ii) What are the possible limitations of this analysis by GC?

.....

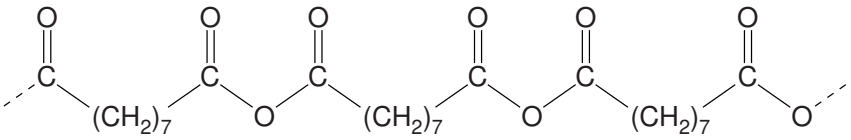
.....

..... **[1]**

(c) Polyanhydrides are condensation polymers that have been recently developed for use in the pharmaceutical industry.

The polyanhydride, **PAPA**, is used to form a protective coating around some anti-cancer drugs.

A section of the polymer chain of **PAPA** is shown below.



(i) **In the diagram above**, draw a box around a repeat unit of **PAPA**. **[1]**

© OCR 2013

(ii) The **PAPA** coating is degradable and breaks down to form the dicarboxylic acid $HOOC(CH_2)_7COOH$.

Name the type of reaction that occurs when **PAPA** degrades.

..... **[1]**

(iii) **PAPA**-coated tablets can be stored for a long time in blister packets. Scientists can detect whether **PAPA** has degraded using infrared (IR) spectroscopy.

Outline how IR spectroscopy could be used to determine if **PAPA** has degraded.

Include in your answer the wavenumber range of any characteristic absorptions that would be seen.

.....

.....

.....

.....

..... **[2]**

(iv) The dicarboxylic acid, $HOOC(CH_2)_7COOH$, can react with benzene-1,3-diol to form a condensation polymer.

Draw **one** repeat unit of this condensation polymer.

[3]

[Total: 13]

END OF QUESTION PAPER

© OCR 2013

STEMUP.CO.UK

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.

© OCR 2013

STEMUP.CO.UK

© OCR 2013

RECOGNISING ACHIEVEMENT

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2013

OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Advanced GCE

Unit **F324:** Rings, Polymers and Analysis

Mark Scheme for January 2013

Oxford Cambridge and RSA Examinations

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

© OCR 2013

Annotations

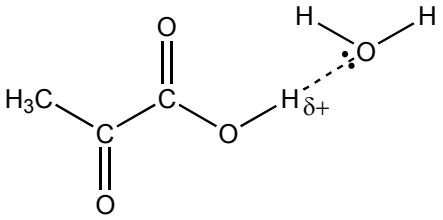
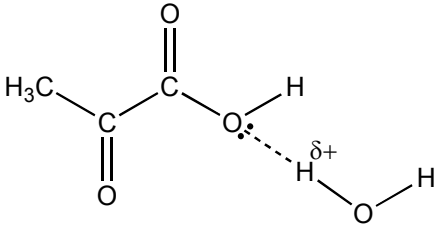
Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Ignore
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures
	Correct response

STEMUP.CO.UK

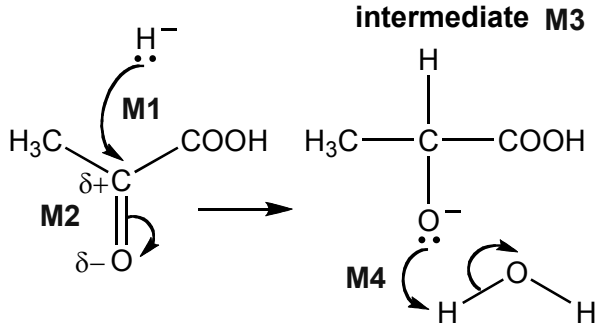
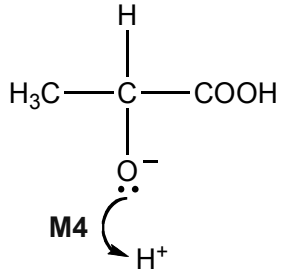
Subject-specific Marking Instructions

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

STEMUP.CO.UK

Question			Answer	Marks	Guidance
1	(a)		**M1 EITHER** in words: (pyruvic acid forms) hydrogen bonds with **water** **OR** correctly **labelled diagram** showing hydrogen bond between pyruvic acid and water ✓ **M2** diagram showing dashed/dotted line between $H^{\delta+}$ in COOH **and lone pair** of electrons on O in H_2O  **OR** diagram showing dashed/dotted line between $H^{\delta+}$ in H_2O and lone pair of electrons on O of OH in COOH ✓ 	2	**FOR M1 only: if use diagram ALLOW a** labelled hydrogen bond to O in C=O **FOR M2 only: IGNORE** a hydrogen bond to C=O, *i.e.* C=O - - - H–O **IGNORE** bond angles Diagram does **not** need to show all of pyruvic acid (**IGNORE** if wrong so allow ethanoic acid) but must have minimum of COOH **MIMIMUM requirement** is a $H^{\delta+}$ (on acid or water) and a lone pair on O (in acid or water) involved in a hydrogen bond ie IGNORE δ-
	(b)		$CH_3CH(OH)CH_2OH + 3[O] \rightarrow CH_3COCOOH + 2H_2O$ four correct formulae ✓ balanced ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous (**IGNORE** lack of brackets round 2° alcohol) **DO NOT ALLOW** molecular formulae **IF** propane1,3-diol used score 0

STEMUP.CO.UK

Question			Answer	Marks	Guidance
1	(c)			4	
			M1: 1 mark for curly arrow from H^- to C of C=O ✓		Curly arrow **MUST** start from – sign **OR** lone pair on H^- Lone pair **does not need** to be shown on H^-
			M2: 1 mark for correct dipoles on C=O **AND** curly arrow from double bond to $O^{\delta-}$ ✓		
			M3: 1 mark for correct intermediate with – charge on O ✓		Lone pair **does not need** to be shown on O^-
			M4: 1 mark for curly arrow from O^- of intermediate to H in H_2O **AND** curly arrow from the O—H **bond** to the O in H_2O: **Do not need** to show formation of OH^-		Curly arrow **MUST** start from – sign **OR** from lone pair on O^- of intermediate Lone pair **does not need** to be shown on O^- **For M4,** **ALLOW** mark for curly arrow from O^- of intermediate to H^+ 

STEMUP.CO.UK

Question			Answer	Marks	Guidance
1	(d)		***Either:*** **Use** Tollens' reagent **AND** correct reference to compound A being oxidised or Tollen's reagent acts as oxidising agent ✓ *Observation:* silver mirror/precipitate/ppt/solid ✓ ***or:*** **Use** $K_2Cr_2O_7$ **AND** H_2SO_4 **AND** correct reference to compound A being oxidised or $K_2Cr_2O_7$ acts as oxidising agent ✓ *Observation:* turns (dark) green **OR** blue ✓ ✎ **QWC** oxidised/oxidized/oxidation/redox *etc*. must be spelled **correctly at least ONCE** (*i.e.* **NOT** oxidisation, oxidated) to score 1st mark **UNLESS** 2,4-DNP(H)/Brady's reagent is used, when condensation/addition–elimination must be spelled **correctly at least ONCE**	3	**ALLOW** $AgNO_3$ in ammonia **OR** ammoniacal $AgNO_3$ **ALLOW** redox reaction **ALLOW** black ppt **OR** grey ppt **ALLOW** $Na_2Cr_2O_7$ **OR** $Cr_2O_7^{2-}$ for $K_2Cr_2O_7$ If formulae used, formulae must be correct **ALLOW** acidified dichromate If name given, **ALLOW** dichromate **OR** dichromate(VI) **IGNORE** reference to dilute/conc **ALLOW** H^+ **ALLOW** $KMnO_4$ **and** H_2SO_4 / acidified manganate(VII)/ permanganate / alkaline manganate(VII) **AND** correct reference to compound A being oxidised or $KMnO_4$ acts as oxidising agent *Observation:* decolourised **ALLOW** Benedict's or Fehling's reagent/solution **AND** correct reference to compound A being oxidised or Benedict's or Fehling's acts as oxidising agent *Observation:* (brick) red ppt **ALLOW** 2,4-DNP(H)/Brady's reagent **AND** measure melting point of derivative **AND** state it is a condensation reaction/addition-elimination reaction *Observation:* orange/yellow/red **precipitate** **ALLOW** solid **OR** crystals **OR** ppt as alternatives for precipitate

STEMUP.CO.UK

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td></td><td></td><td>$HOOCCH_2COOH$ ✓</td><td></td><td>ALLOW correct structural OR displayed OR skeletal formulae OR combination of above as long as unambiguous

ALLOW COO^- if used Tollens' or Fehling's or Benedict's

ALLOW correct unambiguous name:
propan(e-1,3-)dioic acid

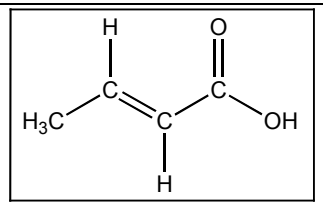
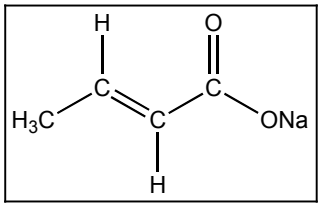
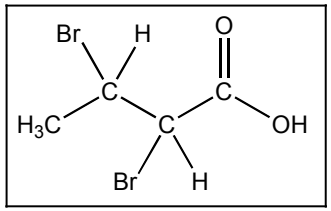
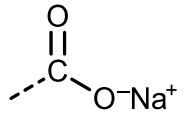
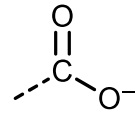
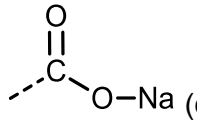
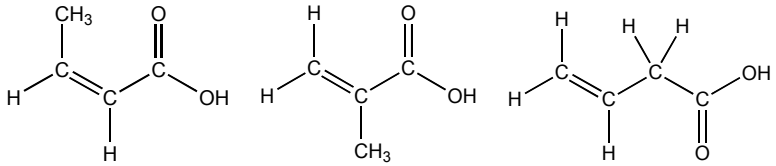
IGNORE dipropanoic acid
DO NOT ALLOW propan(e-1,3-)dicarboxylic acid

if used 2,4-DNP(H):
ALLOW correct hydrazone structure or name
ALLOW "(2,4-dinitrophenyl)hydrazone" (derivative)</td></tr>
<tr><td>1</td><td>(e)</td><td>(i)</td><td><table><tr><td></td><td>C</td><td>H</td><td>O</td></tr><tr><td>%</td><td>55.81%</td><td>7.02%</td><td>37.17%</td></tr><tr><td>mol</td><td>4.65</td><td>7.02</td><td>2.32</td></tr><tr><td>ratio</td><td>2</td><td>3</td><td>1</td></tr></table>empirical formula = C_2H_3O ✓

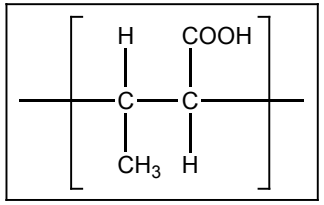
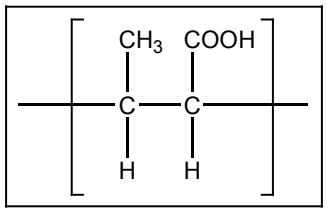
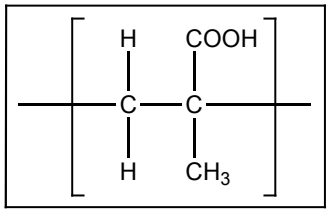
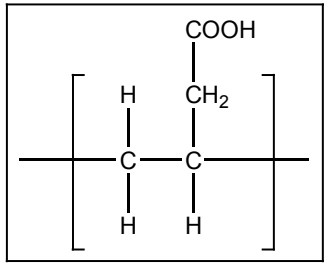
molecular formula = $C_4H_6O_2$ ✓</td><td>2</td><td>Alternative method scores 2 marks:
0.0702/1 x 86 = 6; 0.3717/16 x 86 = 2; 0.5581/12 x 86 = 4

$C_4H_6O_2$ answer alone worth 2 marks</td></tr>
</table>

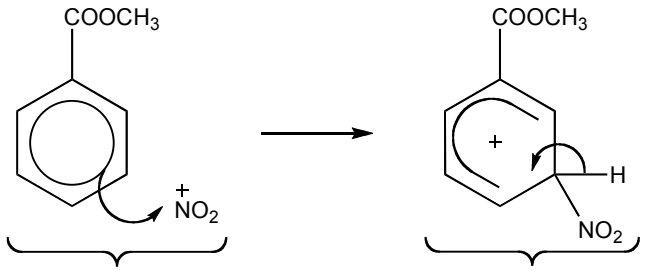
STEMUP.CO.UK

Question			Answer	Marks	Guidance
1	(e)	(ii)	 **compound B** ✓  **compound C** ✓  **compound D** ✓	4	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous eg COOH does not have to be displayed E/trans stereoisomer is needed **For compound C,** **ALLOW**  **OR**  If charges shown on both O and Na then both must be correct **DO NOT ALLOW**  (covalent bond) **ALLOW ECF** for **C** and **D** if **B** is identified as one of the following three structures: 

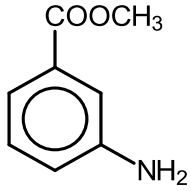
STEMUP.CO.UK

Question	Answer	Marks	Guidance
	 **one repeat unit of polymer E** ✓		**For polymer E**, brackets **not** required **IGNORE** n Free rotation so CH_3 can be shown at top, next to COOH **IF** more than one repeat unit has been drawn a single repeat unit **MUST** be identified by brackets or clear label **The only polymers to ALLOW as ECF from incorrect B are:**   
	Total	**17**	

STEMUP.CO.UK

Question			Answer	Marks	Guidance
2	(a)	(i)	**M1**: $HNO_3 + H_2SO_4 \rightarrow H_2O + HSO_4^- + NO_2^+$ ✓  **M2:** curly arrow from ring to NO_2^+ **M2** ✓ **M3:** correct intermediate **M4:** curly arrow from C-H bond back to reform ring **M3** ✓ **M4** ✓ --- **Note**: **ALLOW M2 AND M4** for benzene **OR ANY** substituted benzene compound For **M3**, credit **ONLY** the **correct** intermediate --- **M5** $H^+ + HSO_4^- \rightarrow H_2SO_4$ ✓	5	**ALLOW** $HNO_3 + 2H_2SO_4 \rightarrow H_3O^+ + 2HSO_4^- + NO_2^+$ **ALLOW** $HNO_3 + H_2SO_4 \rightarrow HSO_4^- + H_2NO_3^+$ then $H_2NO_3^+ \rightarrow H_2O + NO_2^+$ **ALLOW** $^+NO_2$ **OR** NO_2^+ **ALLOW** first curly arrow from the ring **OR** from within the ring to any part of the NO_2^+ including the + charge **DO NOT ALLOW** intermediate with broken ring covering less than half the ring **DO NOT ALLOW incorrect orientation of horseshoe** **ALLOW** non-delocalized (Kekulé) structures **ALLOW** carbocation on either side of H/NO_2 substituents:  **IF** NO_2 is shown in incorrect position or $COOCH_3$ has been omitted in intermediate **DO NOT AWARD** M3 but can award other marks **(max 4)**
		(ii)	electrophilic substitution ✓	1	

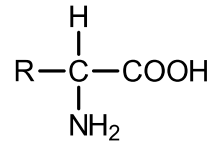
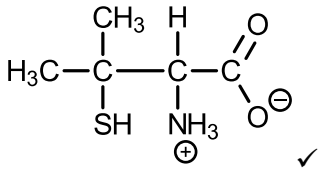
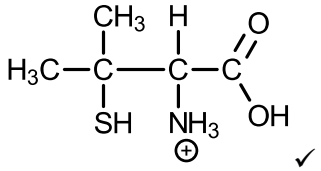
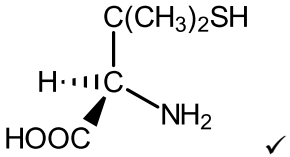
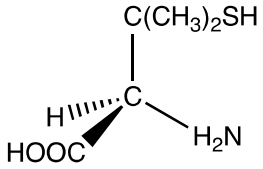
STEMUP.CO.UK

Question			Answer			Marks	Guidance
2	(b)	(i)	 ✓			1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous
		(ii)	Reaction **1**	Sn **AND concentrated** HCl	✓	4	**IGNORE** temperature and reaction type/purpose of reagents
			Reaction **2**	HNO_2 **OR** $NaNO_2$ with (dil) HCl	✓		**IGNORE** reference to concentration
				< 10°C	✓		
			Reaction **4**	hot/heated **aqueous** NaOH	✓		**ALLOW** (heat under) reflux for 'hot' **IGNORE** warm/alkaline if temp stated accept 50º or greater **MUST** have aq or water or any stated concentration

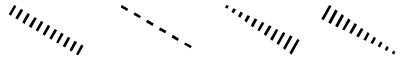
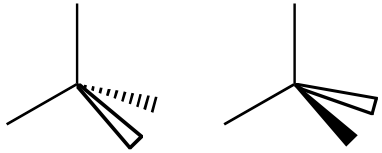
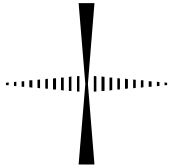
STEMUP.CO.UK

Question			Answer	Marks	Guidance
2	(b)	(iii)	In **amine**, (lone) **pair** of electrons on N is (partially) **delocalised** into the ring ✓ ✎ **QWC** delocalised/delocalized/delocalise, *etc*. must be spelled correctly in the correct context **at least once** for 1st mark electron density is high(er) / increases ✓ great(er) attraction (from aromatic ring) for electrophile/diazonium ion ✓	3	**ALLOW** diagram to show movement of (lone) pair into ring but **delocalised** ring must be mentioned **ALLOW** (lone) pair of electrons on N is (partially) drawn/attracted/pulled into **delocalised** ring **ALLOW** electron density low(er) for benzene **IGNORE** 'activates the ring' **IGNORE** charge density alone but **ALLOW** electron charge density **DO NOT ALLOW** electronegativity **ALLOW** less/low attraction from benzene for electrophile/diazonium ion **ALLOW** amine is a **better** nucleophile/**more** susceptible to electrophilic attack **DO NOT ALLOW** reference to dipole induced in diazonium ion **DO NOT ALLOW** reference to bromine as electrophile
			Total	**14**	

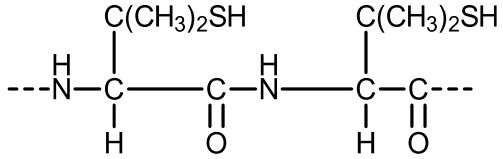
STEMUP.CO.UK

Question			Answer	Marks	Guidance
3	(a)		Both NH_2 and COOH are attached to the same carbon ✓	1	**ALLOW** amine/amino and carboxyl(ic) **ALLOW** (it has the structure)  **ALLOW** $RCH(NH_2)COOH$ in any order but C and H must be adjacent (to each other)
	(b)	(i)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** NH_3^+ **ALLOW** delocalised carboxylate
		(ii)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** NH_3^+
	(c)		 ✓	1	**Connectivity is being tested:** Chiral C **must** be linked to the C of the COOH, the C of the $C(CH_3)_2SH$ and the N of the NH_2 **eg DO NOT ALLOW** an attempted NH_2 shown as below: 

STEMUP.CO.UK

Question			Answer	Marks	Guidance
					The structure must have four central bonds, with at least one wedge in AND one wedge out --- For bond into plane of paper, **ALLOW**:  For bond out of plane of paper, a solid wedge is expected, either way around:  **ALLOW** a hollow wedge for 'in bond' OR an 'out bond', provided it is different from the other in or out wedge e.g.:  **ALLOW** examples of other 3D representations provided they are possible: i.e.  **CARE**: This is a 3D representation so this is possible and the bond are clearly not 90º to one another

STEMUP.CO.UK

Question			Answer	Marks	Guidance
3	(d)	(i)	CH_2CIl_2 ✓	1	**ALLOW** CH_2Br_2 **OR** CH_2I_2 **OR** CH_2F_2 **OR** other dihalogenated methane derivatives eg CH_2BrCl **IGNORE** names
		(ii)	 peptide link ✓ rest of structure ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **ALLOW** —NH— at other end 'End bonds' **MUST** be shown (solid or dotted) **IGNORE** brackets and/or *n* around **two** repeat units 1st mark does not require amide group fully displayed ie **ALLOW** –CONH– **DO NOT ALLOW 2nd** mark if amide/peptide link wrong If more than 2 repeat units only first mark (peptide link) can be awarded
	(e)	(i)	penicillamine = 4 ✓ methionine = 5 ✓	2	
		(ii)	(CO)O**H**, N**H**/N**H**$_2$ **AND** S**H** ✓ all undergo proton exchange ✓	2	**ALLOW** (CO)O**D**, N**D**/N**D**$_2$, S**D**, **ALLOW** H (atoms/protons/ions) replaced by D (atoms/ions)

STEMUP.CO.UK

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3</td><td>(e)</td><td>(iii)</td><td>
<table>
<tr><th colspan="4">^{1}H NMR spectrum for methionine</th><th></th></tr>
<tr><th>Type of proton(s)</th><th>Chemical shift</th><th>Splitting pattern</th><th>Relative peak area</th><th></th></tr>
<tr><td>NH$_2$</td><td>4.5</td><td>singlet</td><td>2</td><td></td></tr>
<tr><td>H$_3$C-S-</td><td>2.1</td><td>singlet</td><td>3</td><td>✓</td></tr>
<tr><td>-S-CH$_2$-</td><td>2.4</td><td>triplet</td><td>2</td><td>✓</td></tr>
<tr><td>S-CH$_2$-CH$_2$</td><td>0.7–2.0</td><td>multiplet OR quartet</td><td>2</td><td>✓</td></tr>
<tr><td>CHNH$_2$</td><td>2.0–3.0</td><td>triplet</td><td>1</td><td>✓</td></tr>
<tr><td>OH</td><td>11–12</td><td>singlet</td><td>1</td><td>✓</td></tr>
</table>
Rows can be in any order
IGNORE extra rows
Do not need to show bonds between atoms
</td><td>5</td><td>
ALLOW any value within ranges given for δ /ppm on the Data Sheet
IGNORE reference to NH$_2$ signals (given as example)

GUIDANCE
• mark by rows
• ALL data in row must be correct for each mark
• ALLOW “triplet of doublets” or “doublet of triplets” for multiplet/quartet signal from —CH$_2$CH$_2$S—

ALLOW quadruplet

ALLOW a response that implies a single peak OR ‘no splitting’

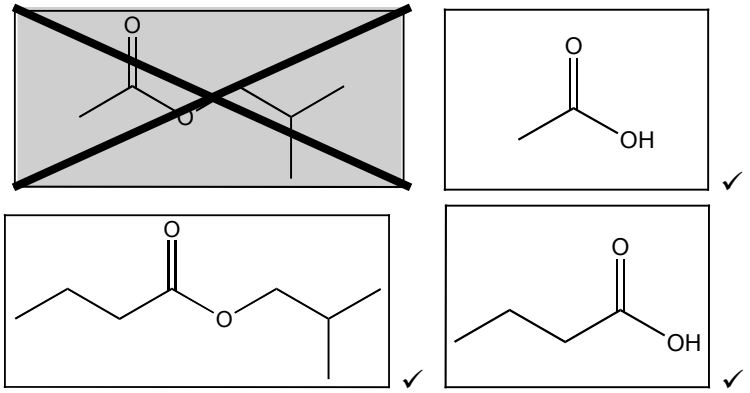
ALLOW a response that implies a splitting into three for a triplet/into four for a quartet

Clear and unambiguous identification of the protons (when more than one type is present) other than by position number should be credited
eg for CHNH$_2$ could be HCCO or CHN or HCN or CH$_2$CH

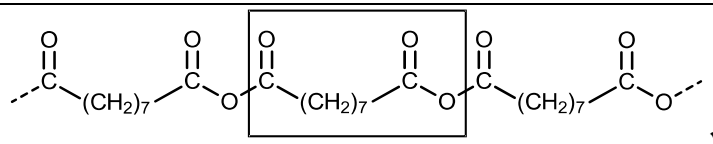
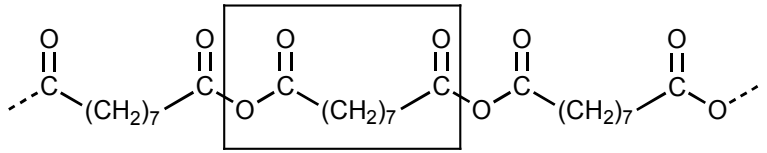
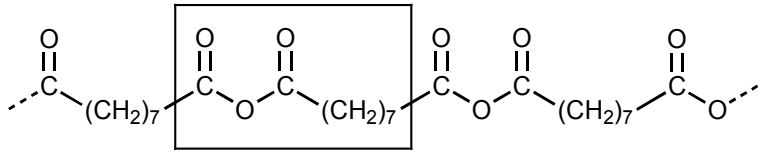
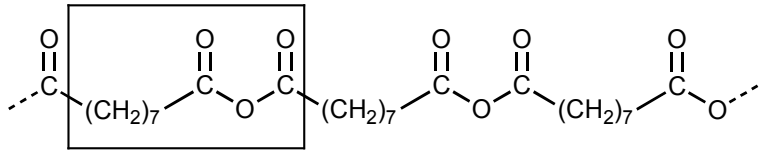
eg for S-CH$_2$-CH$_2$ could be CH$_2$C(H)NH$_2$ or CCH$_2$C or CH$_2$CH$_2$ or RCH$_2$R or RCHR

eg ‘CH between COOH and NH$_2$’ OR identification by number labels on chemical structures
</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>16</td><td></td></tr>
</table>

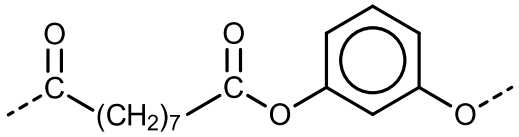
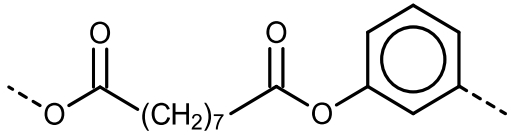
STEMUP.CO.UK

Question			Answer	Marks	Guidance
4	(a)	(i)	(2-)methylpropan-1-ol ✓	1	**ALLOW** without hyphens
		(ii)	 ✓ ✓ ✓	3	**DO NOT MARK** top left hand structure: (on paper) **ALLOW in any order** **ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **If use displayed formulae but omit one or more H atoms DO NOT ALLOW each time**
	(b)	(i)	The time (from the injection of the sample) for the component/compound/substance to leave the column ✓	1	**IGNORE** (time for) gas to leave column **DO NOT ALLOW** time in GC/machine/apparatus **ALLOW** time from injection to detection **ALLOW** time spent in column **ALLOW** time taken to reach detector
		(ii)	They have similar retention times **OR** unknown compounds have no reference retention times for comparison ✓	1	**ALLOW** same retention times **ALLOW** both are esters therefore relative solubilities/ partition/adsorption/retention times will be very similar

STEMUP.CO.UK

Question			Answer	Marks	Guidance
4	(c)	(i)	 ✓	1	**IF end repeat unit shown** the line of the box must go through the continuation bond **ALLOW** other possibilities for showing structure with repeat unit displayed, eg repeat unit with O on left and not on right.  Other possibilities:  
		(ii)	Hydrolysis ✓	1	**IGNORE** decomposition/biodegradation **IGNORE** mention of acid/alkali

STEMUP.CO.UK

Question			Answer	Marks	Guidance
4	(c)	(iii)	broad absorption 2500–3300 (cm^{-1}) ✓ (because) (degradation) forms (di)carboxylic acid / COOH ✓	2	**ALLOW** carboxyl group **IGNORE** reference to carbonyl/1640–1750 (cm^{-1}) **IGNORE** reference to C—O/1000–1300 (cm^{-1})
		(iv)	 **M1** ester link ✓ **M2** the two oxygen atoms from benzene-1,3-diol linked at 1,3 positions ✓ **M3** one repeat unit fully correct ✓	3	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous Ester link does not need to be fully displayed eg accept –COO– **ALLOW** —O— at other end ie  'End bonds' **MUST** be shown (solid or dotted) **DO NOT ALLOW** more repeat units **IGNORE** brackets and/or *n* **IF** more than one repeat unit has been drawn a single repeat unit **MUST** be identified by brackets or clear label
			Total	**13**	

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2013

STEMUP.CO.UK

OCR
RECOGNISING ACHIEVEMENT

Tuesday 19 June 2012 – Afternoon

A2 GCE CHEMISTRY A

F324 Rings, Polymers and Analysis

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry A* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour 15 minutes

F3247306122

F324

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **16** pages. Any blank pages are indicated.

© OCR 2012 [M/500/7836]
OCR is an exempt Charity

STEMUP.CO.UK

Answer **all** the questions.

1 Alkenes and benzene both react with bromine but alkenes are much more reactive.

(a) Explain the relative resistance to bromination of benzene compared with alkenes.



In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

(b) A student investigates two reactions of bromine with phenylethene, $C_6H_5CH=CH_2$.

Reaction 1
The student first mixes phenylethene with excess bromine at room temperature.
An organic compound forms with the molecular formula $C_8H_8Br_2$.

Reaction 2
The student then adds a halogen carrier to the mixture obtained from **reaction 1**.
A mixture of isomers forms. Each isomer has the molecular formula $C_8H_7Br_3$.

(i) Draw the structure of the organic compound formed in **reaction 1**.

[1]

(ii) Predict the number of peaks in the carbon-13 NMR spectrum of the organic compound formed in **reaction 1**.

..... **[1]**

© OCR 2012

STEMUP.CO.UK

(iii) Draw the structures of two of the isomers of $C_8H_7Br_3$ formed in **reaction 2**.

isomer 1	**isomer 2**

[2]

(iv) State the types of mechanism that take place in **reaction 1** and **reaction 2**.

reaction 1 .....

reaction 2 ..... **[2]**

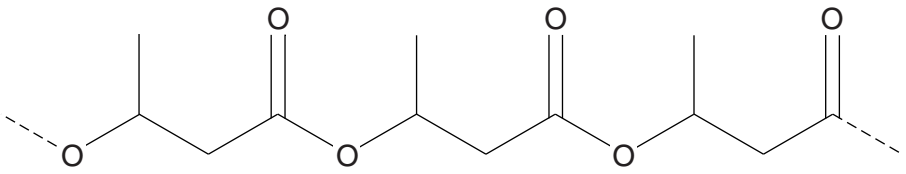
[Total: 10]

© OCR 2012

STEMUP.CO.UK

2 This question looks at different types of condensation polymers: polyesters, polyamides and proteins.

(a) Polyester **A**, shown below, is a degradable polymer prepared by bacterial fermentation of sugars.



polyester **A**

One reason that polyester **A** is degradable is that it can be hydrolysed.

(i) State another way that a polyester may be degraded.

..... **[1]**

(ii) When polyester **A** is hydrolysed with aqueous acid, compound **B** is formed.

Draw the skeletal formula of compound **B**.

[1]

(b) Nylon-4,6 is a polyamide that can be prepared by reacting butane-1,4-diamine, $H_2N(CH_2)_4NH_2$, with hexanedioic acid, $HOOC(CH_2)_4COOH$.

(i) $H_2N(CH_2)_4NH_2$ can be synthesised from 1,4-dichlorobutane, $Cl(CH_2)_4Cl$.

State the reagents and conditions required for this synthesis.

.....

..... **[1]**

(ii) $H_2N(CH_2)_4NH_2$ can act as a base and forms salts with dilute acids.

- Explain how an amine can act as a base.
- Write the formula of the salt formed when $H_2N(CH_2)_4NH_2$ reacts with an **excess** of dilute hydrochloric acid.

explanation .....

.....

formula of salt ..... **[2]**

© OCR 2012

STEMUP.CO.UK

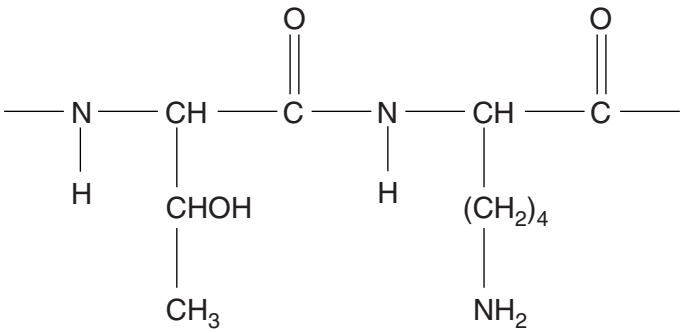
(iii) Draw the repeat unit of nylon-4,6.

Clearly display the bonding that links the two monomers.

[2]

(c) A sample of a protein is hydrolysed. The organic products are separated by chromatography. Each organic product has its pH adjusted to its isoelectric point to form a zwitterion.

A section of the protein is shown below.



(i) In the boxes below, draw the structures of the zwitterions formed from this section of the protein.

[2]

(ii) The isoelectric points of the zwitterions in **(i)** are at pH 5.60 and pH 9.60.

Explain why these isoelectric points are at different pH values.

.....

.....

.....

..... **[1]**

[Total: 10]

© OCR 2012

STEMUP.CO.UK

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

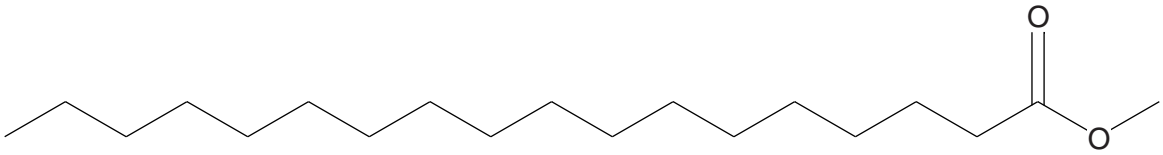
© OCR 2012

3 Fats and oils are mixtures of organic compounds. Some fats contain glycerides and steroids.

(a) Some processed foods contain *trans* oils which have been linked to health risks.

(i) The incomplete structure below shows an octadeca-12-enoate section of a *trans* oil.

- Add the double bond to the structure
- State how the *trans*-isomer is different from the *cis*-isomer.



.....

.....

..... **[2]**

(ii) State **one** possible health risk of a diet that is high in *trans* oils.

.....

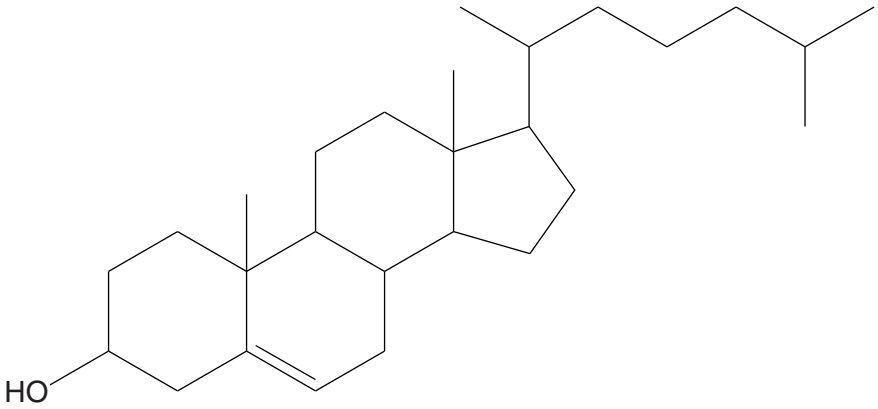
..... **[1]**

© OCR 2012

STEMUP.CO.UK

(b) Cholesterol is part of a family of compounds called steroids.

The structure of cholesterol is shown below.



(i) How many carbon atoms are there in a molecule of cholesterol?

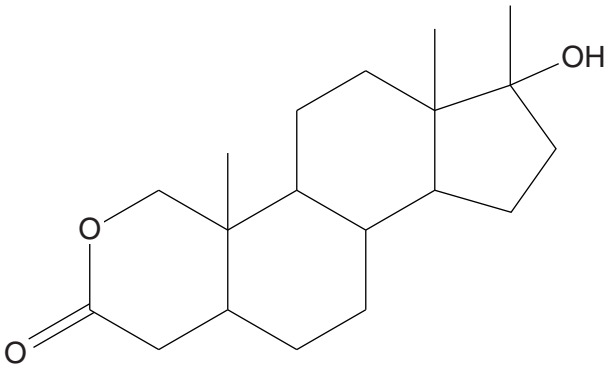
..... **[1]**

(ii) How many chiral centres are there in a molecule of cholesterol?

..... **[1]**

(c) Oxandrolone is a type of synthetic drug called an 'anabolic steroid', prescribed to promote muscle growth.

The structure of oxandrolone is shown below.



(i) What are the functional groups in oxandrolone?

.....

..... **[2]**

© OCR 2012

STEMUP.CO.UK

(ii) Oxandrolone is synthesised from naturally occurring steroids.

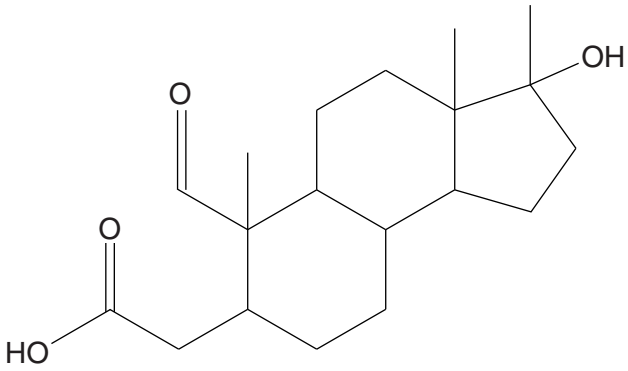
Suggest an advantage of developing a synthetic route to oxandrolone starting from a natural steroid.

.....

.....

..... **[1]**

(iii) Compound **C** below is an intermediate formed during the synthesis of oxandrolone.



compound C

Suggest a two-step synthesis of oxandrolone from compound **C**.

For each step of the synthesis,

- state the reagents and any conditions
- state the functional groups that would react and those that would form.

.....

.....

.....

.....

.....

..... **[4]**

[Total: 12]

© OCR 2012

STEMUP.CO.UK

4 Benzaldehyde, C_6H_5CHO, is the simplest aromatic aldehyde and has a characteristic smell of almonds.

(a) Benzaldehyde can be nitrated with a mixture of concentrated nitric acid and concentrated sulfuric acid to form 3-nitrobenzaldehyde.

Explain, with the aid of curly arrows, the mechanism for the formation of 3-nitrobenzaldehyde.

Your answer should clearly show the role of sulfuric acid as a catalyst.

[6]

(b) Benzaldehyde reacts with a solution of potassium hydroxide. In this reaction, benzaldehyde is both oxidised and reduced to form two organic products.

Suggest an equation for this reaction, showing clearly the structures of the two organic products.

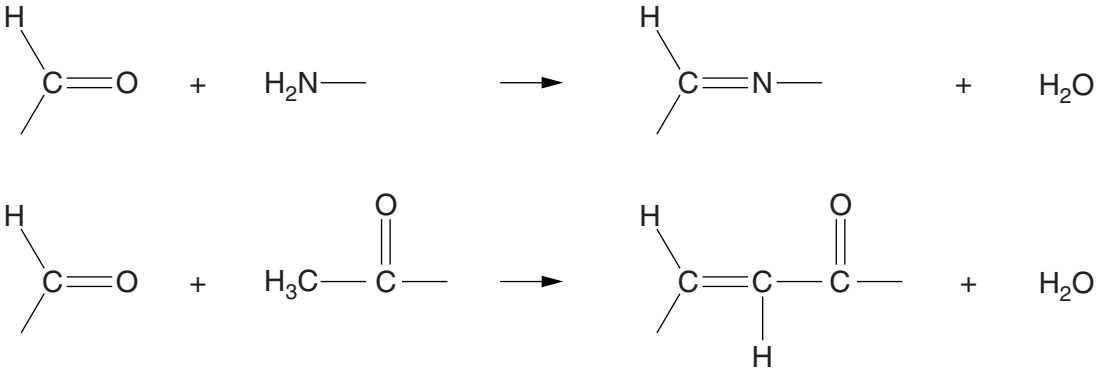
[3]

© OCR 2012

STEMUP.CO.UK

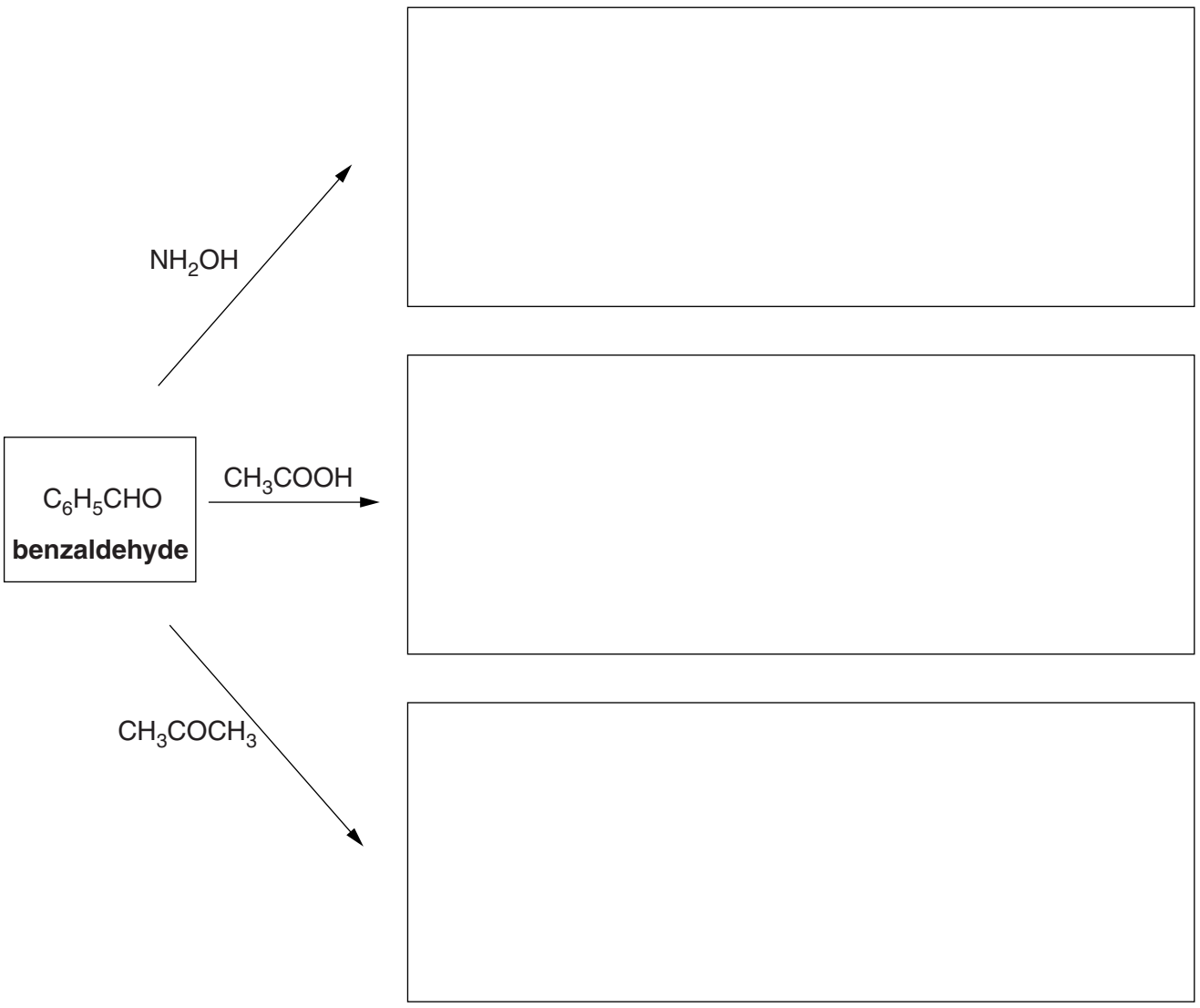
(c) The aldehyde group takes part in 'condensation' reactions with many compounds containing an amine group or a methyl group adjacent to a C=O.

In these reactions, water is formed as a product. Two examples are shown below.



Predict the organic products formed in the following condensation reactions of benzaldehyde. In each reaction, an excess of benzaldehyde is used.

Draw the structure of each organic product in the boxes.



[3]

© OCR 2012

STEMUP.CO.UK

(d) Alkyllithium compounds, RLi, can be used to increase the number of carbon atoms in an organic compound. Different alkyl groups, R, add carbon chains with different chain lengths.

RLi provides a source of R^- ions, which act as a nucleophile.

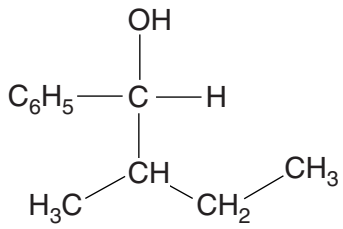
(i) The diagram below shows an incomplete mechanism for the reaction of RLi with benzaldehyde, followed by reaction with aqueous acid.

- Complete, using curly arrows and relevant dipoles, the mechanism for **stage 1**.
- Give the structure of the intermediate and the organic product.



[4]

(ii) A chemist needs to prepare the organic compound below from benzaldehyde.



Draw the structure of the alkyllithium compound needed for this synthesis.

[1]

[Total: 17]

© OCR 2012

5 A chemist uses gas chromatography, GC, to separate the esters in a mixture. The esters are then analysed using different spectroscopic techniques.

(a) (i) How could the chemist use the results from GC to predict the number of esters in the mixture and their relative proportions?

.....

.....

..... **[1]**

(ii) Why would there be some uncertainty about using GC alone to predict the number of esters in a mixture?

.....

..... **[1]**

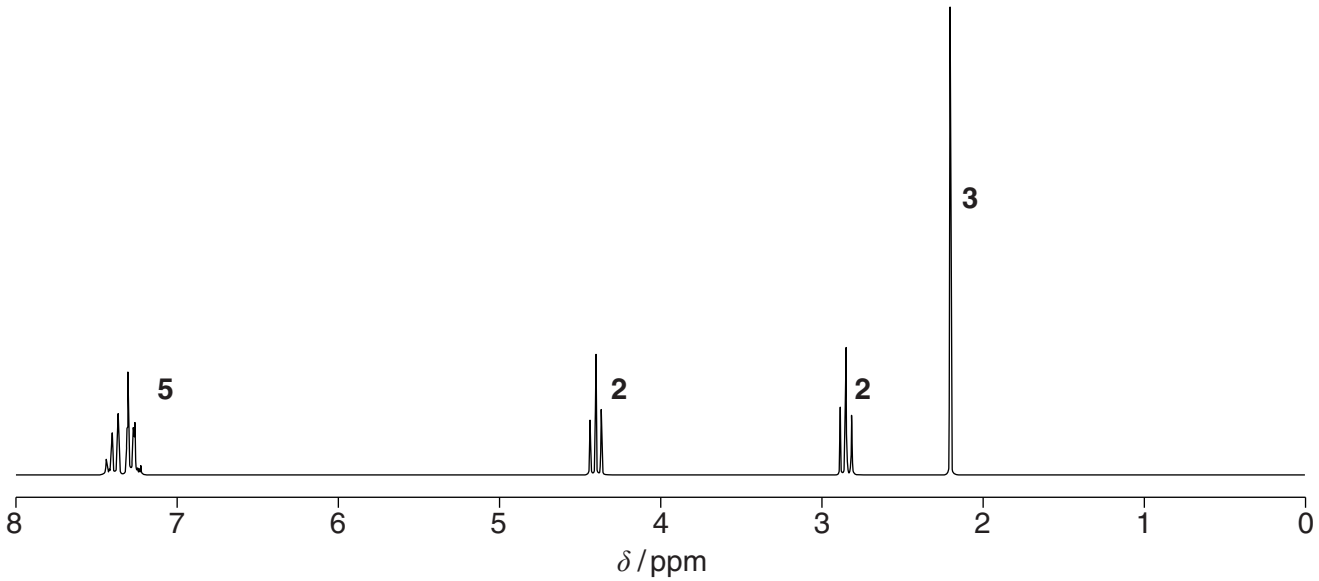
TURN OVER FOR QUESTION 5(b)

© OCR 2012

STEMUP.CO.UK

(b) The chemist obtains a mass spectrum and a proton NMR spectrum of one of the esters separated by GC.

- The mass spectrum has a molecular ion peak at $m/z = 164$.
- The proton NMR spectrum is shown below.
  The numbers on the NMR spectrum represent the relative peak areas.



Analyse this information to identify the ester.

Include full details of your analysis of the proton NMR spectrum.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

© OCR 2012

STEMUP.CO.UK

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[9]**

[Total: 11]

END OF QUESTION PAPER

© OCR 2012

ADDITIONAL PAGE

If additional space is required, you should use the lined page below. The question number(s) must be clearly shown.

RECOGNISING ACHIEVEMENT

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2012

OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Advanced GCE

Unit **F324:** Rings, Polymers and Analysis

Mark Scheme for June 2012

Oxford Cambridge and RSA Examinations

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

© OCR 2012

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

Annotations

Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Ignore
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures
	Correct response

STEMUP.CO.UK

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

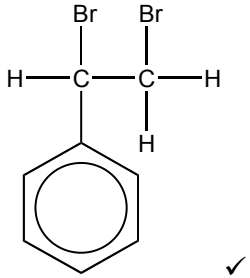
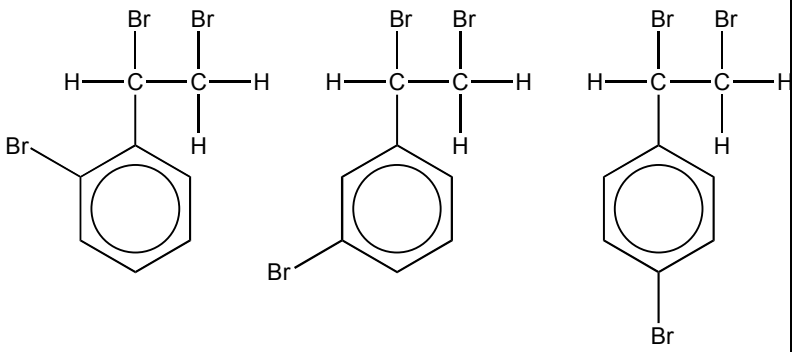
The following questions should be annotated with ticks, etc. to show where marks have been awarded in the body of the text:

Q1(a), Q3(c)(iii), **Q4(a), Q4(d)(i)**, **Q5(b)**.

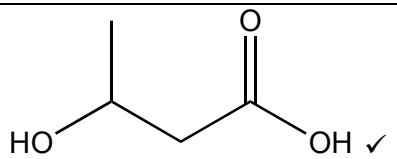
STEMUP.CO.UK

Question			Answer	Marks	Guidance
1	(a)		In benzene, electrons **OR** π-bond(s) are **delocalised** ✓ **QWC** requires delocalised/delocalized **spelled correctly** and used in correct context In alkenes, TT-electrons are **OR** TT-bond is **AND** localised **OR** between two carbons ✓ benzene has a lower electron density **OR** alkene/C=C has a higher electron density ✓ *Comparison* ***essential*** benzene polarises bromine / Br_2 **LESS** **OR** benzene attracts bromine / Br_2 **LESS** **OR** benzene induces a **weaker** dipole in bromine / Br_2 ✓	4	***ANNOTATIONS MUST BE USED*** **ALLOW** diagram with (π-bond) electrons **AND** delocalised **labelled** **IGNORE** benzene has delocalised structure or ring **ALLOW** diagram with π-bond labelled **ALLOW** pi bond for π-bond **π**-bond **OR π-**electrons ***essential*** *for this mark* **IGNORE** charge density **DO NOT ALLOW** electronegativity **ALLOW** Br–Br for Br_2 **ALLOW** electrophile for Br_2 **ALLOW** benzene does **NOT** polarise bromine / Br_2 **OR** alkene/C=C polarises Br_2 **ALLOW** benzene does **NOT** attract bromine / Br_2 **OR** alkene/C=C attracts Br_2 **ALLOW** benzene does **NOT** induce dipole in bromine / Br_2 **OR** alkene/C=C induces dipole in Br_2

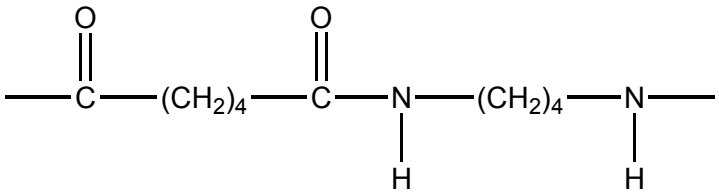
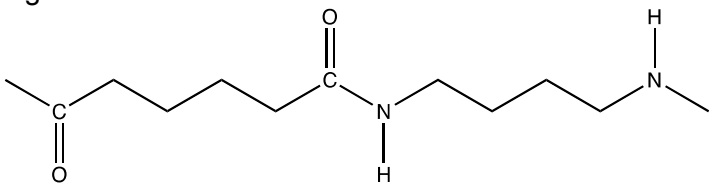
STEMUP.CO.UK

Question			Answer	Marks	Guidance
1	(b)	(i)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous
		(ii)	6 ✓	1	**NO ECF from (i)**
		(iii)	Two of the three structures below with 1 mark for each correct structure ✓✓ 	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous Structures must clearly show position of Br on benzene ring in relation to side chain **ALLOW ECF** from **(i)** if **BOTH** Br atoms on same carbon on side chain **DO NOT ALLOW ECF** from **(i)** if **EITHER** bromine has been substituted onto the benzene ring
		(iv)	**reaction 1**: electrophilic addition ✓ **reaction 2**: electrophilic substitution ✓	2	**ALLOW** electrophile addition **ALLOW** electrophile substitution **ALLOW** other phonetic spellings for electrophilic, e.g. electrophylic, etc.
			Total	**10**	

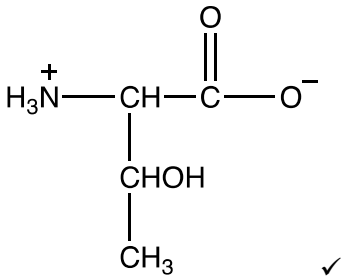
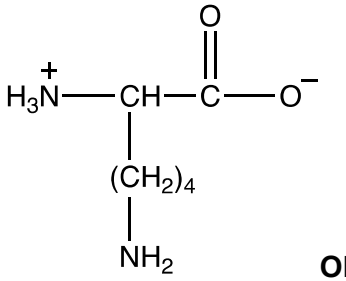
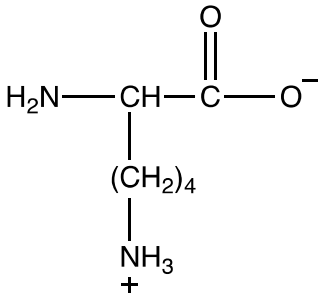
STEMUP.CO.UK

Question			Answer	Marks	Guidance
2	(a)	(i)	photodegradable **OR** light/sunlight/UV ✓	1	**IGNORE** IR/heat **IGNORE** bacteria **DO NOT ALLOW** burn/combustion
		(ii)	 ✓	1	**DO NOT ALLOW** structure with any C shown (especially as part of C=O) **DO NOT ALLOW** OH—
	(b)	(i)	ammonia/NH_3 **AND** ethanol **OR** ethanolic ammonia ✓	1	**ALLOW** ammonia in a sealed tube **IGNORE** heat **ALLOW** dilute ethanolic ammonia /NH_3 **DO NOT ALLOW** any reference to water or hydroxide ions, e.g. **DO NOT ALLOW** dilute ethanolic NH_3(**aq**) e.g. **DO NOT ALLOW** ethanolic NH_3 + NaOH
		(ii)	**Nitrogen** electron pair/lone pair accepts a proton/H^+ ✓ *Requires position of electron pair on N* $Cl^-H_3N^+(CH_2)_4N^+H_3\,Cl^-$ **OR** $ClH_3N(CH_2)_4NH_3Cl$ ✓	2	**DO NOT ALLOW** Nitrogen/N lone pair accepts hydrogen *proton/H^+ required* **ALLOW nitrogen** donates an electron pair **IGNORE** NH_2 group donates electron pair **ALLOW** + charge (if shown) on N or H of NH_3 e.g. $Cl^-H_3N^+(CH_2)_4NH_3^+Cl^-$ **DO NOT ALLOW** just $H_3N^+(CH_2)_4NH_3^+$ i.e. **2 x** Cl^- **MUST** be included

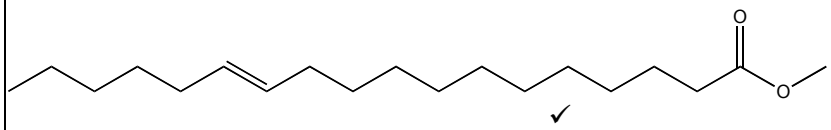
STEMUP.CO.UK

Question			Answer	Marks	Guidance
2		(iii)	1 mark for amide/peptide link correctly displayed within an attempted repeat unit ✓ 1 mark for rest of structure correct including side links ✓ 	2	Minimum requirement is each end of a displayed amide group attached to a carbon atom (could be skeletal) Brackets **not** required **IF** more than one repeat unit has been drawn a single repeat unit **MUST** be identified by brackets or clear label **DO NOT ALLOW 2nd** mark if amide/peptide link wrong *1st mark requires amide group fully displayed* *For 2nd mark, **ALLOW** –CONH– in correct structure* **ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous e.g. 

STEMUP.CO.UK

Question			Answer	Marks	Guidance
2	(c)	(i)	One mark for each correct structure  ✓  **OR**  ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous **ALLOW** COO^- '–' charge must be on O of COO^- but **ALLOW** + sign shown as $^+NH_3$ **OR** NH_3^+ **BUT** only one NH_2 can be protonated in zwitterion
		(ii)	Zwitterion at pH 9.60/higher pH has **one** NH_2 group **OR** Zwitterion **OR** amino acid at pH 9.60/higher pH has a side chain with an NH_2 group ✓ **Note:** **ASSUME** that 'it' refers to zwitterion	1	**ALLOW** amino acid at 9.60/higher pH has **two** NH_2 groups **ALLOW** amino acid at 9.60/higher pH has more NH_2 groups **ALLOW** amine **OR** amino for NH_2 **IGNORE** CHOH slightly acidic
			Total	**10**	

STEMUP.CO.UK

Question			Answer	Marks	Guidance
3	(a)	(i)	 ✓ *cis*-isomer has Hs on same side **OR** *cis*-isomer has branches on same side **OR** *cis*-isomer has same groups on same side **OR** *cis*-isomer has lowest priority groups on same side **OR** *cis*-isomer has highest priority groups on same side ✓	2	**ALLOW** *trans*-isomer has Hs on opposite sides **OR** *trans*-isomer has branches on opposite sides **OR** *trans*-isomer has same groups on opposite sides **DO NOT ALLOW** 'similar groups' for 'same groups' **OR** *trans*-isomer has lowest priority groups on opposite sides **OR** *trans*-isomer has highest priority groups on opposite sides ✓ For explanation, **ALLOW** a clear diagram, *ie*:  *cis* **ALLOW** response in terms of packing, e.g. molecules/chains of *trans*-isomer pack close together **OR** molecules/chains of *cis*-isomer do **not** pack closely together **DO NOT ALLOW** 'carbon atoms' for 'molecules/chains'
		(ii)	heart disease/strokes ✓	1	**ALLOW** any named heart/circulatory complaint e.g. atheroma, atherosclerosis **ALLOW** increase in **bad** cholesterol/LDL **ALLOW** high in LDLs **ALLOW** fat lining arteries **ALLOW** high blood pressure **ALLOW** hypertension **IGNORE** reference to HDLs and cholesterol on its own

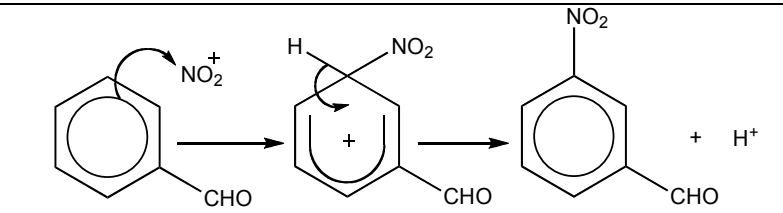
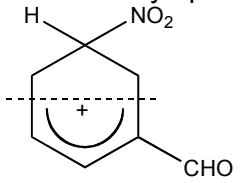
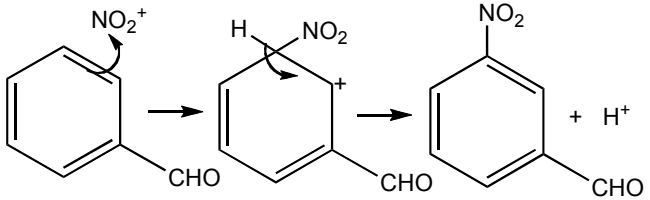
STEMUP.CO.UK

Question			Answer	Marks	Guidance
3	(b)	(i)	27	1	
		(ii)	8	1	
	(c)	(i)	alcohol ✓ ester ✓	2	**IGNORE** OH **OR** hydroxyl **OR** hydroxy **DO NOT ALLOW** phenol **OR** hydroxide **IGNORE** COOR **IF** there is a list with more than two responses, mark wrong responses first, e.g. alcohol, ketone **X**, ether **X** zero marks alcohol ✓, ester, methyl **X** 1 mark ester, hydroxide **X**, ketone **X** zero marks ester ✓, hydroxyl I, ketone **X** 1 mark
		(ii)	ensures correct chirality ✓	1	**ALLOW** enantiomer for optical isomer **ALLOW** produces only one **optical** isomer **ALLOW** stops need/cost/difficulty of separating **optical** isomers **ALLOW** stops formation of the **optical** isomer which may have (harmful) side effects **DO NOT ALLOW** lower doses/dosage needed **DO NOT ALLOW** forms one stereoisomer (could be *E*/*Z*) **DO NOT ALLOW** stereoselectivity

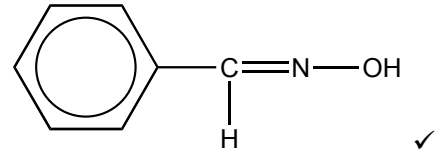
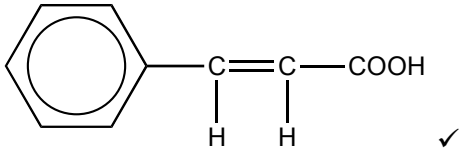
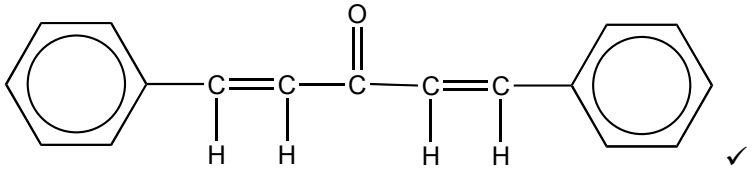
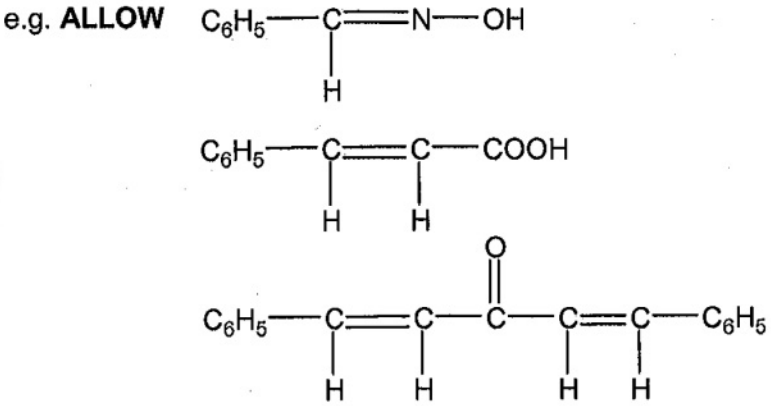
STEMUP.CO.UK

Question			Answer	Marks	Guidance
3		(iii)	***ANNOTATIONS MUST BE USED***		
			1st step		
			reagent: $NaBH_4$ ✓		**ALLOW** H_2/Ni (catalyst) **DO NOT ALLOW** $LiAlH_4$ (*because $LiAlH_4$ reduces COOH*)
			functional groups: **aldehyde** forms an **alcohol** ✓ *names required*		**IGNORE** type of reaction or conditions **IGNORE** CHO **OR** OH **IGNORE** carbonyl **OR** hydroxyl **OR** hydroxy **DO NOT ALLOW** phenol **OR** hydroxide
			2nd step Marks **ONLY** available from correct **hydroxycarboxylic acid** formed in 1st step		
			reagent: Acid **OR** H^+ (catalyst) ✓		**ALLOW** named acid/correct formula **IGNORE** dilute/concentrated
			functional groups: **alcohol** and **carboxylic acid / carboxyl group** form an **ester** ✓ *names required*	4	**IGNORE** OH, COOH, COO, **IGNORE** hydroxyl **OR** hydroxy **DO NOT ALLOW** phenol **OR** hydroxide
			Total	**12**	

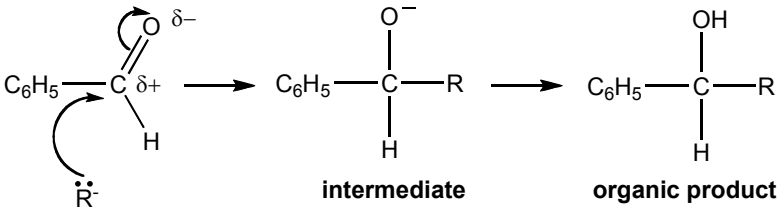
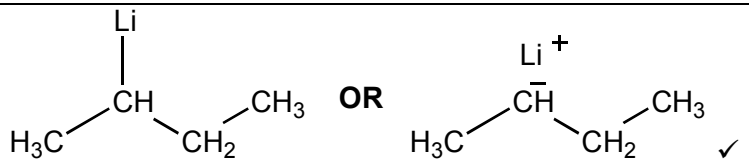
STEMUP.CO.UK

Question			Answer	Marks	Guidance
4	(a)		 curly arrow from ring to NO_2^+ **M1** ✓ correct intermediate curly arrow from C-H bond back to reform ring **M2** ✓ **M3** ✓ correct products **M4** ✓ --- **Note**: **ALLOW M1**, **M2 AND M3** for benzene **OR ANY** substituted benzene compound For **M4**, credit **ONLY** the **correct** products --- $HNO_3 + H_2SO_4 \longrightarrow NO_2^+ + H_2O + HSO_4^-$ ✓ $H^+ + HSO_4^- \longrightarrow H_2SO_4$ ✓ **OR** $HNO_3 + 2H_2SO_4 \longrightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$ ✓ $H^+ + HSO_4^- \longrightarrow H_2SO_4$ ✓ **OR** $HNO_3 + H_2SO_4 \longrightarrow H_2NO_3^+ + HSO_4^-$ **AND** $H_2NO_3^+ \longrightarrow NO_2^+ + H_2O$ ✓ $H^+ + HSO_4^- \longrightarrow H_2SO_4$ ✓	6	***ANNOTATIONS MUST BE USED*** --- **Mark 1 (M1)** **ALLOW** curly arrow from the ring **OR** from within the ring --- **Mark 2 (M2)** – intermediate showing delocalisation over less than 6 carbons with the correct orientation **BUT DO NOT ALLOW** intermediate with π system less than halfway up:  --- **Mark 3 (M3)** curly arrow from C–H bond reforming π-delocalised ring in benzene **ALLOW** Kekulé mechanism:  **ALLOW** double bonds shown in other Kekulé arrangement --- **Mark 4 (M4)** **BOTH** correct products: **3**-nitrobenzaldehyde **AND** H^+

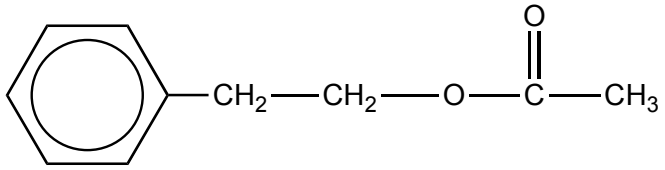
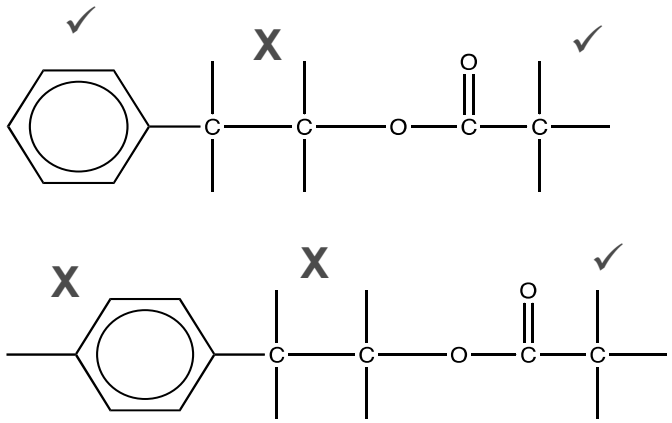
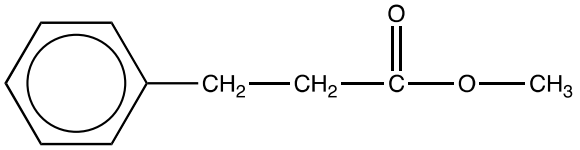
STEMUP.CO.UK

Question			Answer	Marks	Guidance
4	(b)		$2\ C_6H_5CHO + KOH \longrightarrow C_6H_5CH_2OH + C_6H_5COOK$ **OR** $2\ C_6H_5CHO + OH^- \longrightarrow C_6H_5CH_2OH + C_6H_5COO^-$ 1 mark for $C_6H_5CH_2OH$ ✓ 1 mark for C_6H_5COOK **OR** C_6H_5COOH **OR** $C_6H_5COO^-$ ✓ 1 mark for complete fully correct balanced equation (i.e. as above) ✓	3	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous **ALLOW** use of NaOH instead of KOH throughout, i.e. $2\ C_6H_5CHO + NaOH \rightarrow C_6H_5CH_2OH + C_6H_5COONa$ **ALLOW** $C_6H_5COO^-K^+$
	(c)		 ✓  ✓  ✓	3	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous e.g. **ALLOW** 

STEMUP.CO.UK

Question			Answer	Marks	Guidance
4	(d)	(i)	 **intermediate** **organic product** 1 mark for curly arrow from R^- to C of C=O (lone pair not necessary) ✓ 1 mark for correct dipoles on C=O **AND** curly arrow from double bond to $O^{\delta-}$ ✓ 1 mark for correct intermediate with – charge on O ✓ 1 mark for correct product ✓	4	***ANNOTATIONS MUST BE USED*** **IGNORE** connectivity on OH of product Curly arrow **MUST** start from – sign of R^- **OR** from lone pair on R^- lone pair **does not need** to be shown on R^- **IGNORE** any curly arrows shown for **stage 2** i.e. in intermediate
		(ii)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous **IGNORE** C_4H_9Li **OR** $C_4H_9^-Li^-$
			Total	**17**	

STEMUP.CO.UK

Question			Answer	Marks	Guidance
5	(a)	(i)	(number of esters) from number of peaks/retention times **AND** (proportions) from (relative) peak areas ✓	1	**BOTH** points for 1 mark **ALLOW** peak heights **OR** sizes of peaks
		(ii)	(Some esters may have) same retention time ✓	1	**ALLOW** (very) similar retention times **ALLOW** some esters come out at same time
	(b)		**Ester structure 3 marks**  ✓✓✓ **STICKS** IF there are sticks are shown in CH_2CH_2 **OR** in CH_3 **DO NOT AWARD** when first seen **DO NOT ALLOW** sticks on the benzene ring, *Sticks on benzene ring **must** be interpreted as methyl groups* e.g. 	3	***ANNOTATIONS MUST BE USED*** --- **ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous **NO ECF** for structure --- **IF** the structure is **NOT** fully correct, award the following marks: **IF ESTER** shown **AND** contains **ONE** of the following: C_6H_5 **OR** $CH_3C{=}O$ **OR** CH_2CH_2 1 mark ✓ **IF ESTER** shown **AND** contains **TWO** of the following: C_6H_5 **OR** $CH_3C{=}O$ **OR** CH_2CH_2 2 marks ✓✓ **IF ESTER** contains **C_6H_5 AND** CH_2CH_2 **BUT** ester link is reversed 2 marks ✓✓  **DO NOT ALLOW** CH_2CH_2 with H on any adjacent Cs e.g. **DO NOT ALLOW** $CH_2CH_2CH_3$, $CH_2CH_2CH_2$, etc. **IGNORE** any name

STEMUP.CO.UK

Question	Answer	Marks	Guidance
	Mass spectrum 164 linked directly to molecular formula of $C_{10}H_{12}O_2$ **OR** an ester structure with formula $C_{10}H_{12}O_2$ ✓ *This direct link could be seen anywhere in the response* e.g. 164 is $C_{10}H_{12}O_2$ e.g. $C_{10}H_{12}O_2$ = 120 + 12 + 32 = 164 e.g. (164 – 44/COO) = 120; 120 = C_9H_{12} --- **NMR analysis** **QWC** *Triplet must be spelled correctly and used in correct context* Triplet at 2.8 ppm shows an adjacent CH_2 **AND** Triplet at 4.4 ppm shows an adjacent CH_2 ✓ Peak at 2.2 shows C**H_3**–C=O **OR** Peak at 2.2 shows HC–C=O **AND 3** Hs of this type **OR** Peak at 2.2 shows HC–C=O **AND** adjacent to (C with) no Hs✓ Peak at 7.3 shows **5 aromatic Hs OR** shows C_6**H_5** ✓ *5Hs required* Peak at 2.8 shows C_6H_5–C**H OR** C_6H_5–C**H_2** ✓ *Just require C_6H_5–CH as testing environment here* Peak at 4.4 due to **H**C–O **OR** **H_2**C–O ✓ *Just require HC–O as testing environment here*	1 --- 5	***Check back for any responses added to spectrum*** ***Credit responses throughout provided that it is clear which peaks are being referred to*** --- **ALLOW** tolerance on δ values: ± 0.2 ppm Throughout**, ALLOW** for H: proton **OR** H^+ For adjacent CH_2, **ALLOW** (C) adjacent to 2 Hs **ALLOW** There are 2 triplets **AND** triplet shows an adjacent CH_2 For peak at (δ =) 2.2 **ALLOW** singlet **OR** peak labelled 3 For peak at (δ =) 7.3 **ALLOW** peak labelled 5 **OR** multiplet **OR** quintet **OR** hextet **OR** heptet For peak at (δ =) 2.8 **ALLOW** triplet at 2.8 For peak at (δ =) 4.4 **ALLOW** triplet at 4.4
	Total	**11**	

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2012

STEMUP.CO.UK

OCR
RECOGNISING ACHIEVEMENT

Thursday 26 January 2012 – Afternoon

A2 GCE CHEMISTRY A

F324 Rings, Polymers and Analysis

Candidates answer on the Question Paper.

OCR supplied materials:
- *Data Sheet for Chemistry A* (inserted)

Other materials required:
- Scientific calculator

Duration: 1 hour 15 minutes

F3244601121

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.

  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an Insert with this Question Paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **16** pages. Any blank pages are indicated.

© OCR 2012 [M/500/7836]
OCR is an exempt Charity

STEMUP.CO.UK

Answer **all** the questions.

1 This question looks at the properties and chemistry of some α-amino acids. The general formula of an α-amino acid is $RCH(NH_2)COOH$.

(a) In the α-amino acid alanine, $CH_3CH(NH_2)COOH$, R is CH_3.
The isoelectric point of alanine is at pH 6.0.

(i) What is meant by the term *isoelectric point?*

.....

.....

..... **[1]**

(ii) Draw the structures of the ions formed by alanine at pH 6.0 and at pH 1.5.

ion formed at pH 6.0	**ion formed at pH 1.5**

[2]

(iii) Different R groups in α-amino acids result in different isoelectric points.

Suggest the functional group, in the R group, that results in the isoelectric point being lower than pH 3 and higher than pH 10.

functional group resulting in isoelectric point lower than pH 3: .....

functional group resulting in isoelectric point higher than pH 10: ..... **[2]**

(b) The α-amino acid serine, where R is CH_2OH, readily forms a condensation polymer containing peptide links.

Draw a section of poly(serine), showing **two** repeat units.

Display the peptide linkage.

[2]

© OCR 2012

STEMUP.CO.UK

(c) Apart from glycine, where R is H, all α-amino acids show optical isomerism.

(i) Why does glycine **not** show optical isomerism?

.....

.....

..... **[1]**

(ii) Draw 3-D diagrams for the two optical isomers of the α-amino acid cysteine, where R is CH_2SH.

[2]

(iii) α-Amino acids are being used in the development of peptide-based pharmaceuticals. Optical isomerism has been found to be significant in the action of some pharmaceuticals.

- State **two** possible disadvantages of synthesising a peptide-based pharmaceutical that contains a mixture of optical isomers.
- State **two** methods that are used by manufacturers to synthesise pharmaceuticals containing just the required optical isomer.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

.....

.....

.....

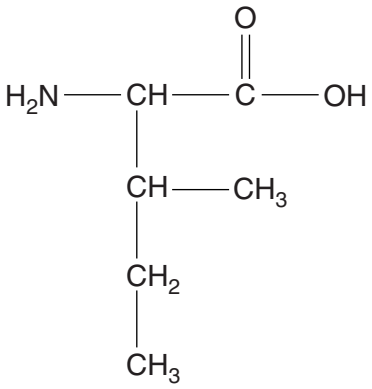
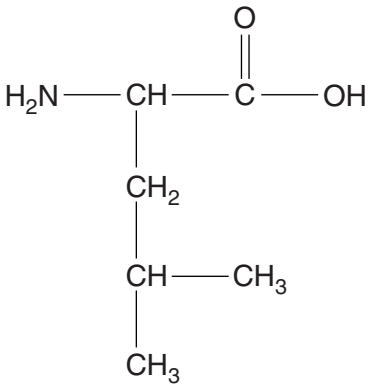
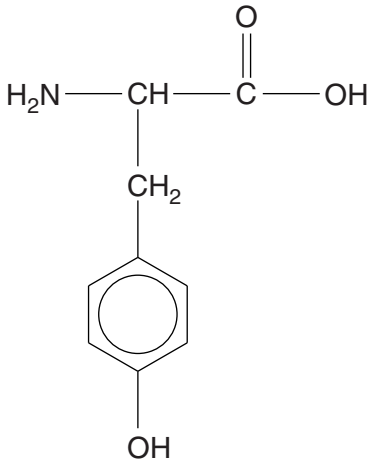
.....

..... **[4]**

© OCR 2012

STEMUP.CO.UK

(d) The structures of the α-amino acids isoleucine, leucine and tyrosine are shown below.

		
isoleucine	**leucine**	**tyrosine**

Predict the number of peaks in the carbon-13 spectrum of each of these α-amino acids.

α-amino acid	**isoleucine**	**leucine**	**tyrosine**
number of peaks			

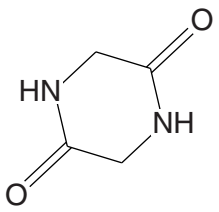
[3]

© OCR 2012

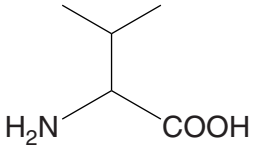
STEMUP.CO.UK

(e) When strongly heated, an α-amino acid can form a cyclic 'dimer' in a condensation reaction.

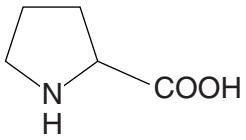
For example, glycine, where R is H, forms the cyclic dimer shown below.



Draw the structures of the cyclic dimers that could be formed from the α-amino acids valine and proline, shown below.



valine



proline

cyclic dimer formed from valine	**cyclic dimer formed from proline**

[2]

[Total: 19]

© OCR 2012

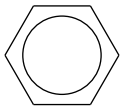
STEMUP.CO.UK

2 Benzene is an important starting material in the production of dyes, detergents and medicines.

(a) Aromatic amines, such as 4-chlorophenylamine, are intermediates in the manufacture of azo dyes.

(i) Benzene can be converted into 4-chlorophenylamine in the three stages shown below.

In the boxes
- show the structures of the organic products
- state the chemicals used.



stage 1 ↓

chemicals: .....

.....

organic product

stage 2 ↓

chemicals: .....

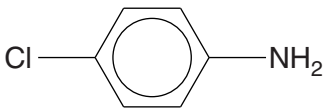
.....

organic product

stage 3 ↓

chemicals: .....

.....



4-chlorophenylamine

[5]

© OCR 2012

(ii) 4-Chlorophenylamine can be converted into a diazonium ion.
The diazonium ion can then be reacted with phenol in aqueous alkali to form an azo dye.

Draw the structures of the diazonium ion and the azo dye.

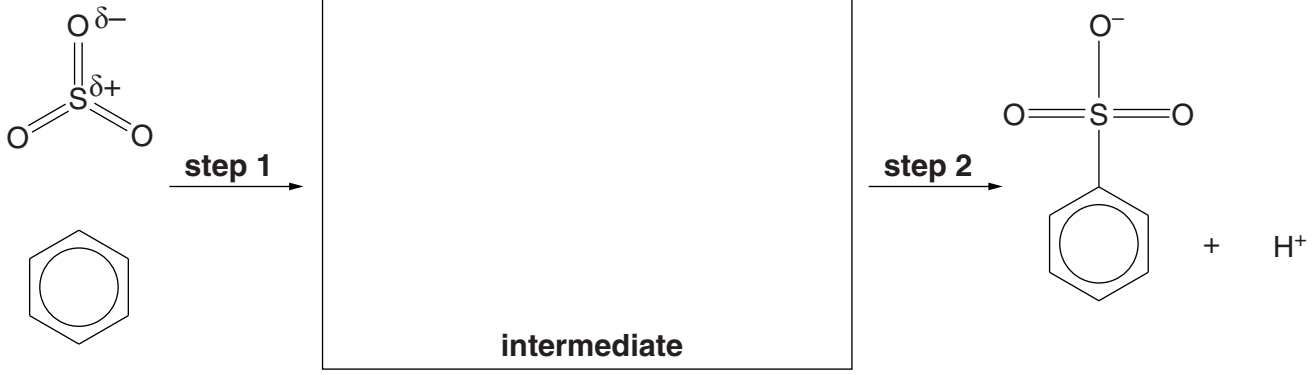
diazonium ion	**azo dye**

[2]

(b) Benzene can be converted into benzenesulfonic acid, $C_6H_5SO_3H$, which is used in the manufacture of many detergents.

The reaction between benzene and sulfuric acid is an electrophilic substitution reaction.
Sulfur trioxide, SO_3, is the electrophile.

Part of the mechanism for this reaction is shown below.



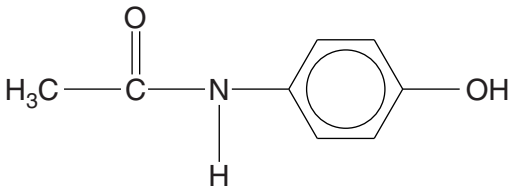
Complete the mechanism by drawing the intermediate and by adding curly arrows to show the movement of electron pairs in **steps 1** and **2**.

[4]

© OCR 2012

STEMUP.CO.UK

(c) The painkiller paracetamol has the structure shown below.



(i) Separate samples of paracetamol are reacted with bromine, Br_2, and with sodium, Na.

Draw the structures of possible organic products formed in each reaction.

reaction with Br_2	**reaction with Na**

[2]

(ii) Another sample of paracetamol is hydrolysed by heating under reflux with hot aqueous sodium hydroxide, NaOH(aq).

Draw the structures of the two organic products formed in this hydrolysis.

[2]

[Total: 15]

© OCR 2012

STEMUP.CO.UK

3 This question is about different organic compounds containing C, H and O.

(a) A technician found an unlabelled bottle in a chemical store cupboard. The technician thinks that the bottle contains pentan-2-one, pentan-3-one or pentanal.

(i) Describe a series of chemical tests that the technician could use to confirm that the compound in the bottle is a ketone. Include appropriate reagents and any relevant observations.

.....

.....

.....

.....

.....

..... **[2]**

(ii) Describe how the technician could use the product of one of the tests in **(i)** to show whether the bottle contains pentan-2-one or pentan-3-one.

The method used should **not** involve spectroscopy.

.....

.....

.....

.....

.....

..... **[2]**

© OCR 2012

STEMUP.CO.UK

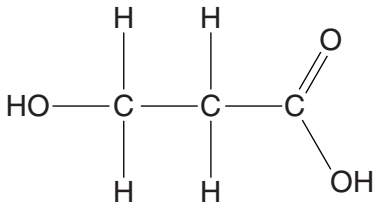
(b) 3-Hydroxypropanoic acid, $HOCH_2CH_2COOH$, can be produced microbiologically from sugars in corn. $HOCH_2CH_2COOH$ can be used as a 'green' starting material for the synthesis of many organic compounds including some important polymers.

Three synthetic routes are shown below for converting $HOCH_2CH_2COOH$, **A**, into different polymers.

The names of the processes for each synthetic step are given.

(i) In the boxes below, give the structures of the organic compounds formed.

Synthesis 1

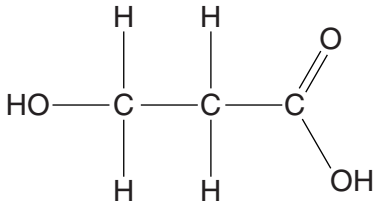


A

polymerisation →

one repeat unit

Synthesis 2

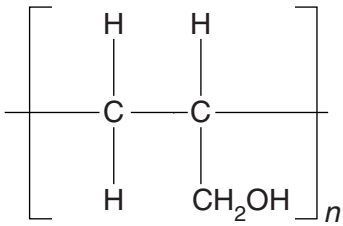


A

elimination of H_2O →

reduction ↓

← **polymerisation**

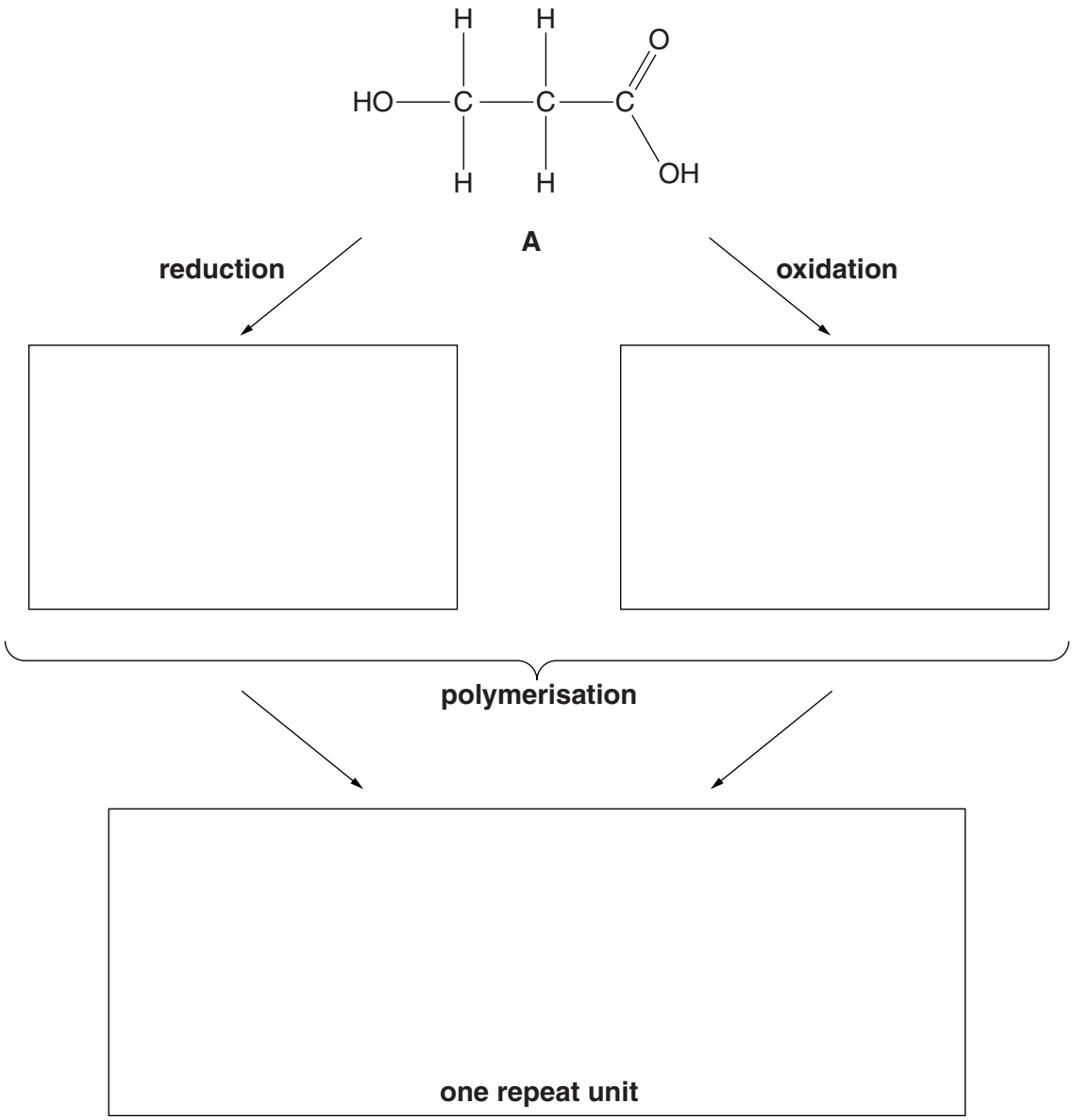


PVA, used in adhesives

© OCR 2012

STEMUP.CO.UK

Synthesis 3



[6]

(ii) State the type of polymerisation taking place in each synthetic route.

Synthesis 1: .....

Synthesis 2: .....

Synthesis 3: .....

[1]

[Total: 11]

© OCR 2012

STEMUP.CO.UK

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© OCR 2012

4 A chemist prepares and analyses some esters.

(a) The chemist prepares an ester of propan-2-ol, $CH_3CH(OH)CH_3$, by reacting $CH_3CH(OH)CH_3$ with ethanoic anhydride, $(CH_3CO)_2O$.

Using structural formulae, write an equation for the reaction of propan-2-ol and ethanoic anhydride.

[2]

(b) A sample contains a mixture of two esters contaminated with an alkane and an alcohol.

The chemist attempts to separate the four organic compounds in the mixture using gas chromatography, GC.

The column in the gas chromatograph contains a liquid alkane which acts as the stationary phase.

(i) How does a liquid stationary phase separate the organic compounds in a mixture?

.....

..... **[1]**

(ii) Suggest how well these four compounds would be separated using the alkane stationary phase. In your answer, include some indication of the length of the retention times.

Explain your answer.

.....

.....

.....

.....

..... **[2]**

© OCR 2012

STEMUP.CO.UK

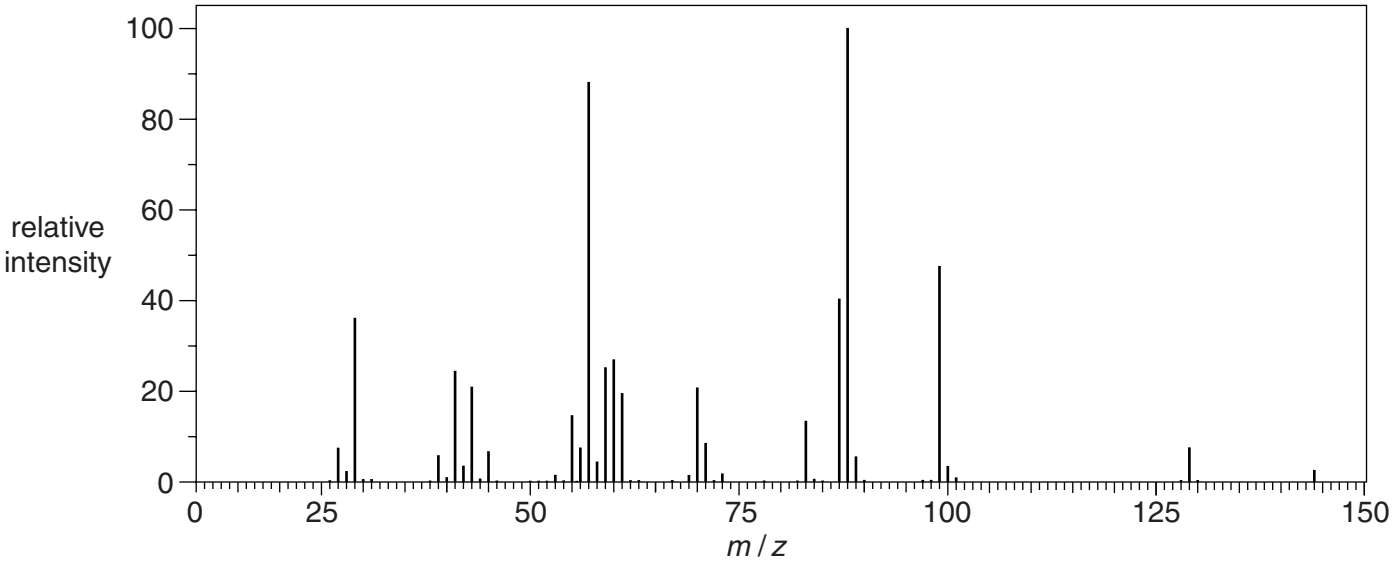
(c) GC is often used together with other techniques, such as mass spectrometry, MS, and NMR spectroscopy, to provide a far more powerful analytical tool than GC alone.

One of the esters in a perfume is separated by GC and then analysed.

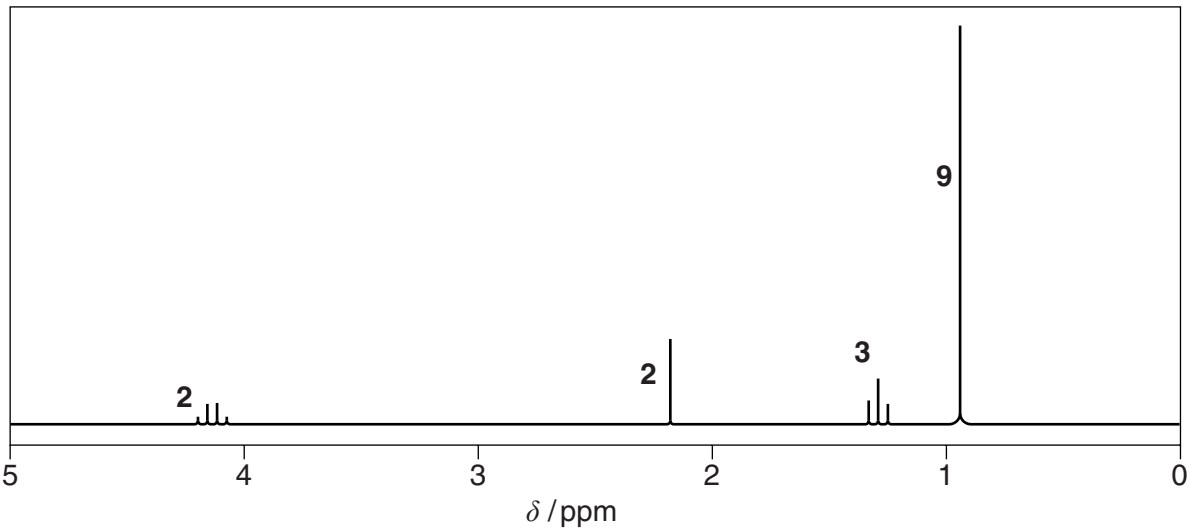
The results are shown below.

Elemental analysis by mass
C, 66.63%; H, 11.18%; O, 22.19%

Mass spectrum



Proton NMR spectrum
The numbers by each peak are the relative peak areas.



© OCR 2012

STEMUP.CO.UK

Use the results to identify the ester. Show **all** your reasoning.

In your answer, you should use appropriate technical terms, spelled correctly.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

.... **[10]**

[Total: 15]

END OF QUESTION PAPER

© OCR 2012

STEMUP.CO.UK

ADDITIONAL PAGE

If additional space is required, you should use the lined page below. The question number(s) must be clearly shown.

RECOGNISING ACHIEVEMENT

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2012

OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Advanced GCE

Unit **F324:** Rings, Polymers and Analysis

Mark Scheme for January 2012

Oxford Cambridge and RSA Examinations

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

© OCR 2012

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

Annotations available in Scoris.

Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Ignore
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures
	Correct response

STEMUP.CO.UK

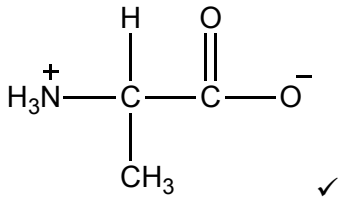
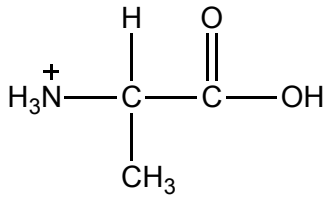
Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

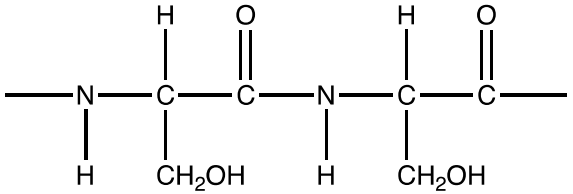
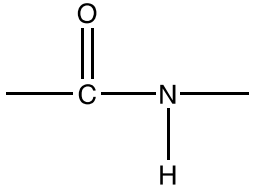
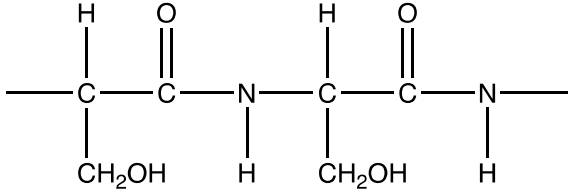
Annotations should be placed to clearly show where they apply within the body of the text (i.e. not in margins) for:

Question 1 c(iii)
Question 2 a(i), (b)
Question 3 a(i), a(ii), b(i)
Question 4 b(ii), (c)

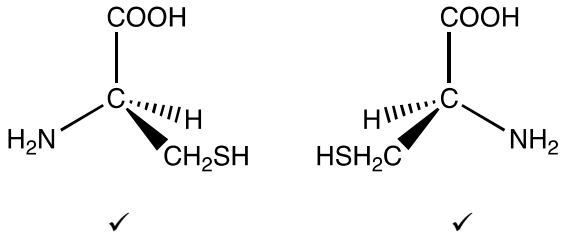
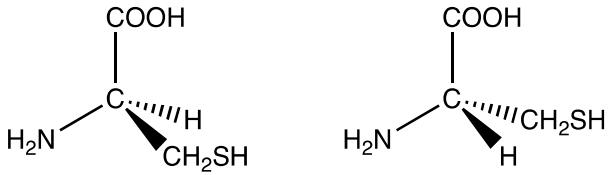
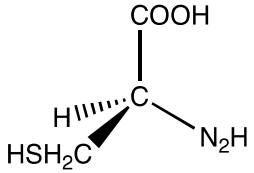
STEMUP.CO.UK

Question			Answer	Mark	Guidance
1	(a)	(i)	The pH **OR** point at which the zwitterion exists ✓	1	**ALLOW** pH/point at which there is no **overall**/**net** charge **IGNORE** pH/point at which there is no charge/ neutral charge *ie overall/net is required* **ALLOW** pH/point at which contains COO^- **AND** NH_3^+
		(ii)	 ✓  ✓	2	**ALLOW** $CH_3CH(NH_3)^+COO^-$ **ALLOW** $CH_3CH(NH_3)^+COOH$ **ALLOW** CO_2^- and CO_2H **ALLOW** + charge on N or H: ie $^+NH_3$ or NH_3^+ **DO NOT ALLOW** '–' charge on C: ie ^-COO **DO NOT ALLOW** H or CH_3 missing **ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous

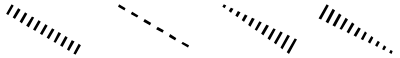
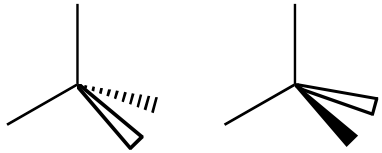
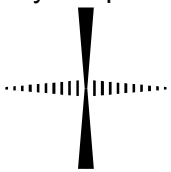
STEMUP.CO.UK

Question			Answer	Mark	Guidance
1	(a)	(iii)	pH < 3: COOH ✓ pH > 10: NH_2 ✓	2	**ALLOW** carboxyl group **OR** carboxylic acid **DO NOT ALLOW** 'acid' **OR** just 'carboxylic' (without 'acid') **ALLOW** amino group **OR** amine **DO NOT ALLOW** if give correct formula but wrong name or correct name and wrong formula eg NH_2 and amide **IF** any carbon chain is shown attached to **BOTH** functional groups **ALLOW** 1 mark eg CH_2COOH **AND** CH_2NH_2 for 1 mark CH_3COOH **AND** CH_3NH_2 for 1 mark RCOOH **AND** RNH_2 for 1 mark **IF** functional groups are shown the wrong way round, **ALLOW** 1 mark i.e. NH_2 COOH
	(b)		 peptide link **must** be fully displayed, i.e.  **TWO** repeat units shown correctly ✓	2	**DO NOT ALLOW** more repeat units **IGNORE** brackets and '*n*' **ALLOW** end bonds shown as ----- **DO NOT ALLOW** if end bonds are missing **ALLOW** terminal N–H on right (OR C=O on left), *ie*  **IF** peptide bond is shown not displayed, i.e. CONH, **2nd mark** can still be awarded

STEMUP.CO.UK

Question			Answer	Mark	Guidance
1	(c)	(i)	There is **no** chiral carbon **OR** there is no asymmetry in the molecule ✓	1	**ALLOW** there is **no** asymmetric carbon **OR** it has **no** non-superimposable mirror image **OR** there are **not** four different atoms/groups of atoms (attached to carbon) **OR** there are only three different atoms/groups of atoms (attached to carbon) **OR** because there are two hydrogen atoms on the carbon
		(ii)	 ✓ ✓	2	**ALLOW** Add the same 3-D structure repeated but with 2 groups 'swapped' as after rotation the 2nd isomer is a mirror image of the first, i.e.  **Connectivity:** Chiral C must be linked to the C of the COOH, the C of the CH_2SH and the N of the NH_2 (ie **connectivity is being tested**) ie, **ALLOW** as in the example but **DO NOT ALLOW** an attempted NH_2 shown as below:  The 2nd mark is for the mirror image of **CORRECT** optical isomer only **CARE**: may be orientated differently **DO NOT** penalise connectivity more than once **Each structure must have four central bonds, with at least one wedge in AND one wedge out**

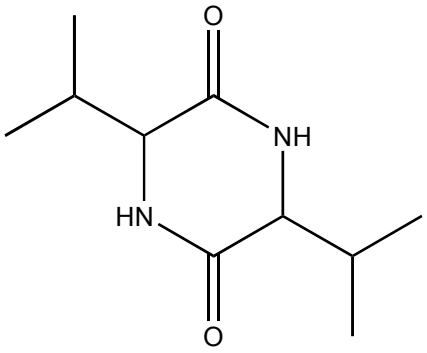
STEMUP.CO.UK

Question	Answer	Mark	Guidance
			--- For bond into plane of paper, **ALLOW**:  For bond out of plane of paper, a solid wedge is expected, either way around:  **ALLOW** a hollow wedge for 'in bond' **OR** an 'out bond', provided it is different from the other in or out wedge eg:  **ALLOW** examples of other 3-D representations provided they are possible: i.e.  **CARE**: This is a 3-D representation so this is possible and the bonds are clearly not 90º to one another

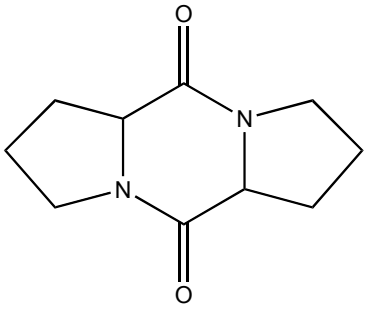
STEMUP.CO.UK

Question			Answer	Mark	Guidance
1	(c)	(iii)	***Disadvantages***: *any **two** from:* • (one stereoisomer might have harmful/adverse) side effects✓ • reduces the (pharmacological) activity/effectiveness ✓ • **cost** of separating stereoisomers **OR** difficulty in separating stereoisomers ✓ ***Synthesis of a single optical isomer*** *any **two** from:* • using enzymes or bacteria ✓ • using (chemical) **chiral** synthesis **OR** using **chiral** catalysts ✓ • using (natural) **chiral** molecules/compounds ✓ ***Quality of Written Communication*** For full marks to be awarded for this question chiral **OR** enzyme **OR** bacteria **OR** catalyst must be spelled correctly at least once in the correct context	2 2	***ANNOTATIONS MUST BE USED*** **IGNORE** harmful/adverse effects only **ALLOW** a response that implies an increased dose **IGNORE** it takes time to separate **ALLOW** biological catalysts **ALLOW chiral** transition metal complex/catalyst **OR stereoselective** transition metal complex/catalyst **ALLOW 'chiral** pool' **OR** L-amino acids / D-sugars

STEMUP.CO.UK

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>1</td><td>(d)</td><td></td><td>
<table>
<tr><td>amino acid</td><td>isoleucine</td><td>leucine</td><td>tyrosine</td></tr>
<tr><td>number of peaks</td><td>6 ✓</td><td>5 ✓</td><td>7 ✓</td></tr>
</table>
</td><td>3</td><td>1 mark for each number</td></tr>
<tr><td></td><td>(e)</td><td></td><td>


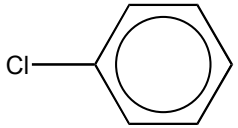
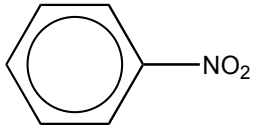
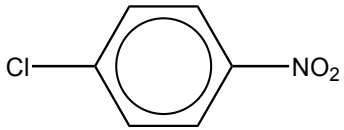
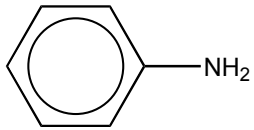
✓
valine anhydride



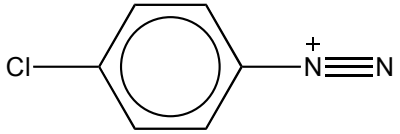
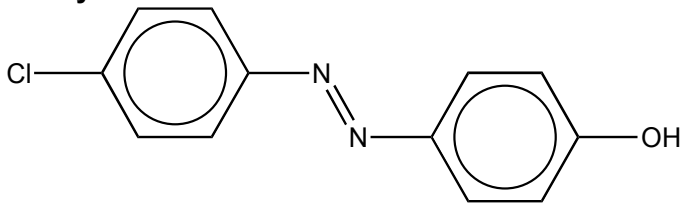
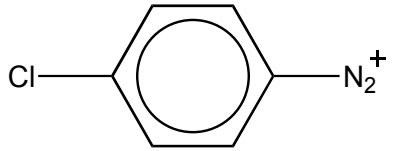
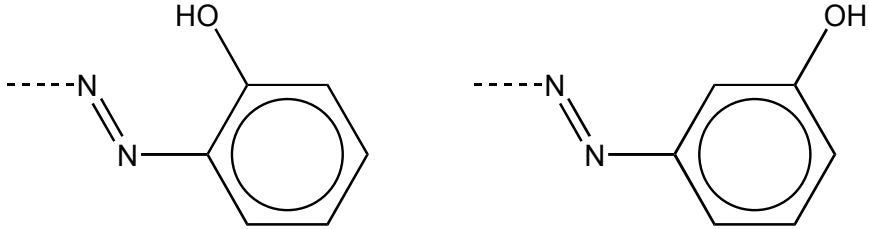
✓
proline anhydride
</td><td>2</td><td>ALLOW correct structural OR displayed OR skeletal formula
ALLOW combination of formulae as long as unambiguous

Common errors:
Look for NH_2 on first structure and NH on second structure</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>19</td><td></td></tr>
</table>

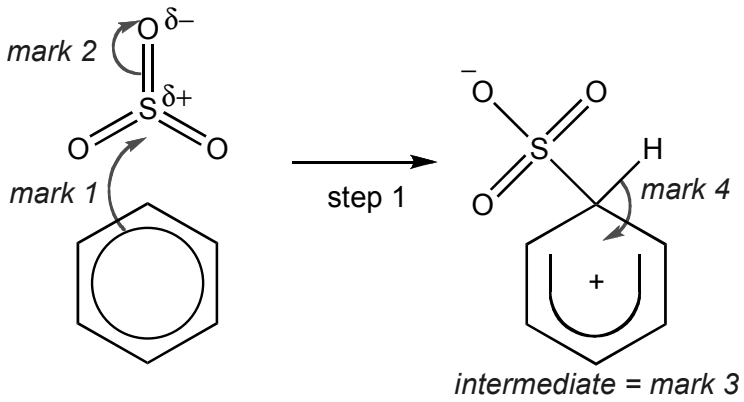
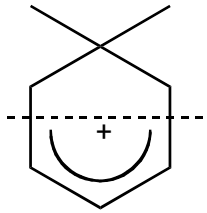
STEMUP.CO.UK

Question			Answer	Mark	Guidance
2	(a)	(i)	Response requires three stages • chlorination • nitration • reduction Reduction must be **a later stage** than nitration **Mark according to which sequence chosen.** **Stage 1** **organic product:**  **OR**  ✓ **chemicals:** Cl_2 **AND** $AlCl_3$ **OR** HNO_3 **AND** H_2SO_4 ✓ **Stage 2** **organic product:**  **OR**  ✓ **chemicals:** HNO_3 **AND** H_2SO_4 **OR** Sn **AND** HCl ✓ **Stage 3** **chemicals:** Cl_2 **AND** $AlCl_3$ **OR** Sn **AND** HCl ✓	5	Acceptable sequence of stages are: • nitration, reduction, chlorination • nitration, chlorination, reduction, • chlorination, nitration, reduction For organic products, **ALLOW** $C_6H_5NO_2$ **OR** C_6H_5Cl **OR** $C_6H_5NH_2$ **ALLOW** NO_2– **AND** NH_2– **DO NOT ALLOW** $ClC_6H_4NO_2$ (formula ambiguous) **DO NOT ALLOW** molecular formulae **IGNORE** any **additional** structures shown eg 2- (*ortho*) and 3- (*meta*) substituted isomers In chemicals boxes, **IGNORE** temperatures **IGNORE** 'catalyst' For **chlorination** chemicals, **ALLOW** Cl_2 **AND** $FeCl_3$ **OR** Cl_2 **AND** Fe **OR** Cl_2 **AND** halogen carrier For **nitration** chemicals, 'concentrated' **not** required for HNO_3 OR H_2SO_4 **BUT** ... **DO NOT ALLOW** 'dilute' For **reduction** chemicals, 'concentrated' HCl **not** required but **DO NOT ALLOW** 'dilute' For Sn/HCl **ALLOW** addition of NaOH also **IF** it is clear that it is a second step **BUT** ……. **DO NOT ALLOW** Sn **AND** HCl **AND** NaOH **IGNORE** catalyst

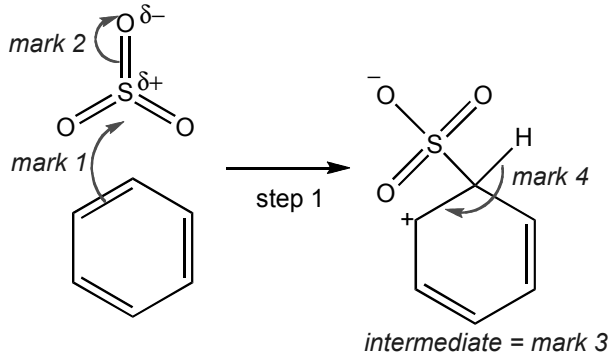
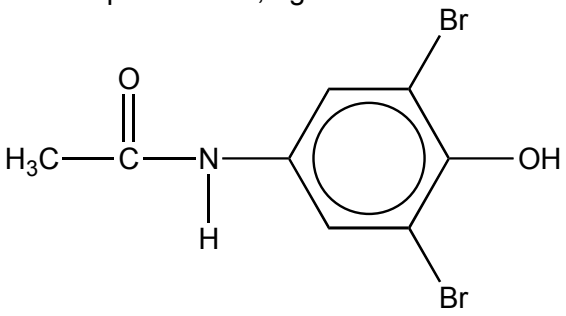
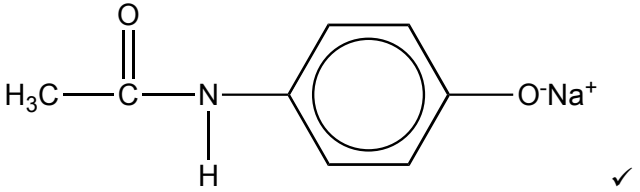
STEMUP.CO.UK

Question			Answer	Mark	Guidance
2	(a)	(ii)	**diazonium ion**  ✓ –N≡N group **MUST** be displayed **azo dye**  ✓ –N=N– group **MUST** be displayed	2	**ALLOW** '+' sign up to halfway along triple bond from left-hand N **IGNORE** presence of Cl^- **DO NOT ALLOW** Cl^- – substituent on benzene ring **DO NOT ALLOW:**  **In azo dye,** **ALLOW** as alternative to phenol OH group: O^- **OR** O^-Na^+ **OR** ONa **ALLOW** phenol part substituted at any carbon (ie 2,3 or 4 position for –OH) i.e.  **IGNORE** geometry/shape, i.e. **ALLOW** —N=N— **Mark independently** **DO NOT ALLOW** if Cl– is missing from benzene ring in **EITHER** structure

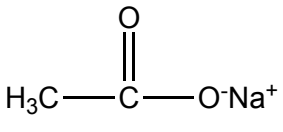
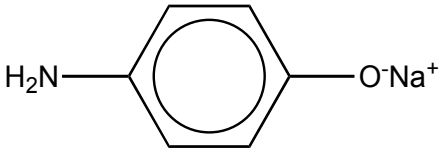
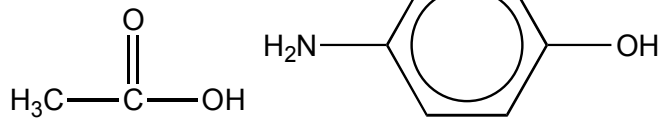
STEMUP.CO.UK

Question	Answer	Mark	Guidance
2 (b)		4	***ANNOTATIONS MUST BE USED*** **mark 1** – curly arrow from π-delocalised ring in benzene to $S^{\delta+}$ in SO_3 ✓ **ALLOW** curly arrow from the ring **OR** from within the ring **mark 2** – curly arrow from **one** S=O double bond to the O (to produce a $S–O^-$) ✓ **ALLOW** curly arrow to any O in SO_3 **mark 3** – intermediate showing delocalisation over 5 carbons ✓ Intermediate must have correct SO_3^- structure **FULLY** displayed **DO NOT ALLOW** intermediate with broken ring less than halfway up in correct orientation:  **mark 4** – curly arrow from C–H bond reforming π- delocalised ring in benzene ✓ **Stand alone mark** **IGNORE** responses after **STEP 2**

STEMUP.CO.UK

Question			Answer	Mark	Guidance
					ALLOW Kekulé mechanism  **ALLOW** double bonds shown in other Kekulé arrangement
2	(c)	(i)	Various possibilities, eg:  ✓		**ALLOW** 1, 2, 3 or 4 Br atoms substituted on phenol ring at carbon atoms 2, 3, 5 or 6 **BUT** –OH must be in correct position shown **DO NOT ALLOW** O^- or ONa **ALLOW** for side chain: CH_3CONH but aromatic part of structure must be shown **IGNORE** any additional inorganic products in boxes (even if incorrect
			Reaction with Na  ✓	2	**ALLOW** ONa **OR** O^- as alternative to O^-Na^+ **DO NOT ALLOW** O–Na **OR** O^-Na (i.e. Na without charge) –ONa must be in correct position shown **ALLOW** for side chain: CH_3CONH but aromatic part of structure must be shown **IGNORE** any additional inorganic products in boxes (even if incorrect)

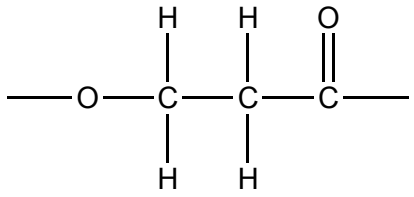
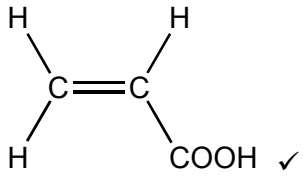
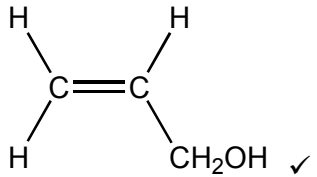
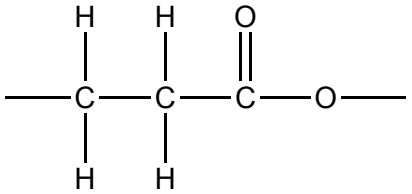
STEMUP.CO.UK

Question			Answer	Mark	Guidance
2	(c)	(ii)	**Hydrolysis with NaOH(aq)**  ✓  ✓ **Mark independently**	2	On **BOTH** structures, **ALLOW** ONa **OR** O^- as alternative to O^-Na^+ **DO NOT ALLOW** O–Na **OR** O^-Na (i.e. Na without charge) –ONa must be in correct position shown on 2nd structure **ALLOW** CH_3COONa/ CH_3CO_2Na **OR** CH_3COO^-/ $CH_3CO_2^-$ **ALLOW** one mark for carboxylic acid **AND** phenol, rather than sodium salts:  **ALLOW** NH_2–, CH_3– **IGNORE** any additional inorganic products in boxes (even if incorrect)
			Total	**15**	

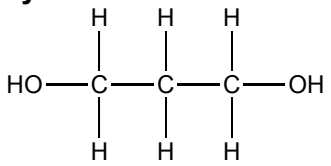
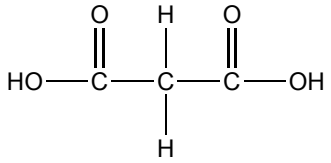
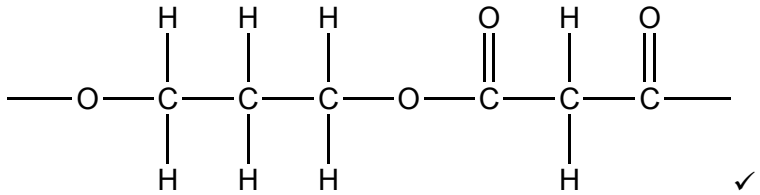
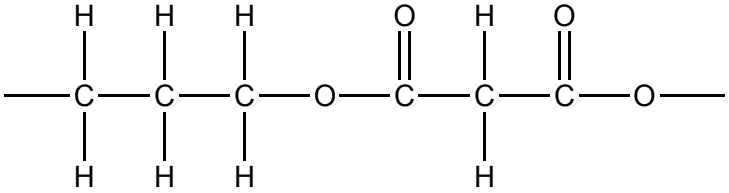
STEMUP.CO.UK

Question			Answer	Mark	Guidance
3	(a)	(i)	One mark is for positive carbonyl test (Add) 2,4-dinitrophenylhydrazine **AND** orange/yellow/red precipitate ✓		**ALLOW** errors in spelling **ALLOW** 2,4(-)DNP **OR** 2,4(-)DNPH **ALLOW** Brady's reagent or Brady's Test **ALLOW** solid **OR** crystals **OR** ppt as alternatives for precipitate
			One mark is for negative aldehyde test **EITHER** (Add) Tollens' reagent/Tollens' test **AND** **no** change **OR no** reaction **OR no** silver (mirror)		**ALLOW** $AgNO_3/NH_3$ (Formulae must be correct) **OR** ammoniacal silver nitrate **ALLOW** Fehling's solution **OR** Benedict's solution **AND no** (brick-red) precipitate **ALLOW** any response that implies that nothing happens **ie no** change **OR no** reaction **OR no** silver (mirror) **ALLOW** 'the aldehyde/pentanal gives a silver mirror'
			OR (Add) H_2SO_4 **AND** $K_2Cr_2O_7$ **AND** **no** change **OR no** reaction **OR no** green colour ✓	2	**ALLOW** H^+ **AND** $Cr_2O_7^{2-}$ (Formulae must be correct) **ALLOW** any response that implies that nothing happens **IGNORE** responses using $NaBH_4$ (as no observations)
		(ii)	**1st mark** Take melting point of orange crystals/derivative/product from 2,4-DNP ✓ **2nd mark** Compare melting point with known values **OR** compare melting point with value in database/reference book ✓	2	**NOTE**: **a(ii)** is marked completely independently of **a(i)** **Mark independently of response for 1st mark** **DO NOT ALLOW** 1st or 2nd marks for taking and comparing boiling points **OR** chromatograms

STEMUP.CO.UK

Question			Answer	Mark	Guidance
3	(b)	(i)	**Synthesis 1**  ✓ Ester linkage **must** be fully displayed **Synthesis 2**  ✓  ✓	6	**NOTE: ALL** Structures **MUST** have Hs shown **IGNORE** bond angles **DO NOT ALLOW** more than one repeat unit **IGNORE** brackets and '*n*' **ALLOW** terminal O— on right (**OR** C=O on left), i.e.  **ALLOW** end bonds shown as ----- **DO NOT ALLOW** if structure has **no** end bonds

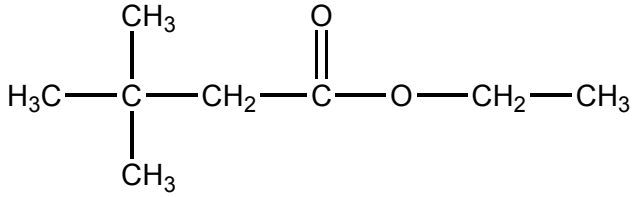
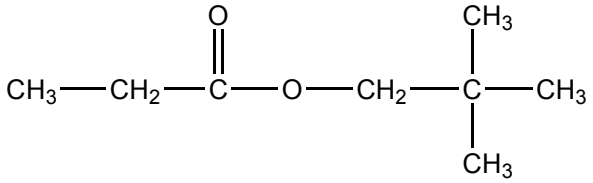
STEMUP.CO.UK

Question			Answer	Mark	Guidance
			Synthesis 3  ✓  ✓  ✓		**Mark each structure independently** HO– **must** be connected correctly on **BOTH** structures **DO NOT ALLOW** more repeat units **IGNORE** brackets and '*n*' **ALLOW** terminal O— on right (**OR** C=O on left), i.e.  **ALLOW** end bonds shown as ----- **DO NOT ALLOW** if structure has **no** end bonds **DO NOT ALLOW ECF** from wrong structure in previous boxes
3	(b)	(ii)	**Synthesis 1**: condensation **AND** **Synthesis 2**: addition **AND** **Synthesis 3**: condensation ✓	1	**All** three correct responses required for the mark
			Total	**11**	

STEMUP.CO.UK

Question			Answer	Mark	Guidance
4	(a)		$(CH_3CO)_2O + CH_3CH(OH)CH_3 \rightarrow CH_3COOCH(CH_3)_2 + CH_3COOH$ **1st mark** Correct structure of ester: $CH_3COOCH(CH_3)_2$✓ **2nd mark** Equation contains correct formulae for $(CH_3CO)_2O$, $CH_3CH(OH)CH_3$ **AND** CH_3COOH ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous **DO NOT ALLOW** molecular formulae **ALLOW** $(CH_3)_2CHOOCCH_3$ **OR** $(CH_3)_2CHOCOCH_3$
	(b)	(i)	(relative) solubility ✓	1	**IGNORE** partition **DO NOT ALLOW** adsorption **OR** absorption
		(ii)	The esters would have similar retention times **AND** similar structures/molecules **OR** same functional groups **OR** similar polarities **OR** similar solubilities ✓ Alcohol would have short retention time **AND** alkane would have long retention time ✓	2	**IGNORE** similar properties

STEMUP.CO.UK

Question			Answer	Mark	Guidance
4	(c)		**Elemental analysis and molecular formula – 2 marks** Use of percentages (to find EF) **AND** 144 ✓ Molecular formula = $C_8H_{16}O_2$ ✓	2 marks	***ANNOTATIONS MUST BE USED*** *Working* C : H : O = 66.63/12 : 11.18/1 : 22.19/16 5.5525 : 11.18 : 1.386875 4 : 8 : 1 Alternative method: carbon: (144 x 66.63/100)/12 = 8 hydrogen: (144 x 11.18/100)/1 = 16 oxygen: (144 x 22.19/100)/16 = 2
			ester structure – 4 marks  ✓✓✓✓	4 marks	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous **NO ECF** from earlier structures If not fully correct award following marks: If structure an ester of formula $C_8H_{16}O_2$ **OR** the organic structure contains $C(CH_3)_3$ ✓ If structure is an ester of formula $C_8H_{16}O_2$ **AND** ester contains $C(CH_3)_3$ ✓✓ If structure is an ester of formula $C_8H_{16}O_2$ **AND** ester contains $O–CH_2C(CH_3)_3$ **AND** ester contains CH_3CH_2COO ✓✓✓ *i.e. If the ester link is reversed*  **IGNORE** any name

STEMUP.CO.UK

Question			Answer	Mark	Guidance
			NMR analysis – 4 marks Triplet (at δ 1.3) shows an adjacent CH_2 **OR** triplet (at δ 1.3) shows (C with) 2 adjacent Hs/protons ✓ *(because of splitting: so triplet)* Peak at (δ) 2.2 shows H adjacent to C=O **AND** adjacent to (C with) no hydrogens ✓ *(because of no splitting: so singlet)* Peak at (δ) 4.2 shows H–C–O **AND** adjacent CH_3 OR 3 adjacent Hs/protons ✓ *(because of splitting: so quartet)* Peak at (δ) 0.9 show 3 x CH_3 ✓ *(because of singlet and area 9)*	4 marks	**NOTE: Each peak can be identified from:** • its δ value: ± 0.2 ppm • a range, eg 'the peak between 2 and 3' • its relative peak area (CARE two peaks have an area of 2) • its splitting (CARE: two peaks are singlets) • labelling on the spectrum --- **QWC: triplet** must be spelled correctly **ALLOW** neighbouring Hs for adjacent to Hs For peak at (δ) 2.2 **ALLOW** singlet at (δ) 2.2 **ALLOW** singlet labelled 2 For peak at (δ) 4.2 **ALLOW** quartet (labelled 2) --- ***Check back for any responses added to spectra*** ***ADD ^ MARK TO THE SPECTRUM PAGE TO SHOW THAT IT HAS BEEN LOOKED AT***
			Total for 4(c)	10	
			Total	**15**	

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2012

STEMUP.CO.UK

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

CHEMISTRY A

Rings, Polymers and Analysis

F324

Candidates answer on the question paper.

OCR supplied materials:
- *Data Sheet for Chemistry A* (inserted)

Other materials required:
- Scientific calculator

Friday 24 June 2011
Morning

Duration: 1 hour

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The insert will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Answer **all** the questions.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **20** pages. Any blank pages are indicated.

© OCR 2011 [M/500/7836]
OCR is an exempt Charity

STEMUP.CO.UK

Answer **all** the questions.

1 Benzene and other arenes can be chlorinated to produce chloroarenes which are used in the manufacture of pesticides, drugs and dyes.

(a) Chlorobenzene, C_6H_5Cl, is formed by the reaction of benzene and chlorine in the presence of a suitable catalyst, such as $AlCl_3$.

$$C_6H_6 + Cl_2 \rightarrow C_6H_5Cl + HCl$$

Outline the mechanism for the formation of chlorobenzene from benzene.

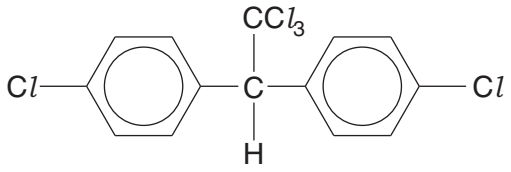
Show how $AlCl_3$ behaves as a catalyst.

[6]

© OCR 2011

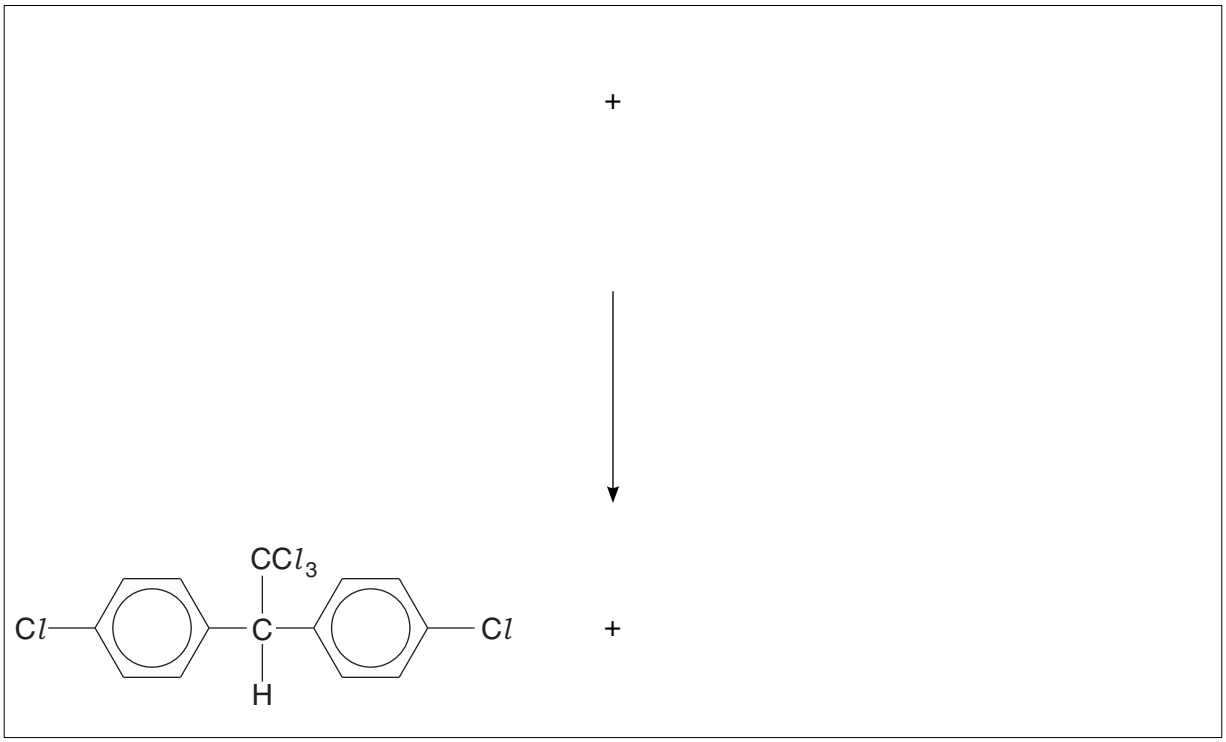
STEMUP.CO.UK

(b) Chlorobenzene reacts with trichloroethanal, Cl_3CCHO, to produce the pesticide DDT.



DDT

(i) Construct an equation for the reaction of chlorobenzene with trichloroethanal to form DDT.



[2]

(ii) Predict the number of peaks in the ^{13}C NMR spectrum of DDT.

..... **[1]**

(c) Chlorobenzene can be nitrated to form a mixture of products.

Suggest why the reaction forms a mixture of products.

.....

.....

..... **[1]**

© OCR 2011

STEMUP.CO.UK

(d) Explain why phenol reacts more readily with chlorine than benzene reacts with chlorine.



In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

[Total: 13]

© OCR 2011

STEMUP.CO.UK

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© OCR 2011

STEMUP.CO.UK

2 A student was investigating the reactions and uses of organic amines.

(a) The student found that amines such as ethylamine, $C_2H_5NH_2$, and phenylamine, $C_6H_5NH_2$, both behave as bases.

(i) Explain why amines can behave as bases.

.....

..... **[1]**

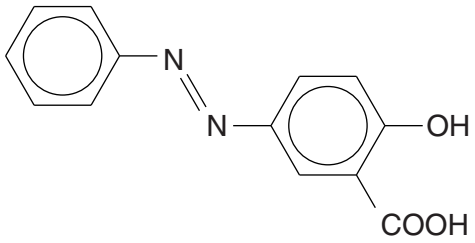
(ii) The student reacted an excess of $C_2H_5NH_2$ with two different acids.

Write the formulae of the salts that would be formed when an **excess** of $C_2H_5NH_2$ reacts with:

sulfuric acid, ...

ethanoic acid. ..... **[2]**

(b) The student reacted phenylamine with a mixture of $NaNO_2$(aq) and HC*l*(aq) whilst keeping the temperature below 10 °C. A diazonium ion was formed. The student then reacted the diazonium ion with compound **B**. After neutralisation, compound **A** was formed.



compound **A**

(i) Draw the structures of the diazonium **ion** and compound **B**.

Display the functional group in the diazonium ion.

diazonium **ion**	compound **B**

[2]

(ii) State the conditions required for the reaction of the diazonium ion with compound **B** and state a possible use for compound **A**.

conditions .....

possible use for compound **A**. ..... **[1]**

© OCR 2011

STEMUP.CO.UK

(iii) The student added Na_2CO_3 to a solution of compound **A**.

Draw the structure of the organic product and state the formulae of any other products from this reaction.

[2]

(c) The student repeated the experiment in part **(b)** but allowed the temperature to rise above 10 °C.

Under these conditions, the diazonium **ion** in **(b)(i)** reacts with water to produce phenol. A gas with molar mass of 28.0 g mol^{-1} and one other product are also formed.

Construct an equation for this reaction.

[1]

[Total: 9]

© OCR 2011

STEMUP.CO.UK

3 Mandelic acid (2-phenyl-2-hydroxyethanoic acid), $C_6H_5CH(OH)COOH$, is used in some skin creams and can be converted into a condensation polymer.

The addition polymer of ethyl methacrylate (ethyl 2-methyl-2-propenoate), $CH_2C(CH_3)COOC_2H_5$, is used to make some artificial fingernails.

(a) Explain what is meant by the term *condensation polymerisation*.

Your answer should use appropriate technical terms, spelled correctly.

.....

.....

..... **[1]**

(b) Draw **two** repeat units of a polymer that is formed when,

(i) mandelic acid, $C_6H_5CH(OH)COOH$, polymerises

[2]

(ii) ethyl methacrylate, $CH_2C(CH_3)COOC_2H_5$, polymerises.

[1]

© OCR 2011

STEMUP.CO.UK

(c) When ethyl methacrylate, $CH_2C(CH_3)COOC_2H_5$, is heated under reflux with aqueous dilute acid, a hydrolysis reaction takes place forming compound **C** and ethanol.

When compound **C** is heated with steam in the presence of an acid catalyst, an addition reaction takes place forming two organic products **D** and **E**.

Compounds **D** and **E** are structural isomers with the molecular formula $C_4H_8O_3$.

Draw the structures of compounds **C**, **D** and **E**.

compound **C**
compound **D**
compound **E**

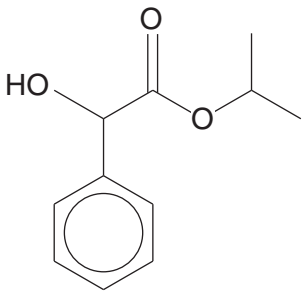
[3]

TURN OVER FOR PART (d)

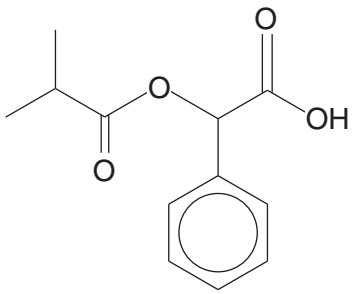
© OCR 2011

STEMUP.CO.UK

(d) Mandelic acid has anti-bacterial properties and is used in some skin creams. A cosmetic chemist used mandelic acid to prepare two different esters that might be suitable for new skin creams. The structures of the two esters are shown below.



ester 1



ester 2

(i) Draw the structure of an organic compound that could react with mandelic acid, $C_6H_5CH(OH)COOH$, to produce **ester 1**.

[1]

(ii) Identify an organic compound that could react with mandelic acid to produce **ester 2.**

[1]

© OCR 2011

STEMUP.CO.UK

(iii) **Ester 1** is less soluble in water than mandelic acid, $C_6H_5CH(OH)COOH$.

Explain the difference in water solubility of mandelic acid and **ester 1**.

You may use a labelled diagram in your answer.

.....

.....

.....

.....

.....

..... **[3]**

(iv) Before any skin cream can be sold to the public, it must be tested to ensure it is safe to use.

Suggest why.

.....

..... **[1]**

[Total: 13]

© OCR 2011

STEMUP.CO.UK

4 'Methylglyoxal', CH_3COCHO, is formed in the body during metabolism.

Describe **one** reduction reaction and **one** oxidation reaction of methylglyoxal that could be carried out in the laboratory.

Your answer should include reagents, equations and observations, if any.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[5]**

[Total: 5]

© OCR 2011

5 Forest fires release a large number of organic compounds into the atmosphere, many in very small quantities.

(a) Compounds in the smoke from forest fires can be analysed using GC-MS.
Explain how GC-MS enables the compounds to be identified.

.....

.....

.....

..... **[2]**

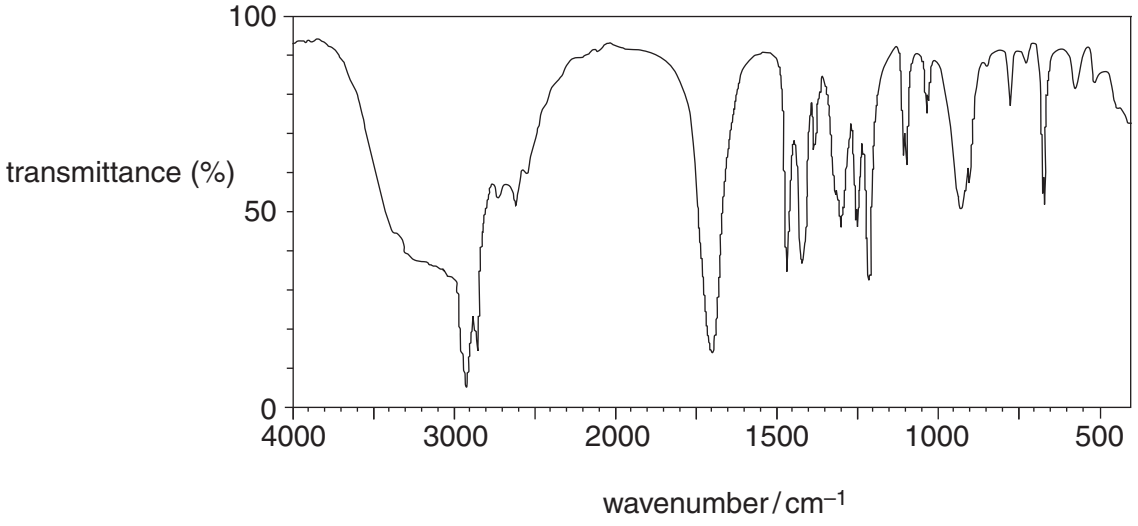
(b) Compound **F** was found to be present in the smoke.
Compound **F** contains C, H and O only and contains 54.2% oxygen by mass.
The molar mass of compound **F** is 118.0 g mol^{-1}.

(i) Using the information, show that the molecular formula of compound **F** is $C_4H_6O_4$.

Show all of your working.

[2]

(ii) The infrared spectrum of compound **F** is shown below.



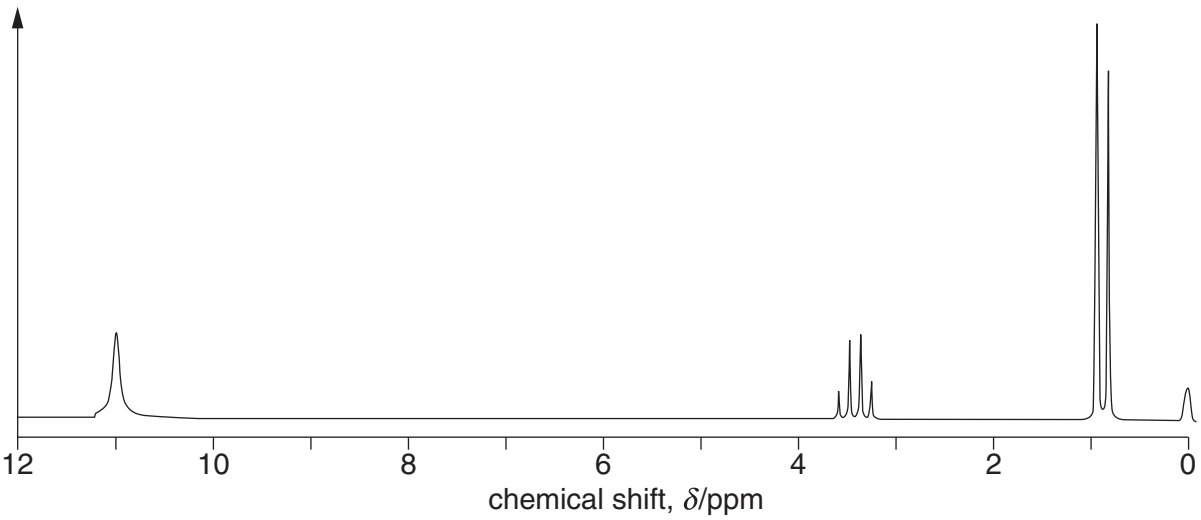
Using this spectrum, name the functional group present in compound **F**.

..... **[1]**

© OCR 2011

STEMUP.CO.UK

(c) Compound **F**, $C_4H_6O_4$, was dissolved in deuterated dimethylsulfoxide, $(CD_3)_2SO$, and some tetramethylsilane, TMS, was added. The proton NMR spectrum of compound **F** is shown below.



The peak centred at $\delta = 3.4$ ppm would normally be expected at a chemical shift value about 1 ppm to the right, i.e. 2.4 ppm.

(i) Using the chemical shifts and splitting patterns, deduce the structural formula of compound **F**.

Explain your reasoning.

.....

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

© OCR 2011

STEMUP.CO.UK

(ii) Explain why deuterated dimethylsulfoxide, $(CD_3)_2SO$, is used as the solvent rather than $(CH_3)_2SO$.

.....

.....

..... **[1]**

(iii) State why TMS was added.

.....

..... **[1]**

(iv) A second proton NMR spectrum of compound **F** was obtained after adding a few drops of D_2O.

What difference would you expect to see between the proton NMR spectra of compound **F** obtained with and without D_2O?

.....

.....

..... **[1]**

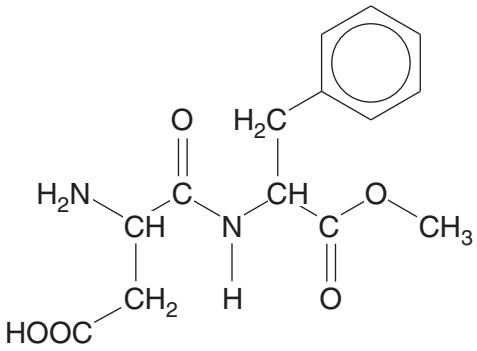
[Total: 12]

© OCR 2011

STEMUP.CO.UK

6 The addition of sucrose, table sugar, to food and drink has been linked to the increased risk of obesity and insulin resistance. Aspartame is used as an alternative to sugar.

The structure of aspartame is shown below.



aspartame

(a) Aspartame contains five functional groups including the benzene ring, and has two chiral carbon atoms.

(i) Circle the **two** chiral carbon atoms on the structure above. **[1]**

(ii) **Name** the **four** functional groups, other than the benzene ring, in aspartame.

....

.... **[2]**

(b) Aspartame consumed in food or drink might be hydrolysed by the acid in the stomach. This acid consists mainly of hydrochloric acid.

Draw the structures of the **three** organic products formed by the **complete** acid hydrolysis of aspartame.

[4]

© OCR 2011

STEMUP.CO.UK

(c) Some artificial sweeteners commonly available many years ago have now been withdrawn from use.

Suggest why.

.....

..... **[1]**

[Total: 8]

END OF QUESTION PAPER

© OCR 2011

STEMUP.CO.UK

ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

© OCR 2011

ADDITIONAL PAGE

© OCR 2011

ADDITIONAL PAGE

OCR
RECOGNISING ACHIEVEMENT

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2011

OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Advanced GCE

Unit **F324:** Rings, Polymers and Analysis

Mark Scheme for June 2011

Oxford Cambridge and RSA Examinations

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of pupils of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

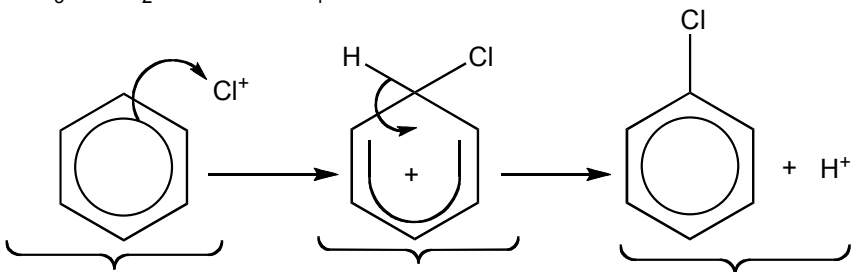
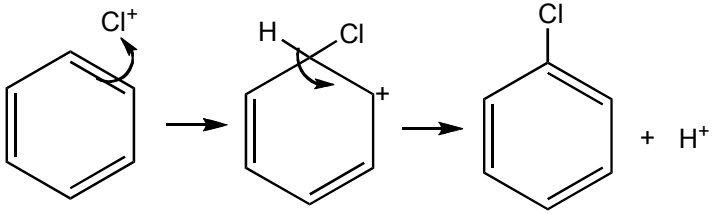
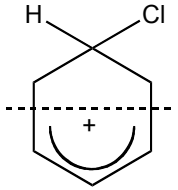
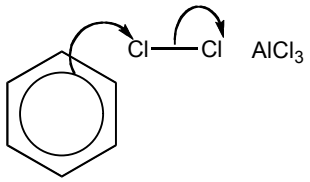
© OCR 2011

Any enquiries about publications should be addressed to:

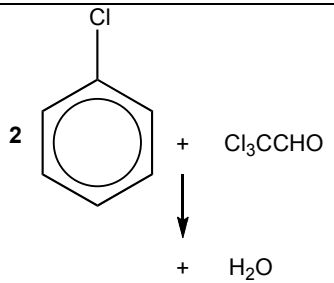
OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

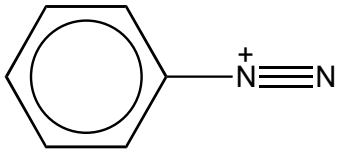
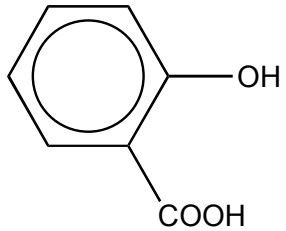
ALLOW Kekulé structures throughout

Question	Answer	Mark	Guidance
1 (a)	$AlCl_3 + Cl_2 \longrightarrow AlCl_4^- + Cl^+$ ✓  curly arrow from π-bond to Cl^+ ✓ correct intermediate ✓ curly arrow from C–H bond back to reform π-ring ✓ correct products ✓ $H^+ + AlCl_4^- \longrightarrow AlCl_3 + HCl$ ✓ **Note**: 1st curly arrow should start within the ring or on the ring --- **Note: ALLOW** mechanism using Kekulé structures:  	6	***ANNOTATIONS MUST BE USED*** **DO NOT ALLOW** the following intermediate:  π-ring must be more than 1/2 way up **AND** 'horseshoe' the right way up, *ie* gap towards C with Cl **ALLOW** + sign anywhere inside the 'hexagon' of intermediate **ALLOW** 1st curly arrow starting within the hexagon **ALLOW** mechanism with Cl–Cl----$AlCl_3$ for 1st 2 marks, ie  Second curly arrow to either –Cl or $AlCl_3$ **Note**: If Br^+ is used, **DO NOT ALLOW** 1st mechanism mark but all other marks available by **ECF**

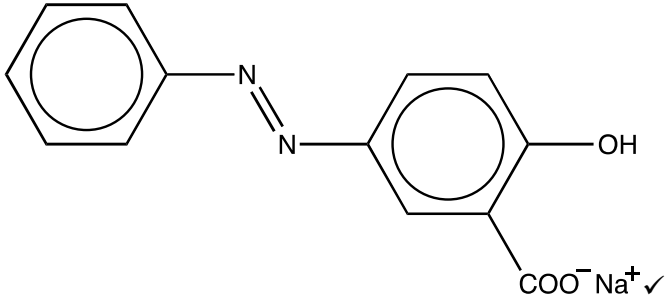
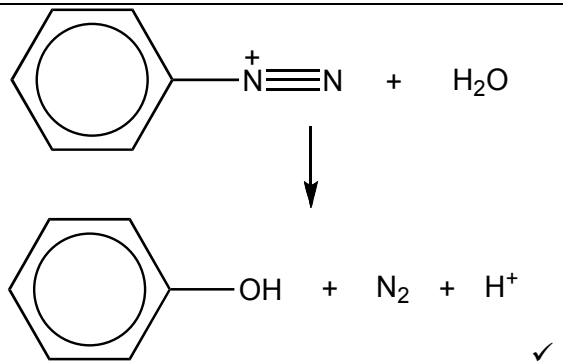
STEMUP.CO.UK

Question			Answer	Mark	Guidance
1	(b)	(i)	 **1st mark**: reactants, correctly balanced, ✓ *ie* **2** C_6H_5Cl + Cl_3CCHO **2nd mark**: product, (correctly balanced) ✓ *ie* H_2O	**2**	**Each mark is independent of the other** **ALLOW** C_6H_5Cl for chlorobenzene **ALLOW** any unambiguous structure for Cl_3CCHO, e.g. CCl_3CHO **BUT** ….. **DO NOT ALLOW** CCl_3COH **Standalone mark** **Standalone mark**
		(ii)	6 ✓	**1**	
	(c)		substitution/nitration/NO_2 at different positions (on the ring) **OR** forms different isomers **OR** multiple substitution/nitration ✓	**1**	**ALLOW** examples, e.g. 1-chloro-2-nitrobenzene and 1-chloro-2-nitrobenzene **ALLOW** 'it' for nitro group **ALLOW** examples, e.g. 1-chloro-2,3-dinitrobenzene **IGNORE** nitrate/NO_3
	(d)		In phenol, (lone) pair of electrons on O is (partially) **delocalised** into the ring ✓ **QWC**: delocalised/delocalized/delocalise, etc must be spelt correctly in the correct context for benzene **OR** phenol at least once electron density increases/is high ✓ **ORA** Cl_2/electrophile is (more) polarised ✓ **ORA**	**3**	***ANNOTATIONS MUST BE USED*** **ALLOW** diagram to show movement of lone pair into ring but **delocalised** ring must be mentioned **ALLOW** lone pair of electrons on O is (partially) drawn/ attracted/pulled into **delocalised** ring **IGNORE** 'activates the ring' **DO NOT ALLOW** charge density or electronegativity **ALLOW** Cl_2 is (more) attracted **OR** Cl_2 is not polarised by benzene **OR** induces dipoles (in chlorine/electrophile)
			Total	**13**	

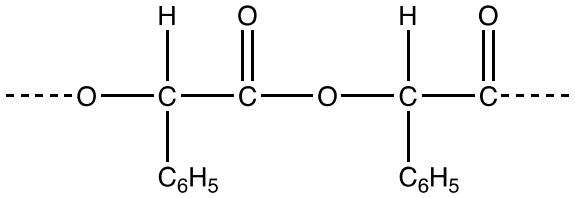
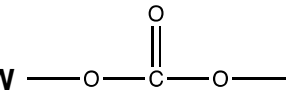
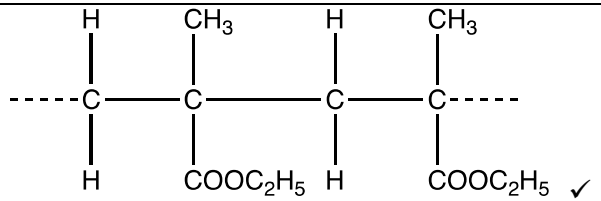
STEMUP.CO.UK

Question			Answer	Mark	Guidance
2	(a)	(i)	donates a lone pair (on N) **OR** accepts a proton/H^+ ✓	1	**IGNORE** 'forms a dative covalent bond' (no direction of lone pair) **ALLOW** 'forms a dative covalent bond with/to **H^+**' **ALLOW** mark for N:→H^+ (can be from correct equation)
		(ii)	$(C_2H_5NH_3^+)_2SO_4^{2-}$ ✓ $C_2H_5NH_3^+$ CH_3COO^- ✓	2	**ALLOW** $(C_2H_5NH_3)_2\,SO_4$ **DO NOT ALLOW** $(C_2H_5NH_3)\,HSO_4$ **OR** $(C_2H_5NH_3^+)\,HSO_4^-$ *brackets not required* **ALLOW** $(C_2H_5NH_3)\,(CH_3COO)$ **OR** $(C_2H_5NH_3^+)\,(CH_3COO^-)$ *brackets not required* **ALLOW** separate ions with or without a '+' sign between them, e.g. $C_2H_5NH_3^+$ + CH_3COO^-
	(b)	(i)	 diazonium ion ✓  compound **B** ✓	2	In diazonium ion, **IGNORE** Cl^- **ALLOW** '+' sign up to halfway along triple bond from left-hand N In compound **B**, **ALLOW** –OH ionised as $–O^-$ **ALLOW** –COOH ionised as COO^-
		(ii)	conditions = alkaline /OH^- **AND** use = dye/pigment/colouring ✓	1	**BOTH** responses required for one mark **ALLOW** named alkali, e.g. NaOH/KOH **ALLOW** base **IGNORE** references to temperature **ALLOW** use = indicator

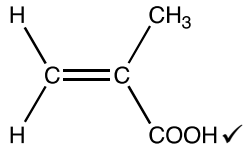
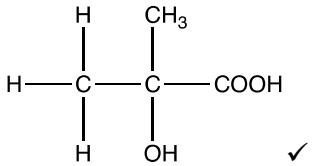
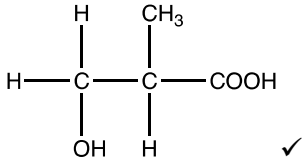
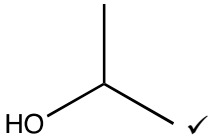
STEMUP.CO.UK

Question			Answer	Mark	Guidance
2	(b)	(iii)	Organic product:  ✓ Other products: CO_2 **AND** H_2O ✓	2	**IGNORE** phenoxide: O^- **OR** O^-Na^+ **ALLOW** COO^- **OR** COONa **ALLOW** H_2CO_3 **Note**: must be formulae and not names (in question)
	(c)		 ✓	1	**ALLOW** N_2^+ on structural formula **ALLOW** $C_6H_5N_2^+ + H_2O \rightarrow C_6H_5OH + N_2 + H^+$ **ALLOW** $C_6H_5N_2Cl + H_2O \rightarrow C_6H_5OH + N_2 + HCl$ If + charge shown, **IGNORE** its position
			Total	9	

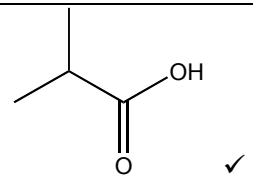
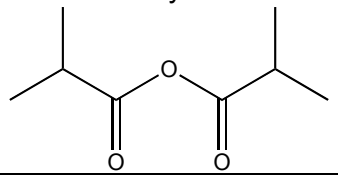
STEMUP.CO.UK

Question			Answer	Mark	Guidance
3	(a)		**monomers** join/bond/add/react/form polymer/form chain **AND** another product/small molecule e.g. H_2O/HCl ✓ **QWC** must spell **AND** use 'monomer(s)' correctly throughout	1	**IGNORE** 'two' when referring to monomers, ie (two) monomers ……...
	(b)	(i)	 ester link ✓ **Note**: Any ester link shown **must** be correct rest of the structure ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) **ALLOW** benzene ring for C_6H_5 'End bonds' **MUST** be shown (do not have to be dotted) **ALLOW one** or more repeat units but has to have a whole number of repeat units (*ie* does not have to be two) For ester, **DO NOT ALLOW**  **ALLOW** structure with no O at left end and COO at right end **IGNORE** brackets **IGNORE** *n*
		(ii)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) **ALLOW one** or more repeat units but has to have a whole number of repeat units (*ie* does not have to be two) 'End bonds' **MUST** be shown (do not have to be dotted) **IGNORE** brackets **IGNORE** *n*

STEMUP.CO.UK

Question			Answer	Mark	Guidance
3	(c)		compound **C**  ✓ compound **D** and compound **E**  ✓  ✓	**3**	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) **ALLOW** $CH_2C(CH_3)COOH$ **ALLOW D** and **E** by **ECF** from an incorrect structure of **C** provided that **C** contains a double bond and molecular formulae of **D** and **E** is $C_4H_8O_3$ with H_2O added across double bond
	(d)	(i)	 ✓	**1**	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) e.g. $(CH_3)_2CHOH$ **DO NOT ALLOW** –HO **IGNORE** working (*ie* other structures) provided correct structure of propan-2-ol is shown **IGNORE** name (even if wrong)

STEMUP.CO.UK

Question			Answer	Mark	Guidance
3	(d)	(ii)	 ✓ **OR** acid anhydride: 	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) **OR** (2-)methylpropanoic acid **DO NOT ALLOW** incorrect name (will CON a correct structure) **ALLOW** acyl chloride: $(CH_3)_2CHCOCl$ **IGNORE** working provided correct structure of propan-2-ol is shown
		(iii)	Hydrogen bonds form **with** water ✓ **Note**: Can be shown in diagram as dashed line, *ie* ---- (no label required) **DO NOT CON** 'hydrogen bond' from an incorrect hydrogen bond in diagram Mandelic acid forms more hydrogen bonds (with water) ✓ **ORA** Mandelic acid has an extra OH **OR** 2 OH groups **OR** has a COOH group ✓ **ORA**	3	***ANNOTATIONS MUST BE USED*** **ALLOW** a diagram showing hydrogen bonds with water, dipole and lone pair are not required **ALLOW** a hydrogen bond to C=O, ie C=O---H–O **IGNORE** bond angles Diagram does **not** need to show all of mandelic acid (**IGNORE** if wrong) **ALLOW** any comparison of numbers of hydrogen bonds provided that mandelic acid has more hydrogen bonds **DO NOT ALLOW** 'No –OH groups in ester (as there are)' **DO NOT ALLOW** reference to $–OH^-$ / hydroxide **IGNORE** reference to carbon chain and van der Waals' forces **Note**: If a response compares **Ester 1** with **Ester 2** rather than with mandelic acid, maximum of 2 marks: **1st mark** hydrogen bonds **2nd mark** **Ester 2** has more Os/oxygens **OR** **Ester 2** forms more hydrogen bonds

STEMUP.CO.UK

Question			Answer	Mark	Guidance
3	(d)	(iv)	To test for (adverse) side effects **OR** to test toxicity **OR** to test for irritation ✓	1	**ALLOW** a stated adverse side effect, *eg* allergy, carcinogenic, etc **IGNORE** references to optical isomers, chirality, etc **IGNORE** vague statements such as harmful to skin, dangerous to skin, corrosive to skin, reacts with skin **ALLOW** company liable to litigation/damages
			Total	13	

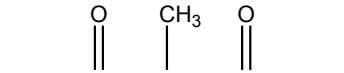
STEMUP.CO.UK

Question			Answer	Mark	Guidance
4					***ANNOTATIONS MUST BE USED*** Throughout question, **ALLOW** correct structural **OR** displayed **OR** skeletal formula **DO NOT ALLOW** molecular formulae
			Equations $CH_3COCHO + 4[H] \longrightarrow CH_3CHOHCH_2OH$ ✓ $CH_3COCHO + [O] \longrightarrow CH_3COCOOH$ ✓	**1** **1**	**ALLOW** partial reduction (ie reduction of either C=O group) [H] implies reduction [O] implies oxidation
			Reduction reagents and observation Methylglyoxal is **reduced** by $NaBH_4$ ✓	**1**	reduced **AND** reagent are **both** required for the mark **ALLOW** link to equation with [H] for reduction **ALLOW** $LiAlH_4$ as alternative for $NaBH_4$ **ALLOW** any recognisable attempt at name **IGNORE** any reference to acids
			Oxidation reagents and observation Methylglyoxal is **oxidised** by H_2SO_4 **AND** $K_2Cr_2O_7$ ✓ Observation: turns green **OR** blue ✓		oxidised **AND** reagent are **both** required for the mark **ALLOW** link to equation with [O] for oxidation **ALLOW** $Na_2Cr_2O_7$ instead of $K_2Cr_2O_7$ **ALLOW** H^+ **AND** $Cr_2O_7^{2-}$ **OR** H^+ **AND** CrO_4^{2-} If name given, **ALLOW** dichromate **OR** dichromate(VI) **ALLOW** acidified dichromate **ALLOW** any strong acid If formulae used, formulae must be correct
			OR Methylglyoxal is **oxidised** by Tollens' reagent ✓ Observation: Silver (mirror) ✓	**2**	**ALLOW** $AgNO_3$ in ammonia **OR** ammoniacal $AgNO_3$ **ALLOW oxidised** by manganate Observation: decolourised **Note**: If one reaction is identified as oxidation, assume the other is reduction (and vice versa)
			Total	**5**	

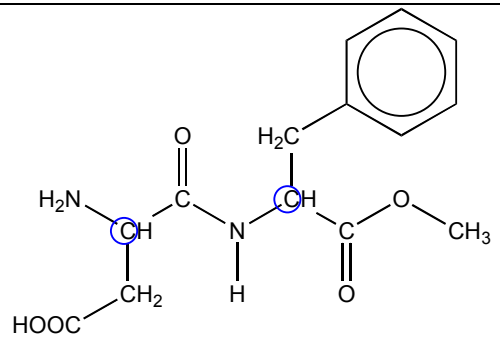
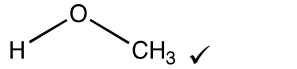
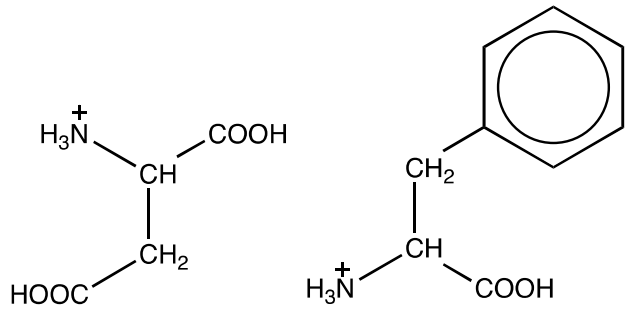
STEMUP.CO.UK

Question			Answer	Mark	Guidance
5	(a)		idea of separating (the components/compounds) ✓ idea of (identifying compounds) by comparison with a (spectral) database ✓	2	**ALLOW** (identifies compounds) using fragmentation (patterns)/fragment ions (but **IGNORE** molecular ions) ✓ **Note**: Each marking point does **not** need to be linked to GC or MS (The question asks about GC–MS as a combined technique)
	(b)	(i)	54.2% of 118 **OR** 54.2/118 x 100 = 64/63.96 (hence there are 4 oxygens) ✓ 118 – 64 = 54 hence 4 carbon (48) and 6 hydrogen (6) ✓	2	**IGNORE** calculation that proves that $C_4H_6O_4$ has a molar mass of 118 (ie 12 x 4 + 6 x 1 + 16 x 4) **ALLOW** 64/118 x 100 = 54.2% for 1st mark **IGNORE** method using empirical formula **ALLOW** any reasonable working leading to 4C **Note**: 54.2(%) ÷ 16 would **not** get the 1st mark but the answer could be used to get the 2nd mark
		(ii)	carboxyl group **OR** carboxylic acid ✓ must be **name** (in question)	1	**IGNORE** working, e.g. O–H, C=O, C–O on IR spectrum

STEMUP.CO.UK

Question			Answer	Mark	Guidance
5	(c)	(i)	***Chemical shifts*** Any **two** peaks identified for **1 mark** ✓ peak at δ = 0.8 ppm due to R–C**H** / CH_3CH peak at δ = 3.4 ppm due to **H**C–C=O peak at δ = 11 ppm due to COO**H** / carboxylic acid ***Splitting*** quartet shows adjacent CH_3 **OR** 3 adjacent Hs ✓ doublet shows adjacent CH **OR** 1 adjacent H ✓ ***Identification***  ✓	1 2 1	***ANNOTATIONS MUST BE USED*** **CHECK SPECTRUM** for responses **ANNOTATE** with '^' For peak at (δ =) 0.8 (ppm), **ALLOW** doublet and vice versa For peak at (δ =) 3.4 (ppm), **ALLOW** quartet ' and vice versa For peak at (δ =) 11 (ppm), **ALLOW** singlet and vice versa **ALLOW** peak at δ = 2.4 ppm for peak at δ = 3.4 ppm **ALLOW** tolerance on δ values: ± 1 ppm For quartet, **ALLOW** quadruplet **ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous)
		(ii)	$(CD_3)_2SO$ / D / It does **not** absorb **OR** does not give a peak ✓	1	**ALLOW** $(CD_3)_2SO$ / does **not** contain H **ALLOW** undeuterated solvents would absorb **OR** give peaks **ALLOW** responses in terms of $(CH_3)_2SO$ producing peaks …… **but IGNORE** number of peaks
		(iii)	TMS is the standard (for chemical shift measurements) ✓	1	**ALLOW** TMS is the reference **OR** TMS has δ = 0 (ppm) **OR** for calibration **IGNORE** unreactive, volatile, it gives a sharp peak
		(iv)	peak at δ = 11.0 (ppm) disappears ✓	1	**ALLOW** COOH (peak) disappears **ALLOW** OH (peak) disappears
			Total	12	

STEMUP.CO.UK

Question			Answer	Mark	Guidance
6	(a)	(i)	 ✓	1	Circles can be around C **OR** CH atoms but must **not** include other atoms **ALLOW** any suitable way of highlighting chiral carbons, e.g. asterisk, * **Note**: Mark the circles and ignore other working on diagram
		(ii)	carboxyl **OR** carboxylic acid, amine, amide, ester must be **names** 2 marks for 4 correct functional groups ✓✓ 1 mark for 3 correct functional groups ✓	2	**ALLOW** peptide for amide
	(b)		 ✓  1 mark for left-hand amino acid with NH_3^+ **OR** NH_2 ✓ 1 mark for right-hand amino acid with NH_3^+ **OR** NH_2 ✓ 1 mark for **both** amino acids shown with NH_3^+ ✓	4	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **OR** mixture of the above (as long as unambiguous) **ALLOW** + charge on H of NH_3 groups, ie NH_3^+ **Note**: If there are more than three structures shown, credit any correct structures and ignore incorrect structures

STEMUP.CO.UK

Question			Answer	Mark	Guidance
6	(c)		(adverse) side effects **OR** toxicity **OR** irritation ✓	1	**ALLOW** a stated adverse side effect, *eg* allergy, carcinogenic, hyperactivity etc **IGNORE** references to optical isomers, chirality, etc **IGNORE** vague statements such as harmful to body, dangerous to body **DO NOT ALLOW** obesity, corrosive to body **ALLOW** company liable to litigation/damages **Note**: Scroll down to bottom of page to check for any further writing
			Total	8	

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2011

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

CHEMISTRY A

Rings, Polymers and Analysis

F324

Candidates answer on the question paper.

OCR supplied materials:
- *Data Sheet for Chemistry A* (inserted)

Other materials required:
- Scientific calculator

Wednesday 26 January 2011
Morning

Duration: 1 hour

OCE/25761

F324

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The insert will be found in the centre of this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Answer **all** the questions.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **16** pages. Any blank pages are indicated.

© OCR 2011 [M/500/7836]
OCR is an exempt Charity

STEMUP.CO.UK

Answer **all** the questions.

1 Methylbenzene, $C_6H_5CH_3$, is an aromatic hydrocarbon and is used widely as a solvent. It is readily nitrated and it can form mono-, di-, or tri-nitromethylbenzenes.

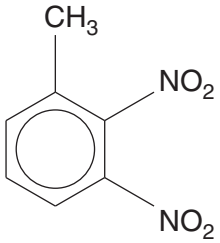
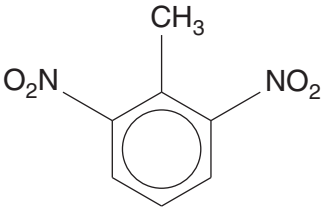
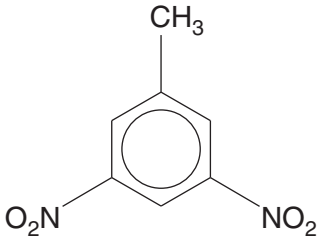
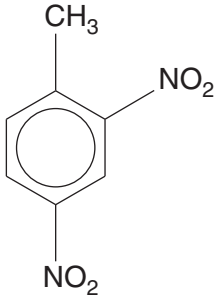
(a) 4-Nitromethylbenzene can be formed by the nitration of methylbenzene.

Outline the mechanism for the formation of 4-nitromethylbenzene from methylbenzene using NO_2^+ as the electrophile.

[4]

(b) There are six possible structural isomers of $CH_3C_6H_3(NO_2)_2$ that are dinitromethylbenzenes. Four of the isomers are shown below.

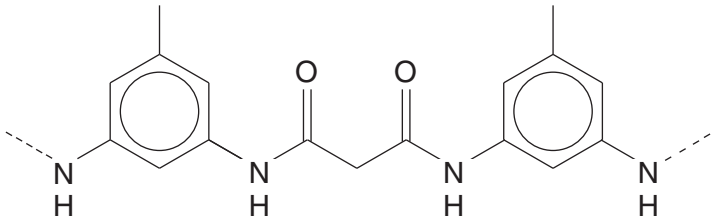
Draw the structures of the other two isomers in the boxes provided.

 **isomer 1**	 **isomer 2**	 **isomer 3**
 **isomer 4**	**isomer 5**	**isomer 6**

[2]

© OCR 2011

(c) A research chemist investigated whether dinitromethylbenzenes could be used in the manufacture of fibres.
The chemist devised a **two**-stage synthesis of the condensation polymer below, starting from one of the isomers in part **(b)**.



For the **first** stage of the synthesis,

- Which of the isomers **1**, **2**, **3** or **4** could be used?
- Identify the product formed and state suitable reagents.
- Write an equation.

For the **second** stage of the synthesis,

- Suggest an organic compound that could react with the organic product from the **first** stage to form the polymer.
- State the type of condensation polymer formed.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

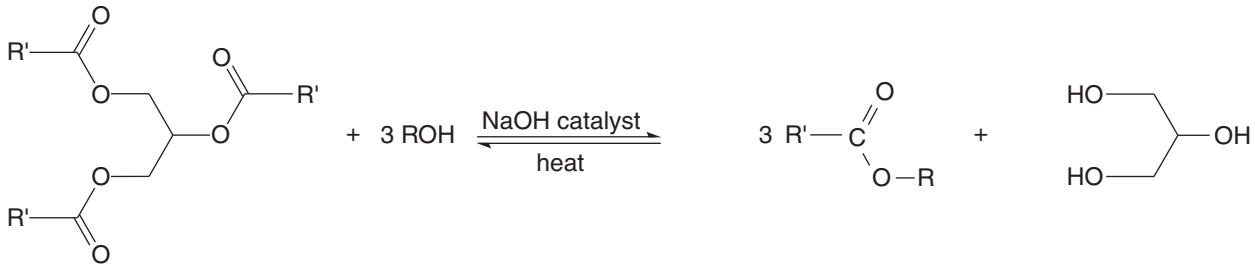
..... **[6]**

[Total: 12]

© OCR 2011

STEMUP.CO.UK

2 Esters of fatty acids are used as biodiesels. These esters can be produced from triglycerides by the transesterification process below.



triglyceride **biodiesel** **glycerol**

(a) Give the systematic name of glycerol.

..... **[1]**

(b) **(i)** Suggest a suitable alcohol, ROH, that could be used industrially to make biodiesel.

Justify your answer.

.....

.....

.....

..... **[1]**

(ii) The alcohol, ROH, is added in excess.

Suggest why the alcohol has to be in excess.

.....

.....

..... **[1]**

© OCR 2011

STEMUP.CO.UK

(c) Esters can also be made by reacting an alcohol with either a carboxylic acid or with an acid anhydride.

Write equations for the formation of ethyl propanoate, $CH_3CH_2COOCH_2CH_3$, starting from:

- a carboxylic acid and an alcohol,

- an acid anhydride and an alcohol.

[2]

(d) Compound **A**, $C_4H_8O_3$, can lose water to form either:

compound **B**, a cyclic ester
OR
compound **C**, a polyester.

Identify compounds **A**, **B** and **C**.

compound **A**	compound **B**
compound **C**	

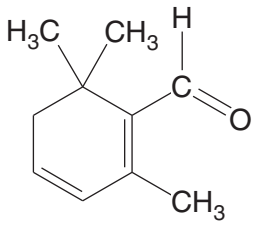
[3]

[Total: 8]

© OCR 2011

STEMUP.CO.UK

3 Safranal, shown below, is an aldehyde which contributes to the aroma of saffron.



safranal

An undergraduate chemist investigated some reactions of safranal.

(a) She prepared a solution of Tollens' reagent and added a few drops of safranal. She then warmed the mixture for about 5 minutes in a water bath.

Describe what you would expect the chemist to see.

State the type of reaction that the safranal undergoes.

Draw the structure of the organic product formed in this reaction.

.....

.....

.....

[3]

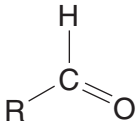
© OCR 2011

STEMUP.CO.UK

(b) The chemist then reduced safranal using an aqueous solution of $NaBH_4$.

Outline the mechanism for this reaction.

Use curly arrows and show any relevant dipoles.



can be used to represent safranal.

[4]

(c) Suggest one reaction of safranal that does **not** involve the aldehyde group.

State the reagent, observation (if any) and draw the organic product.

reagent .....

observation .....

organic product

[3]

[Total: 10]

© OCR 2011

STEMUP.CO.UK

4 Read the passage below and answer the questions that follow.

α-Amino acids can be synthesised in the laboratory by the two synthetic routes below.

Synthesis 1

An α-chlorocarboxylic acid is reacted with an excess of concentrated ammonia solution. The resulting solution is neutralised to produce an α-amino acid.

$$C\ell CH(R)COOH \xrightarrow[\text{concentrated ammonia solution}]{\textbf{step 1}} H_2NCH(R)COO^- \xrightarrow[\text{neutralisation}]{\textbf{step 2}} H_2NCH(R)COOH$$

Synthesis 2

An aldehyde is reacted with an aqueous solution of potassium cyanide and ammonium chloride. The resulting product is hydrolysed with aqueous acid and then neutralised to produce an α-amino acid.

$$RCHO \xrightarrow{KCN(aq)/NH_4C\ell(aq)} H_2NCH(R)CN \xrightarrow[\text{followed by neutralisation}]{\text{aqueous acid}} H_2NCH(R)COOH$$

(a) A chemist attempted the synthesis of the α-amino acid alanine (where R is CH_3) using **synthesis 1**.

(i) Write the equation for the reaction of $C\ell CH(CH_3)COOH$ with excess concentrated ammonia solution, $NH_3(aq)$, in **step 1** of **synthesis 1**.

[1]

(ii) A disadvantage of **synthesis 1** is that the α-amino acid can react further. For example, in the synthesis of alanine, an impurity with molecular formula $C_6H_{11}NO_4$ is also formed.

Draw the structure of this impurity.

[1]

© OCR 2011

(b) A chemist attempted the synthesis of the α-amino acid aspartic acid (where R is CH_2COOH) using **synthesis 2**.

(i) Draw the **skeletal** formula of the organic compound that could be used to synthesise aspartic acid using **synthesis 2**.

[1]

(ii) Draw **3D** diagrams of the optical isomers of aspartic acid.

[2]

(c) Many pharmaceuticals also have a chiral centre.

Discuss two possible **disadvantages** of producing a chiral drug as a mixture of stereoisomers.

State **two** ways in which a single optical isomer might be synthesised.

.....

.....

.....

.....

.....

.....

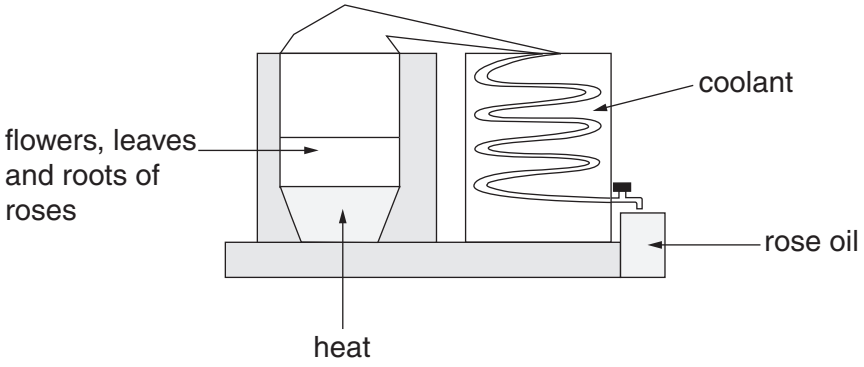
..... **[4]**

[Total: 9]

© OCR 2011

STEMUP.CO.UK

5 Rose oil can be extracted from the flowers, leaves and roots of roses using the apparatus below.



(a) The rose oil contains a mixture of compounds, some of which can be separated by using thin-layer chromatography (TLC). The chromatogram obtained is shown below.

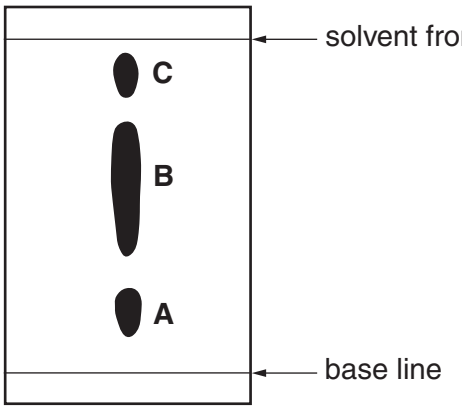


Fig. 5.1

(i) Explain how TLC separates compounds in the mixture.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

..... **[1]**

(ii) Estimate the R_f value of **A**.

[1]

© OCR 2011

STEMUP.CO.UK

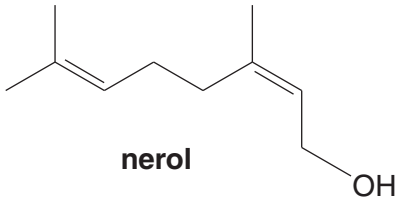
(iii) Using the chromatogram in **Fig. 5.1**, suggest why it is **not** possible to conclude that the rose oil contains **only** three different compounds.

.....

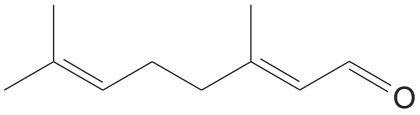
.....

..... **[1]**

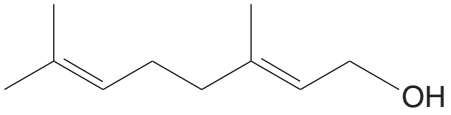
(b) GC–MS was used to identify the compounds present in the rose oil as nerol, geraniol, citral and menthol, shown below. These compounds all have stereoisomers.



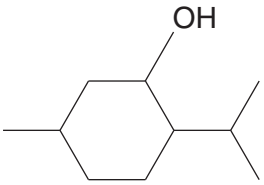
nerol



citral



geraniol



menthol

(i) Explain how GC–MS can be used to identify these compounds in the rose oil.

.....

.....

..... **[1]**

(ii) Suggest, with a reason, which two compounds might be present in **B** in **Fig. 5.1**.

.....

.....

..... **[1]**

(iii) Explain what is meant by the term *stereoisomers*.

.....

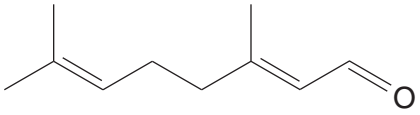
.....

..... **[1]**

© OCR 2011

STEMUP.CO.UK

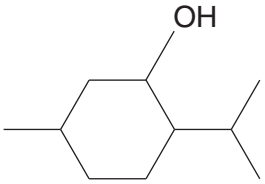
(iv) Draw a circle around the feature in citral that causes the stereoisomerism.



citral

[1]

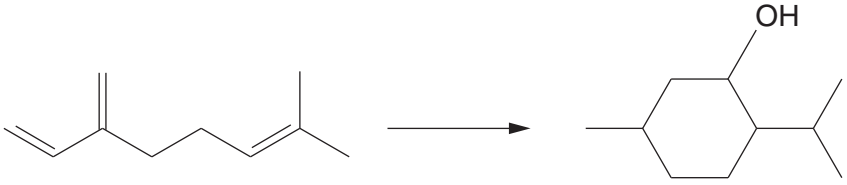
(v) Identify with asterisks (*) **all** the chiral centres in menthol that cause the stereoisomerism.



menthol

[2]

(c) Menthol is used in a wide range of products including lip balms, cough medicines and perfumery. The demand for menthol exceeds the supply from natural sources. Menthol is manufactured, using a chiral synthesis, from myrcene, a readily available starting material.



myrcene **menthol**

Calculate the mass of menthol that can be synthesised from 34.0 g of myrcene.
The percentage yield is 60%. M_r (Myrcene) = 136.

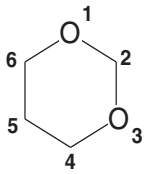
mass of menthol = ... g **[3]**

[Total: 12]

© OCR 2011

6 A company was planning to build a power station that will burn plastic waste. The local residents were concerned about possible emission of pollutants such as dioxanes and aromatic hydrocarbons. The residents employed an independent chemical engineer to advise about possible emissions.

Some scientists suspect that dioxanes, such as 1,3-dioxane, and aromatic hydrocarbons may be linked to some types of cancer.



1,3-dioxane

(a) Predict the splitting patterns in the proton NMR spectrum of 1,3-dioxane.

Identify which protons are responsible for each splitting pattern.

In your answer, you should use appropriate technical terms, spelled correctly.

.....

.....

.....

.....

.....

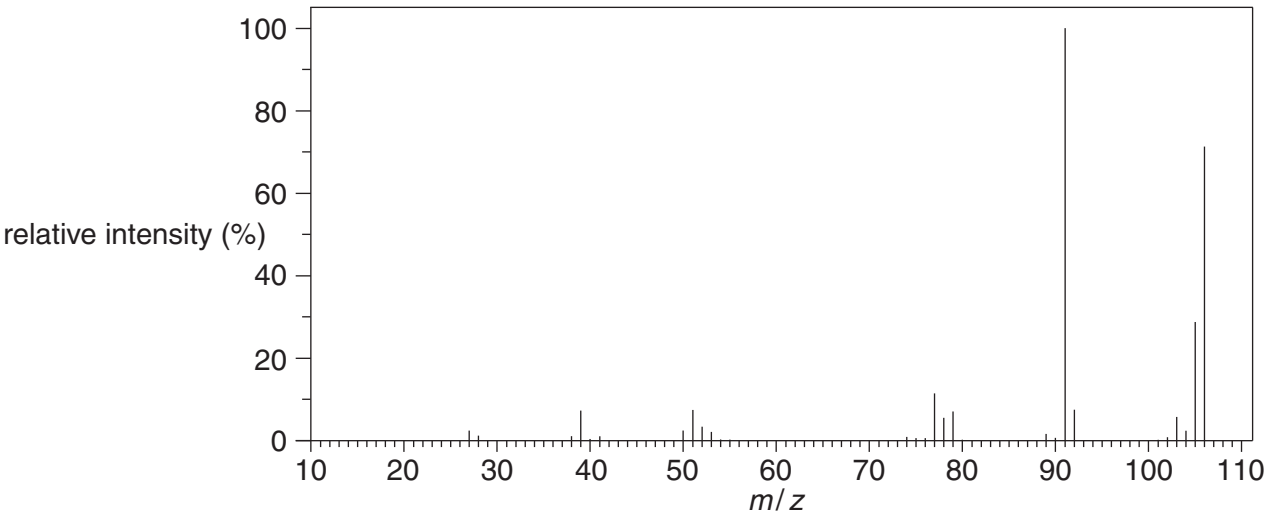
..... **[3]**

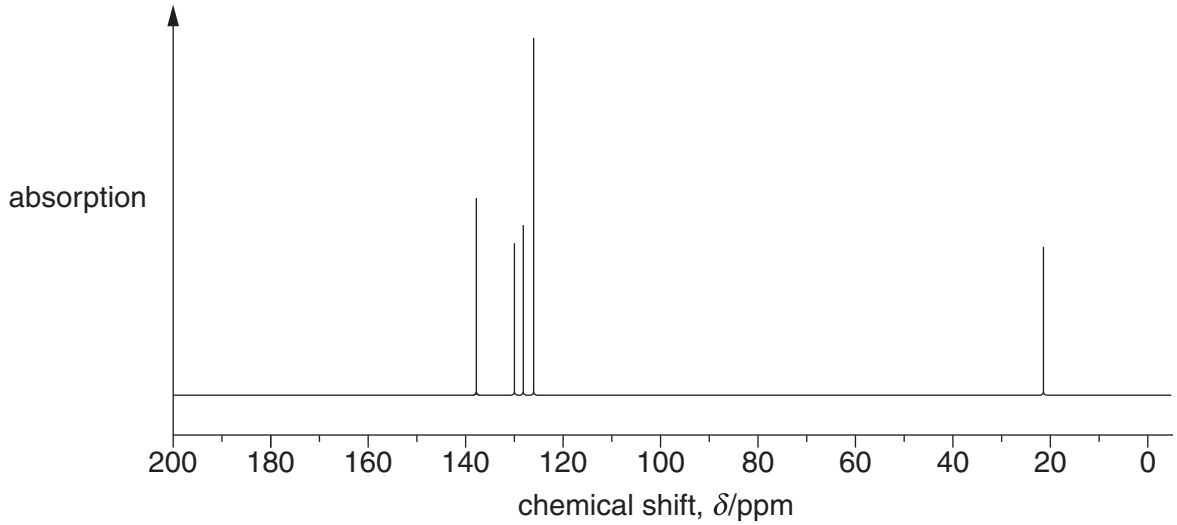
TURN OVER FOR QUESTION 6 (b)

© OCR 2011

STEMUP.CO.UK

(b) The independent chemical engineer investigated an unknown aromatic hydrocarbon.
He obtained the mass spectrum and the ^{13}C NMR spectrum of the aromatic hydrocarbon, which are shown below.





The aromatic hydrocarbon is one of **four** possible isomers.

Use the spectra to identify the aromatic hydrocarbon.

Show **all** of your working and explain how you ruled out the other three isomers.

.....

.....

.....

.....

.....

.....

.....

© OCR 2011

STEMUP.CO.UK

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

aromatic hydrocarbon is:

[6]

[Total: 9]

END OF QUESTION PAPER

© OCR 2011

PLEASE DO NOT WRITE ON THIS PAGE

OCR
RECOGNISING ACHIEVEMENT

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2011

OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Advanced GCE

Unit **F324:** Rings, Polymers and Analysis

Mark Scheme for January 2011

Oxford Cambridge and RSA Examinations

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of pupils of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

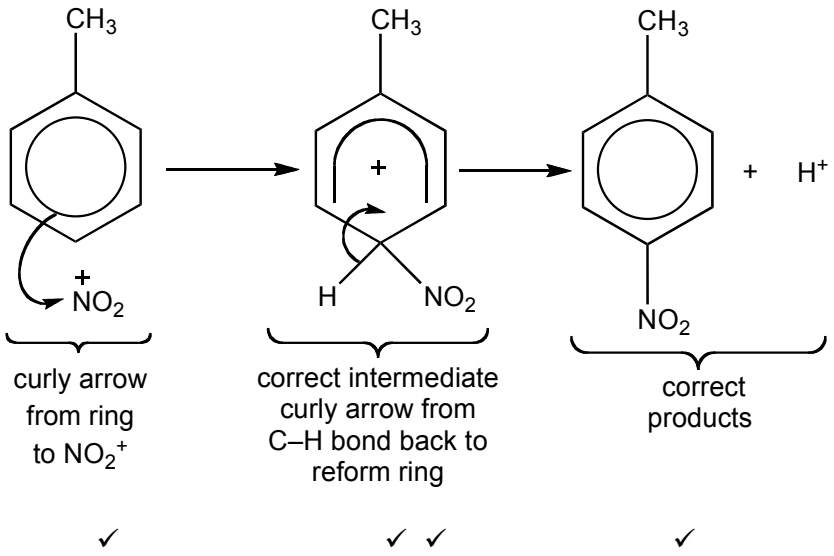
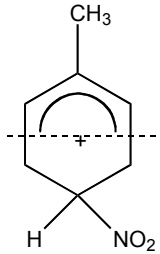
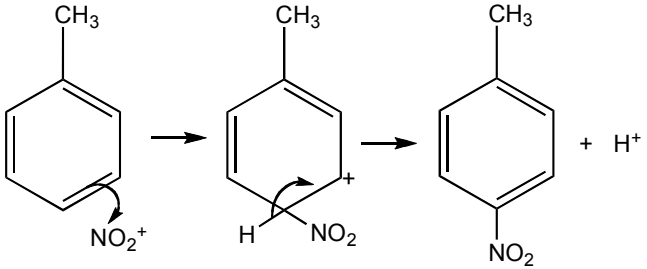
© OCR 2011

Any enquiries about publications should be addressed to:

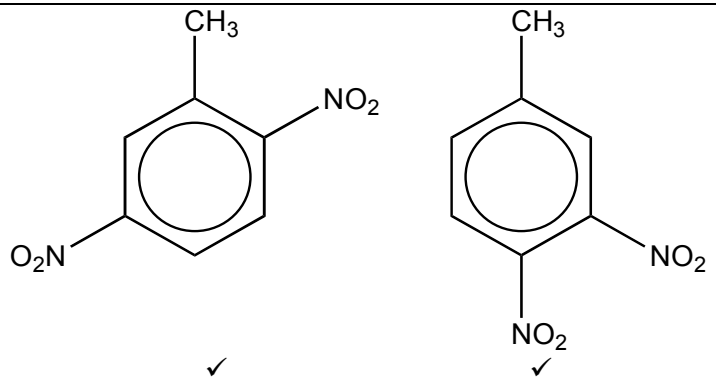
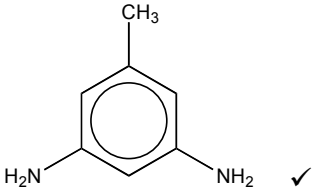
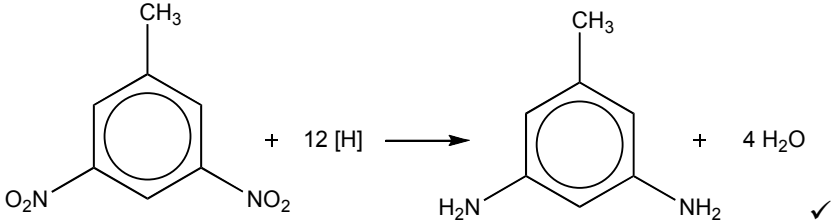
OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

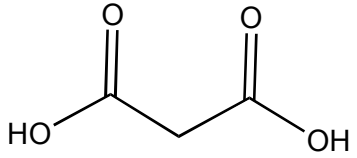
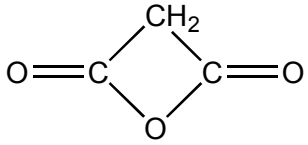
ALLOW Kekulé structures throughout

Question	Answer	Mark	Guidance
1 (a)	 ✓ ✓ ✓ ✓ 1 mark for intermediate 1 mark for curly arrow	4	***ANNOTATIONS MUST BE USED*** **ALLOW** skeletal CH_3 **ALLOW** $^{+}NO_2$ **OR** NO_2^{+} **ALLOW** 1st curly arrow from the ring OR from within the ring to any part of the NO_2^{+} including the + charge **DO NOT ALLOW** intermediate with broken ring less than halfway down:  Horseshoe must have open end towards NO_2 **ALLOW** Kekulé mechanism:  **ALLOW** double bonds shown in other Kekulé arrangement **IF** CH_3 has been omitted completely (*ie* benzene shown), **DO NOT AWARD** intermediate mark **OR** products mark **(max 2)** **IF** NO_2 is shown in incorrect position in intermediate or product, **DO NOT AWARD** intermediate mark but award other marks **(max 3)**

STEMUP.CO.UK

Question			Answer	Mark	Guidance
1	(b)		 ✓ ✓	2	**ALLOW** any correct unambiguous structures **ALLOW** NO_2– **Note**: connectivity is **NOT** being assessed in this part
1	(c)		**1st stage** *isomer*: **isomer 3** ✓ *product*:  ✓ *reagents*: Sn **AND** (conc) HCl ✓ *equation*:  ✓		***ANNOTATIONS MUST BE USED*** **ALLOW** structure of **isomer 3** shown separately **OR** in equation **ALLOW** structure of **product** shown separately **OR** in equation **ALLOW** correct name (3,5-diaminomethylbenzene) **IGNORE** incorrect name **DO NOT ALLOW** $CH_3C_6H_3(NH_2)_2$ **ALLOW** Zn + HCl/H_2 + metal catalyst/$LiAlH_4$/Na in ethanol **IGNORE** $NaBH_4$ **ALLOW** Sn and HCl followed by NaOH **DO NOT ALLOW** Sn and HCl and NaOH **IF** isomer **3 OR** product are given in equation but not shown previously then credit here Also credit reagents here if shown (*eg* above arrow) **ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous

STEMUP.CO.UK

Question			Answer	Mark	Guidance
	(c)	(i)	**2nd stage** *organic compound*: $HOOC–CH_2–COOH$ ✓	6	 **DO NOT ALLOW** molecular formula **ALLOW** name of compound: propanedioic acid **OR** propane-1,3-dioic acid **ALLOW** absence of 'e' after 'propan' **ALLOW** acyl dichloride: $ClOC–CH_2–COCl$ **ALLOW** cyclic acid anhydride of propanedioic acid: 
			type of polymer: polyamide ✓		**ALLOW** Nylon or Kevlar **DO NOT ALLOW** polypeptide **DO NOT ALLOW** amide
			Total	**12**	

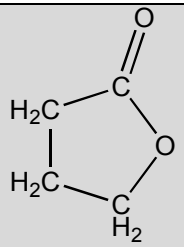
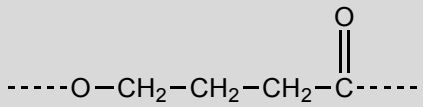
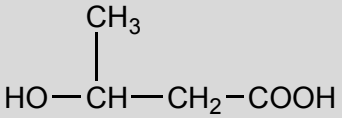
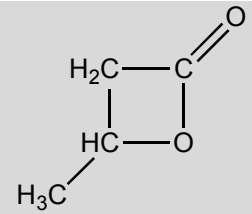
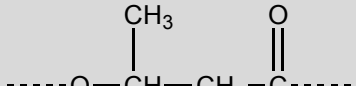
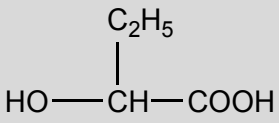
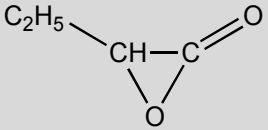
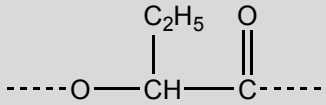
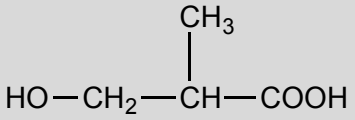
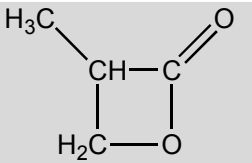
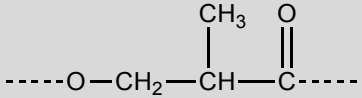
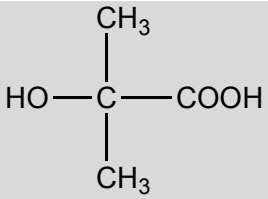
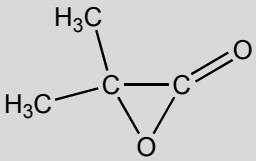
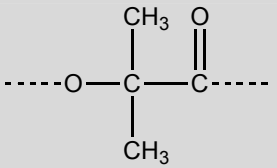
STEMUP.CO.UK

Question			Answer	Mark	Guidance
2	(a)		propane-1,2,3-triol ✓	1	**ALLOW** absence of 'e' after 'propan' **ALLOW** 1,2,3-propanetriol **ALLOW** absence of hyphens 1, 2 and 3 must be clearly separated: **ALLOW** full stops: 1.2.3 **OR** spaces: 1 2 3 **DO NOT ALLOW** 123
2	(b)	(i)	methanol **OR** ethanol **AND** renewable ✓	 1	**BOTH points required for the mark** **ALLOW** correct structural **OR** displayed **OR** skeletal formula **DO NOT ALLOW** molecular formulae **ALLOW** easy/cheap to manufacture/produce as alternative for renewable/from plants/from fermentation/burns more easily/efficiently
	(b)	(ii)	equilibrium shifts to right ✓	1	**ALLOW** equilibrium shifts in forward direction **ALLOW** more products form **ALLOW** greater yield **OR** fully reacts **OR** goes to completion **DO NOT ALLOW** improves atom economy

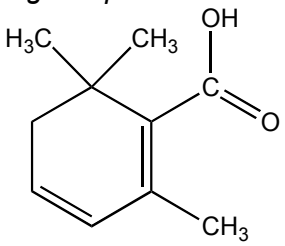
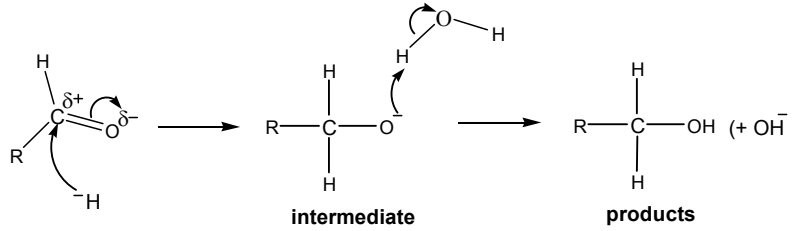
STEMUP.CO.UK

Question			Answer	Mark	Guidance
2	(c)		$CH_3CH_2COOH + CH_3CH_2OH \rightarrow CH_3CH_2COOCH_2CH_3 + H_2O$ ✓ $(CH_3CH_2CO)_2O + CH_3CH_2OH \rightarrow CH_3CH_2COOCH_2CH_3 + CH_3CH_2COOH$ ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous **DO NOT ALLOW** molecular formulae **ALLOW** further esterification, *ie* $(CH_3CH_2CO)_2O + 2CH_3CH_2OH \rightarrow 2CH_3CH_2COOCH_2CH_3 + H_2O$ ***ALLOW*** *linear formula for anhydride,* ie $CH_3CH_2COOCOCH_2CH_3$ If incorrect carboxylic acid/anhydride/alcohol is used, **ALLOW ECF** for second equation

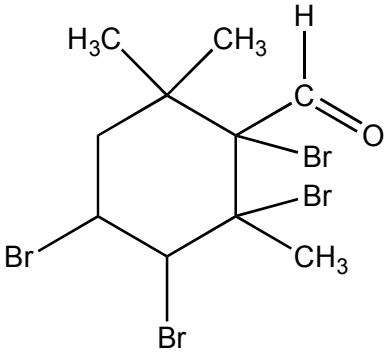
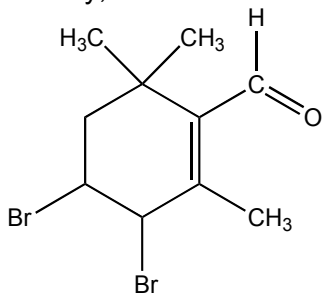
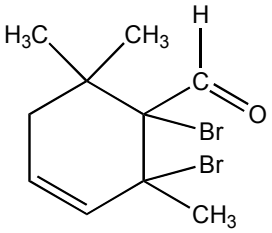
STEMUP.CO.UK

Question			Answer			Mark	Guidance
2	(d)		**A**	**B**	**C**	3	Mark **A**, **B** and **C** independently ie • **A** can be **any** of the alternatives in the 1st column • **B** can be **any** of the alternatives in the 2nd column • **C** can be **any** of the alternatives in the 3rd column **ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous **DO NOT ALLOW** molecular formulae **ALLOW** correct names for **A**, **B** and **C** **For B** accept diester **For C**, **IGNORE** '*n*' **OR** brackets (even if wrong); **ALLOW** solid side bonds Minimum is **one** correct repeat unit. Polymer must be open at both ends
							
			OR	**OR**	**OR**		
							
			OR	**OR**	**OR**		
							
			OR	**OR**	**OR**		
							
			OR	**OR**	**OR**		
							
					Total	**8**	

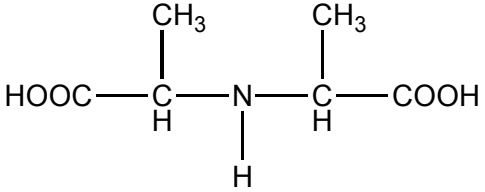
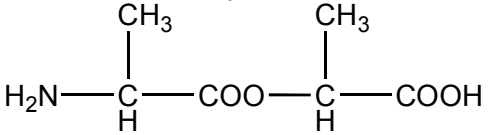
STEMUP.CO.UK

Question			Answer	Mark	Guidance
3	(a)		*observation*: silver **OR** Ag ✓ *type of reaction*: oxidation✓ *organic product*:  ✓	3	**ALLOW** black **OR** grey **ALLOW** redox **ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous **DO NOT ALLOW** molecular formulae **ALLOW** carboxylate, $–COO^-$
3	(b)		 **intermediate** **products** 1 mark for curly arrow from H^- to C of C=O ✓ 1 mark for correct dipole on C=O **AND** curly arrow from double bond to $O^{\delta-}$ ✓ 1 mark for correct intermediate with negative charge on O **AND** curly arrow from O^- to H of H–O–H **AND** curly arrow from H–O to O of H–O–H ✓ 1 mark for correct **organic** product ✓	4	***ANNOTATIONS MUST BE USED*** **ALLOW** mechanism showing curly arrows from lone pair on H^- and O^- of intermediate Dipole not required on H–O–H **DO NOT ALLOW** incorrect dipole on H–O–H **ALLOW** 1 mark for correct intermediate with '–' charge on O **AND** curly arrow from O^- to H^+ **IGNORE** missing OH^- **DO NOT ALLOW** incorrect second product

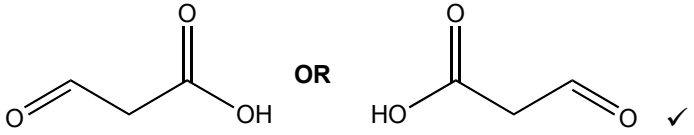
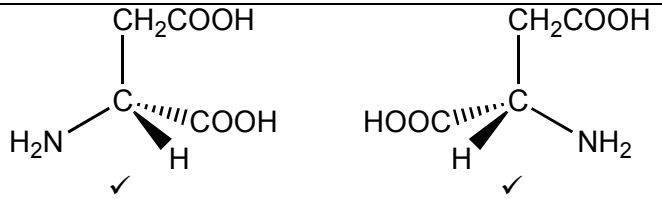
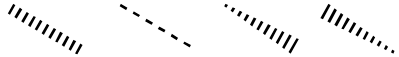
STEMUP.CO.UK

Question	Answer	Mark	Guidance
3 (c)	*reagent*: Br_2 ✓ *observation*: decolourised **OR** orange to colourless ✓ *organic product*: ✓ 	3	**DO NOT ALLOW ECF** from incorrect reagent, eg 2,4-DNP **DO NOT ALLOW** goes clear **ALLOW** red/orange/yellow/brown in any combination **ALLOW** organic product from reaction of one of the double bonds only, ie  **OR**  **ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous **DO NOT ALLOW** molecular formulae ***ALTERNATIVE reagents*** **For 1st mark,** **ALLOW** H_2 **OR** Cl_2 **OR** I_2 **OR** HCl **OR** HBr **OR** HI **OR** H_2O **For 2nd mark**, there **must** be a statement of no change **OR** no observation or similar that implies there is no visible change **EXCEPT** for I_2 which has an observation of 'decolourised' **OR** brown to colourless **For 3rd mark,** correct organic product must be shown that could be from reaction of both or one of the double bonds.
	Total	**10**	

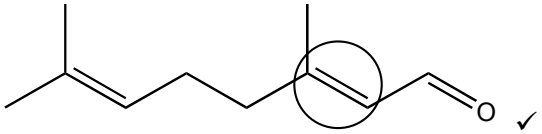
STEMUP.CO.UK

Question			Answer	Mark	Guidance
4	(a)	(i)	$ClCH(CH_3)COOH + 3NH_3 \rightarrow H_2NCH(CH_3)COO^- + NH_4^+ + NH_4Cl$ ✓	1	**ALLOW** use of **two** NH_3: $ClCH(CH_3)COOH + 2NH_3 \rightarrow H_2NCH(CH_3)COO^- + NH_4^+ + HCl$ **ALLOW** products as above **OR** $H_2NCH(CH_3)COOH + NH_4Cl$ **ALLOW** use of **one** NH_3: $ClCH(CH_3)COOH + NH_3 \rightarrow H_2NCH(CH_3)COO^- + H^+ + HCl$ **ALLOW** products as above **OR** $H_2NCH(CH_3)COOH + HCl$ For alternatives below, for NH_4Cl, **ALLOW** $NH_4^+Cl^-$ **OR** $NH_4^+ + Cl^-$ for HCl, **ALLOW** H^+Cl^- **OR** $H^+ + Cl^-$ for $H_2NCH(CH_3)COO^- + NH_4^+$ **ALLOW** $H_2NCH(CH_3)COO^-NH_4^+$ **OR** $H_2NCH(CH_3)COONH_4$ **ALLOW** R in equation in place of CH_3 (either or both sides) **ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous **DO NOT ALLOW** molecular formulae
	(a)	(ii)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous **ALLOW** product from carboxylate ion as nucleophile: 

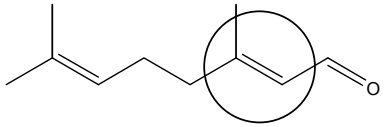
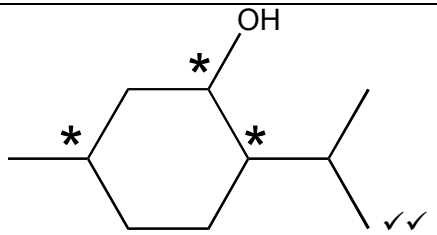
STEMUP.CO.UK

Question			Answer	Mark	Guidance
4	(b)	(i)	 ✓	1	**DO NOT ALLOW** any structure containing C **OR** H (except in OH)
	(b)	(ii)	 ✓ ✓	2	**ALL** bond linkages must be correct, eg the chiral C must be linked to the C of the COOH, the C of the CH_2COOH and the N of the NH_2 (connectivity is being tested) The 2nd mark is for the mirror image of an amino acid. This could be any amino acid **EXCEPT** glycine **DO NOT** penalise connectivity more than once **ALLOW** R in equation in place of CH_2COOH (either or both sides) Each structure **must** have four central bonds, with at least two wedges, one in; one out For bond into paper, accept: 
4	(c)		***Disadvantages*** *Any **two** from:* • (one stereoisomer might have harmful) side effects ✓ • reduces the (pharmacological) activity/effectiveness ✓ • cost **OR** difficulty in separating stereoisomers ✓ ***Synthesis of a single optical isomer*** *Any **two** from:* • using enzymes or bacteria ✓ • using a chiral catalyst **OR** transition metal complex/transition metal catalyst ✓ • using chiral synthesis **OR** chiral starting material **OR** natural amino acid ✓	2 max 2 max	***ANNOTATIONS MUST BE USED*** **ALLOW** optical isomer **OR** enantiomers as alternative for stereoisomers **ALLOW** a response that implies an increased dose **ALLOW** biological catalyst **ALLOW** 'chiral pool' **OR** L-amino acids **OR** D-sugars
			Total	**8**	

STEMUP.CO.UK

Question			Answer	Mark	Guidance
5	(a)	(i)	Adsorption ✓(onto the stationary phase) ***Quality of Written Communication*** 'Adsorption' must be spelled correctly	1	**ALLOW** adsorbtion or adsorb(s) or adsorbed spelled correctly at least once **DO NOT ALLOW** anything that begins with ab...
	(a)	(ii)	0.2 ✓	1	**ALLOW** any value in the range 0.1 – 0.3 **IGNORE** significant figures **DO NOT ALLOW** fraction/percent as final answer
	(a)	(iii)	Spot may contain more than one compound/component ✓	1	**ALLOW** compounds have similar R_f values/adsorptions **OR** compounds have not (fully) separated **OR B** is spread over a large region **OR** compounds are similar **IGNORE** retention times
5	(b)	(i)	GC separates the components/compounds **AND** MS is compared to a database/reference ✓	1	**ALLOW** chromatography for GC **ALLOW** they have different retention times **ALLOW** MS analyses compounds/gives structural information/gives different mass spectra **ALLOW** (uses) fragmentation patterns/fragments/peaks/parts of the compound **DO NOT ALLOW** MS identifies compounds (in question) **DO NOT ALLOW** molecular ion alone/M_r etc.
		(ii)	nerol and geraniol **AND** they are stereoisomers **OR** primary alcohols ✓	1	Compounds **AND** reason required for the mark **ALLOW** they are *E*/*Z* isomers **OR** *cis-trans* isomers **ALLOW** straight-chain alcohols **OR** unsaturated alcohols
		(iii)	stereoisomers have the same structural formula **AND** different 3D arrangements ✓	1	**BOTH** points required for the mark **ALLOW** different arrangements in space
		(iv)	 ✓	1	Circle must include the correct C=C double bond **AND** must not extend further than the adjacent atoms in the main chain, ie limit is:

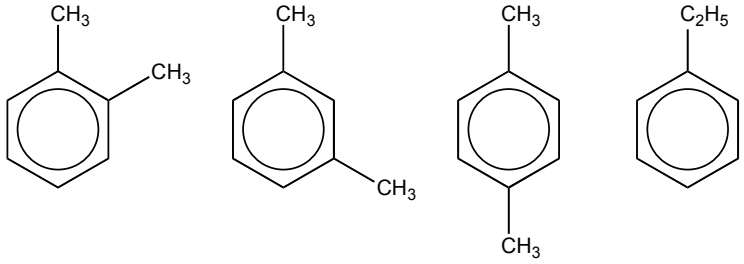
STEMUP.CO.UK

Question			Answer	Mark	Guidance
					
	(b)	(v)	 ✓✓	2	**ALL THREE** chiral centres required for 2 marks **ANY TWO** chiral centres required for 1 mark If more than three asterisks are shown, mark incorrect asterisk(s) first
5	(c)		Correctly calculates amount of myrcene = 34/136 **OR** 0.25 (mol) ✓ Correctly calculates 60% yield of menthol = 0.25 × 60/100 **OR** 0.15 (mol) ✓ Correctly calculates mass of menthol = 0.15 × 156 = 23.4 (g) ✓	3	***ANNOTATIONS MUST BE USED*** **ALLOW** amount of myrcene × 60/100 **ALLOW** amount of menthol × 156 **ALLOW** alternative approach based on reacting masses (using same **ECF** principles as above): correctly calculates mass of myrcene that could be obtained from 34 g myrcene: mass = 34 × 156/136 = 39 (g) × 156 ✓; ÷ 136 ✓ 60% of 39 g = 39 × 60/100 = 23.4 (g) ✓ **ALLOW** final answer to 2 or more significant figures correctly rounded Correct answer of 23.4 (g) with no working scores all 3 marks
			Total	**12**	

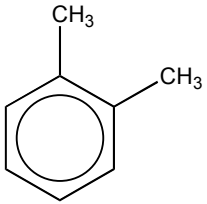
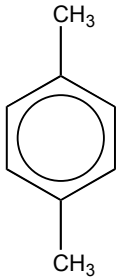
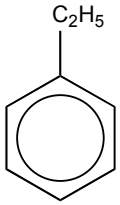
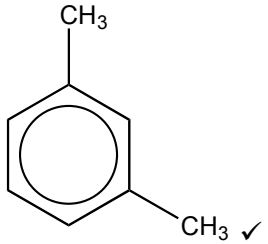
STEMUP.CO.UK

Question	Answer	Mark	Guidance
6 (a)	a **singlet** for position 2 **OR** a **singlet** because it has no adjacent H's✓ A **triplet** for positions 4 and 6 ***OR** a **triplet** because it has 2 adjacent H's* ✓ A **quintet** for position 5 **OR** a **quintet** because it has four adjacent H's ✓ ***Quality of Written Communication*** singlet **OR** triplet **OR** quintet **OR** pentet **OR** multiplet (see Guidance) must be spelled correctly at least once	3	***ANNOTATIONS MUST BE USED*** **ALLOW** a response that implies a single peak **OR** 'no splitting' **ALLOW** a response that implies a splitting into three **DO NOT ALLOW** implications of more than one triplet **ALLOW** 'pentet' **OR** a response that implies a splitting into five **OR** multiplet **ALLOW** 1 mark for singlet and triplet and quintet/pentet/multiplet with no identification of protons Any suggestion that the oxygens cause a splitting scores a maximum of 2 marks. • All 3 remaining splitting patterns correct 2 marks. • Any 2 correct 1 mark. **IF** number labels for protons in diagram are **not** identified, **ALLOW** identification by chemical shifts for 2 marks max: • singlet at 3.3–4.2 **AND** a triplet at 3.3–4.2 ✓ • quintet/pentet/multiplet at 0.7–2.0 ✓ Clear and unambiguous identification of the protons other than by position number should be credited, *ie* 'CH_2 between two oxygens'

STEMUP.CO.UK

Question	Answer	Mark	Guidance
6 (b)	***ANY 5 marks plus correct structure (in box)***		***ANNOTATIONS MUST BE USED***
	Molecular ion/M^+ peak at (*m*/*z* of) 106 ✓		**ALLOW** molecular mass **OR** relative molecular mass
	Fragment peak at 91 is $C_6H_4–CH_3^+$/$C_6H_5–CH_2^+$ ✓		**ALLOW** $C_6H_4–CH_3$/$C_6H_5–CH_2$ **ALLOW** peak at 91 represents loss of CH_3
	Molecular formula is C_8H_{10} (or implied, *ie* any one of the structures below) ✓		**ALLOW** correct structural **OR** displayed **OR** skeletal formula **ALLOW** combination of formulae as long as unambiguous **ALLOW** a correct name eg a dimethylbenzene
	 ✓		**ALL FOUR** structures needed for 1 mark **ALLOW** correct names
	^{13}C NMR spectrum shows 5 C environments ✓		**ALLOW** NMR spectrum shows five different types of carbon **DO NOT ALLOW** 'NMR spectrum has five peaks' – the mark is for realising what the peaks show, not for just describing the spectrum
	Peak near 20 is a C attached at another carbon, **C**–C **OR** peaks at ~125–140 for aromatic **C**s ✓		

STEMUP.CO.UK

Question			Answer	Mark	Guidance
6	(b)		Number of peaks for other three isomers matched to structures: *Any 2 correct for 2 marks* ✓✓ *1 correct for 1 mark* ✓    4 peaks 3 peaks 6 peaks Correct structure shown:  ✓	6	**ALLOW** 'carbon environments' for peaks
			Total	**9**	

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2011

THIS IS A NEW SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE
CHEMISTRY A
Rings, Polymers and Analysis

F324

Candidates answer on the Question Paper

OCR Supplied Materials:
- *Data Sheet for Chemistry A* (inserted)

Other Materials Required:
- Scientific calculator

Monday 28 June 2010
Morning

Duration: 1 hour

OCE/15373

F 3 2 4

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of the booklet. The question number(s) must be clearly shown.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **16** pages. Any blank pages are indicated.

© OCR 2010 [M/500/7836]
OCR is an exempt Charity

STEMUP.CO.UK

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© OCR 2010

Answer **all** the questions.

1 Benzene is an important industrial chemical and is used in a wide range of manufacturing processes. Over time our understanding of the structure and bonding of benzene has changed and various models have been proposed.

(a) In 1865, Kekulé proposed a model for the structure and bonding of benzene, but there is considerable evidence to suggest that Kekulé's model may not be correct. Scientists have proposed alternative models for the structure and bonding of benzene.

Explain the evidence that led scientists to doubt the model proposed by Kekulé.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

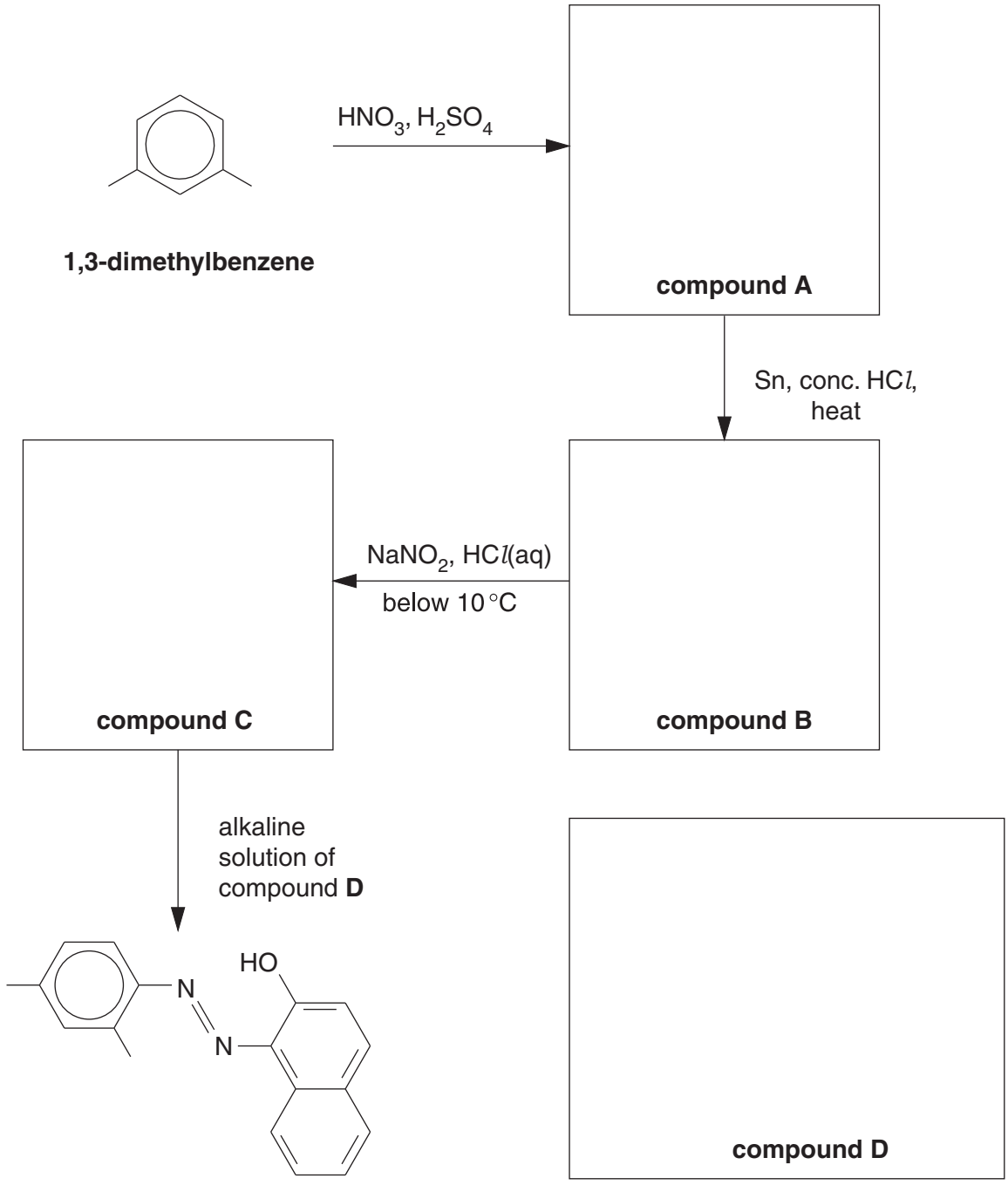
© OCR 2010

STEMUP.CO.UK

(b) Sudan II is an azo dye which was used as a colourant in chilli powder. However, scientists advised the Food Standards Agency that Sudan II was linked to an increased risk of cancer and it is now no longer used as a food colourant.

The flowchart below shows how Sudan II could be prepared in the laboratory from 1,3-dimethylbenzene.

(i) Draw the structures of the organic compounds **A**, **B**, **C** and **D** in the boxes below. Display the functional group in compound **C**.



Sudan II

[4]

© OCR 2010

STEMUP.CO.UK

(ii) Compound **A** is formed by reacting 1,3-dimethylbenzene with HNO_3 and H_2SO_4.

Explain, with the aid of curly arrows, the mechanism for the formation of compound **A**.

Your answer should clearly show the role of H_2SO_4 as a catalyst.

[5]

(iii) Deduce how many **other** structural isomers of compound **A** could have been formed from the mononitration of 1,3-dimethylbenzene.

..... **[1]**

[Total: 13]

© OCR 2010

STEMUP.CO.UK

2 A student was researching the development of polymers and discovered three polyesters, PET, PEN and PGA, that are used in the manufacture of plastic bottles.

(a) The student discovered that the first polyester developed was Terylene which is also known as poly(ethylene terephthalate) or PET.

PET can be made by reacting benzene-1,4-dicarboxylic acid with ethane-1,2-diol.

(i) Draw the **displayed** formula of the repeat unit in PET.

[2]

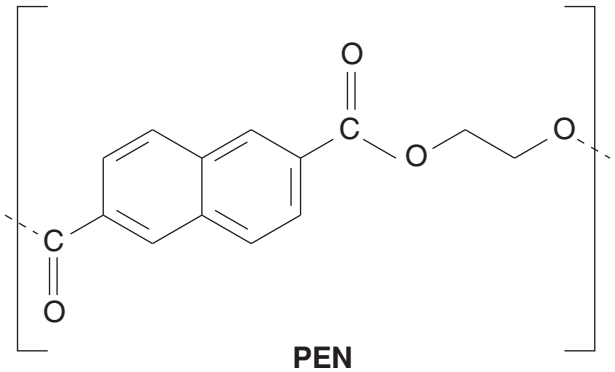
(ii) The industrial manufacture of PET involves two main stages. The first stage, known as 'pre-polymerisation', forms compound **F** with molecular formula $C_{12}H_{14}O_6$.

Draw the structure of compound **F**.

[1]

(b) PEN is a new kind of polyester. PEN is rigid at high temperature whereas PET readily softens.

The repeat unit of PEN is shown below.



PEN

(i) What is the empirical formula of the repeat unit in PEN?

..... **[1]**

© OCR 2010

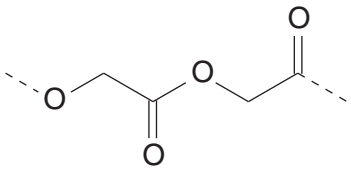
STEMUP.CO.UK

(ii) Draw the structures of **two** monomers that could be used to make PEN.

[2]

(c) Polyglycolic acid, PGA, is a polymer that is being developed as an inner coating for PET bottles.

A short section of PGA is shown below.



PGA

(i) Compared with other synthetic polymers, PGA can be easily hydrolysed.

Draw the skeletal formula of the organic product formed from the complete hydrolysis of PGA by NaOH(aq).

[2]

(ii) Explain why scientists now think that polymers such as PGA are better for the environment than hydrocarbon-based polymers.

In your answer, you should use appropriate technical terms, spelt correctly.

.....

.....

.....

.....

..... **[1]**

[Total: 9]

© OCR 2010

STEMUP.CO.UK

3 A student was given three compounds, an aldehyde, a ketone, and a carboxylic acid.

(a) The student carried out the same two chemical tests on each compound. This allowed her to distinguish between all three compounds.

- Describe two suitable tests that the student could have used.
- Show how the observations would allow her to distinguish between the compounds.

.....

.....

.....

.....

.....

.....

..... **[4]**

(b) Explain how the student could use infrared spectroscopy to confirm which compound is a carboxylic acid.

.....

.....

..... **[1]**

(c) The aldehyde has the molecular formula $C_5H_{10}O$.

The ^1H NMR spectrum of the aldehyde contains a doublet at $\delta = 0.9$ ppm with a relative peak area of six compared with the aldehyde proton.

Analyse this information to deduce the structure of the aldehyde. Explain your reasoning.

.....

.....

.....

.....

.....

..... **[3]**

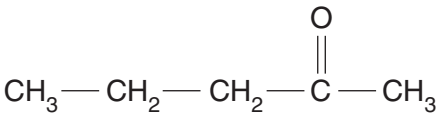
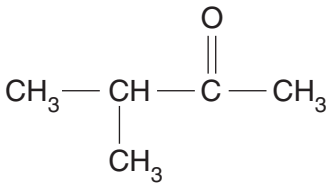
© OCR 2010

STEMUP.CO.UK

(d) The ketone also has the molecular formula $C_5H_{10}O$. There are three structural isomers of this formula that are ketones.

(i) Two of these isomers are shown below.

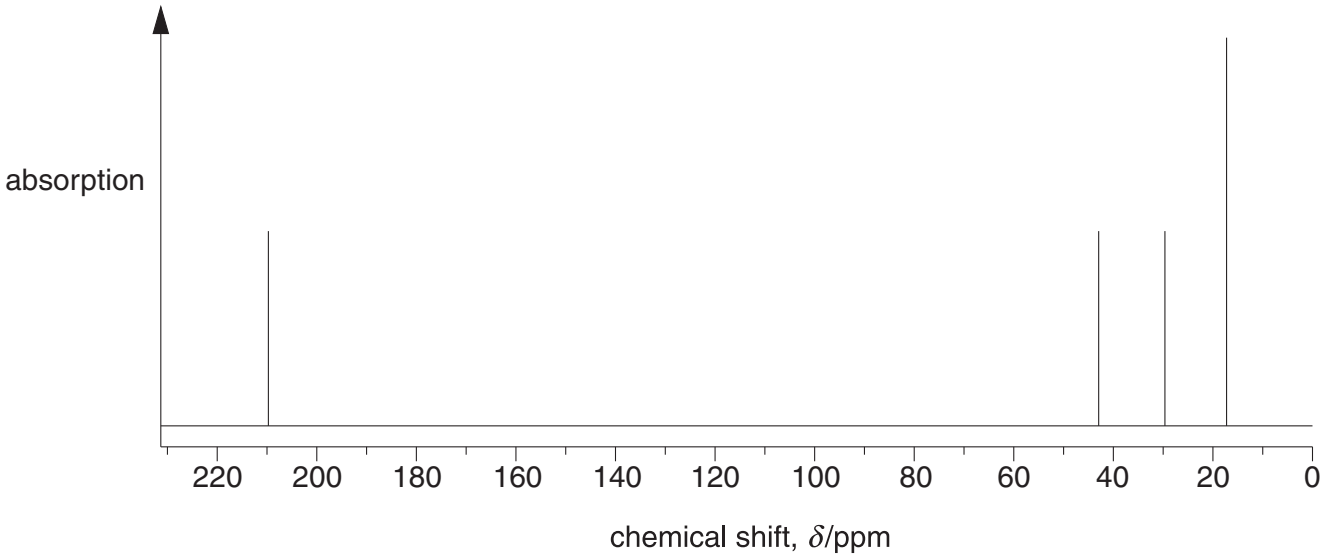
Draw the structural formula of the third structural isomer in the box below.

		
ketone 1	**ketone 2**	**ketone 3**

[1]

(ii) The ^{13}C NMR spectrum of the ketone given to the student is shown below.

- Use the spectrum to identify the ketone. Explain your reasoning.
- Identify the carbon responsible for the peak at $\delta = 210$ ppm.



.....

.....

.....

.....

.....

..... **[3]**

[Total: 12]

© OCR 2010

STEMUP.CO.UK

4 Two esters, $CH_3(CH_2)_2COO(CH_2)_3CH_3$ and $CH_3(CH_2)_2COOCH_2CH_3$, contribute to the odour of pineapple. A food scientist analysed a sample of pineapple essence by separating the two esters using gas chromatography, GC, and measuring their retention times.

(a) (i) State what is meant by *retention time*.

.....

..... **[1]**

(ii) Explain the possible limitations of GC in separating the two esters.

.....

.....

..... **[1]**

(iii) Give the systematic name for the ester $CH_3(CH_2)_2COO(CH_2)_3CH_3$.

..... **[1]**

(b) The unsaturated ester, ethyl deca-2,4-dienoate contributes to the flavour of pears.

(i) Draw the structure of this ester.

[2]

(ii) When pears ripen, ethyl deca-2,4-dienoate is formed following the breakdown of triglycerides.

Draw the general structure of a triglyceride with any functional groups fully displayed.

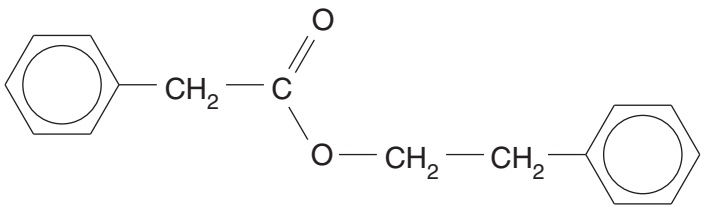
You can use 'R' to represent the carbon chains.

[1]

© OCR 2010

STEMUP.CO.UK

(c) The food scientist decided to synthesise the ester shown below, for possible use as a flavouring.



The **only** organic compound available to the food scientist was phenylethanal ($C_6H_5CH_2CHO$).

Explain how the food scientist was able to synthesise this ester using only phenylethanal and standard laboratory reagents.

In your answer, you should use appropriate technical terms, spelt correctly.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[7]**

[Total: 13]

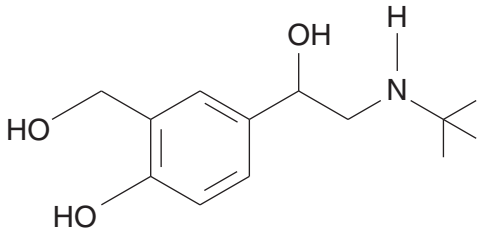
© OCR 2010

STEMUP.CO.UK

5 Hydroxyamines are organic compounds containing hydroxyl and amino functional groups.

(a) Salbutamol is a hydoxyamine used in the treatment of asthma and bronchitis. Salbutamol is an example of a chiral drug.

(i) Draw a circle around the chiral carbon in the structure of salbutamol shown below.



salbutamol

[1]

(ii) Suggest possible problems of making a chiral drug such as salbutamol and describe **two** ways that the pharmaceutical industry might overcome these problems.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

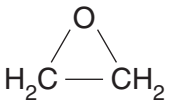
..... **[4]**

© OCR 2010

STEMUP.CO.UK

(b) Monoethanolamine, MEA, $H_2NCH_2CH_2OH$, is a hydroxyamine that is used in aqueous solution as a gas scrubber to remove acidic gases from emissions in incinerators.

MEA is prepared industrially by reacting ammonia with epoxyethane.



epoxyethane

(i) Write an equation for the industrial preparation of MEA.

[1]

(ii) During the manufacture of MEA, a compound with molecular formula $C_4H_{11}NO_2$ is also formed.

Draw the structure of the compound with molecular formula $C_4H_{11}NO_2$.

[1]

(c) The combustion of some polymers produces emissions containing toxic acidic gases such as HC*l* and H_2S. MEA can remove HC*l* and H_2S from the emissions.

Give the formula of the organic salts formed when MEA removes:

(i) HC*l*,

[1]

(ii) H_2S.

[1]

TURN OVER FOR QUESTION 5 PARTS (d) AND (e)

© OCR 2010

STEMUP.CO.UK

(d) MEA, $H_2NCH_2CH_2OH$, can be oxidised to form an α-amino acid.

(i) Explain what is meant by an α-amino acid.

.....

.....

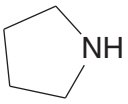
..... **[1]**

(ii) Write an equation for the oxidation of MEA to form an α-amino acid.

Use [O] to represent the oxidising agent.

..... **[1]**

(e) Isomers **F** and **G** are hydroxyamines each with the molecular formula $C_4H_{11}NO$.

- Isomer **F** can be dehydrated to form the cyclic compound 

- Isomer **G** has two chiral centres.

Identify and draw the structural isomers **F** and **G**.

isomer F	**isomer G**

[2]

[Total: 13]

END OF QUESTION PAPER

© OCR 2010

STEMUP.CO.UK

ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

© OCR 2010

ADDITIONAL PAGE

OCR
RECOGNISING ACHIEVEMENT

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations, is given to all schools that receive assessment material and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2010

OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Advanced GCE **F324**

Mark Scheme for June 2010

Oxford Cambridge and RSA Examinations

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of pupils of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

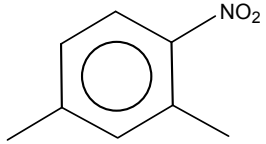
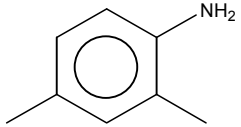
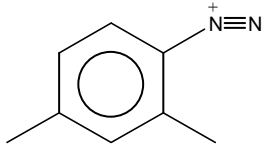
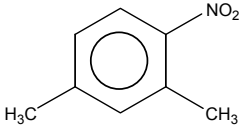
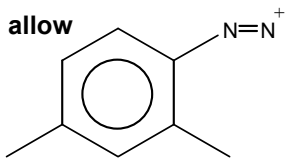
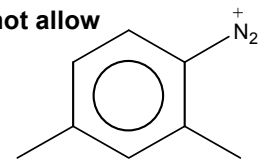
© OCR 2010

Any enquiries about publications should be addressed to:

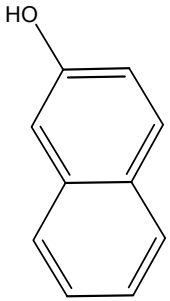
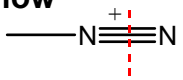
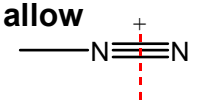
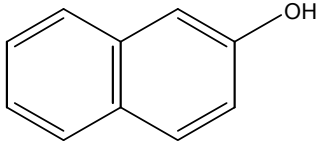
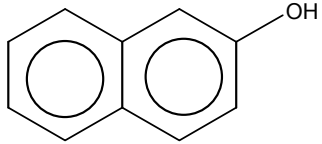
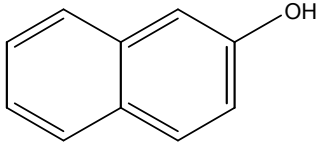
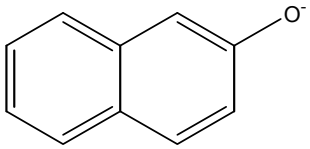
OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

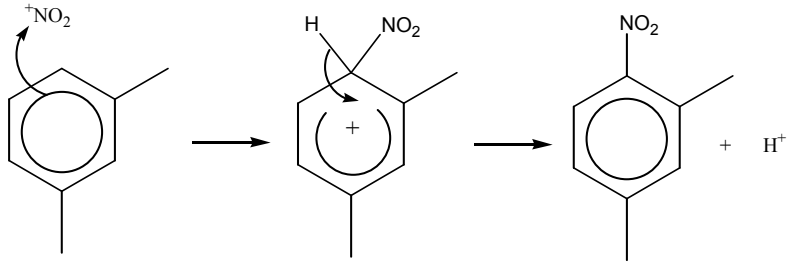
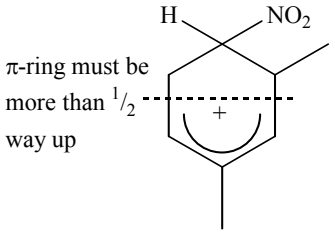
Allow Kekulé structures throughout

Question			Expected Answers	Marks	Additional Guidance
1	a		Bond length intermediate between/different from (short) C=C and (long) C–C ✓ ΔH hydrogenation less exothermic than expected (when compared to ΔH hydrogenation for cyclohexene) ✓ Only reacts with Br_2 at high temp or in presence of a halogen carrier / resistant to electrophilic attack ✓ **Please annotate, use ticks to show where marks are awarded**	3	**ALLOW** all carbon–carbon bonds the same length **ALLOW** ΔH hydrogenation less (negative) than expected **ALLOW** ΔH hydrogenation different from that expected **DO NOT ALLOW** ΔH halogenation/hydration **ALLOW** doesn't decolourise/react with/polarise Br_2 **ALLOW** doesn't undergo addition reactions (with Br_2)
	b	i	compound **A**  if NO_2 in wrong position penalise here and ECF for rest of **b(i)** and **b(ii)** ✓ compound **B**  ✓ compound **C**  ✓	4	**ALLOW** any 4-nitro-1,3-dimethylbenzene drawn in any orientation **ALLOW**  drawn in any orientation **ALLOW** any 4-amino-1,3-dimethylbenzene drawn in any orientation **ECF** amine of incorrect compound **A** (e.g. position of NO_2 or lack of methyl sticks/groups) **ALLOW** diazonium chloride salt of 1,3-dimethylbenzene **ECF** diazonium salt/compound of incorrect compound **B** **IGNORE** Cl^- ion **allow**  **not allow** 

STEMUP.CO.UK

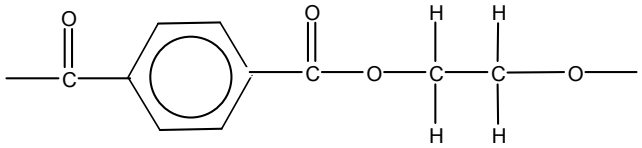
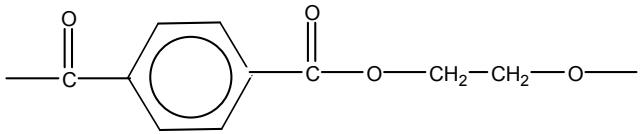
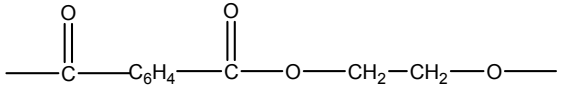
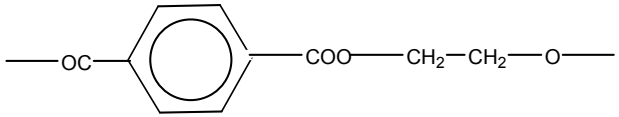
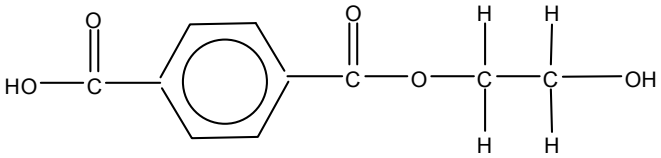
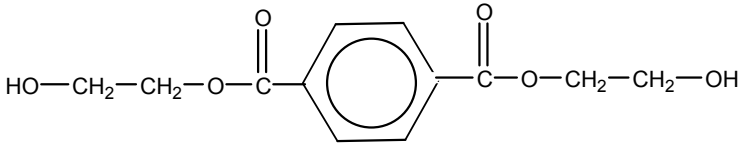
Question	Expected Answers	Marks	Additional Guidance
	compound **D**  ✓		**ALLOW** if + charge is floating between the two Ns only if it is closer to the correct N **allow**  **not allow**  **ALLOW** any of     **ALLOW** O^- in place of OH

STEMUP.CO.UK

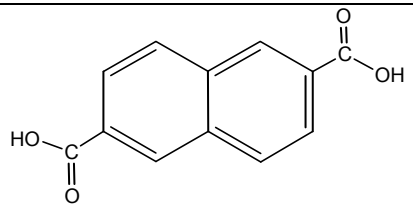
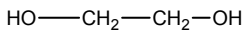
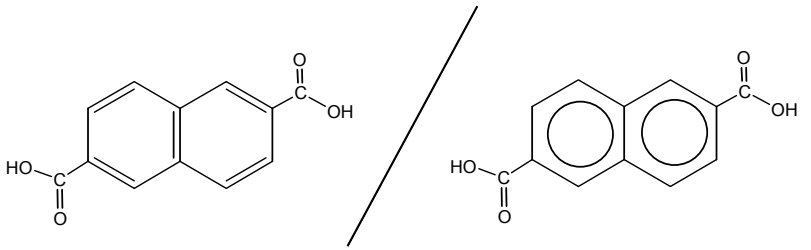
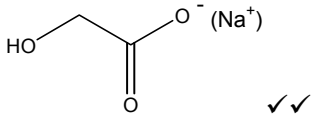
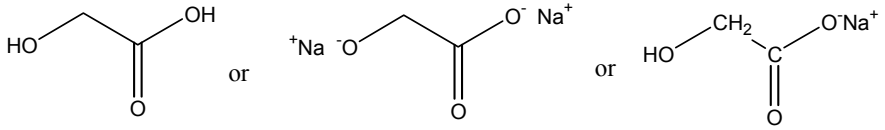
Question	Expected Answers	Marks	Additional Guidance
ii	***mark 1*** $HNO_3 + 2H_2SO_4 \rightarrow H_3O^+ + 2HSO_4^- + NO_2^+$ ✓ ***mark 4*** – curly arrow from C–H bond back to reform π ring **AND** correct products ✓  ***mark 2*** – curly arrow from π ring to $^+NO_2$ ✓ ***mark 3*** – intermediate with π ring broken in the correct place ✓ ***mark 5*** - $H^+ + HSO_4^- \rightarrow H_2SO_4$ ✓ Link to compound **A** in part **(i)** – cannot score full marks [in **b(i)** & **b(ii)**] if NO_2 is not adjacent to a methyl	5	Equation to show formation of NO_2^+ ion ✓ **ALLOW** $HNO_3 + H_2SO_4 \rightarrow H_2O + HSO_4^- + NO_2^+$ $HNO_3 + H_2SO_4 \rightarrow HSO_4^- + H_2NO_3^+ \rightarrow H_2O + NO_2^+$ **ALLOW** mark 2 curly arrow must be from 1,3-dimethylbenzene to NO_2^+ and **ECF** for marks 3 and 4 **DO NOT ALLOW** intermediate  **ALLOW** CH_3s shown **ALLOW** $H_3O^+ + HSO_4^- \rightarrow H_2O + H_2SO_4$
iii	2 ✓	1	No other correct response
	Total	**13**	

If NO_2 is in correct position do not penalise even if compound **A** in **b(i)** is not in correct position

STEMUP.CO.UK

Question			Expected Answers	Marks	Additional Guidance
2	a	i	 ✓✓ Ester group must be displayed to get both marks and must contain 4 Os	2	**ALLOW** for both marks  **ALLOW** for one mark  **ALLOW** for one mark  **ALLOW** Kekulé structure / $(CH_2)_2$ **ALLOW** one mark if end bonds missing **ALLOW** 1 mark if the CH_2CH_2 is drawn skeletally **ALLOW** for  **ALLOW** <u>1 mark</u> if repeat unit shows a displayed ester group and contains a benzene ring and two other carbons **DO NOT ALLOW** $-OCC_6H_4COOCH_2CH_2O-$
		ii	 ✓	1	**ALLOW** Kekulé structure/ $(CH_2)_2$ CO_2 for ester groups C_6H_4 if already penalised in **a(i)**

STEMUP.CO.UK

Question			Expected Answers	Marks	Additional Guidance
	b	i	$C_7H_5O_2$	1	**ALLOW** any order of elements **ALLOW** $C_{14}H_{10}O_4 \rightarrow C_7H_5O_2$ or $C_{14}H_{10}O_4 = C_7H_5O_2$
		ii	  ✓ ✓ **Penalise incorrect bond linkage in 2b(ii) only. Do not penalise elsewhere on the paper**	2	**ALLOW** $COOH/CO_2H$ **ALLOW**  **ALLOW** $HO(CH_2)_2OH$
	c	i	 ✓✓	2	**ALLOW** any of the following for 1 mark  **DO NOT ALLOW** any other response
		ii	(PGA is) (bio)degradable **OR** photodegradable **OR** hydrolysed (but hydrocarbon based polymers are non-biodegradable) ✓ One of (bio)degradable **OR** photodegradable **OR** hydrolysed must be spelt correctly – if one spelt correctly and another incorrectly spelt – **ALLOW** mark	1	**ALLOW** broken down by bacteria (must be spelt correctly) **ALLOW** degrade as alternative to degradable **ALLOW** undergoes hydrolysis as alternative to hydrolysed **IGNORE** any additional information if the additional information is correct e.g. biodegradable and doesn't produce toxic gases **DO NOT ALLOW** any additional information if the additional information is incorrect e.g. biodegradable and can be recycled
			Total	9	

STEMUP.CO.UK

<table>
<tr><th colspan="3">Question</th><th colspan="2">Expected Answers</th><th>Marks</th><th>Additional Guidance</th></tr>
<tr><td>3</td><td>a</td><td></td><td colspan="2">Alternative approaches</td><td rowspan="3">4</td><td rowspan="3">ALLOW ammoniacal $AgNO_3$/ $Ag^+(NH_3)_2$ / $Ag^+(NH_3)$
ALLOW acidified dichromate OR Fehlings as an alternative to Tollens – observation ‘turn green’ OR ‘red precipitate’ respectively
ALLOW acidified manganagate(VII) and observation as either brown precipitate/decolourised/pale pink
ALLOW Brady’s (reagent)
ALLOW orange/red/yellow for colour of the 2,4-DNP(H) precipitate
ALLOW solid/crystals in place of precipitate
IGNORE any reference to melting points
ALLOW PCl_5 as a test for the acid – observation would be ‘white fumes (of HCl)’

ALLOW detection of (carboxylic) acid by reacting with an alcohol to make an ester but no mark for the observation.

DO NOT ALLOW detection of (carboxylic) acid by pH or indicator

Please annotate, use ticks to show where marks are awarded</td></tr>
<tr><td></td><td></td><td></td><td>Tollens’ test AND ‘silver precipitate/mirror’ ✓
is the aldehyde ✓

react with 2,4-DNP(H) and ‘orange precipitate’ ✓

must be the ketone ✓</td><td>Tollens’ test AND ‘silver precipitate/mirror’ ✓
is the aldehyde ✓

react with carbonate/ hydrogencarbonate/ Na/Mg and ‘fizzes/ bubbles/ effervesces/ gas evolved ✓

must be the (carboxylic) acid ✓</td></tr>
<tr><td></td><td></td><td></td><td>2,4-DNP(H) AND orange precipitate ✓
is either aldehyde OR ketone ALLOW carbonyl OR C=O✓

Tollens’ test & ‘silver ppt/mirror’ ✓
is the aldehyde ✓</td><td>2,4-DNP(H) and no orange precipitate ✓
is the (carboxylic) acid ✓

Tollens’ test & ‘silver ppt/mirror’ ✓
is the aldehyde ✓</td></tr>
<tr><td></td><td>b</td><td></td><td colspan="2">Peak in range 2500–3300 (cm^{-1}) or (around) 3000 shows O–H ✓
[need wavenumber (or range) <u>and</u> O–H bond]</td><td>1</td><td>DO NOT ALLOW single peak quoted within range 2500–3300 other than 3000 (cm^{-1}) for OH
DO NOT ALLOWrange 3200–3550 (cm^{-1})
IGNORE any reference to C-O or C=O</td></tr>
</table>

STEMUP.CO.UK

<table>
<tr><th colspan="3">Question</th><th>Expected Answers</th><th>Marks</th><th>Additional Guidance</th></tr>
<tr><td></td><td>c</td><td></td><td>Alternative approaches depending on whether or not the aldehyde is correct

Doublet indicates adjacent C is bonded to only 1H
OR
(relative) peak area indicates 2 x CH_3 (in the same environment) ✓

If aldehyde is correct
$(CH_3)_2CH$——CH_2—CHO
✓ ✓
If aldehyde is correct only need to explain doublet OR peak areas

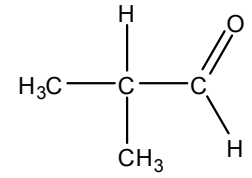
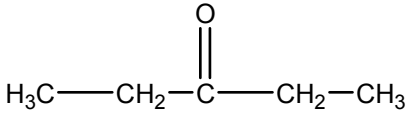
Doublet indicates adjacent C is bonded to only 1H✓
AND
(relative) peak area indicates 2 x CH_3 (in the same environment) ✓

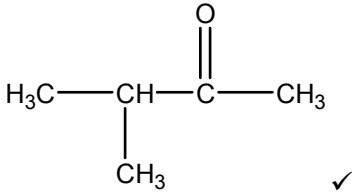
If aldehyde identified is incorrect ×

if aldehyde is incorrect must explain both doublet or peak areas</td><td></td><td>ALLOW 3-methylbutanal , any correct unambiguous structure
ALLOW two marks for correct aldehyde with no explanation

ALLOW doublet/peak at 0.9ppm due to R–CH
ALLOW the splitting shows adjacent to CH/environment that contains 1 H/proton

ALLOW 6 Hs/ protons in same environment
DO NOT ALLOW 6 Hs in same environment next to CHO

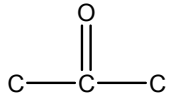
e.g. 
would score two marks if the doublet and the peak areas were correctly explained</td></tr>
<tr><td></td><td>d</td><td>i</td><td>  ✓
ketone 3</td><td>1</td><td>ALLOW displayed/skeletal formulae</td></tr>
<tr><td></td><td></td><td>ii</td><td>There are 4 (different C) environments ✓

(therefore) it is ketone 2 /
  ✓

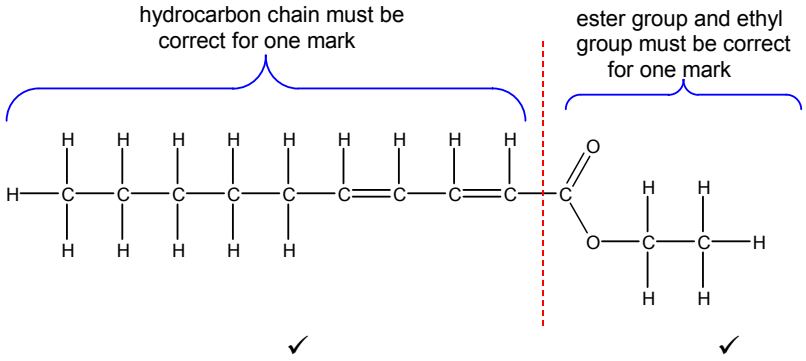
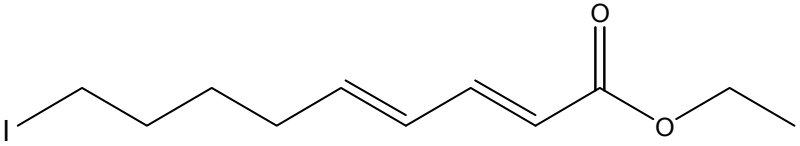
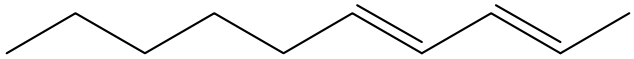
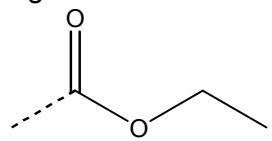
(C responsible for peak at δ = 210 ppm) is C=O/carbonyl carbon ✓</td><td>3</td><td>ALLOW 2 Cs are in same environment/equivalent

ALLOW 3-methylbutan(-2-)one/ any correct unambiguous structure

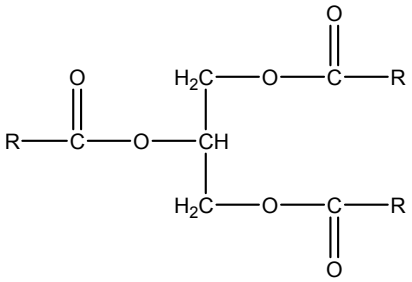
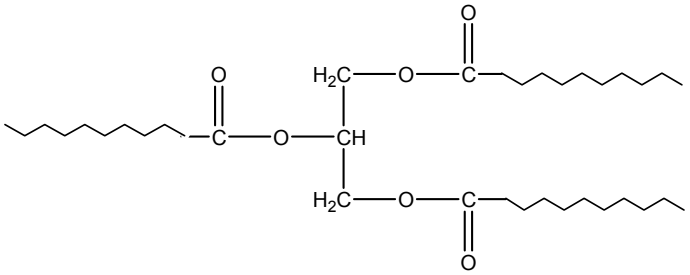
ALLOW 2-methylbutan-3-one

ALLOW
  </td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>12</td><td></td></tr>
</table>

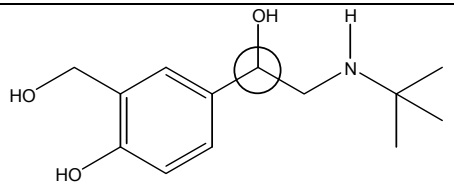
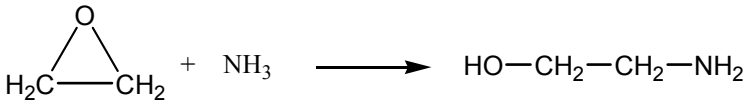
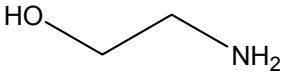
STEMUP.CO.UK

Question			Expected Answers	Marks	Additional Guidance
4	a	i	The time (from the injection of the sample) for the component to leave the column ✓	1	**ALLOW** time from injection to detection **ALLOW** time spent in column **ALLOW** time taken to reach detector
		ii	They have similar retention times ✓	1	**ALLOW** both are esters therefore partition/adsorption/retention times will be very similar **ALLOW ECF** if they describe R_f values in part **a(i)** **ALLOW** same retention times
		iii	Butylbutanoate ✓	1	**ALLOW** butyl butanoate **ALLOW** but-1-yl butanoate **DO NOT ALLOW** butanyl butanoate
	b	i	 ✓ ✓	2	**ALLOW** any correct unambiguous structure/ $CH_3(CH_2)_4CHCHCHCHCOOCH_2CH_3$ / $CH_3(CH_2)_4CHCHCHCHCOOC_2H_5$ $CH_3(CH_2)_4(CH)_4COOCH_2CH_3$ **DO NOT ALLOW** $C_5H_{11}CHCHCHCHCOOCH_2CH_3$ etc **ALLOW** CO_2 for ester  **ALLOW** 1 mark for correct 2,4-decadiene structure e.g.  **ALLOW** 1 mark for correct ethyl … oate structure e.g.  or —$CO_2C_2H_5$ or —$COOC_2H_5$

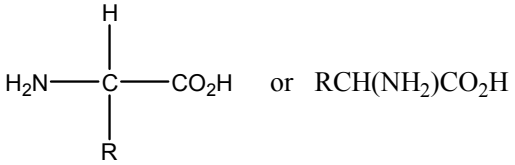
STEMUP.CO.UK

Question	Expected Answers	Marks	Additional Guidance
ii		1	**ALLOW**  any orientation of the three fatty acids
c	**1.** react phenylethanal with $H_2SO_4/K_2Cr_2O_7$ ✓ **2.** to get phenylethanoic acid/$C_6H_5CH_2COOH$ ✓ mark **2** can be scored if dichromate is used without being acidified **3.** react phenylethanal with $NaBH_4$ ✓ **4.** to get 2-phenylethanol/$C_6H_5CH_2CH_2OH$ ✓ mark **3** must be correct to score mark **4** **5.** react phenylethanoic acid with 2-phenylethanol. If both already correctly named **ALLOW** acid and alcohol✓ **6.** H_2SO_4 if linked to the reaction of an alcohol and acid✓ **7.** reflux in either **(1)** or **(5)** or catalyst used in **(5)** ✓ QWC must spell catalyst or reflux correctly if either phenylethanoic acid or 2-phenyethanol not prepared – automatically lose two marks	7	**ALLOW** H^+ & $Cr_2O_7^{2-}$ or $H_2SO_4/Na_2Cr_2O_7$ - any other oxidising agent or other named acid – please consult with TL **ALLOW** $LiAlH_4$ as alternative to $NaBH_4$ phenylethanoic acid & phenylethanol must be unambiguously identified by either name or formula **DO NOT ALLOW** or oxidised to form(a carboxylic) acid or reduced to form alcohol for marks 2 and 4 **ALLOW** conc H_2SO_4 **DO NOT ALLOW** dilute or H_2SO_4(aq) **DO NOT ALLOW** just acid catalyst **DO NOT ALLOW** HCl, HNO_3 **Please annotate, use ticks to show where marks are awarded**
	Total	**13**	

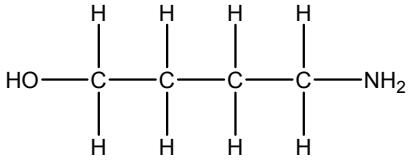
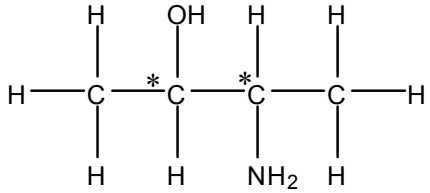
STEMUP.CO.UK

Question			Expected Answers	Marks	Additional Guidance
5	a	i	 ✓	1	**ALLOW** * in place of circle **ALLOW** if circle extends to include OH
		ii	**Mark 1** – production of a single isomer is more expensive/difficult **OR** separation of the single isomer is expensive/difficult✓ **Mark 2** – one of the isomers is more (pharmacologically) active or one of the isomers might have adverse/harmful/nasty side effects ✓ **Marks 3 and 4** – problems are overcome by using: Enzymes/bacteria/biological catalyst Chiral synthesis Chiral catalyst or transition metal complex Start with a natural chiral molecule or chiral pool } ✓✓ any	4	**IGNORE** any reference to dosage **ALLOW** one is more effective/works (better) **DO NOT ALLOW** use naturally occurring isomer unless stated that it is a chiral compound **DO NOT ALLOW** transition metal ion **DO NOT ALLOW** pool synthesis Chiral pool synthesis scores 1 (not 2) marks
	b	i	 ✓	1	**ALLOW**  **ALLOW** epoxy ethane as C_2H_4O, $(CH_2)_2O$, CH_2OCH_2 **ALLOW** product as $HO(CH_2)_2NH_2$ **DO NOT ALLOW** product as C_2H_7NO
		ii	$HO—CH_2—CH_2—NH—CH_2—CH_2—OH$ ✓	1	**ALLOW** $(CH_2)_2$ **ALLOW** displayed/skeletal formula **DO NOT ALLOW** molecular formula

STEMUP.CO.UK

Question			Expected Answers	Marks	Additional Guidance
	c	i	$HO—CH_2—CH_2—NH_3^+ Cl^-$ Must show Cl^- ion ✓	1	**ALLOW** $HOCH_2CH_2NH_3Cl$ if formula is correct and both charges not shown **ALLOW** $(CH_2)_2$/ any correct unambiguous structure **DO NOT ALLOW** ions joined by covalent bonds
		ii	$HO—CH_2—CH_2—NH_3^+ HS^-$ Must show HS^- ion ✓	1	**ALLOW** if formula is correct and both charges not shown **ALLOW** $(CH_2)_2$/ any correct unambiguous structure **ALLOW** $\left(HO—CH_2—CH_2—NH_3^+\right)_2 S^{2-}$
	d	i	Both NH_2 and COOH are joined to the same C ✓	1	**ALLOW**  or $RCH(NH_2)CO_2H$ The 4 groups/atoms attached to the C can be in any order but CH must be adjacent. ( ) not essential
		ii	$HO—CH_2—CH_2—NH_2 + 2[O] \longrightarrow HO—\overset{\overset{O}{\|\|}}{C}—CH_2—NH_2 + H_2O$ ✓	1	**ALLOW** $(CH_2)_2$ **DO NOT ALLOW** molecular formula
	e	i	**Question 5e is followed by two blank lined pages (15 and 16) which candidates can use instead of requesting additional paper. Please check to see whether or not pages 15 or 16 have been used**		

STEMUP.CO.UK

Question			Expected Answers	Marks	Additional Guidance
	e	i	Isomer **F**  ✓ Isomer **G**  * not required ✓	2	**ALLOW** $HO(CH_2)_4NH_2$/ **ALLOW** any correct unambiguous structure of 1-aminobutan-4-ol **ALLOW** $CH_3CH(OH)CH(NH_2)CH_3$ **ALLOW** any correct unambiguous structure of 2-aminobutan-3-ol.
			Total	**13**	

STEMUP.CO.UK

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2010

THIS IS A NEW SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE
CHEMISTRY A
Rings, Polymers and Analysis

F324

Candidates answer on the Question Paper

OCR Supplied Materials:
- *Data Sheet for Chemistry A* (inserted)

Other Materials Required:
- Scientific calculator

Wednesday 27 January 2010
Morning

Duration: 1 hour

OCE/15371

F 3 2 4

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means for example you should:
  - ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  - organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry A* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.
- This document consists of **16** pages. Any blank pages are indicated.

© OCR 2010 [M/500/7836]
OCR is an exempt Charity

STEMUP.CO.UK

Answer **all** the questions.

1 A chemist was investigating the reactions of benzene, phenol and cyclohexene with bromine. She found that they all reacted with bromine but under different conditions.

(a) The chemist found that when benzene reacts with bromine, a halogen carrier is required as a catalyst.

Write an equation for this reaction.
You do **not** need to show the halogen carrier in your equation.

[1]

(b) The chemist also found that when phenol or cyclohexene reacts with bromine, a halogen carrier is **not** required.

(i) The chemist observed that bromine decolourises when it reacts with phenol.

What other observation would she have made?

Draw the structure of the organic product formed.

Observation .....

Organic product:

[2]

(ii) Cyclohexene also decolourises bromine.

Name the organic product formed.

..... **[1]**

© OCR 2010

(iii) Explain the relative resistance to bromination of benzene compared to phenol and compared to cyclohexene.



In your answer, you should use appropriate technical terms, spelt correctly.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

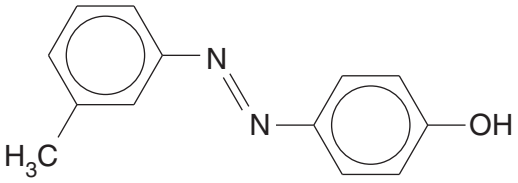
.....

..... **[5]**

© OCR 2010

STEMUP.CO.UK

(c) Compound **A**, shown below, is being considered as an azo dye by a chemical company. A chemist planned a two-stage synthesis of compound **A** starting from an aromatic amine.



compound A

The aromatic amine is first converted into a diazonium ion.

- Draw the displayed formula of the aromatic amine **and** of the diazonium ion.
- State the reagents and conditions for each stage in the synthesis of compound **A** from an aromatic amine.

.....

.....

.....

..... **[5]**

[Total: 14]

© OCR 2010

STEMUP.CO.UK

2 Hydroxyethanal, $HOCH_2CHO$, is sometimes referred to as the 'first sugar' as it is the simplest possible molecule that contains both an aldehyde group and an alcohol group.

A biochemist investigated some redox reactions of hydroxyethanal and found that several different products were produced.

(a) The biochemist reacted hydroxyethanal with Tollens' reagent.

(i) State what the biochemist would see when hydroxyethanal reacts with Tollens' reagent.

..... **[1]**

(ii) Write the structural formula of the organic product formed when hydroxyethanal reacts with Tollens' reagent.

[1]

(b) The biochemist also reacted hydroxyethanal with acidified dichromate by heating under reflux.

Write an equation for this oxidation.

Use **[O]** to represent the oxidising agent.

[2]

(c) The biochemist then reduced hydroxyethanal using aqueous $NaBH_4$.

(i) Write the structural formula of the organic product.

..... **[1]**

(ii) Outline the mechanism for this reduction.

Use curly arrows and show any relevant dipoles.

[4]

[Total: 9]

© OCR 2010

STEMUP.CO.UK

3 α-Amino acids are found in human sweat. A student had read that chromatography could be used to separate and identify the amino acids present in human sweat.

(a) The student used Thin-Layer Chromatography (TLC) to separate the α-amino acids in a sample of human sweat and discovered that three different α-amino acids were present.

(i) Name the process by which TLC separates α-amino acids.

..... **[1]**

(ii) The chromatogram was treated to show the positions of the separated α-amino acids.

Explain how the student could analyse the chromatogram to identify the three α-amino acids that were present.

.....

.....

.....

..... **[2]**

(iii) Several α-amino acids have structures that are very similar.

Suggest why this could cause problems when using TLC to analyse mixtures of α-amino acids.

.....

..... **[1]**

(b) Some of the α-amino acids found in human sweat are shown in the table below.

α-amino acid	**R group**
glycine	H
leucine	$CH_2CH(CH_3)_2$
isoleucine	$CH(CH_3)CH_2CH_3$
alanine	CH_3
valine	$CH(CH_3)_2$
lysine	$(CH_2)_4NH_2$
glutamic acid	$(CH_2)_2COOH$

Table 1

© OCR 2010

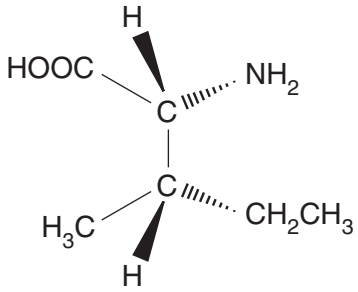
STEMUP.CO.UK

(i) State the general formula of an α-amino acid.

[1]

(ii) There are four stereoisomers of isoleucine.

One of the stereoisomers is shown below.



Draw 3D diagrams for the other **three** stereoisomers of isoleucine.

[3]

© OCR 2010

STEMUP.CO.UK

α-amino acid	R group
glycine	H
leucine	$CH_2CH(CH_3)_2$
isoleucine	$CH(CH_3)CH_2CH_3$
alanine	CH_3
valine	$CH(CH_3)_2$
lysine	$(CH_2)_4NH_2$
glutamic acid	$(CH_2)_2COOH$

Table 1

(c) α-Amino acids form different ions at different pH values. Zwitterions are formed when the pH is equal to the isoelectric point of the α-amino acid.

The isoelectric points of three α-amino acids are given below:

alanine, pH = 6.0 **glutamic acid, pH = 3.2** **lysine, pH = 9.7**

Draw the structures of the ions formed by these α-amino acids at the pH values below. Refer to **Table 1** above.

alanine at pH = 6.0	glutamic acid at pH = 10	lysine at pH = 2.0

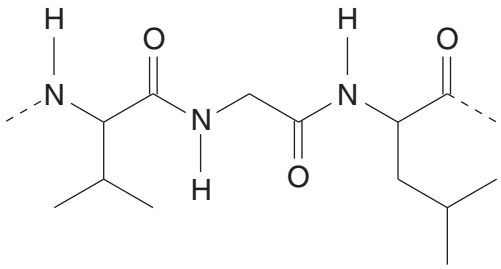
[3]

© OCR 2010

STEMUP.CO.UK

(d) α-Amino acids can react to form polypeptides.

A short section of a polypeptide is shown below.

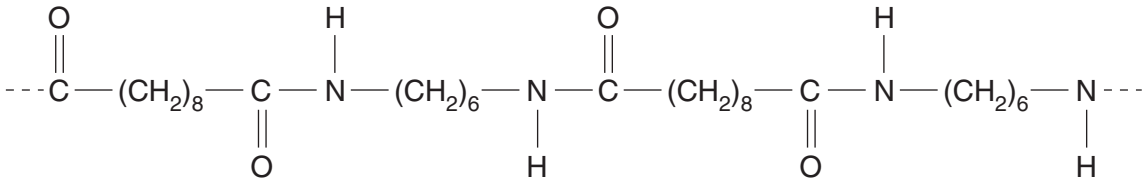


Name the α-amino acid sequence in this section of the polypeptide. Refer to **Table 1**.

..... **[1]**

(e) Synthetic polyamides, such as nylon, contain the same link as polypeptides. Nylon is the general name for a family of polyamides.

A short section of a nylon polymer is shown below.



Draw the structures of **two** monomers that could be used to make this nylon.

[2]

[Total: 14]

© OCR 2010

STEMUP.CO.UK

4 An industrial chemist discovered five bottles of different chemicals (three esters and two carboxylic acids) that were all labelled $C_5H_{10}O_2$.

The different chemicals had the structural formulae below.

$CH_3CH_2COOCH_2CH_3$ $(CH_3)_3CCOOH$ $CH_3COOCH(CH_3)_2$

$(CH_3)_2CHCH_2COOH$ $(CH_3)_2CHCOOCH_3$

(a) The chemist used both infrared and ^{13}C NMR spectroscopy to identify the two carboxylic acids and to distinguish between them.

How do both types of spectra allow the carboxylic acids to be identified and distinguished?

.....

.....

.....

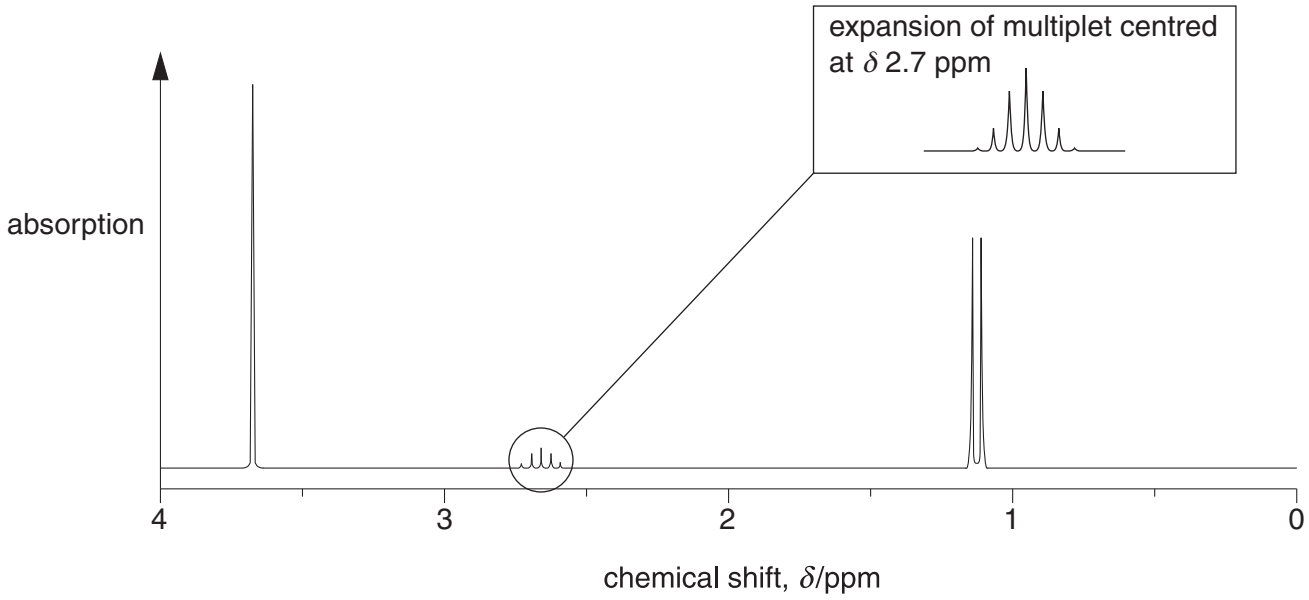
.....

.....

.....

..... **[3]**

(b) The chemist analysed one of the esters by ^1H NMR spectroscopy. The spectrum is shown below.



© OCR 2010

STEMUP.CO.UK

11

Analyse the splitting patterns and the chemical shift values to identify the ester.

Give your reasoning.

In your answer, you should use appropriate technical terms, spelt correctly.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

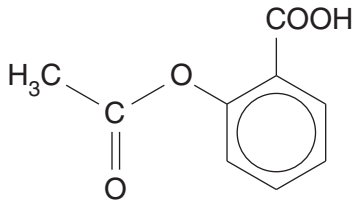
..... **[6]**

[Total: 9]

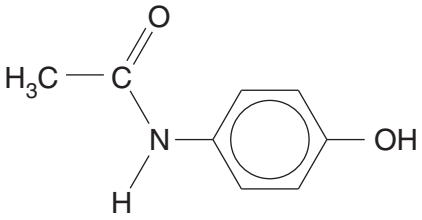
© OCR 2010

STEMUP.CO.UK

5 Aspirin and paracetamol are commonly available painkillers.



aspirin



paracetamol

Aspirin and paracetamol can be prepared using ethanoic anhydride, $(CH_3CO)_2O$.

Some examples of the reactions of ethanoic anhydride are shown below.

reaction 1 $(CH_3CO)_2O + CH_3OH \rightarrow CH_3COOCH_3 + CH_3COOH$

reaction 2 $(CH_3CO)_2O + CH_3NH_2 \rightarrow CH_3CONHCH_3 + CH_3COOH$

reaction 3 $(CH_3CO)_2O + C_6H_5OH \rightarrow CH_3COOC_6H_5 + CH_3COOH$

(a) Draw the structure of a compound that could react with ethanoic anhydride to form aspirin.

[1]

© OCR 2010

STEMUP.CO.UK

(b) Ethanoic anhydride can react with 4-aminophenol to produce paracetamol.

(i) Write an equation, showing structural formulae, for this formation of paracetamol.

[2]

(ii) An impurity with molecular formula $C_{10}H_{11}NO_3$ is also formed.

Draw the structure of this impurity.

[1]

(iii) Explain why it is necessary for pharmaceutical companies to ensure that drugs and medicines are pure.

.....

.....

..... **[1]**

(c) Name the functional groups in aspirin and in paracetamol.

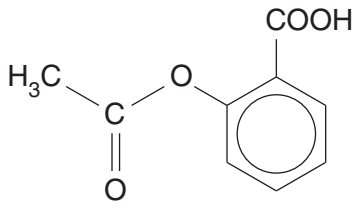
aspirin .....

paracetamol ..... **[2]**

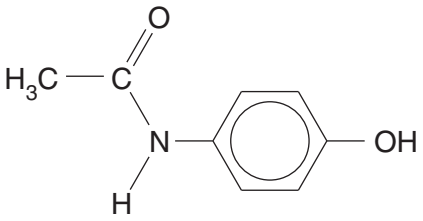
© OCR 2010

STEMUP.CO.UK

(d) A student carried out some reactions with samples of aspirin and paracetamol in the laboratory. Their structures are repeated below.



aspirin



paracetamol

The student tried to react each of the reagents **A**, **B** and **C** with aspirin and paracetamol.

- Reagent **A** reacted with aspirin **and** with paracetamol.
- Reagent **B** reacted **only** with aspirin.
- Reagent **C** reacted **only** with paracetamol.

Suggest possible identities of reagents **A**, **B** and **C** and the organic products that would be formed.

(i) Reagent **A**: .....

Organic product with aspirin:

Organic product with paracetamol:

[3]

© OCR 2010

STEMUP.CO.UK

(ii) Reagent **B**: .....

Organic product with aspirin:

[2]

(iii) Reagent **C**: .....

Organic product with paracetamol:

[2]

[Total: 14]

END OF QUESTION PAPER

© OCR 2010

STEMUP.CO.UK

PLEASE DO NOT WRITE ON THIS PAGE

RECOGNISING ACHIEVEMENT

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations, is given to all schools that receive assessment material and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

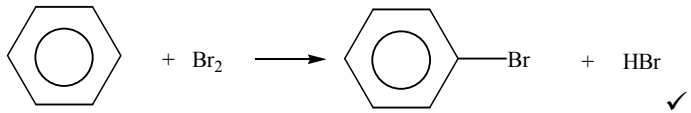
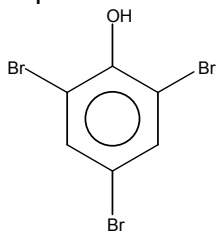
If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

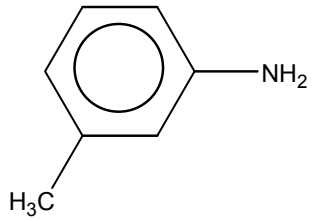
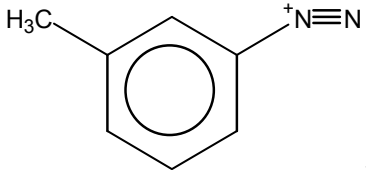
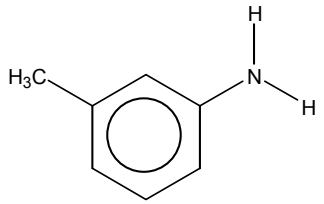
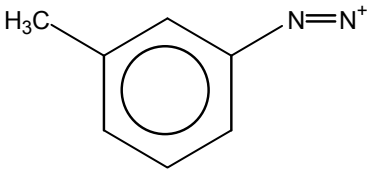
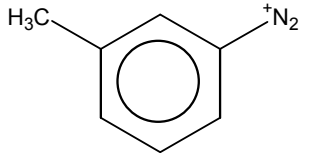
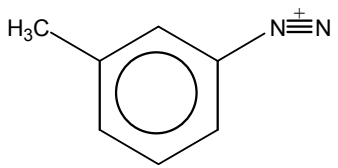
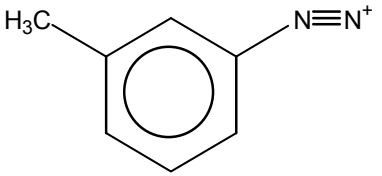
OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2010

F324 Rings, Polymers and Analysis

Question			Expected Answers	Marks	Additional Guidance
1	(a)		 ✓	1	**ALLOW** $C_6H_6 + Br_2 \longrightarrow C_6H_5Br + HBr$ **DO NOT ALLOW** multiple substitution **DO NOT ALLOW** Br^+
	(b)	(i)	White precipitate **OR** white solid **OR** white crystals ✓  ✓	2	**DO NOT ALLOW** colourless **DO NOT ALLOW** white ppt and bubbles **DO NOT ALLOW** $Br_3C_6H_2OH$ **OR** 2,4,6-tribromophenol **OR** tribromophenol
		(ii)	1,2-Dibromocyclohexane ✓	1	**ALLOW** 1,2dibromocyclohexane **OR** 1-2dibromocyclohexane **OR** 12dibromocyclohexane **OR** cyclo-1,2-dibromohexane **DO NOT ALLOW** dibromocyclohexane **OR** $C_6H_{10}Br_2$ **OR** structures
		(iii)	**MUST** spell delocalised/delocalized or localised/localized correctly once in the answer to obtain all 5 marks **benzene** electrons or π-bonds are delocalised ✓ **phenol** a lone or non-bonded pair of electrons on the oxygen or the OH group is (partially) delocalised into the ring ✓ **cyclohexene** electrons are localised **OR** delocalised between two carbons ✓ benzene has a lower **electron density OR** phenol has a higher electron density **OR** cyclohexene has a higher electron density ✓ benzene cannot **polarise** or induce a dipole in Br_2 **OR** phenol can polarise the Br_2 **OR** cyclohexene can polarise Br_2 or the Br–Br bond ✓	5	**ALLOW** diagram to show overlap of all 6 p-orbitals for delocalisation **DO NOT ALLOW** benzene has delocalised structure or ring **ALLOW** diagram to show movement of lone pair into ring for phenol **ALLOW** diagram or description of overlap of 2 adjacent p-orbitals for bonding in cyclohexene **DO NOT ALLOW** cyclohexene has a C=C double bond **IGNORE** slip if cyclohexene is written as cyclohexane but π - bonding correctly described **DO NOT ALLOW** charge density **OR** electronegativity instead of electron density **ALLOW** $Br^{\delta+}$ **OR** electrophile Br^+ as alternate to polarise

STEMUP.CO.UK

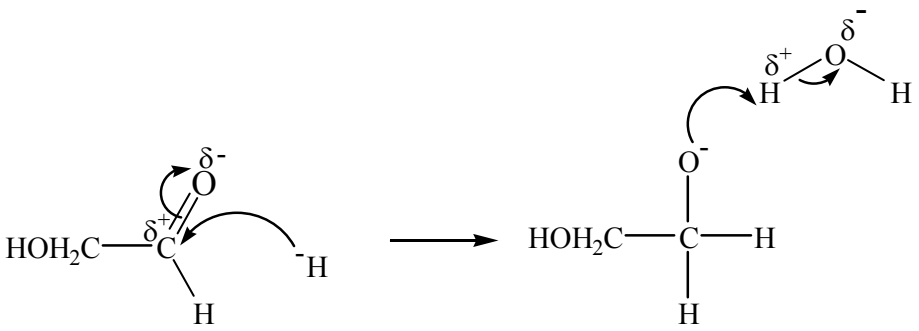
	(c)		 ✓  ✓✓ **ALLOW** ECF ✓✓ on incorrect amine HNO_2 + HCl and temp < 10 °C **OR** $NaNO_2$ + HCl and temp < 10 °C ✓ alkaline **AND** phenol (if temperature stated must be below 10 °C) ✓	**5**	**ALLOW**  **IGNORE** Cl^- ion **DO NOT ALLOW** if ring is connected to the N triple bond in the diazonium or if diazonium has a negative charge **ALLOW** one mark for correct displayed diazonium if alkyl group is not shown **ALLOW**  for both marks **ALLOW**  for one mark **ALLOW**  for one mark **ALLOW**  for one mark **ALLOW** NaOH **OR** KOH & C_6H_5OH **OR** phenoxide ion **OR** $C_6H_5O^-$ **ALLOW** reagents and conditions from the equations
			Total	**14**	

STEMUP.CO.UK

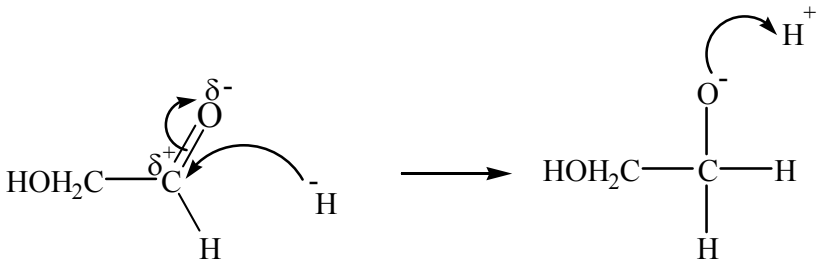
Question			Expected Answers	Marks	Additional Guidance
2	(a)	(i)	silver mirror ✓	1	**ALLOW** Ag(s) **OR** Ag mirror **OR** precipitate **OR** ppt **OR** solid **ALLOW** brown **OR** black **OR** grey
		(ii)	$HOCH_2COOH$ ✓	1	**ALLOW** $CH_2OHCOOH$ **OR** CH_2OHCO_2H **OR** $HOCH_2CO_2H$ **OR** displayed **OR** skeletal formula **OR** $HOCH_2COO^-$ **DO NOT ALLOW** C_2H_4O **OR** 2-hydroxyethanoic acid
	(b)		$HOCH_2CHO + 3[O] \rightarrow HOOCCOOH + H_2O$ reagents ✓ both products ✓	2	**ALLOW** displayed/skeletal formula/COOHCOOH ✓✓ if molecular formula used $C_2H_4O_2 + 3[O] \rightarrow C_2H_2O_4 + H_2O$ max = 1 ✓ **Any correctly balanced equation for partial oxidation** can score 1 mark ✓ $HOCH_2CHO + [O] \rightarrow HOCH_2COOH$ **OR** $HOCH_2CHO + 2[O] \rightarrow OHCCOOH + H_2O$ **OR** $HOCH_2CHO + [O] \rightarrow OHCCHO + H_2O$ **OR** $HOCH_2CHO + 2[O] \rightarrow HOOCCHO + H_2O$
	(c)	(i)	$HOCH_2CH_2OH$ ✓	1	**ALLOW** $HO(CH_2)_2OH$ **OR** $(CH_2OH)_2$ **OR** skeletal formula **OR** displayed formula **DO NOT ALLOW** molecular formula ($C_2H_6O_2$)
		(ii)	curly arrow from H^- to $C^{\delta+}$ ✓ dipoles and curly arrow from C=O bond to O ✓ intermediate ✓ curly arrow from intermediate to $H^{\delta+}$ in H_2O/ H^+ and if H_2O is used it must show the curly arrow from the O–H bond to the O ✓ *lone pairs are not essential*	4	**ALLOW** curly arrow to C even if dipole missing or incorrect **ALLOW** maximum of 3 marks if incorrect starting material is used See page 36 for detailed mechanisms – ***Alternative 3*** scores all 4 marks even though the intermediate is not shown

STEMUP.CO.UK

Alternative 1

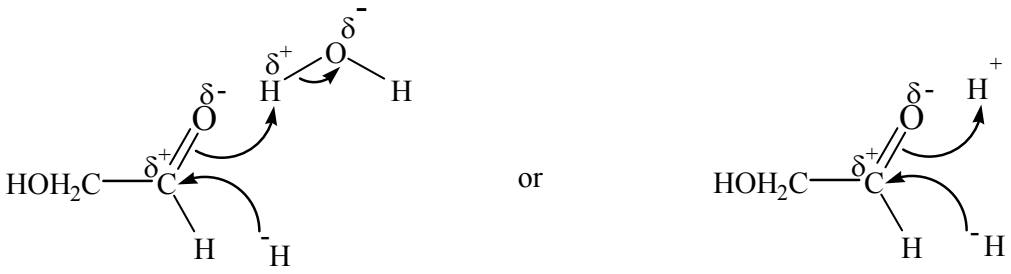


Alternative 2



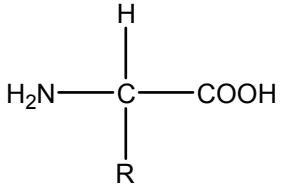
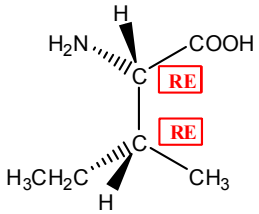
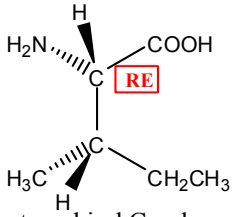
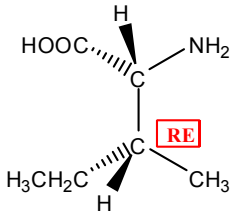
products are not required

Alternative 3

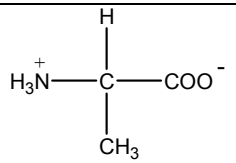
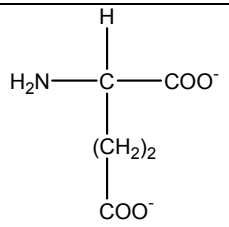
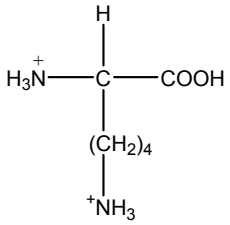


				Total	**9**

STEMUP.CO.UK

Question			Expected Answers	Marks	Additional Guidance
3	(a)	(i)	adsorption ✓	1	**ALLOW** partition **OR** adsorbtion **IGNORE** solubility **OR** desorption **DO NOT ALLOW** absorption
		(ii)	measure how far each spot travels relative to the solvent front or calculate the R_f value ✓ compare R_f values to those for known amino acids ✓	2	**ALLOW** compare R_f values to database **ALLOW** compare to known amino acids **DO NOT ALLOW** retention times for first mark, but the 2nd mark would be available as ✓ ECF **ALLOW** alternative approach: on the same plate compare position of spots ✓ with known amino acids ✓
		(iii)	(amino acids won't separate because) similar compounds have similar R_f (values) ✓	1	**ALLOW** spots often overlap **OR** don't (fully) separate **ALLOW** they have similar R_f (values) or similar adsoptions or similar retention times ECF to **a(ii)**
	(b)	(i)	 ✓	1	**ALLOW** $RCH(NH_2)COOH$ any order for R, NH_2 and COOH but C must be next to H 'CH' must be shown **ALLOW** CO_2H brackets around NH_2 are **not** essential **ALLOW** structure
		(ii)	must attempt 3D use RE symbol in the "tools" to denote whether or not each chiral C is a reflection of the one given in the question  both chiral Cs are mirror images  top chiral C only is a mirror image  bottom chiral C only is a mirror image	3	each chiral C must have 2 — bonds, 1 wedge bond (**IGNORE** shading) & 1 dash bond (**IGNORE** wedge) check the clockwise orientation of each C. For each C start with the H and if on the: • top C the H is followed by COOH it is not a mirror image. If it is a mirror image annotate using RE. • bottom C the H is followed by CH_3 it is not a mirror image. If it is a mirror image annotate using RE. the four groups can be attached in any order. If the molecule is drawn upside down – clockwise becomes anti-clockwise. **MUST** check that the drawn structure is non-superimposable irrespective of the orientation or the way it has been drawn. **IGNORE** bond linkage for all groups

STEMUP.CO.UK

	(c)		 alanine at pH = 6.0 ✓  glutamic acid at pH =10 ✓  lysine at pH = 2.0 ✓		**ALLOW** CO_2^- **ALLOW** NH_3^+ If NH_3 fully displayed **ALLOW** + charge on N or H If COO fully displayed **ALLOW** $^-$ charge on O only
	(d)		valine–glycine–leucine ✓	**1**	**ALLOW** val–gly–leu **DO NOT ALLOW** structures
	(e)		$H_2N(CH_2)_6NH_2$ ✓ $HOOC(CH_2)_8COOH$ ✓	**2**	**ALLOW** $H_2NCH_2CH_2CH_2CH_2CH_2CH_2NH_2$ **ALLOW** $HOOCCH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$ **ALLOW** CO_2H for COOH **ALLOW** acid chloride, $ClOC(CH_2)_8COCl$ **ALLOW** displayed formulae or skeletal formulae
			Total	**14**	

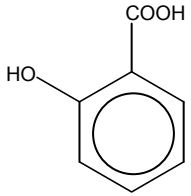
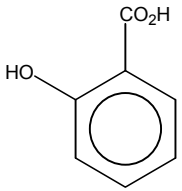
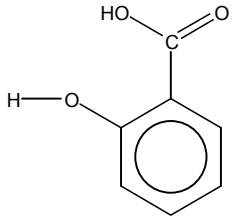
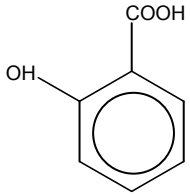
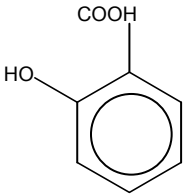
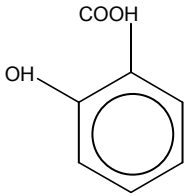
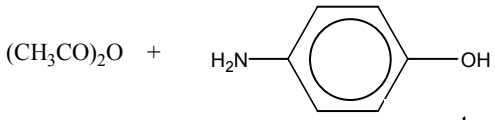
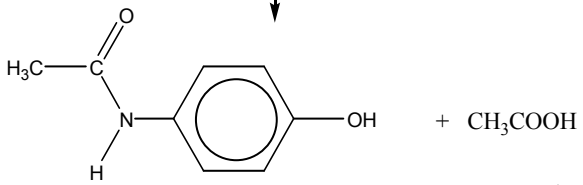
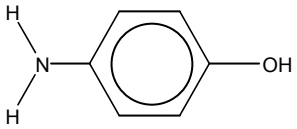
STEMUP.CO.UK

Question			Expected Answers	Marks	Additional Guidance
4	(a)		**infrared – 1 mark only** shows (very broad) peak between 2500–3300 (cm^{-1}) (due to O–H bond) ✓	3	**ALLOW** (very broad) peak around 3000 (cm^{-1}) **OR** any stated value between 2500 and 3300 (cm^{-1}) for O–H **DO NOT ALLOW** peak in range 3200–3550 (cm^{-1}) **IGNORE** any reference to C=O or C–O as both are also present in an ester **OR** to fingerprint region
			^{13}C NMR – 2 marks $(CH_3)_2CHCH_2COOH$ has 4 peaks (due to 4 different C environments) ✓ $(CH_3)_3CCOOH$ has 3 peaks (due to 3 different C environments) ✓		**ALLOW** '*^{13}C NMR detects the number of/different C environments*' for 1 ✓, suitable example for the 2nd mark
	(b)		**splitting pattern** explains any two in terms of '*n* + 1 rule' for two marks ✓✓ Explains any one peak for 1 mark ✓ • *singlet* therefore adjacent C (if any) has no Hs • *multiplet* **OR** split into 7 therefore adjacent Cs have lots of/6 Hs • *doublet* therefore adjacent C is bonded to 1H *must spell **one** of multiplet / heptet, singlet, doublet correctly* **max = 2 marks**	6	**1 mark** for correct ester if two splitting patterns are correctly analysed **ignore** the third **ALLOW** singlet because next or bonded to an O **ALLOW** multiplet/heptet because next to 2 CH_3s **ALLOW** doublet because next to a CH
			chemical shifts		**ALLOW** tolerance on δ values; 3.6–3.8, 2.6–2.8 and 1.1–1.3

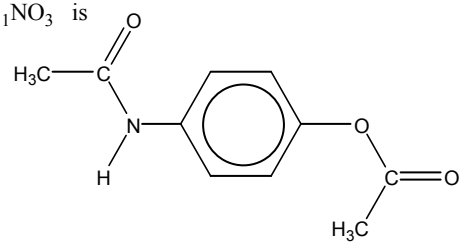
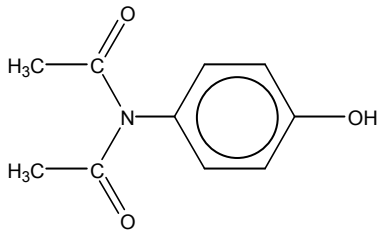
STEMUP.CO.UK

			two marks if any two absorptions are identified correctly ✓✓ one mark if any one absorption is identified correctly ✓ • peak ~3.7 (ppm) – bonded to an O • peak ~2.7 (ppm) – indicates it is next to a C=O • peak ~1.2 (ppm) – bonded to other Cs **OR** part of a chain **max = 2 marks** compound identified as $(CH_3)_2CHCOOCH_3$ ✓✓ **2 marks** compound identified as $CH_3COOCH(CH_3)_2$ ✓ **1 mark**		(ppm) **ALLOW** any two gets 2 marks, any one scores 1 mark  3.7 (ppm) 2.7 (ppm) 1.2 (ppm) **ALLOW** peaks labelled on the spectrum **ALLOW** singlet must be bonded to O, multiplet to C=O and doublet to CH or R for both chemical shift marks if two chemical shifts are correctly identified **IGNORE** the third
			Total	**9**	

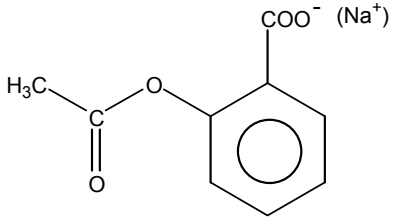
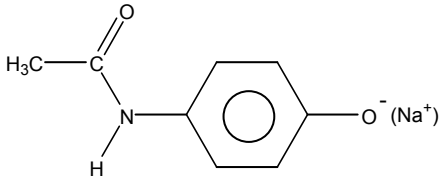
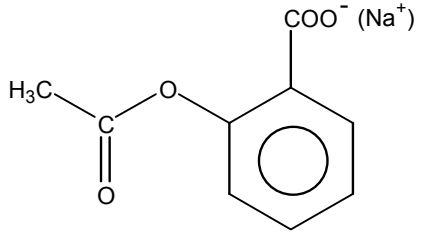
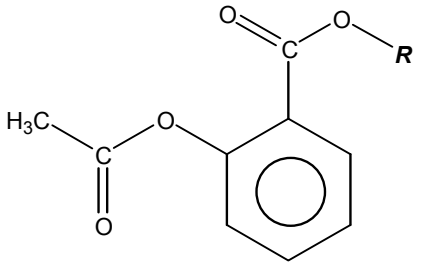
STEMUP.CO.UK

Question	Expected Answers	Marks	Additional Guidance
5 (a)	 ✓	1	**ALLOW**  or  **DO NOT ALLOW** incorrect bond linkage  or  or 
(b) (i)	equation  reactants ✓  products✓	2	**ALLOW** $(CH_3CO)_2O + H_2NC_6H_4OH \rightarrow CH_3CONHC_6H_4OH + CH_3COOH$ **ALLOW**  **DO NOT ALLOW** molecular formulae

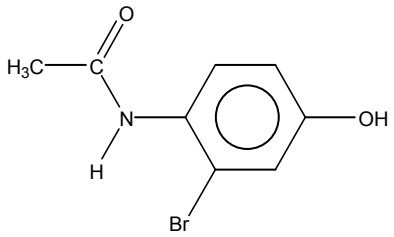
STEMUP.CO.UK

		(ii)	$C_{10}H_{11}NO_3$ is  or  ✓	1	**ALLOW** amide shown as either $CH_3CONH–$ **OR** $H_3CCONH–$ **OR** $CH_3COHN–$ **OR** $H_3CCOHN–$ **ALLOW** ester shown as either $–OCOCH_3$ **OR** $–OOCCH_3$
		(iii)	to ensure that there are no (harmful) side effects ✓	1	**ALLOW** impurities reduce effectiveness (of drug) **OR** might be toxic **OR** avoids litigation **OR** harmful **OR** hazardous **ALLOW** to ensure that the drug/active component is safe **IGNORE** dangerous **OR** nasty **OR** can kill **OR** increased dosage
	(c)		(aspirin contains) ester **AND** carboxylic acid ✓ (paracetamol contains) amide **AND** phenol ✓	2	**IGNORE** arene or benzene or aromatic or phenyl or methyl but any other group loses the mark **ALLOW** carboxyl group **DO NOT ALLOW** acid **IGNORE** arene or benzene or aromatic or phenyl or methyl but any other group loses the mark **ALLOW** peptide **ALLOW** hydroxy(l) **DO NOT ALLOW** hydroxide or alcohol **DO NOT ALLOW** amine
	(d)	(i)	**Both**	3	**ALLOW** hydrolysis by $H^+(aq)$ or H^+ or HCl(aq) or HCl or $H_2SO_4(aq)$

STEMUP.CO.UK

			Na **OR** NaOH ✓  from aspirin ✓  from paracetamol ✓		or H_2SO_4 to give hydroxybenzoic acid + ethanoic acid with aspirin ✓ and ammonium salt of 4-aminophenol + ethanoic acid with paracetamol ✓ **ALLOW** hydrolysis by $OH^-(aq)$ or NaOH(aq) and other alkali leading to hydrolysis to give carboxylate salt and phenoxide salt on the ring + ethanoate with aspirin ✓ and 4-aminophenoxide ion + ethanoate ion with paracetamol ✓ **ALLOW** HNO_3 (and H_2SO_4) to give NO_2 in one or more positions on the ring in both aspirin and paracetamol ✓✓ **DO NOT ALLOW** NH_3 but correct ammonium salts can be awarded 2 marks ECF **DO NOT ALLOW** H_2O but correct products can be awarded 2 marks ECF if no reagent there cannot be any marks for the products If reagent selected is incorrect but would react with **either** aspirin or paracetamol **ALLOW** ✓ ECF for the correct organic product
		(ii)	**aspirin only** $NaHCO_3$ **OR** Na_2CO_3 **OR** metal oxide ✓  ✓	**2**	**ALLOW** Mg, carbonates, NH_3 **ALLOW** alcohols (***R***OH) to give ester if no reagent there cannot be any marks for the products  If reagent selected is incorrect but would react with **BOTH** aspirin and paracetamol **ALLOW** ✓ ECF for the correct organic product
		(iii)	**paracetamol only**		**ALLOW** Br_2 water

STEMUP.CO.UK

			Br_2 ✓  ✓	**2**	**ALLOW** one or more Br at **any** position on the ring **DO NOT ALLOW** Br substitution of OH **ALLOW** acyl chloride or acid anhydride and corresponding ester **ALLOW** $FeCl_3$ to form a purple <u>complex ion</u> (structure not required) **ALLOW** diazonium and structure showing azo group substituting one of the Hs in the ring if no reagent there cannot be any marks for the products If reagent selected is incorrect but would react with **BOTH** aspirin and paracetamol **ALLOW** ✓ ECF for the correct organic product
			Total	**14**	

STEMUP.CO.UK