OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry B (Salters)

Advanced GCE

Unit **F334:** Chemistry of Materials

Mark Scheme for January 2013

Oxford Cambridge and RSA Examinations

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

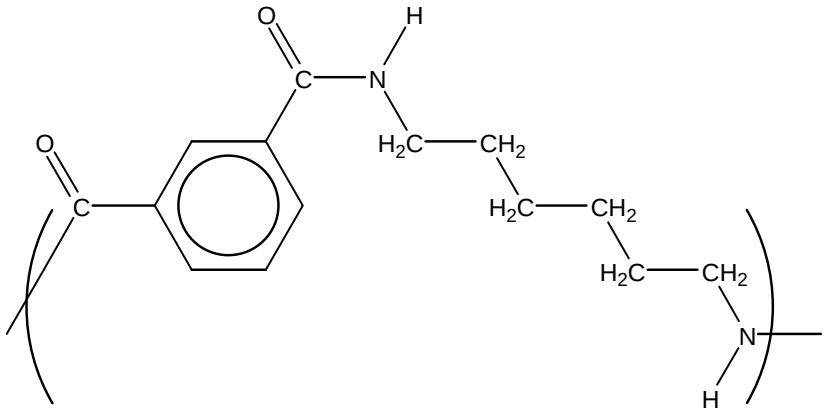
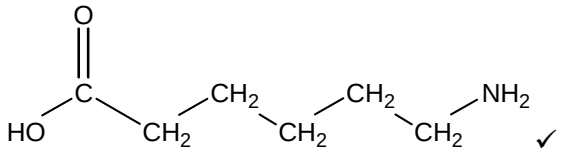
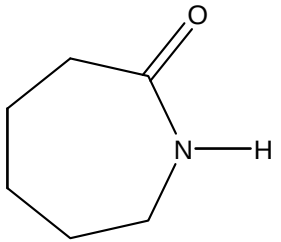
OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	separates marking points
not	answers which are not worthy of credit and which will CON a correct answer
ignore	statements which are irrelevant and will NOT 'CON' a correct answer
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 (replaces the old 'or words to that effect')
ora	or reverse argument

Annotations used in scoris:

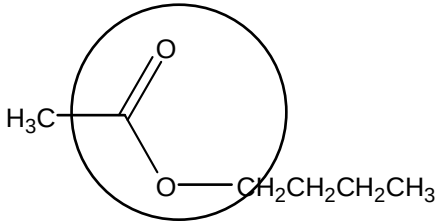
Annotation	Meaning
	correct response
	incorrect response
	benefit of the doubt
	benefit of the doubt **not** given
	error carried forward
	information omitted
	Ignore
	Reject

Question			Answer	Marks	Guidance
1	(a)	(i)	 all correct 2 marks ✓✓ amide link only ✓	2	**ALLOW** • any correct structural formula including skeletal • mixtures of structural and skeletal • –CONH– • Cs and Hs on ring **IGNORE** brackets and n etc
		(ii)	–CONH– circled ✓	1	**ALLOW** adjacent C atoms in circle
		(iii)	1,6-diamino ✓ hexane ✓ **OR** hexane ✓ -1,6-diamine ✓	2	If butane **ALLOW** 1,4-diamino for ecf mark **IGNORE** commas and dashes **ALLOW** 1,6-hexanediamine
	(b)	(i)	 ✓	1	**ALLOW** any formula that makes structure clear **ALLOW** cyclic amide 

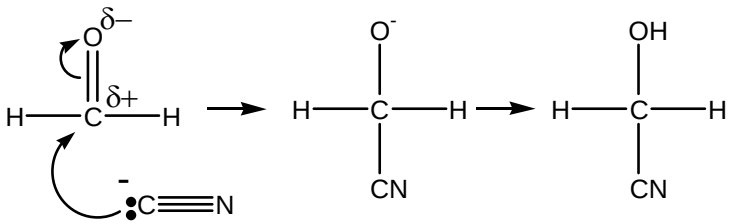
Question			Answer	Marks	Guidance
		(ii)	condensation **AND** water is eliminated/formed/lost ✓ **IF** cyclic amide in 1b(i) **THEN** addition AND hydrolysis (of ring) / water added	1	'addition' or 'addition polymerisation' is a **CON** **ALLOW** 'small molecule' instead of water any other named small molecule is a **CON**
	(c)	(i)	(polymer) <u>chains/molecules</u> are (highly) ordered/aligned **AW** ✓	1	**ALLOW** labelled diagram that shows alignment of chains by using parallel lines **AW** means other suitable phrases *eg* 'stacked closely and neatly' 'arranged regularly'/'regularity of chains'
		(ii)	PPA chains are **closer** together **ORA** ✓ so **intermolecular bonds** in PPA will be **stronger** **OR** more hydrogen bonds in PPA **OR** more intermolecular bonds in PPA **ORA** ✓ **more energy/heat** will be required to break the **intermolecular bonds OR** melt the polymer **OR** allow chains to move over each other **ORA** ✓	3	**AS ALWAYS** intermolecular **bonds** is synonymous with intermolecular **forces** **NOT** more areas of contact **NOT** just compacted together **NOT** just closely packed **NOTE** ALL 3 marking points are **comparative** **ALLOW** any named intermolecular bond **NOT** 'higher temperature' for 'energy'
		(iii)	cold-drawing ✓	1	**NOT** co-polymerising **IGNORE** 'necking'

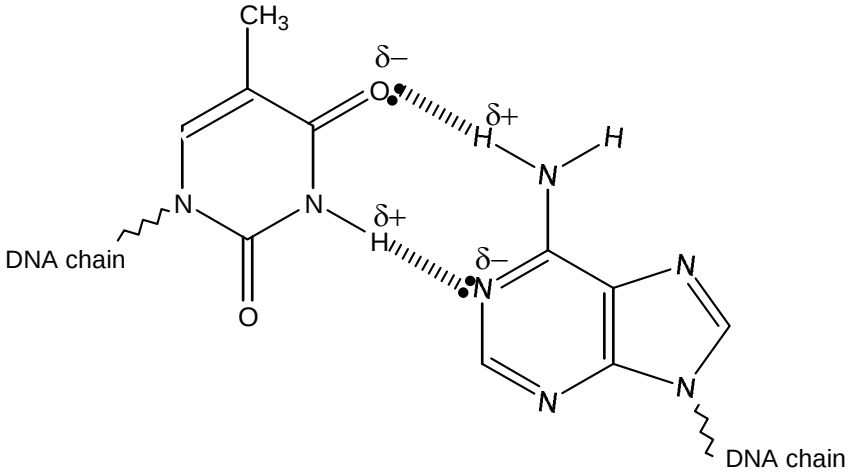
Question			Answer	Marks	Guidance
	(d)	(i)	1. elimination ✓ 2. addition ✓ 3. addition ✓	3	**IGNORE** 'nucleophilic'
		(ii)	can be used in step 3 **AW** ✓	1	**NOT** step 2 **ALLOW** • can be sold • can be used as a source of energy • can be recycled
	(e)		acidified dichromate ✓	1	**IGNORE** • metal cation • name of acid • wrong formulae if name given • oxidation state of 'dichromate' **ALLOW** H_2SO_4/H^+ and $Cr_2O_7^{2-}$ **DO NOT ALLOW** just dichromate
			Total	**17**	

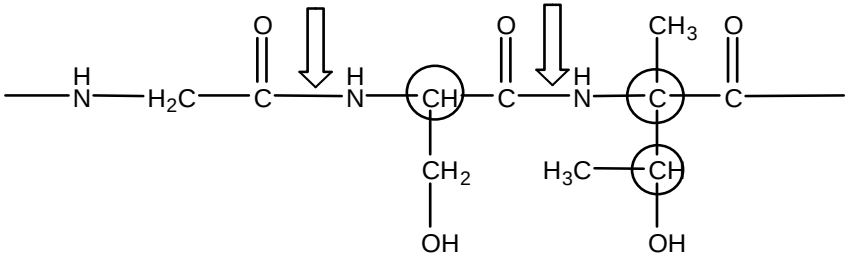
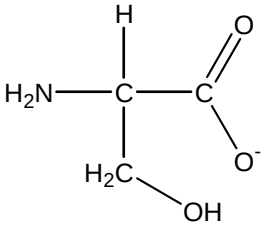
Question			Answer	Marks	Guidance
2	(a)		–COOH / carboxyl / carboxylic acid group ✓ is a proton/H^+ donor / loses H^+ ✓	2	correct equation showing dissociation gains both marks **ALLOW** 'gives H^+' *Mark separately*
	(b)	(i)	$CH_2OHCOOH + NaOH \rightarrow CH_2OHCOONa + H_2O$ ✓	1	**ALLOW** $CH_2OHCOO^- Na^+$, $Na^+ CH_2OHCOO^-$ **OR** $Na(CH_2OHCOO)$ **IGNORE** state symbols **NOT** $CH_2OHNaCOO$
		(ii)	1. moles of NaOH used in titration = **16.00/1000** x **0.250** ✓ = 0.00400	6	*There are several possible routes through this question after point 2, the 'mole route' A, the 'mass route' B and the 'concentration route' C* **If final answer is incorrect please annotate with ticks where the marks are awarded** 2. **ALLOW** by implication if 0.004 used subsequently **The marks are awarded for the working out given in bold OR** the correctly calculated answer to that working (but no mark if calculated answer is shown and is wrong) 4. Award if 76 used correctly anywhere
			2. moles of glycolic acid used in titration = answer from **1, *scaled by ratio in equation in 2bi*** ✓ 0.00400 **CHECK equation in 2(b)(i)**		
			3A. moles of glycolic acid in 250 cm^3 = (answer from **2)** x **10** ✓ = 0.0400 mol **OR** 3B. mass of glycolic in 25 cm^3 = (answer from **2**)x M_r of glycolic acid ✓ 0.304 g **OR** 3C. concentration of glycolic acid = (answer from **2**) **x 1000/25** ✓ 0.16 mol dm^{-3}		
			4. M_r of glycolic acid = **76.(0)** ✓		

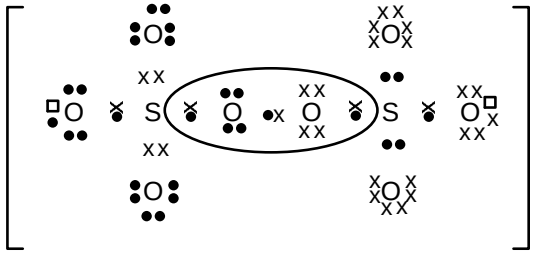
Question			Answer	Marks	Guidance
			5A. moles of glycolic acid in 100 cm^3 = (answer from **3A**) x 100/14 ✓ 0.286 mol **OR** 5Bi. mass of glycolic acid in 250 cm^3 = (answer from **3A**) x M_r of glycolic acid ✓ 3.04 g **OR** 5Bii. mass of glycolic in 250 cm^3 = (answer from **3B**) x **10** = ✓ 3.04 g **OR** 5C. concentration of undiluted glycolic acid = (answer from **3C**) x **250/14** ✓ 2.86 mol dm^{-3} 6. mass of glycolic acid in 100 cm^3 undiluted = (answer from **5A**) x M_r of glycolic acid **OR** = (answer from **5B**) **x 100/14** **OR** = (answer from **5C** /10) x M_r of glycolic acid **= 21.7** (3 sf) **AND** correct comment ✓		**ALLOW** ecf for incorrect equation **AND** between each step **ALLOW** 'Acnegone' for 'glycolic acid' **ALLOW** answers in standard form *The following on the answer line with correct corresponding comment, score as follows, irrespective of working or lack of it*: 21.7 scores 6 1.22 scores 5 (error in 5C) 12.2 scores 5 (error in 6C) 2.17 scores 5 (error in 3A or 5Bii) 3.04 scores 5 (error in 6) *these to other sf* **OR** *with incorrect comment score one mark less* **If one of the answers above applies place correct number of ticks by answer**
	(c)	**(i)**	 butyl ethanoate ✓ ester link correct ✓	2	**IGNORE** where the circle cuts the bond as long COO is included **ALLOW** adjacent C atoms in circle **ALLOW** butylethanoate without gap
		(ii)	butan-1-ol ✓ <u>concentrated</u> sulfuric acid/hydrochloric acid ✓	2	**MUST HAVE** number 1 **DO NOT ALLOW ecf** for alcohol in 2(c)(i) **ALLOW** formula for acid **ONLY** **IGNORE** spelling of name for H_2SO_4 as long as it is clear

Question			Answer	Marks	Guidance
		(iii)	**ethanoic acid:** hydrogen bonding ✓ **IGNORE** pd-pd **compound D:** pd-pd ✓ hydrogen bonding is **CON** instantaneous dipole – induced dipole / id-id in both ✓	3	**ALLOW** 'pd-pd' / id-id abbreviations here **ALLOW** Van der Waals for id-id
	(d)	(i)	*The answer requires a comment for a carboxylic acid AND an alcohol so award ONE mark from each section below:* **CARBOXYLIC ACID** (strong) peak at 1743 (cm^{-1}) shows C=O in ester not acid **OR** no peak 1700 – 1725 (cm^{-1}) shows no C=O in acid **OR** no broad peak at 2500 – 3200 (cm^{-1}) shows no O–H in acid ✓ **ALCOHOL** no peak greater than 3000 / in range 3200 – 3600 (allow 3640) so no O–H in alcohol ✓	2	answers may be given on spectrum to score each point, **range**, **bond** and **group** in which it is found must be given **ALLOW** carboxyl or carboxylic acid or COOH or ethanoic acid (or formula) for **'acid'** FOR O–H **ALLOW** OH / hydroxyl FOR C=O **ALLOW** carbonyl **NOT** CO
		(ii)	**peak at *m/z* 73:** CH_3COOCH_2 / $C_3H_5O_2$ ✓ positive charge on any formula ✓ **species lost:** $CH_2CH_2CH_3$ / C_3H_7 (NO charge) ✓	3	**ALLOW** any correct structural or molecular formula for both answers **ALLOW** $C_4H_9O^+$ **IF** $C_4H_9O^+$ given above **THEN species lost must be** C_2H_3O / CH_3CO
	(e)	(i)	nucleophilic ✓ addition ✓	2	

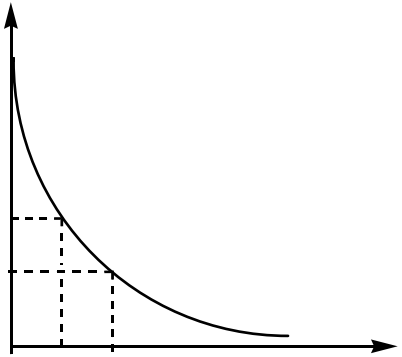
Question			Answer	Marks	Guidance
		(ii)	H^+ or H_2O or HCN  HCHO with bond polarity correct ✓ CN^- with lone pair of electrons on C ✓ both curly arrows correct (lower one must be from C of CN) ✓ intermediate ion correct ✓ gain of H^+ from **water, HCN** or **direct** to form the cyanohydrin ✓	5	**ALLOW** CN^- without triple bond **ALLOW** –ve charge on N of CN^- **IGNORE** any arrow used to add H^+ etc to the intermediate
			Total	**28**	

Question			Answer	Marks	Guidance
3	(a)	(i)	repeating unit in DNA is a **nucleotide** ✓ formed from pentose/**sugar/**deoxyribose, **phosphate** and a **base** AW ✓	2	*mark separately* **ALLOW** • names for the four bases (T,A,C,G) instead of 'bases' • a named example of a base **IGNORE** ribose for **two marks** it must be clear that the sugar etc makes up the nucleotide
		(ii)	proteins are formed from **amino acid(s)** ✓	1	
		(iii)	proteins have **more** amino acids than the **bases/nucleotides** in DNA ✓ from which to construct many unique/different/more structures/arrangements/combinations to carry genetic data AW ✓	2	**ALLOW** actual numbers *eg* there are 20/21 amino acids in proteins and only 4 bases/nucleotides in DNA
	(b)		 correct formula completed for adenine **AND** both H bonds between correct atoms ✓ correct polarities for one hydrogen bond ✓ lone pair for one hydrogen bond ✓	3	

Question			Answer	Marks	Guidance
	(c)	(i)	 ANY TWO of the THREE CORRECT chiral Cs ONLY ✓	1	
		(ii)	arrows as in (d) (i) ✓	1	**IGNORE** extra arrows pointing to C–N bonds at ends of chain. Any other arrows are a **CON**
		(iii)	 correct amino acid (see opposite) ✓ correct formula of ion ✓	2	**IGNORE** any cations **ALLOW** any correct structural formula **IGNORE** species formed from amino acids to right and left **IGNORE** • added H^+ to $–NH_2$ • negative charge on alcohol i.e. $–O^-$ • –COOH instead **NO** ecf **IF** anion formed at CH_2O^- then 1 mark max for amino acid
		(iv)	secondary: folding/twisting of polypeptide/amino acid chains/primary structure ✓ tertiary: further/final folding **OR** 3D shape/structure ✓	2	**ALLOW** (alpha)-helix/coiled **OR** (beta-)sheets / pleated sheets **ALLOW** overall/global structure
			Total	**14**	

Question			Answer	Marks	Guidance
4	(a)	(i)	 2- correct inside oval (around peroxy Os) ✓ rest correct ✓	2	**ALLOW** another symbol for S electrons second mark depends on first
		(ii)	$(NH_4)_2 S_2O_8$ ✓	1	**ALLOW** • with correct charges • $S_2O_8(NH_4)_2$
	(b)		$S_2O_8^{2-}$ (is the stronger oxidising agent) because $S_2O_8^{2-}$ has **a more positive** $E^{\ominus}$ value ✓ indicates a **greater** tendency AW to gain/attract/accept electrons/to be reduced ✓ **ORA ie:** $S_2O_8^{2-}$ (is the stronger oxidising agent) because $Cr_2O_7^{2-}$ has **a less positive** / **more negative** $E^{\ominus}$ value ✓ indicates a **smaller** tendency AW to gain/attract/accept electrons/to be reduced **OR** indicates a **greater** tendency AW to lose electrons/to be oxidised ✓	2	without reference to oxidising strength of $S_2O_8^{2-}$ only scores **1** as it doesn't answer the question **NOT** 'higher' for 'more positive' both statements **MUST BE** comparative
	(c)	(i)	$S_2O_8^{2-} + 2I^- \rightarrow 2SO_4^{2-} + I_2$ correct equation balanced ✓	1	**IGNORE** state symbols

Question			Answer	Marks	Guidance
		(ii)	1. use filter of complementary colour to iodine/solution ✓ 2. zero colorimeter with water ✓ 3. measure absorbance readings of standard solutions/solutions of known concentration (of iodine) ✓ 4. plot calibration graph ✓ 5. take absorbance readings of the reacting mixture at known/certain times AW (must refer to **<u>time</u>** – may state units of time) ✓ 6. convert absorbance readings to iodine concentrations using the calibration curve ✓ **QWC:** In order to gain the mark for point 3, 5 or 6, absorbance must be used **AND** spelled correctly at least once	6	**Using starch ANYWHERE is a CON and CANNOT gain marking point 3** **ALLOW** • filter/wavelength giving maximum absorption/absorbance • green/blue filter • suitable filter orange/yellow/brown is **CON** **NOT** 'solvent' instead of 'water' **IGNORE** references to quenching procedures

Question			Answer	Marks	Guidance
		(iii)	 $t_{1/2}$ $t_{1/2}$ suitable graph sketched ✓ construction lines to determine half-lives from graph ✓ constant half-life (means first order) ✓	3	graph should show a curve (**NOT** straight line) **decreasing** from left to right (ANY decreasing curve will do) at least **two** sets of construction lines should be shown on graph dependent on showing half-lives on graph (numbers on scale *or* by labelling with $t_{1/2}$)
	(d)	(i)	homogeneous, reactants and catalyst/Fe^{3+} are in the same phase / state ✓	1	**MUST** mention 'reactants **and** catalyst' **IGNORE** 'redox' **NOT** 'substrate' **ALLOW** 'all in solution' for 'same phase'
		(ii)	Fe^{2+} $1s^2 2s^2 2p^6$ **$3s^2$ $3p^6$ $3d^6$** Fe^{3+} $1s^2 2s^2 2p^6$ **$3s^2$ $3p^6$ $3d^5$** correct number of **EXTRA** electrons added 14(Fe^{2+}) and 13(Fe^{3+}) ✓ both fully correct ✓	2	**IGNORE** $4s^0$

Question			Answer	Marks	Guidance
		(iii)	1. Fe^{3+} reacts with/oxidises I^- **ORA** ✓ $2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$ ✓ *explanation:* the $E^{\ominus}$ of Fe^{3+}/Fe^{2+} half-cell is **more positive / less negative** than that of the I^-/I_2 half-cell **ORA** ✓ AW 2. Fe^{2+} reacts with/reduces $S_2O_8^{2-}$ **ORA** ✓ $S_2O_8^{2-} + 2Fe^{2+} \rightarrow 2SO_4^{2-} + 2Fe^{3+}$ ✓ *explanation:* the $E^{\ominus}$ of $S_2O_8^{2-}/SO_4^{2-}$ half-cell is **more positive** than that of the Fe^{3+}/Fe^{2+} half-cell **ORA** ✓ AW **QWC:** to gain the explanation mark for either **1** or **2**, the data has to be linked correctly to the reaction	6	**IGNORE** references to activation enthalpy **OR** variable valency/oxidation states **ALLOW** $E^{\ominus}$ of $Fe^{3+}$is more positive etc **ALLOW** $E^{\ominus}$ of $S_2O_8^{2-}$is more positive etc **NOTE** If answer starts with Fe^{2+} rather than Fe^{3+} lose 1st mark but ecf since not answering question so can get 5 marks
	(e)	(i)	Rate = k x $[S_2O_8^{2-}]$ ✓ x $[I^-]$ ✓	2	**IGNORE** state symbols
		(ii)	uses one of the 3 sets of results: 1. $k = 2.0 \times 10^{-5} / (0.075 \times 0.040)$ 2. $k = 4.0 \times 10^{-5} / (0.150 \times 0.040)$ 3. $k = 1.0 \times 10^{-5} / (0.075 \times 0.020)$ ✓ k = **0.0067** ✓ $mol^{-1}\ dm^3\ s^{-1}$ ✓	3	ecf from part e(i) provided working is shown **ALLOW** standard form (eg 6.7×10^{-3}) Correct numerical answer without working scores 2 for calculation part **NO** ecf from first mark to second **ALLOW** any number of sig figs *e.g.* 0.007, 0.00667 **NOT** 0.006 **NOR** 0.0066 **ALLOW** units in any order, *e.g.* $dm^3\ s^{-1}\ mol^{-1}$
		(iii)	2.0×10^{-5} ✓ $mol\ dm^{-3}\ s^{-1}$ ✓	2	*Mark separately*
			Total	**31**	

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

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553