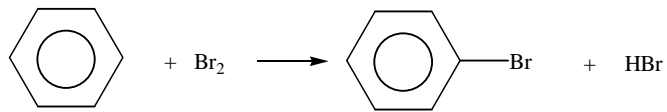
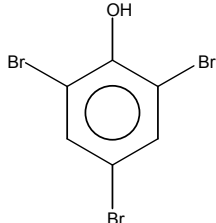
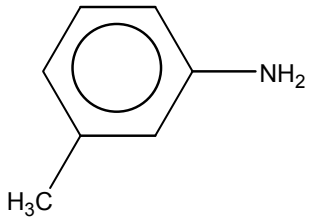
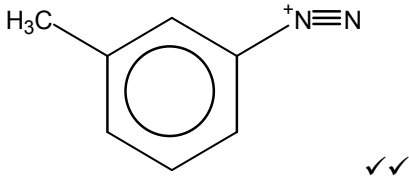
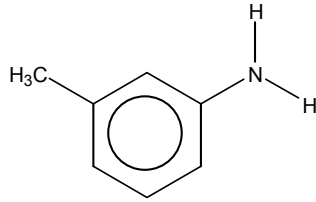
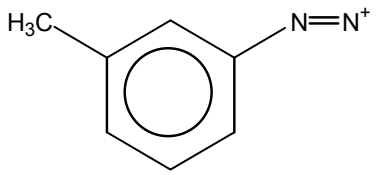
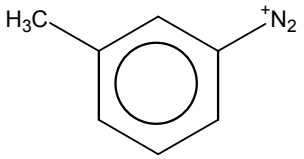
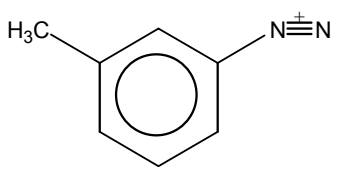
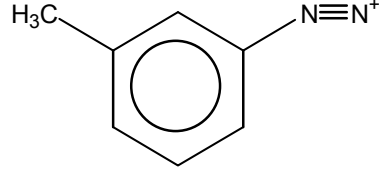
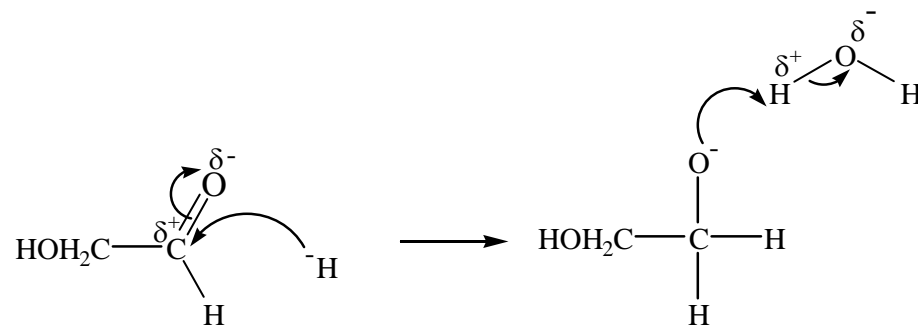
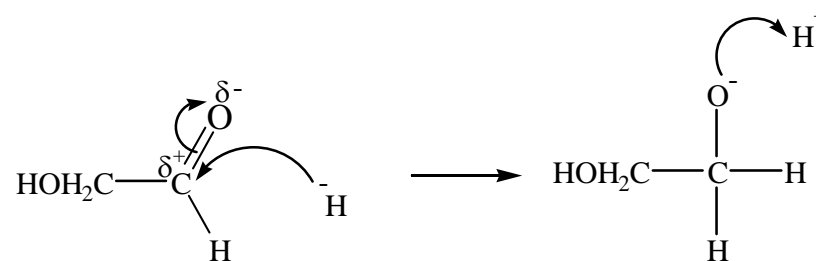


# F324 Rings, Polymers and Analysis

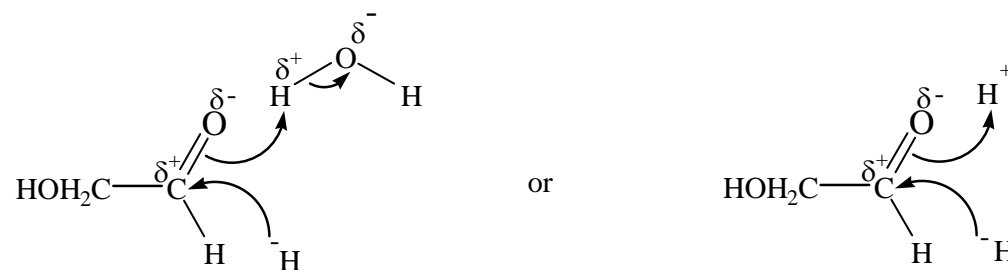
Question		Expected Answers	Marks	Additional Guidance
1	(a)		1	<p><b>ALLOW</b> <math>C_6H_6 + Br_2 \longrightarrow C_6H_5Br + HBr</math></p> <p><b>DO NOT ALLOW</b> multiple substitution <b>DO NOT ALLOW</b> <math>Br^+</math></p>
	(b) (i)	<p>White precipitate <b>OR</b> white solid <b>OR</b> white crystals ✓</p> 	2	<p><b>DO NOT ALLOW</b> colourless <b>DO NOT ALLOW</b> white ppt <u>and</u> bubbles</p> <p><b>DO NOT ALLOW</b> <math>Br_3C_6H_2OH</math> <b>OR</b> 2,4,6-tribromophenol <b>OR</b> tribromophenol</p>
	(ii)	1,2-Dibromocyclohexane ✓	1	<p><b>ALLOW</b> 1,2dibromocyclohexane <b>OR</b> 1-2dibromocyclohexane <b>OR</b> 1,2dibromocyclohexane <b>OR</b> cyclo-1,2-dibromohexane <b>DO NOT ALLOW</b> dibromocyclohexane <b>OR</b> <math>C_6H_{10}Br_2</math> <b>OR</b> structures</p>
	(iii)	<p><b>MUST</b> spell <u>delocalised/delocalized</u> or <u>localised/localized</u> correctly once in the answer to obtain all 5 marks</p> <p><b>benzene</b> <u>electrons</u> or <u><math>\pi</math>-bonds</u> are delocalised ✓</p> <p><b>phenol</b> a <u>lone</u> or <u>non-bonded</u> pair of electrons on the oxygen or the OH group is (partially) delocalised into the ring ✓</p> <p><b>cyclohexene</b> electrons are localised <b>OR</b> delocalised between two carbons ✓</p> <p>benzene has a lower <b>electron density</b> <b>OR</b> phenol has a higher electron density <b>OR</b> cyclohexene has a higher electron density ✓</p> <p>benzene cannot <b>polarise</b> or induce a dipole in <math>Br_2</math> <b>OR</b> phenol can polarise the <math>Br_2</math> <b>OR</b> cyclohexene can polarise <math>Br_2</math> or the <math>Br-Br</math> bond ✓</p>	5	<p><b>ALLOW</b> diagram to show overlap of all 6 p-orbitals for delocalisation <b>DO NOT ALLOW</b> benzene has delocalised structure or ring</p> <p><b>ALLOW</b> diagram to show movement of lone pair into ring for phenol</p> <p><b>ALLOW</b> diagram or description of overlap of 2 adjacent p-orbitals for bonding in cyclohexene <b>DO NOT ALLOW</b> cyclohexene has a <math>C=C</math> double bond <b>IGNORE</b> slip if cyclohexene is written as cyclohexane but <math>\pi</math>-bonding correctly described</p> <p><b>DO NOT ALLOW</b> charge density <b>OR</b> electronegativity instead of electron density <b>ALLOW</b> <math>Br^{\delta+}</math> <b>OR</b> electrophile <math>Br^+</math> as alternate to polarise</p>

(c)	 ✓  ✓✓ <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <b>ALLOW ECF ✓✓ on incorrect amine</b> </div> <p>HNO<sub>2</sub> + HCl and temp &lt; 10 °C <b>OR</b> NaNO<sub>2</sub> + HCl and temp &lt; 10 °C ✓  alkaline <b>AND</b> phenol (if temperature stated must be below 10 °C) ✓</p>	<p><b>5</b></p>	<p><b>ALLOW</b></p>  <p><b>IGNORE</b> Cl<sup>-</sup> ion  <b>DO NOT ALLOW</b> if ring is connected to the N triple bond in the diazonium or if diazonium has a negative charge  <b>ALLOW</b> one mark for correct displayed diazonium if alkyl group is not shown</p> <p><b>ALLOW</b></p>  for both marks  for one mark <p><b>ALLOW</b></p>  for one mark  for one mark <p><b>ALLOW</b> NaOH <b>OR</b> KOH &amp; C<sub>6</sub>H<sub>5</sub>OH <b>OR</b> phenoxide ion <b>OR</b> C<sub>6</sub>H<sub>5</sub>O<sup>-</sup>  <b>ALLOW</b> reagents and conditions from the equations</p>
	<b>Total</b>	<b>14</b>	

Question		Expected Answers	Marks	Additional Guidance
2	(a) (i)	<u>silver</u> mirror ✓	1	<b>ALLOW</b> Ag(s) <b>OR</b> Ag mirror <b>OR</b> precipitate <b>OR</b> ppt <b>OR</b> solid <b>ALLOW</b> brown <b>OR</b> black <b>OR</b> grey
	(ii)	HOCH <sub>2</sub> COOH ✓	1	<b>ALLOW</b> CH <sub>2</sub> OHCOOH <b>OR</b> CH <sub>2</sub> OHCO <sub>2</sub> H <b>OR</b> HOCH <sub>2</sub> CO <sub>2</sub> H <b>OR</b> displayed <b>OR</b> skeletal formula <b>OR</b> HOCH <sub>2</sub> COO <sup>-</sup> <b>DO NOT ALLOW</b> C <sub>2</sub> H <sub>4</sub> O <b>OR</b> 2-hydroxyethanoic acid
	(b)	$\text{HOCH}_2\text{CHO} + 3[\text{O}] \rightarrow \text{HOCCOOH} + \text{H}_2\text{O}$ reagents ✓                      both products ✓	2	<b>ALLOW</b> displayed/skeletal formula/COOHCOOH ✓✓ if molecular formula used C <sub>2</sub> H <sub>4</sub> O <sub>2</sub> + 3[O] → C <sub>2</sub> H <sub>2</sub> O <sub>4</sub> + H <sub>2</sub> O max = 1 ✓  <b>Any correctly balanced equation for partial oxidation</b> can score 1 mark ✓ HOCH <sub>2</sub> CHO + [O] → HOCH <sub>2</sub> COOH <b>OR</b> HOCH <sub>2</sub> CHO + 2[O] → OHCCOOH + H <sub>2</sub> O <b>OR</b> HOCH <sub>2</sub> CHO + [O] → OHCCHO + H <sub>2</sub> O <b>OR</b> HOCH <sub>2</sub> CHO + 2[O] → HOCCCHO + H <sub>2</sub> O
	(c) (i)	HOCH <sub>2</sub> CH <sub>2</sub> OH ✓	1	<b>ALLOW</b> HO(CH <sub>2</sub> ) <sub>2</sub> OH <b>OR</b> (CH <sub>2</sub> OH) <sub>2</sub> <b>OR</b> skeletal formula <b>OR</b> displayed formula <b>DO NOT ALLOW</b> molecular formula (C <sub>2</sub> H <sub>6</sub> O <sub>2</sub> )
	(ii)	curly arrow from H <sup>-</sup> to C <sup>δ+</sup> ✓ dipoles <u>and</u> curly arrow from C=O bond to O ✓ intermediate ✓ curly arrow from intermediate to H <sup>δ+</sup> in H <sub>2</sub> O/ H <sup>+</sup> and if H <sub>2</sub> O is used it must show the curly arrow from the O–H bond to the O ✓  <i>lone pairs are not essential</i>	4	<b>ALLOW</b> curly arrow to C even if dipole missing or incorrect  <b>ALLOW</b> maximum of 3 marks if incorrect starting material is used  See page 36 for detailed mechanisms – <b>Alternative 3</b> scores all 4 marks even though the intermediate is not shown

**Alternative 1****Alternative 2**

products  
are not  
required

**Alternative 3****Total****9**

Question		Expected Answers	Marks	Additional Guidance
3	(a) (i)	adsorption ✓	1	<b>ALLOW</b> partition <b>OR</b> adsorbtion <b>IGNORE</b> solubility <b>OR</b> desorption <b>DO NOT ALLOW</b> 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	<b>ALLOW</b> compare $R_f$ values to database <b>ALLOW</b> compare to known amino acids <b>DO NOT ALLOW</b> retention times for first mark, but the 2nd mark would be available as ✓ ECF <b>ALLOW</b> 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	<b>ALLOW</b> spots often overlap <b>OR</b> don't (fully) separate <b>ALLOW</b> they have similar $R_f$ (values) or similar adsorptions or similar retention times ECF to <b>a(ii)</b>
(b)	(i)	$\begin{array}{c} \text{H} \\   \\ \text{H}_2\text{N}-\text{C}-\text{COOH} \\   \\ \text{R} \end{array}$ ✓	1	<b>ALLOW</b> $\text{RCH}(\text{NH}_2)\text{COOH}$ any order for R, $\text{NH}_2$ and $\text{COOH}$ but C must be next to H 'CH' must be shown <b>ALLOW</b> $\text{CO}_2\text{H}$ brackets around $\text{NH}_2$ are <b>not</b> essential <b>ALLOW</b> structure
	(ii)	must attempt 3D use <b>RE</b> symbol in the "tools" to denote whether or not each chiral C is a reflection of the one given in the question	3	each chiral C must have 2 — bonds, 1 wedge bond ( <b>IGNORE</b> shading) & 1 dash bond ( <b>IGNORE</b> wedge) check the clockwise orientation of each C. For each C start with the H and if on the: <ul style="list-style-type: none"> <li>• top C the H is followed by <math>\text{COOH}</math> it is not a mirror image. If it is a mirror image annotate using RE.</li> <li>• bottom C the H is followed by <math>\text{CH}_3</math> it is not a mirror image. If it is a mirror image annotate using RE.</li> </ul> the four groups can be attached in any order. If the molecule is drawn upside down – clockwise becomes anti-clockwise.  <b>MUST</b> check that the drawn structure is non-superimposable irrespective of the orientation or the way it has been drawn.  <b>IGNORE</b> bond linkage for all groups

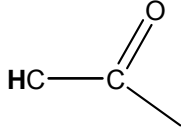
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Mark Scheme

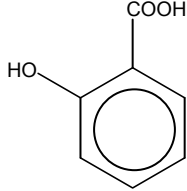

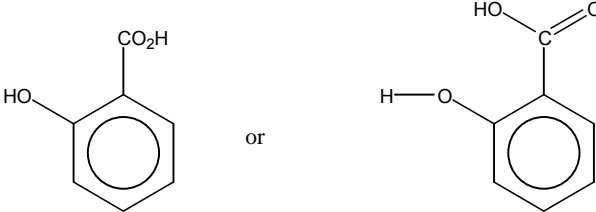
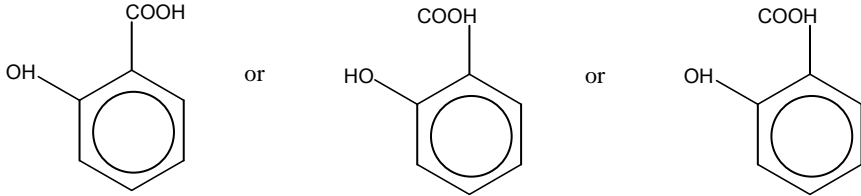
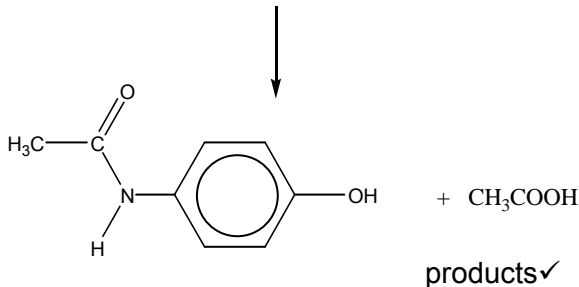
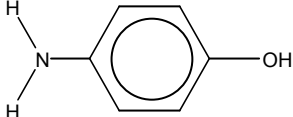
January 2010

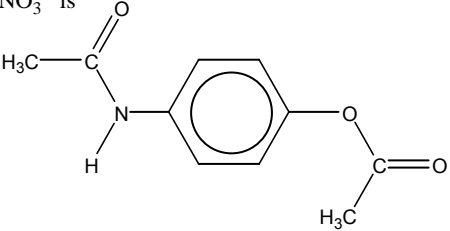
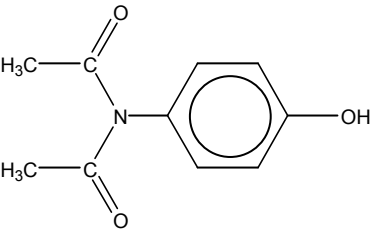
	(c)	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <math display="block">\begin{array}{c} \text{H} \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{COO}^- \\   \\ \text{CH}_3 \end{array}</math> <p>alanine at pH = 6.0 ✓</p> </div> <div style="text-align: center;"> <math display="block">\begin{array}{c} \text{H} \\   \\ \text{H}_2\text{N} - \text{C} - \text{COO}^- \\   \\ (\text{CH}_2)_2 \\   \\ \text{COO}^- \end{array}</math> <p>glutamic acid at pH = 10 ✓</p> </div> <div style="text-align: center;"> <math display="block">\begin{array}{c} \text{H} \\   \\ \text{H}_3\text{N}^+ - \text{C} - \text{COOH} \\   \\ (\text{CH}_2)_4 \\   \\ \text{}^+\text{NH}_3 \end{array}</math> <p>lysine at pH = 2.0 ✓</p> </div> </div>		<p><b>ALLOW</b> <math>\text{CO}_2^-</math></p> <p><b>ALLOW</b> <math>\text{NH}_3^+</math></p> <p>If <math>\text{NH}_3</math> fully displayed <b>ALLOW</b> + charge on N or H</p> <p>If <math>\text{COO}</math> fully displayed <b>ALLOW</b> <math>-</math> charge on O only</p>
	(d)	valine–glycine–leucine ✓	1	<p><b>ALLOW</b> val–gly–leu</p> <p><b>DO NOT ALLOW</b> structures</p>
	(e)	$\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$ ✓  $\text{HOOC}(\text{CH}_2)_8\text{COOH}$ ✓	2	<p><b>ALLOW</b> <math>\text{H}_2\text{NCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2</math></p> <p><b>ALLOW</b> <math>\text{HOOCCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}</math></p> <p><b>ALLOW</b> <math>\text{CO}_2\text{H}</math> for <math>\text{COOH}</math></p> <p><b>ALLOW</b> acid chloride, <math>\text{ClOC}(\text{CH}_2)_8\text{COCl}</math></p> <p><b>ALLOW</b> displayed formulae or skeletal formulae</p>
<b>Total</b>			<b>14</b>	

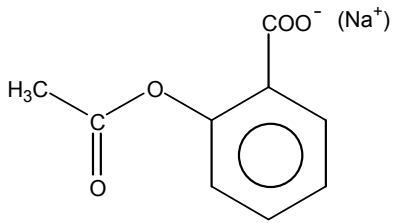
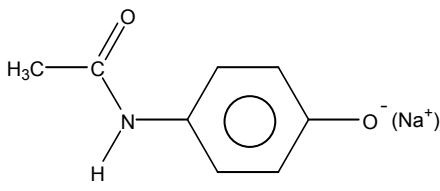
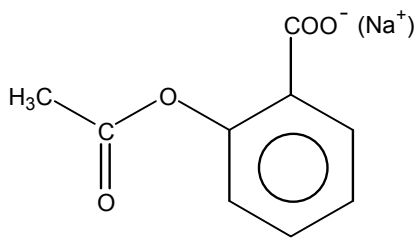
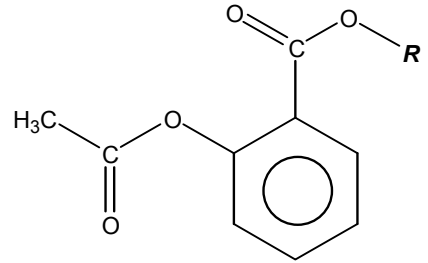
Question	Expected Answers	Marks	Additional Guidance
4 (a)	<p><b>infrared – 1 mark only</b> shows (very broad) peak between 2500–3300 (cm<sup>-1</sup>) (due to O–H bond) ✓</p> <p><b><sup>13</sup>C NMR – 2 marks</b> (CH<sub>3</sub>)<sub>2</sub>CHCH<sub>2</sub>COOH has 4 peaks (due to 4 different C environments) ✓ (CH<sub>3</sub>)<sub>3</sub>CCOOH has 3 peaks (due to 3 different C environments) ✓</p>	3	<p><b>ALLOW</b> (very broad) peak around 3000 (cm<sup>-1</sup>) <b>OR</b> any stated value between 2500 and 3300 (cm<sup>-1</sup>) for O–H <b>DO NOT ALLOW</b> peak in range 3200–3550 (cm<sup>-1</sup>)</p> <p><b>IGNORE</b> any reference to C=O or C–O as both are also present in an ester <b>OR</b> to fingerprint region</p> <p><b>ALLOW</b> '<sup>13</sup>C NMR detects the number of/different C environments' for 1 ✓, suitable example for the 2nd mark</p>
(b)	<p><b>splitting pattern</b> explains any two in terms of 'n + 1 rule' for two marks ✓✓ Explains any one peak for 1 mark ✓</p> <ul style="list-style-type: none"> <li>• <i>singlet</i> therefore adjacent C (if any) has no Hs</li> <li>• <i>multiplet</i> <b>OR</b> split into 7 therefore adjacent Cs have lots of/6 Hs</li> <li>• <i>doublet</i> therefore adjacent C is bonded to 1H</li> </ul> <p><i>must spell one of multiplet / heptet, singlet, doublet correctly</i></p> <p style="text-align: right;"><b>max = 2 marks</b></p> <p><b>chemical shifts</b></p>	6	<p><b>1 mark</b> for correct ester</p> <p>if two splitting patterns are correctly analysed <b>ignore</b> the third</p> <p><b>ALLOW</b> singlet because next or bonded to an O</p> <p><b>ALLOW</b> multiplet/heptet because next to 2 CH<sub>3</sub>s</p> <p><b>ALLOW</b> doublet because next to a CH</p> <p><b>ALLOW</b> tolerance on δ values; 3.6–3.8, 2.6–2.8 and 1.1–1.3</p>

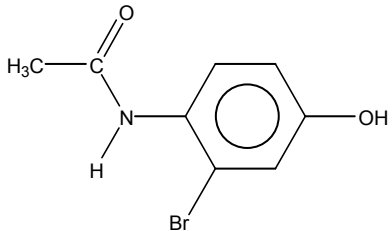
	<p>two marks if any two absorptions are identified correctly ✓✓  one mark if any one absorption is identified correctly ✓</p> <ul style="list-style-type: none"> <li>• peak ~3.7 (ppm) – bonded to an O</li> <li>• peak ~2.7 (ppm) – indicates it is next to a C=O</li> <li>• peak ~1.2 (ppm) – bonded to other Cs <b>OR</b> part of a chain</li> </ul> <p style="text-align: right;"><b>max = 2 marks</b></p> <p>compound identified as <math>(\text{CH}_3)_2\text{CHCOOCH}_3</math> ✓✓  <b>2 marks</b></p> <p>compound identified as <math>\text{CH}_3\text{COOCH}(\text{CH}_3)_2</math> ✓  <b>1 mark</b></p>		<p>(ppm)</p> <p><b>ALLOW</b> any two gets 2 marks, any one scores 1 mark</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <math>\text{HC}-\text{O}</math>  3.7 (ppm) </div> <div style="text-align: center;">   2.7 (ppm) </div> <div style="text-align: center;"> <math>\text{R}-\text{CH}</math>  1.2 (ppm) </div> </div> <p><b>ALLOW</b> peaks labelled on the spectrum  <b>ALLOW</b> singlet must be bonded to O, multiplet to C=O and doublet to CH or R for both chemical shift marks</p> <p>if two chemical shifts are correctly identified <b>IGNORE</b> the third</p>
	<b>Total</b>	<b>9</b>	



Question	Expected Answers	Marks	Additional Guidance
5 (a)	 	1	<p><b>ALLOW</b></p>  <p><b>DO NOT ALLOW</b> incorrect bond linkage</p> 
(b) (i)	<p>equation</p> $(\text{CH}_3\text{CO})_2\text{O} + \text{H}_2\text{N}-\text{C}_6\text{H}_4-\text{OH}$ <p>reactants ✓</p>  <p>products ✓</p>	2	<p><b>ALLOW</b></p> $(\text{CH}_3\text{CO})_2\text{O} + \text{H}_2\text{NC}_6\text{H}_4\text{OH} \rightarrow \text{CH}_3\text{CONHC}_6\text{H}_4\text{OH} + \text{CH}_3\text{COOH}$ <p><b>ALLOW</b></p>  <p><b>DO NOT ALLOW</b> molecular formulae</p>

	(ii)	<p><math>C_{10}H_{11}NO_3</math> is</p>  <p>or</p>  <p style="text-align: right;">✓</p>	1	<p><b>ALLOW</b> amide shown as either <math>CH_3CONH-</math> <b>OR</b> <math>H_3CCONH-</math> <b>OR</b> <math>CH_3COHN-</math> <b>OR</b> <math>H_3CCOHN-</math></p> <p><b>ALLOW</b> ester shown as either <math>-OCOCH_3</math> <b>OR</b> <math>-OOCCH_3</math></p>
	(iii)	to ensure that there are no (harmful) side effects ✓	1	<p><b>ALLOW</b> impurities reduce effectiveness (of drug) <b>OR</b> might be toxic <b>OR</b> avoids litigation <b>OR</b> harmful <b>OR</b> hazardous</p> <p><b>ALLOW</b> to ensure that the drug/active component is safe</p> <p><b>IGNORE</b> dangerous <b>OR</b> nasty <b>OR</b> can kill <b>OR</b> increased dosage</p>
(c)		<p>(aspirin contains) ester <b>AND</b> carboxylic acid ✓</p> <p>(paracetamol contains) amide <b>AND</b> phenol ✓</p>	2	<p><b>IGNORE</b> arene or benzene or aromatic or phenyl or methyl but any other group loses the mark</p> <p><b>ALLOW</b> carboxyl group</p> <p><b>DO NOT ALLOW</b> acid</p> <p><b>IGNORE</b> arene or benzene or aromatic or phenyl or methyl but any other group loses the mark</p> <p><b>ALLOW</b> peptide</p> <p><b>ALLOW</b> hydroxy(l)</p> <p><b>DO NOT ALLOW</b> hydroxide or alcohol</p> <p><b>DO NOT ALLOW</b> amine</p>
(d)	(i)	<b>Both</b>	3	<b>ALLOW</b> hydrolysis by $H^+(aq)$ or $H^+$ or $HCl(aq)$ or $HCl$ or $H_2SO_4(aq)$

	<p>Na OR NaOH ✓</p>  <p>from aspirin</p>  <p>from paracetamol</p>	<p>✓</p> <p>✓</p>	<p>or H<sub>2</sub>SO<sub>4</sub> to give hydroxybenzoic acid + ethanoic acid with aspirin ✓ and ammonium salt of 4-aminophenol + ethanoic acid with paracetamol ✓</p> <p><b>ALLOW</b> hydrolysis by OH<sup>-</sup>(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 ✓</p> <p><b>ALLOW</b> HNO<sub>3</sub> (and H<sub>2</sub>SO<sub>4</sub>) to give NO<sub>2</sub> in one or more positions on the ring in both aspirin and paracetamol ✓✓</p> <p><b>DO NOT ALLOW</b> NH<sub>3</sub> but correct ammonium salts can be awarded 2 marks ECF</p> <p><b>DO NOT ALLOW</b> H<sub>2</sub>O but correct products can be awarded 2 marks ECF</p> <p>if no reagent there cannot be any marks for the products If reagent selected is incorrect but would react with <b>either</b> aspirin or paracetamol <b>ALLOW</b> ✓ ECF for the correct organic product</p>
(ii)	<p><b>aspirin only</b> NaHCO<sub>3</sub> OR Na<sub>2</sub>CO<sub>3</sub> OR metal oxide ✓</p> 	<p>✓</p>	<p><b>ALLOW</b> Mg, carbonates, NH<sub>3</sub> <b>ALLOW</b> alcohols (ROH) to give ester if no reagent there cannot be any marks for the products</p> <p>2</p>  <p>If reagent selected is incorrect but would react with <b>BOTH</b> aspirin and paracetamol <b>ALLOW</b> ✓ ECF for the correct organic product</p>
(iii)	<p><b>paracetamol only</b></p>		<p><b>ALLOW</b> Br<sub>2</sub> water</p>

			<p>Br<sub>2</sub> ✓</p>  <p style="text-align: right;">✓</p>	<p><b>2</b></p> <p><b>ALLOW</b> one or more Br at <b>any</b> position on the ring  <b>DO NOT ALLOW</b> Br substitution of OH  <b>ALLOW</b> acyl chloride or acid anhydride and corresponding ester  <b>ALLOW</b> FeCl<sub>3</sub> to form a purple <u>complex ion</u> (structure not required)  <b>ALLOW</b> 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</p> <p>If reagent selected is incorrect but would react with <b>BOTH</b> aspirin and paracetamol <b>ALLOW</b> ✓ ECF for the correct organic product</p>
			<b>Total</b>	<b>14</b>

# Grade Thresholds

Advanced GCE Chemistry A (H034/H434)  
January 2010 Examination Series

## Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
F321	Raw	60	46	40	35	30	25	0
	UMS	90	72	63	54	45	36	0
F322	Raw	100	77	68	59	51	43	0
	UMS	150	120	105	90	75	60	0
F324	Raw	60	43	38	33	29	25	0
	UMS	90	72	63	54	45	36	0

## Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
H034	300	240	210	180	150	120	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
H034	12.9	37.5	62.7	83.1	96.2	100	1415

**1415 candidates aggregated this series.**

For a description of how UMS marks are calculated see:  
<http://www.ocr.org.uk/learners/ums/index.html>

Statistics are correct at the time of publication.