OCR
Oxford Cambridge and RSA

GCE

Chemistry A

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

Advanced GCE

Mark Scheme for June 2016

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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.

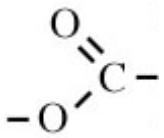
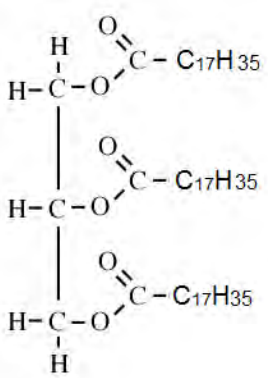
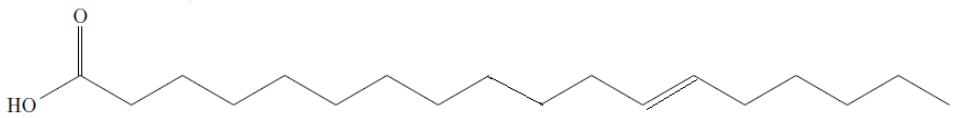
All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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

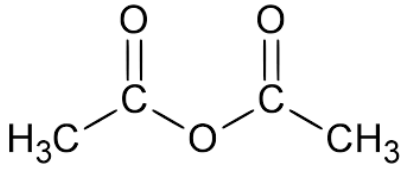
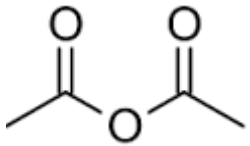
OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Abbreviations, annotations and conventions

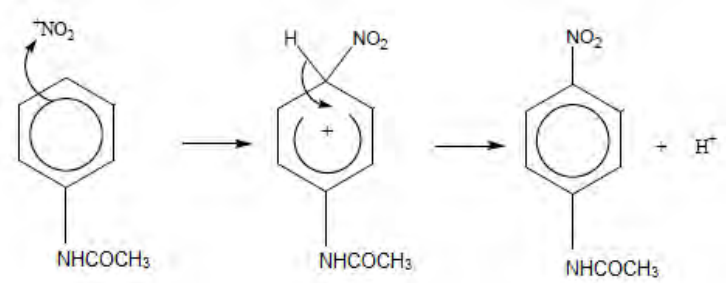
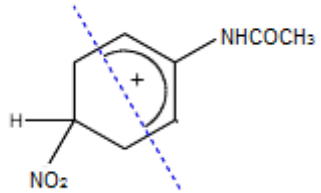
Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording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

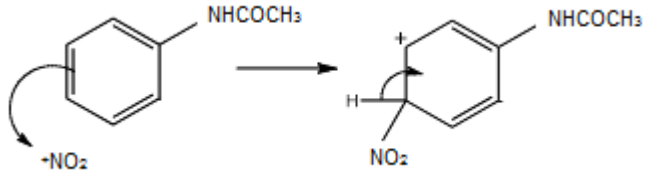
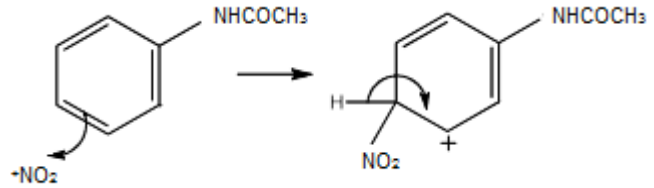
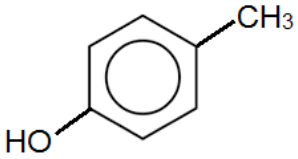
Question			Answer	Mark	Guidance
1	(a)		Stearic acid/octadecanoic acid **AND** Saturated (fat) ✓	1	**ALLOW** stearic acid **AND** no C=C double bonds **IGNORE** comments about LDL and cholesterol **DO NOT ALLOW** stearic acid is a trans fatty acid
	(b)		$C_{17}H_{35}COOH + NaOH \rightarrow C_{17}H_{35}COO^{-}Na^{+} + H_2O$ ✓	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

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**	

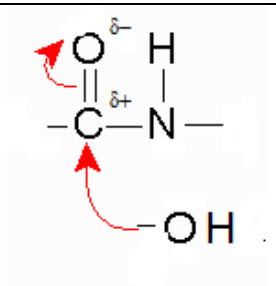
Question			Answer	Mark	Guidance
2	(a)	(i)	$H_2N(CH_2)_6NH_2$ ✓ $HOOC(CH_2)_4COOH$ ✓	2	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** a combination of above as long as unambiguous **ALLOW** acid chloride, $ClOC(CH_2)_4COCl$
		(ii)	<u>Type of condensation polymer</u> Polyamide **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

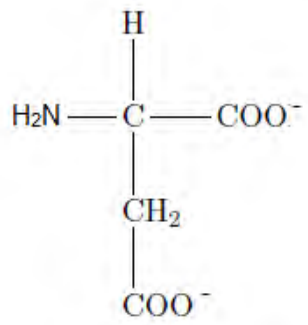
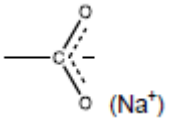
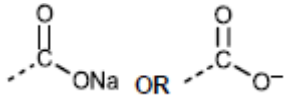
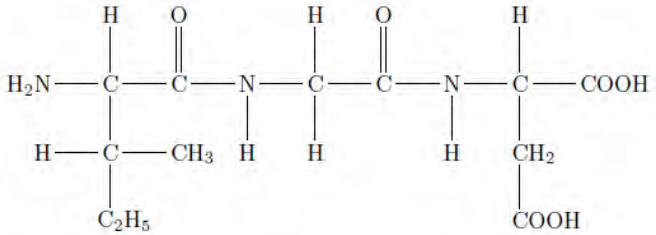
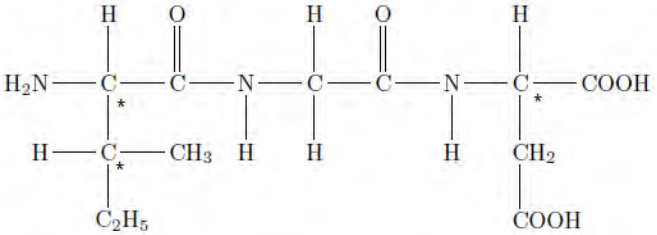
Question			Answer	Mark	Guidance
		(ii)	**FIRST CHECK THE ANSWER ON THE ANSWER LINE** **IF** answer = 2.66 (g) award 3 marks **IF** answer = 4.36 (g) award 2 marks (% yield not used) **IF** answer = 7.14 (g) award 2 marks (% yield used incorrectly) n(phenylamine) (= 3.00/93.0) = 0.0323 mol ✓ n(compound 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

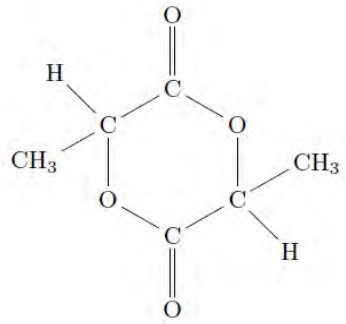
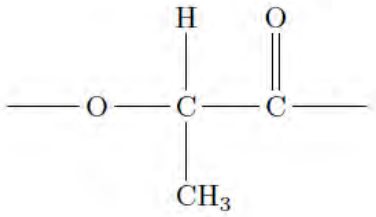
Question			Answer	Mark	Guidance
		(iii)	**M1** $H_2SO_4 + HNO_3 \rightarrow HSO_4^- + H_2O + NO_2^+$ ✓ **M2** curly arrow from π ring **OR** from within the ring to $^+NO_2$ ✓  **M3** correct intermediate (with charge) ✓ **M4** curly arrow from C-H to reform ring **AND** correct products ✓	5	**ANNOTATE 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

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)**

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 $10^{o}C$ **DO NOT ALLOW** heat/boil/warm
			Total	**17**	

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 zwitterion ✓ ✎ **QWC**: **zwitterion** spelled correctly in the correct context	1	**DO NOT ALLOW** PH/ph **ALLOW** zwitter ion

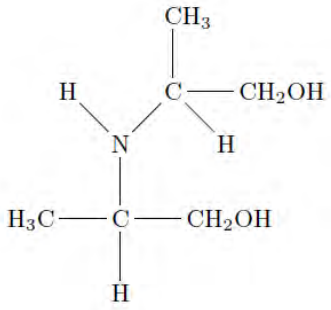
Question			Answer	Mark	Guidance
		(ii)	 ✓	1	**ALLOW** correct structural **OR** displayed **OR** skeletal formulae **OR** combination of above as long as unambiguous **Two** COO^- groups are required in the structure **ALLOW** $–COO^-Na^+$ **OR** -COONa  **ALLOW** delocalised carboxylate **ALLOW**  **DO 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**	

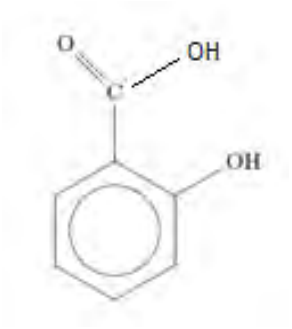
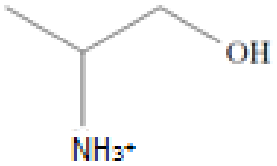
Question			Answer	Mark	Guidance
4	(a)		2(-)hydroxypropanoic acid ✓	1	**DO NOT ALLOW** 2-hydroxylpropanoic acid **IGNORE** other dashes, commas and spaces
	(b)		Lactic acid synthesised in the laboratory will contain optical isomers/two optical isomers **OR** Lactic acid produced by bacteria will be present 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

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**	

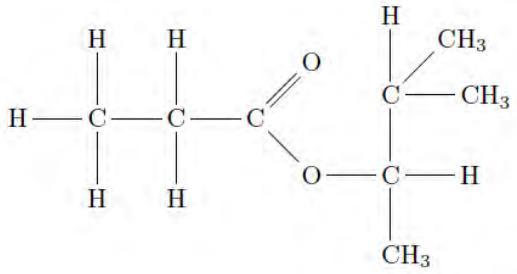
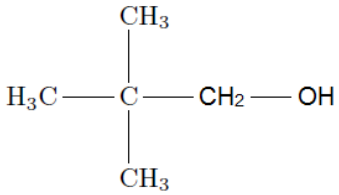
<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>5</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><th colspan="3">^{1}H NMR spectrum for 2-aminopropan-1-ol</th></tr>
<tr><th>Chemical shift, δ/ppm</th><th>Relative peak area</th><th>Splitting pattern</th></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>

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**	

Question			Answer	Mark	Guidance
6	(a)		<u>Reducing agent</u> $NaBH_4$ / sodium tetrahydridoborate(III) / sodium borohydride ✓ <u>Equation</u> $CH_3(CH_2)_3CHO + 2[H] \rightarrow CH_3(CH_2)_3CH_2OH$ ✓	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

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**	

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