OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry A

Advanced GCE

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

Mark Scheme for June 2013

Oxford Cambridge and RSA Examinations

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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.

Annotations

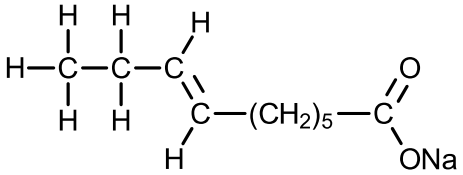
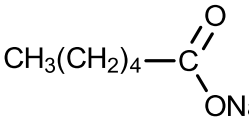
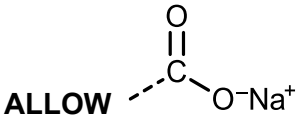
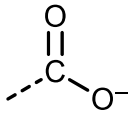
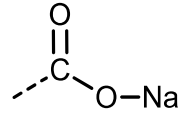
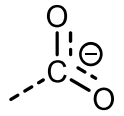
Annotations available in Scoris.

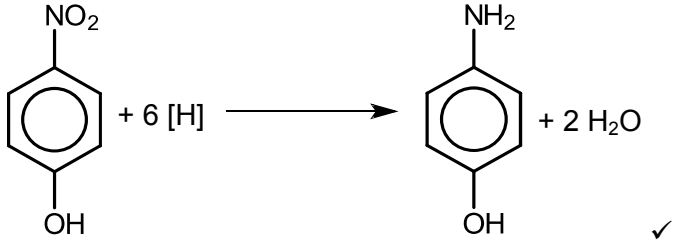
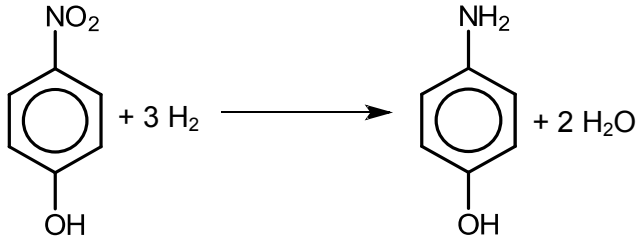
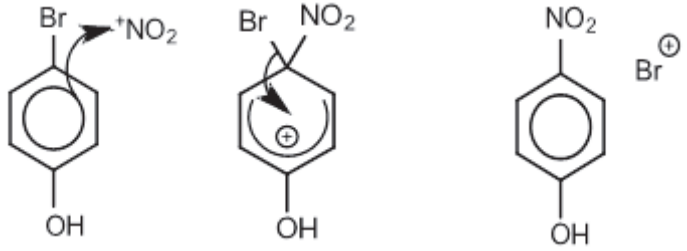
Annotation	Meaning
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
I	Ignore
NAQ	Not answered question
NBUD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
RE	Rounding error
SF	Error in number of significant figures
	Correct response
SEEN	Noted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

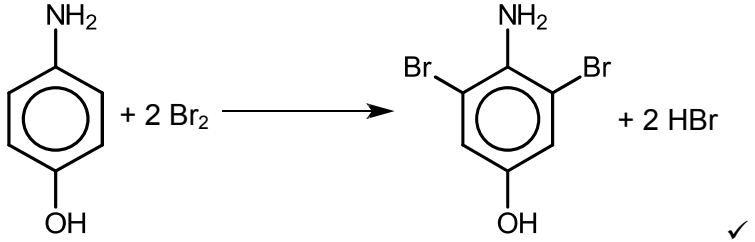
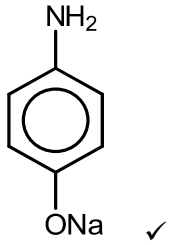
Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

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

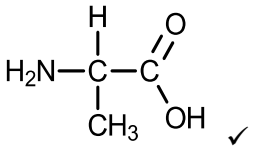
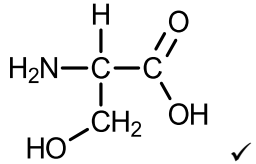
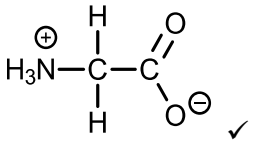
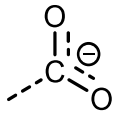
All questions should be annotated with ticks to show where marks have been awarded in the body of the text.
All questions where an ECF has been applied should also be annotated with the ECF annotation.

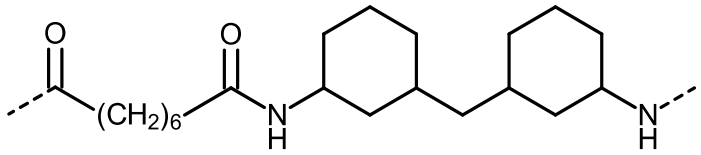
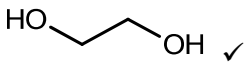
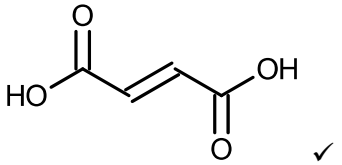
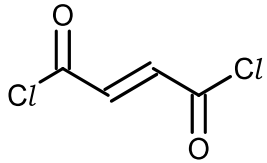
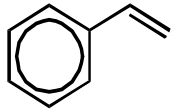
Question			Answer	Marks	Guidance
1	(a)	(i)	propane-1,2,3-triol ✓	1	**ALLOW** absence of 'e' after 'propan' **ALLOW** 1,2,3-propanetriol **ALLOW** absence of hyphens 1, 2 and 3 must be clearly separated: **ALLOW** full stops: 1.2.3 **OR** spaces: 1 2 3 **DO NOT ALLOW** 123 **IGNORE** glycerol
		(ii)	  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**	

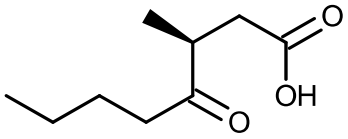
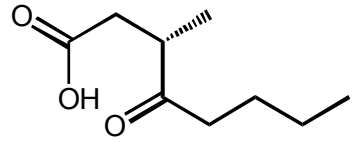
Question			Answer	Marks	Guidance
2	(a)		**Nitrogen** lone pair accepts a proton/H^+ ✓ *Requires position of lone pair on N*	1	**DO NOT ALLOW** Nitrogen/N lone pair accepts hydrogen *Proton/H^+ is required* **ALLOW nitrogen** donates a lone pair **IGNORE** NH_2 group donates a lone pair
	(b)		 ✓	1	**ALLOW** 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*

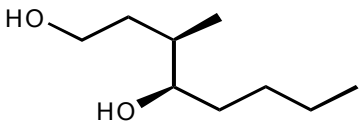
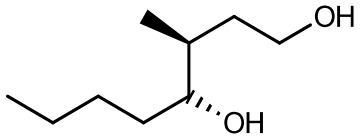
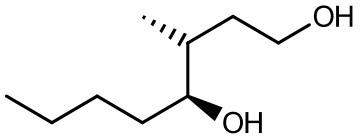
Question			Answer	Marks	Guidance
		(ii)	4-amino-3,5-dibromophenol ✓	1	**ALLOW** 3,5-dibromo-4-aminophenol **ALLOW** 2,6-dibromo-4-hydroxyphenylamine **ALLOW** 2,6-dibromo-4-hydroxy(-1-)aminobenzene **OR** (1-)amino-2,6-dibromo-4-hydroxybenzene **ALLOW** absence of hyphens numbers must be clearly separated **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

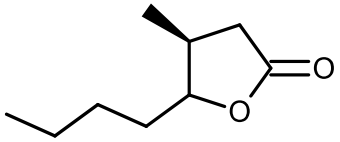
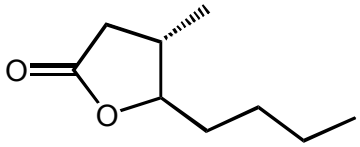
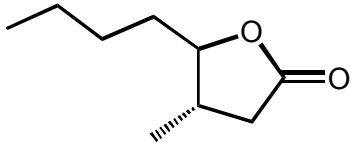
Question			Answer	Marks	Guidance
		(ii)		5	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous *No alternative pathway possible*
			reaction **1** HNO_2 (with or without HC*l*) **OR** $NaNO_2$ + HC*l* ✓		**ALLOW dilute** H_2SO_4 but **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**	

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

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**	

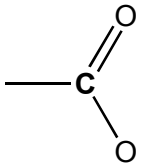
Question			Answer	Marks	Guidance
4	(a)	(i)	**F =**  **AND** reagent $NaBH_4$ ✓ **NB One mark for BOTH**	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous Wedge out of the paper is required i.e.( or  or ) **DO NOT ALLOW** dashed 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

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%

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**	

<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
✓ ✓

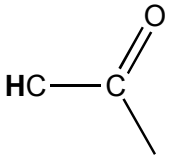
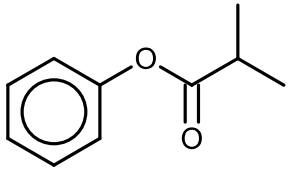
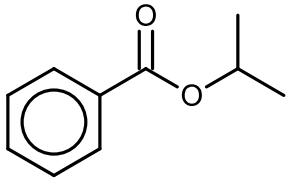
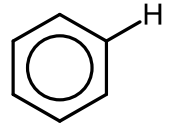
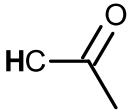
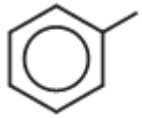
This mark is for some evidence of using M_r, which is twice the value that you would obtain from the empirical formula</td></tr>
<tr><td></td><td>(b)</td><td></td><td>seven ✓</td><td>1</td><td></td></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>TMS is the standard (for chemical shift measurements) ✓</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>

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**	

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