

# 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

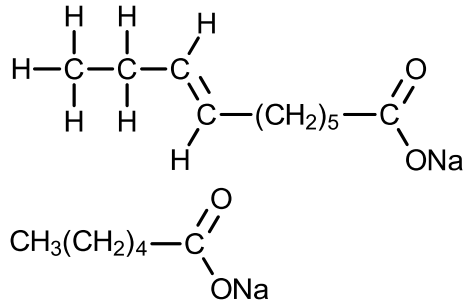
Annotations available in Scoris.

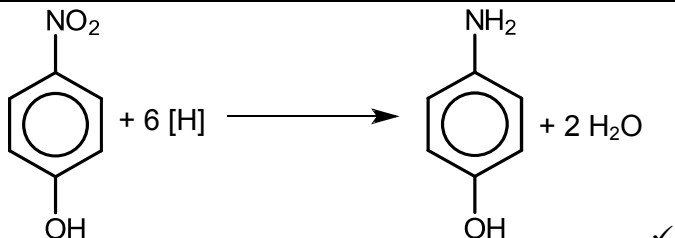
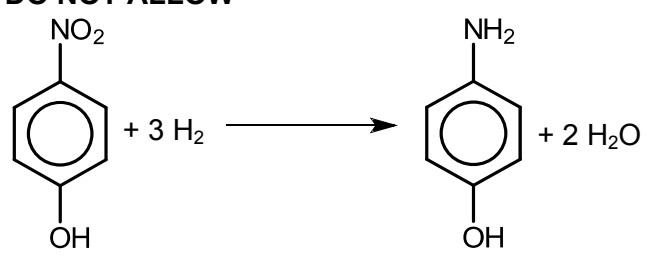
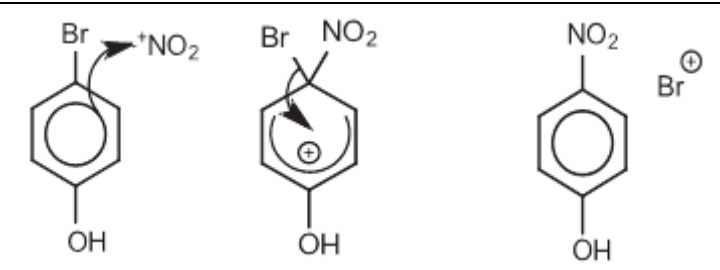
Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Ignore
	Not answered question
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Rounding error
	Error in number of significant figures
	Correct response
	Noted but no credit given
	Repeat

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

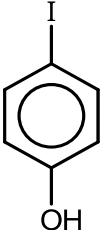
<b>Annotation</b>	<b>Meaning</b>
<b>DO NOT ALLOW</b>	Answers which are not worthy of credit
<b>IGNORE</b>	Statements which are irrelevant
<b>ALLOW</b>	Answers that can be accepted
( )	Words which are not essential to gain credit
—	Underlined words must be present in answer to score a mark
<b>ECF</b>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

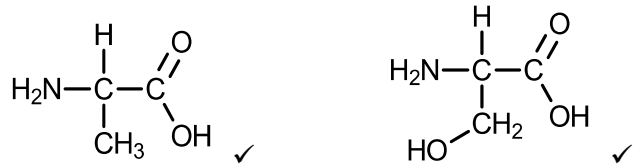
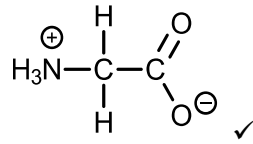
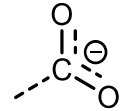
Question			Answer	Marks	Guidance
1	(a)	(i)	propane-1,2,3-triol ✓	1	<b>ALLOW</b> absence of 'e' after 'propan' <b>ALLOW</b> 1,2,3-propanetriol <b>ALLOW</b> absence of hyphens 1, 2 and 3 must be clearly separated: <b>ALLOW</b> full stops: 1.2.3 <b>OR</b> spaces: 1 2 3 <b>DO NOT ALLOW</b> 123 <b>IGNORE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

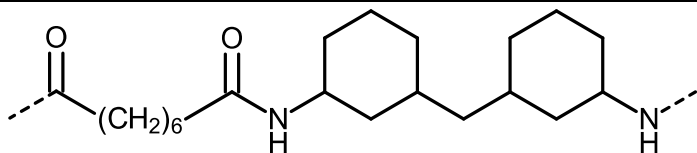
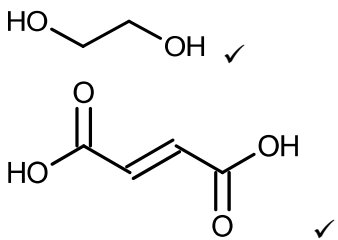
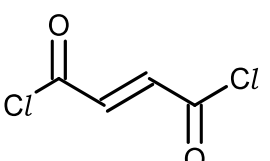
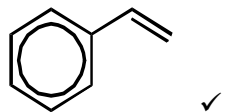
Question		Answer	Marks	Guidance
2	(a)	<p><b>Nitrogen</b> lone pair accepts a proton/<math>H^+</math> ✓  <i>Requires position of lone pair on N</i></p>	1	<p><b>DO NOT ALLOW</b> Nitrogen/N lone pair accepts hydrogen  <i>Proton/<math>H^+</math> is required</i>  <b>ALLOW</b> nitrogen donates a lone pair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

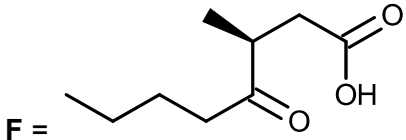






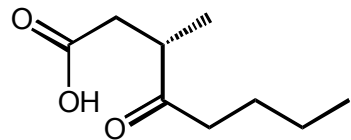
Question		Answer	Marks	Guidance
	(ii)	4-amino-3,5-dibromophenol ✓	1	<b>ALLOW</b> 3,5-dibromo-4-aminophenol <b>ALLOW</b> 2,6-dibromo-4-hydroxyphenylamine <b>ALLOW</b> 2,6-dibromo-4-hydroxy(-1-)aminobenzene <b>OR</b> (1-)amino-2,6-dibromo-4-hydroxybenzene <b>ALLOW</b> absence of hyphens numbers must be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

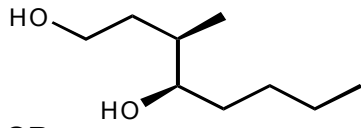
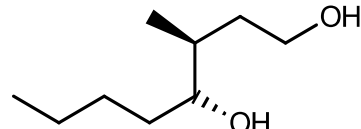
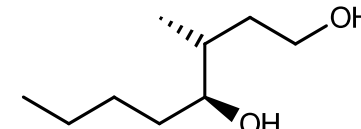







Question	Answer	Marks	Guidance
(ii)	<p>reaction 1 <math>\text{HNO}_2</math> (with or without <math>\text{HCl}</math>) <b>OR</b> <math>\text{NaNO}_2 + \text{HCl}</math> ✓</p> <p>temp <math>&lt; 10^\circ\text{C}</math> ✓</p> <p>compound B =  ✓</p> <p>reaction 2 <math>\text{CuI}</math> ✓</p> <p>reaction 3 alkali(ne) ✓</p>	5	<p><b>ALLOW</b> correct structural <b>OR</b> displayed <b>OR</b> skeletal formulae  <b>OR</b> combination of above as long as unambiguous  <i>No alternative pathway possible</i></p> <p><b>ALLOW dilute</b> <math>\text{H}_2\text{SO}_4</math> but <b>NOT</b> conc <math>\text{H}_2\text{SO}_4</math>  <b>ALLOW</b> conc <math>\text{HCl}</math></p> <p><b>ALLOW</b> <math>\text{KOH(aq)}</math>/<math>\text{NaOH(aq)}</math>/<math>\text{OH}^{\text{(aq)}}</math>  <b>IGNORE</b> temp <math>&lt; 10^\circ\text{C}</math>  <b>DO NOT ALLOW</b> heat/boil/warm  <b>DO NOT ALLOW</b> use of phenol in M5</p>
	<b>Total</b>	<b>16</b>	

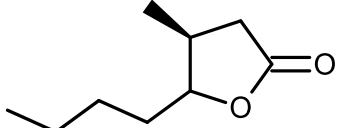







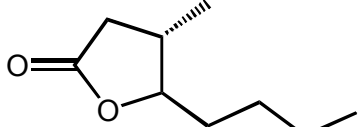
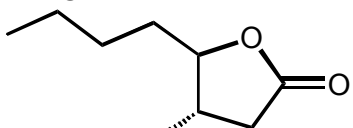


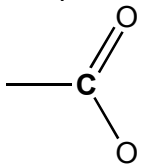
Question		Answer	Marks	Guidance
3	(a) (i)	monomers join/bond/add/react/form polymer/form chain AND another product/small molecule e.g. H <sub>2</sub> O/HCl ✓	1	IGNORE 'two' when referring to monomers, i.e. (two) monomers...
	(ii)		2	ALLOW correct structural OR displayed OR skeletal formulae OR combination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

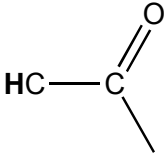
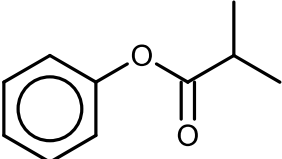
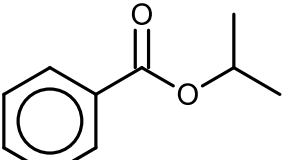
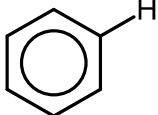
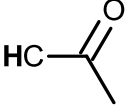
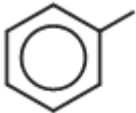
Question		Answer	Marks	Guidance
(c)		 <p>amide link ✓ correct structure ✓</p>	2	<p><b>ALLOW</b> correct structural <b>OR</b> displayed <b>OR</b> skeletal formulae  <b>OR</b> combination of above as long as unambiguous  <b>ALLOW</b> 'terminal' —NH— at other end  'End bonds' <b>MUST</b> be shown (solid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

Question		Answer	Marks	Guidance
4	(a) (i)	 <p>F =</p> <p>AND reagent NaBH<sub>4</sub> ✓</p> <p>NB One mark for BOTH</p>	1	<p><b>ALLOW</b> correct structural <b>OR</b> displayed <b>OR</b> skeletal formulae</p> <p><b>OR</b> combination of above as long as unambiguous</p> <p>Wedge out of the paper is required i.e. (  or  or  )</p> <p><b>DO NOT ALLOW</b> dashed wedge on methyl group in this orientation</p> <p>(  or  or  )</p> <p><b>ALLOW</b></p> 
	(ii)	Colour changes from orange to green / blue / green blue ✓	1	
	(iii)	to ensure <u>carboxylic acid</u> is formed <b>OR</b> prevents formation of <u>aldehyde</u> <b>OR</b> distillation only makes the <u>aldehyde</u> ✓	1	
	(iv)	(nucleophilic) addition ✓	1	<b>ALLOW</b> redox <b>OR</b> reduction
	(b)	2,4-DNP(H) ✓ orange precipitate ✓	2	<p><b>ALLOW</b> Brady's (reagent)</p> <p><b>ALLOW</b> orange/red/yellow for colour of the 2,4-DNP(H) precipitate</p> <p><b>ALLOW</b> solid/crystals in place of precipitate</p> <p><b>IGNORE</b> 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 <b>ALLOW</b>  or  or </p> <p>For dashed wedge <b>ALLOW</b>  or  or  or </p> <p><b>DO NOT ALLOW</b> any other representation of the structure, <i>i.e.</i> anything not skeletal</p> <p><b>ALLOW</b> open wedges</p> <p><b>ALLOW</b> isomers shown in any alternative correct orientation</p>
	(ii)	<p>If answer = 63.5 award 3 marks</p> <p>moles of <b>E</b> used = <math>4.56/160(.0) / 0.0285</math> (mol) ✓  moles of <b>G</b> formed = <math>3.15/174(.0) / 0.0181</math> (mol) ✓  yield = <math>0.0181/0.0285 \times 100\%</math> / 63.5% ✓</p>	3	<p>0.0285 mol is exact calculator value  0.0181 mol is to 3sf (calculator value 0.0181034...)  <b>IGNORE</b> trailing numbers in this answer  <b>ALL ANSWERS MUST</b> be to a minimum of 3sf, the final answer must be to 3 sf  (calculator value gives 63.520871%)  (rounding of moles of <b>G</b> gives 63.508772%)  <b>ALLOW</b> ecf from incorrect Mr or moles unless the yield is &gt;100%</p>

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

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><b>19.48%</b></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 <b>OR</b> = 5:6:1  <b>OR</b> empirical formula = C<sub>5</sub>H<sub>6</sub>O ✓  <i>M<sub>r</sub></i> is 164 so molecular formula = C<sub>10</sub>H<sub>12</sub>O<sub>2</sub> ✓</p>		C	H	O	%	73.15%	7.37%	<b>19.48%</b>	mol	6.10	7.37	1.22	ratio	5	6	1	2	<b>ALLOW</b> alternative method $73.15\% \times 164 = 120$ } ratio = 10 <b>OR</b> 5 $7.37\% \times 164 = 12.1$ } } 12 <b>OR</b> 6 $19.48\% \times 164 = 31.9$ } } 2 <b>OR</b> 1 ✓ ✓
			C	H	O															
		%	73.15%	7.37%	<b>19.48%</b>															
		mol	6.10	7.37	1.22															
ratio	5	6	1																	
(b)	seven ✓	1																		
(c)	(i)	TMS is the standard (for chemical shift measurements) ✓	1	<b>ALLOW</b> TMS is the reference <b>OR</b> for calibration <b>IGNORE</b> unreactive / volatile / it gives a sharp peak <b>ALLOW</b> TMS = 0 ppm / TMS is used for comparison																
	(ii)	(relative) number of protons/hydrogens in each environment / peak / region <b>OR</b> three proton environments with protons in ratio 5:1:6 ✓	1	<b>ALLOW</b> (relative) number of each type of proton/hydrogen <b>IGNORE</b> number of protons in the compound																
	(iii)	<sup>13</sup> C NMR Analysis (1 mark) The peak at 185ppm suggests an ester group /  <b>AND</b> one of the following: The peaks between 120ppm and 160ppm indicate a benzene ring <b>OR</b> the peaks at 18ppm <b>AND</b> 36ppm suggest C-C ✓	7	<b>FULL ANNOTATIONS WITH TICKS, CROSSES, CON ETC MUST BE USED</b> Inclusion of an incorrectly assigned <sup>13</sup> C peak <b>CONS</b> M1																

Question	Answer	Marks	Guidance
	<p><b><sup>1</sup>H ANALYSIS (4 marks)</b></p> <p>Doublet / peak at 1.2 shows R-CH <b>AND</b> 6 H's / 2 CH<sub>3</sub> (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 CH<sub>3</sub> groups are attached to a CH <b>OR</b> the multiplet / septet / heptet suggests that the CH group is attached to two CH<sub>3</sub> groups ✓</p> <p><b>QWC</b> must spell <b>one</b> of <i>multiplet, septet, heptet OR doublet</i> correctly</p> <p>Peak at 7.3ppm indicates a benzene ring <b>AND</b> 5 H's ✓</p> <p><b>Compound identification (2 marks)</b></p> <p> IF identified as then <b>two</b> marks ✓✓</p> <p> IF identified as then <b>one</b> mark ✓</p>	<p><b>Total</b> 12</p>	<p>Candidates may quote <math>\delta</math> values as ranges taken from Data Sheet, so <b>ALLOW</b> 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><b>ALLOW</b> peaks labelled on the spectrum If <b>QWC</b> word is not used, MAX 3 for proton NMR</p> <p><b>ALLOW</b> C<sub>6</sub>H<sub>5</sub> <b>IGNORE</b> reference to phenol</p> <p> Allow has 5 H's as C<sub>6</sub>H<sub>5</sub> if they state that the benzene ring</p>

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