

Chemistry A

Advanced GCE

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

Mark Scheme for June 2013

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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.

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Annotations

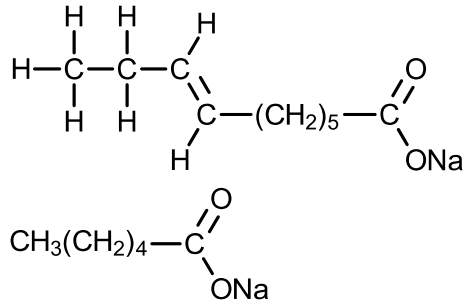
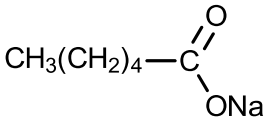
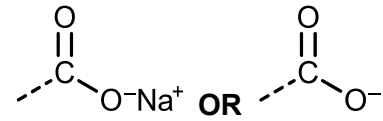
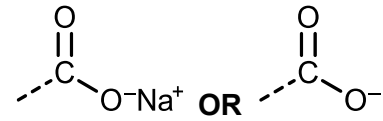
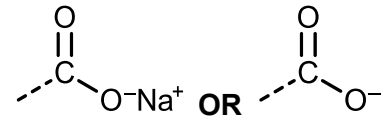
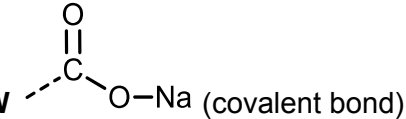
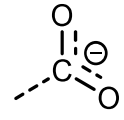
Annotations available in Scoris.

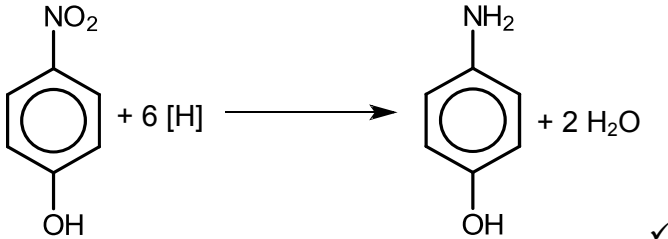
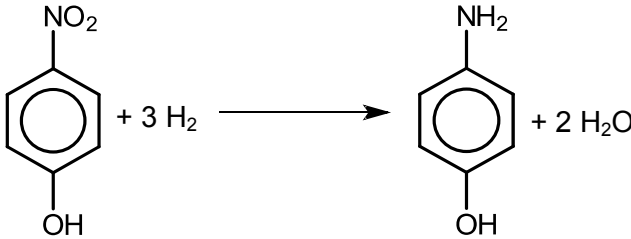
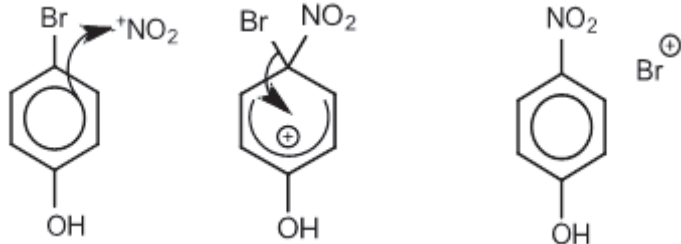
Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Ignore
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures
	Correct response
	Noted but no credit given
	Repeat

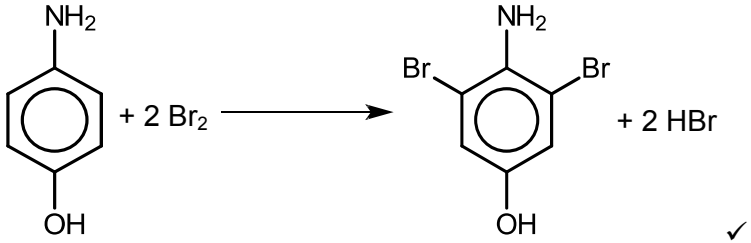
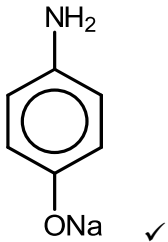
Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

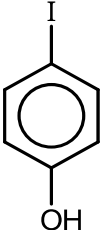
Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
()	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording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

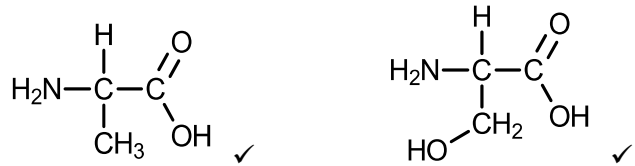
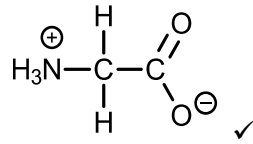
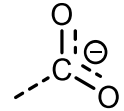
All questions should be annotated with ticks to show where marks have been awarded in the body of the text.
All questions where an ECF has been applied should also be annotated with the ECF annotation.

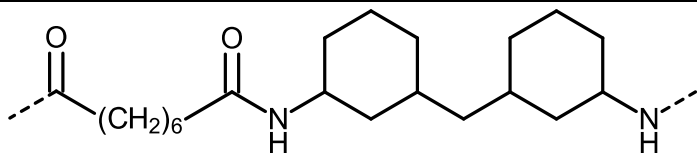
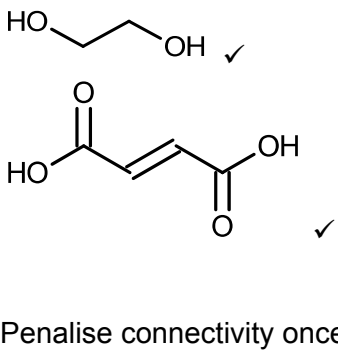
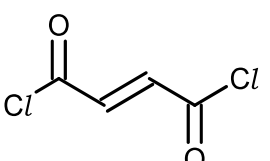
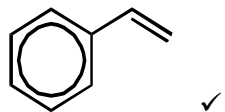
Question			Answer	Marks	Guidance
1	(a)	(i)	propane-1,2,3-triol ✓	1	ALLOW absence of 'e' after 'propan' ALLOW 1,2,3-propanetriol ALLOW absence of hyphens 1, 2 and 3 must be clearly separated: ALLOW full stops: 1.2.3 OR spaces: 1 2 3 DO NOT ALLOW 123 IGNORE glycerol
		(ii)	  One mark for decanoate salt OR decanoic 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 <i>cis</i> structure  ALLOW  OR  DO NOT ALLOW  (covalent bond) ALLOW delocalised carboxylate  IGNORE glycerol
	(b)		one of the fatty acids is <u>trans</u> ✓ 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	

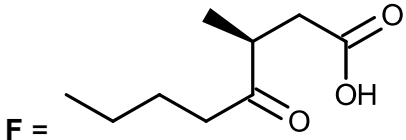






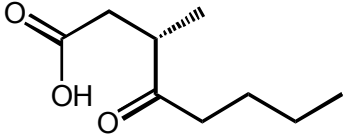
Question		Answer	Marks	Guidance
2	(a)	Nitrogen lone pair accepts a proton/ H^+ ✓ <i>Requires position of lone pair on N</i>	1	DO NOT ALLOW Nitrogen/N lone pair accepts hydrogen <i>Proton/H^+ is required</i> ALLOW nitrogen donates a lone pair IGNORE NH_2 group donates a lone pair
	(b)		1	ALLOW correct structural OR displayed OR skeletal formulae OR combination of above as long as unambiguous DO NOT ALLOW 
	(c)	 <p>✓ curly arrow from ring to $^+NO_2$ ✓ correct intermediate ✓ curly arrow from $C-Br$ to reform ring ✓ correct products MUST HAVE Br^-</p>	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/ HCl ✓	1	ALLOW conc / dilute HCl

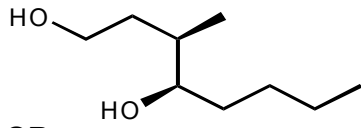
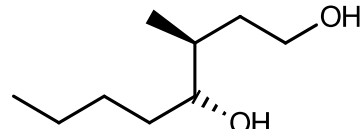
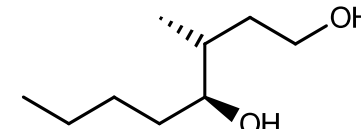







Question		Answer	Marks	Guidance
	(ii)	4-amino-3,5-dibromophenol ✓	1	ALLOW 3,5-dibromo-4-aminophenol ALLOW 2,6-dibromo-4-hydroxyphenylamine ALLOW 2,6-dibromo-4-hydroxy(-1-)aminobenzene OR (1-)amino-2,6-dibromo-4-hydroxybenzene ALLOW absence of hyphens numbers must be clearly separated ALLOW full stops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

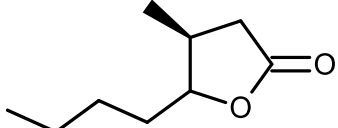







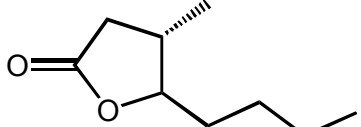
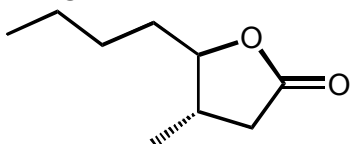
Question	Answer	Marks	Guidance
(ii)	<p>reaction 1 HNO_2 (with or without HCl) OR $\text{NaNO}_2 + \text{HCl}$ ✓</p> <p>temp $< 10^\circ\text{C}$ ✓</p> <p>compound B =  ✓</p> <p>reaction 2 CuI ✓</p> <p>reaction 3 alkali(ne) ✓</p>	5	<p>ALLOW correct structural OR displayed OR skeletal formulae OR combination of above as long as unambiguous <i>No alternative pathway possible</i></p> <p>ALLOW dilute H_2SO_4 but NOT conc H_2SO_4 ALLOW conc HCl</p> <p>ALLOW KOH(aq)/NaOH(aq)/$\text{OH}^{\text{(aq)}}$ IGNORE temp $< 10^\circ\text{C}$ DO NOT ALLOW heat/boil/warm DO NOT ALLOW use of phenol in M5</p>
	Total	16	

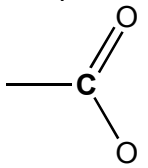
Question		Answer	Marks	Guidance
3	(a) (i)	monomers join/bond/add/react/form polymer/form chain AND another product/small molecule e.g. H ₂ O/HCl ✓	1	IGNORE 'two' when referring to monomers, i.e. (two) monomers...
	(ii)		2	ALLOW correct structural OR displayed OR skeletal formulae OR combination of above 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 <u>methionine</u> ✓	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

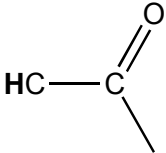
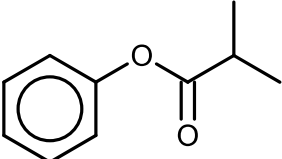
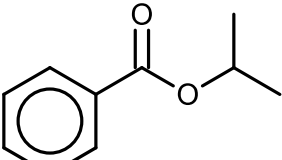
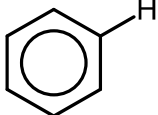
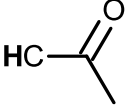
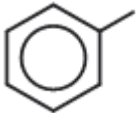
Question		Answer	Marks	Guidance
(c)		 <p>amide link ✓ correct structure ✓</p>	2	<p>ALLOW correct structural OR displayed OR skeletal formulae OR combination of above as long as unambiguous ALLOW 'terminal' —NH— at other end 'End bonds' MUST be shown (solid or dotted) IGNORE brackets and/or <i>n</i> DO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

Question		Answer	Marks	Guidance
4	(a) (i)	 <p>F =</p> <p>AND reagent NaBH₄ ✓</p> <p>NB One mark for BOTH</p>	1	<p>ALLOW correct structural OR displayed OR skeletal formulae</p> <p>OR combination of above as long as unambiguous</p> <p>Wedge out of the paper is required i.e. ( or  or )</p> <p>DO NOT ALLOW dashed wedge on methyl group in this orientation</p> <p>( or  or )</p> <p>ALLOW</p> 
	(ii)	Colour changes from orange to green / blue / green blue ✓	1	
	(iii)	to ensure <u>carboxylic acid</u> is formed OR prevents formation of <u>aldehyde</u> OR distillation only makes the <u>aldehyde</u> ✓	1	
	(iv)	(nucleophilic) addition ✓	1	ALLOW redox OR reduction
	(b)	2,4-DNP(H) ✓ orange precipitate ✓	2	<p>ALLOW Brady's (reagent)</p> <p>ALLOW orange/red/yellow for colour of the 2,4-DNP(H) precipitate</p> <p>ALLOW solid/crystals in place of precipitate</p> <p>IGNORE any reference to recrystallising/melting points</p>

Question		Answer	Marks	Guidance
4	(c) (i)	<p>One of:</p>  <p>OR</p>  <p>OR</p>  <p>for one mark ✓ optical (isomerism) ✓</p>	2	<p>For bold wedge ALLOW  or  or </p> <p>For dashed wedge ALLOW  or  or  or </p> <p>DO NOT ALLOW any other representation of the structure, <i>i.e.</i> anything not skeletal</p> <p>ALLOW open wedges</p> <p>ALLOW isomers shown in any alternative correct orientation</p>
	(ii)	<p>If answer = 63.5 award 3 marks</p> <p>moles of E used = $4.56/160(.0) / 0.0285$ (mol) ✓ moles of G formed = $3.15/174(.0) / 0.0181$ (mol) ✓ yield = $0.0181/0.0285 \times 100\%$ / 63.5% ✓</p>	3	<p>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%</p>

Question	Answer	Marks	Guidance
(iii)	 <p>for first mark ✓</p> <p>Other product = H₂O for second mark ✓</p>	2	<p>ALLOW abbreviation of alkyl chain</p> <p>Wedge out of the paper is required i.e. ( or  or )</p> <p>DO NOT ALLOW dashed wedge on methyl group in this orientation ( or  or  or )</p> <p>ALLOW</p>  <p>Be careful with orientation of lactone:</p> <p>ALLOW</p> 
	Total	13	

Question		Answer	Marks	Guidance																										
5	(a)	<table border="1"> <thead> <tr> <th></th> <th>C</th> <th>H</th> <th>O</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>molar ratio (C:H:O) = 6.10 : 7.37 : 1.22 OR = 5:6:1 OR empirical formula = C₅H₆O ✓ <i>M_r</i> is 164 so molecular formula = C₁₀H₁₂O₂ ✓</p>		C	H	O	%	73.15%	7.37%	19.48%	mol	6.10	7.37	1.22	ratio	5	6	1	2	<p>ALLOW alternative method</p> <table> <tr> <td>73.15% × 164 = 120</td> <td rowspan="3">} ratio =</td> <td>10</td> <td>OR 5</td> </tr> <tr> <td>7.37% × 164 = 12.1</td> <td>12</td> <td>OR 6</td> </tr> <tr> <td>19.48% × 164 = 31.9</td> <td>2</td> <td>OR 1</td> </tr> </table> <p style="text-align: center;">✓</p> <p>This mark is for some evidence of using <i>M_r</i>, which is twice the value that you would obtain from the empirical formula</p>	73.15% × 164 = 120	} ratio =	10	OR 5	7.37% × 164 = 12.1	12	OR 6	19.48% × 164 = 31.9	2	OR 1
			C	H	O																									
		%	73.15%	7.37%	19.48%																									
		mol	6.10	7.37	1.22																									
ratio	5	6	1																											
73.15% × 164 = 120	} ratio =	10	OR 5																											
7.37% × 164 = 12.1		12	OR 6																											
19.48% × 164 = 31.9		2	OR 1																											
(b)	seven ✓	1																												
(c)	(i)	TMS is the standard (for chemical shift measurements) ✓	1	<p>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</p>																										
	(ii)	(relative) number of protons/hydrogens in each environment / peak / region OR three proton environments with protons in ratio 5:1:6 ✓	1	<p>ALLOW (relative) number of each type of proton/hydrogen IGNORE number of protons in the compound</p>																										
	(iii)	<p>¹³C NMR Analysis (1 mark)</p> <p>The peak at 185ppm suggests an ester group /</p>  <p>AND one of the following:</p> <p>The peaks between 120ppm and 160ppm indicate a benzene ring OR the peaks at 18ppm AND 36ppm suggest C-C ✓</p>	7	<p>FULL ANNOTATIONS WITH TICKS, CROSSES, CON ETC MUST BE USED</p> <p>Inclusion of an incorrectly assigned ¹³C peak CONS M1</p>																										

Question	Answer	Marks	Guidance
	<p>¹H ANALYSIS (4 marks)</p> <p>Doublet / peak at 1.2 shows R-CH AND 6 H's / 2 CH₃ (in this environment) ✓</p> <p>Multiplet / septet / heptet / peak split into 7 / peak at 2.7ppm indicates</p> <p> ✓</p> <p>The doublet suggests that two CH₃ groups are attached to a CH OR the multiplet / septet / heptet suggests that the CH group is attached to two CH₃ groups ✓</p> <p>QWC must spell one of <i>multiplet, septet, heptet OR doublet</i> correctly</p> <p>Peak at 7.3ppm indicates a benzene ring AND 5 H's ✓</p> <p>Compound identification (2 marks)</p> <p> then two marks ✓✓</p> <p>IF identified as</p> <p> then one mark ✓</p> <p>IF identified as</p>	<p>Total 12</p>	<p>Candidates may quote δ values as ranges taken from Data Sheet, so ALLOW tolerance (ppm) eg</p> <p>6.5–8 aromatic </p> <p>2.0–2.9 carboxyl </p> <p>0.7–2.0 alkyl R-CH</p> <p>ALLOW peaks labelled on the spectrum If QWC word is not used, MAX 3 for proton NMR</p> <p>ALLOW C₆H₅ IGNORE reference to phenol</p> <p> Allow has 5 H's as C₆H₅ if they state that the benzene ring</p>

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

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Facsimile: 01223 552553

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