OCR
Oxford Cambridge and RSA

GCE

Chemistry B (Salters)

Unit **F334:** Chemistry of Materials

Advanced GCE

Mark Scheme for June 2017

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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.

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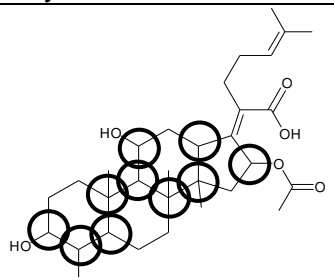
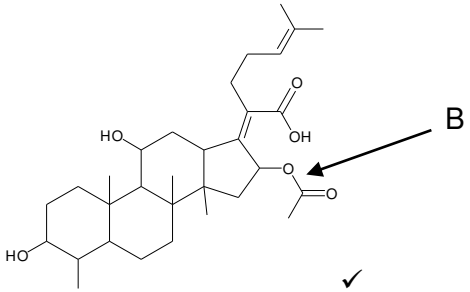
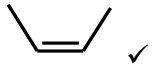
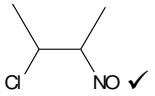
1 Annotations: the following annotations are available on RM ASSESSOR.

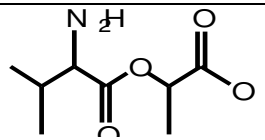
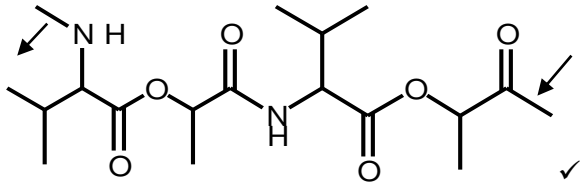
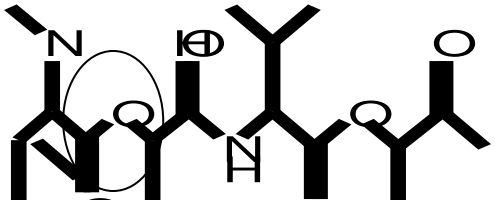
Annotation	Meaning
BOD	Benefit of doubt given
CON	Contradiction
	Incorrect response
ECF	Error carried forward
TE	Transcription error
NBOD	Benefit of doubt not given
POT	Power of 10 error
^	Omission mark
SF	Error in number of significant figures
	Correct response
	Wrong physics or equation

Question			Expected Answers	Marks	Additional Guidance
1	a		Is it safe? AW Does it work? AW Is it better than the standard treatment? AW **ALL** correct ✓✓ Any **TWO** correct ✓	2	**ALLOW** Can it be formulated correctly (for skin application)? **ALLOW** reference to cost effectiveness
	b	i	alkene / carbon-carbon double bond ester hydroxyl / (secondary) alcohol **ALL** correct ✓✓ Any **TWO** correct ✓	2	**DO NOT ALLOW** 'double bond' alone primary is a **CON**
	b	ii	 **ANY FOUR ALL** correct✓	1	If more than 4 circled – all must be correct
	b	iii	**EITHER:** **YES**, because: 3 electron clouds/densities/groups (around C) ✓ these repel ✓ as far (apart) as possible ✓ **OR** **NO** because: 3 electron clouds/densities/groups (around C) ✓ C=C/double bond repels more than C-H/single bond ✓ so bond angle will be <u>less/reduced/smaller</u> (between the single bonds**)** ✓	3	**ALLOW** '3 regions of negative charge' In YES response **ALLOW** 2nd and 3rd marks for 'position themselves to minimise repulsion' **IGNORE** 'as much as possible' **DO NOT ALLOW** 'bonds repel' Double bonds repel less than single bonds followed by angle will be greater scores 3rd mark ecf. 'Bonds repel differently so angles are different' **MAX 2** Failure to categorically agree or disagree – 2 marks

Question			Expected Answers	Marks	Additional Guidance
					max
	b	**iv**	It gives an accurate value of molecular ion peak AW ✓ use accurate (atomic) masses (to at least 4 decimal places) for the constituent atoms AW ✓ different compounds have different accurate M_r values✓	**3**	No credit for fragmentation
1	**c**		**with Pd** H_2 adds on to the terminal C=C ✓ forming structure ($(CH_3)_2$**C**H**C**H_2-) in which neither carbon is asymmetric AW✓ **with Pt** H_2 also adds on to the C=C bonded to COOH group ✓ forming structure (R_1(COOH)**C**H**C**HR_2R_3-) where both carbons are now asymmetric AW✓	**4**	**ALLOW** any unambiguous identification of the two double bonds For 2nd mark in each pair **ALLOW** description of asymmetry instead of the word itself 'One H_2 with Pd and a second with Pt across C=C bonds' scores **1 mark**
	d	**i**	 ✓	**1**	**ALLOW** **EITHER** C–O in O-C=O (as shown and correct) **OR** C–O to main part of structure Any label must point to the bond and not the atom
	d	**ii**	ethanoic acid because M_r / molecular ion peak is 60 ✓ hydrolysis of ester forms acid ✓ (broad) peak at (any value between) 2500-3300 in spectrum indicates O-H in carboxylic acid ✓ (strong) peak at (any value between)1700-1730 in spectrum indicates C=O in carboxylic acid ✓	**4**	**QWC** only award second mark if first scored **ALLOW** any frequency within range **NOTE** they must identify the two peaks **on the spectrum** or **in response** If 'in carboxylic acid' is not mentioned candidate can still score 3rd marking point if BOTH peaks identified
			Total	**20**	

Question			Expected Answers	Marks	Additional Guidance
2	a	i	 ✓ bent **AND** 2 bonds and 1 lone pair around central (N) atom ✓	2	Shared electrons must be two different symbols **ALLOW** 'bent AND 3 groups of electrons around central (N) atom' **ECF** from incorrect dot and cross diagram
	a	ii	N in ClNO has oxidation state of +3 **AND** N in NO has oxidation state of +2 ✓ (oxidation state decreases so) it has been reduced whilst oxidising ✓	2	Check stem of question to see if +3 and +2 have been written against formulae.
	b	i	Chlorine is a yellow-green gas ✓ colour change will be difficult to measure/detect/see AW ✓	2	**ALLOW** argument based on the decrease in colour of chlorine masking the increase in colour of ClNO
	b	ii	rate = k x $[NO]^2$ x $[Cl_2]$ ✓ *From expt.* 1:(2.06 x 10^{-7} = k x $(0.15)^2$ x (0.10)) so k = **9.2 x 10^{-5}** ✓ units: mol^{-2} $dm^{(+)6}$ s^{-1} ✓ rate = (9.2 x 10^{-5} x $(0.1)^2$ x 0.10) = **9.2 x 10^{-8}** ✓ both k and rate given to 2 s.f. ✓	5	**ALLOW** ecf from rate equation **ALLOW** ecf from 2nd to 4th marking point **NOTE** Expts. 2 and 3 also give **9.2 x 10^{-5}** and **9.2 x 10^{-8}** **ALLOW** units in any order + sign not necessary on units Final marking point for any pair of answers given to 2 s.f.
	b	iii	The rate equation (rate = k x $[NO]^2$ x $[Cl_2]$) identifies the number of reacting molecules and type in the rds/slow step of the reaction ✓ **EITHER** therefore 2 molecules of NO and 1 molecule of Cl_2 react in the slow step ✓ explained by a single step mechanism (unlikely – 3 body collision) ✓ **OR** 2 slow steps **or** 1st fast – 2nd slow which between them involve 2 molecules of NO and one of Cl_2 ✓ given by equations eg fast or slow NO + Cl_2 → $NOCl_2$	3	First mark for **explicit** link between rate equation and numbers in r.d.s '2 molecules of NO and 1 molecule of Cl_2 collide in the slow step' scores 2nd and 3rd marking point

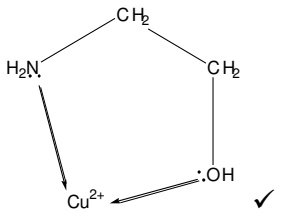
Question			Expected Answers	Marks	Additional Guidance
			slow $NOCl_2$ + NO → 2NOCl ✓		
2	**c**	**i**	^{+}NO ✓	**1**	positive charge **MUST** be on N
	c	**ii**	 ✓  ✓	**2**	**ALLOW** any unambiguous formulae **ALLOW** ecf from first part of cii only
			Total	**17**	

Question			Expected Answers	Marks	Additional Guidance
3	a	i	two compounds/molecules react by <u>addition</u> AW ✓ followed by the elimination/loss/removal of a small molecule/water ✓	2	**ALLOW** 2 molecules <u>add</u> together (to form one molecule) for first mark 'It is an addition-elimination reaction' scores 1 mark
	a	ii	 ✓	1	
	a	iii	 ✓	1	**ALLOW** any unambiguous representation **IGNORE** any brackets or 'n' Bonds by which the units join to the rest of the chain must be clearly identified
	a	iv	 ✓	1	Amide and ONE ester required **ALLOW** carbons adjacent to circled links
	a	v	amide correctly assigned to E or F ✓ ester correctly assigned to E or F ✓	2	Ester and amide identified without labelling E and F on the diagram scores 1 mark **IGNORE** peptide here

	b		**1** draw **pencil-line** near bottom of <u>paper</u> ✓ **2** place (a small amount of) **unknown amino acid aqueous solution** (and a small amount each of aqueous alanine and valine) on the line ✓ **3** place paper in water/solvent, **line above solvent** level **AND** add **lid**/**cover** ✓ **4** when solvent nears **top of plate** (after a suitable time), **remove**/**dry AND** locate spots with **ninhydrin** ✓ **5 compare** heights/position/migration of spot from unknown with the 2 known amino acids **OR** **calculate** R_f value of spot and compare with those of alanine and valine ✓	**5**	**DO NOT ALLOW** TLC/silica for first marking point
	c		<u>enzymes</u> in soil organisms can break down (secondary) amide and/or ester linkages ✓	**1**	**ALLOW** peptide here **NB** '(secondary)' in brackets **ALLOW** named organisms or types of organism (bacteria, fungi, nematodes etc)
	d	**i**	regular packing/alignment of polymer chains/molecules ✓ due to regular structure of polymer AW ✓	**2**	
	d	**ii**	valine has a longer/larger/more branched side chain/more methyl groups **AND** chains/molecules cannot pack/align as regularly/closely AW ✓	**1**	**ALLOW** reverse argument based on alanine
	d	**iii**	(polymer with) alanine – intermolecular/interchain forces/bonds greater/stronger/more ✓	**1**	**ALLOW** more energy required to break bonds/imf between chains

	d	**iv**	**two** from the following: ✓✓ cold-drawing add copolymers reduce the side groups/branches (on the monomers) introduce side groups which increase imf introduce named side groups excluding alkyl cross-linking groups (eg SH)	**2**	
			Total	**19**	

Question			Expected Answers	Marks	Additional Guidance
4	**a**	**i**	$4Cu(s) + O_2(aq) \rightarrow 2Cu_2O(s)$ $2Cu_2O(s) + O_2(aq) \rightarrow 4CuO(s)$ both equations correct ✓ state symbols correct ✓	**2**	**ALLOW** multiples or halves 2nd marking point can be scored for wrong equations but equation must be balanced
	a	**ii**	still water: little/no oxygen/oxygen rapidly used up **AND** flowing water oxygen renewed continuously AW ✓	**1**	
	a	**iii**	Cu $1s^2 2s^2 2p^6 \mathbf{3s^2 3p^6 3d^{10} 4s^1}$ ✓ $Cu^+ 1s^2 2s^2 2p^6 \mathbf{3s^2 3p^6 3d^{10}} (4s^0)$ $Cu^{2+} 1s^2 2s^2 2p^6 \mathbf{3s^2 3p^6 3d^9} (4s^0)$ Cu^+ **AND** Cu^{2+} correct ✓	**2**	**NOTE** 4s written before 3d **MAX** 1
	b	**i**	$[CuCl_4]^{2-}$ ✓ ligand transfer/ ligand substitution/ligand exchange ✓ chloride ions/Cl^- replace water/H_2O around Cu^{2+} ions ✓	**3**	**ALLOW** ligand displacement **ALLOW** 'chloride ions form more stable complex than water' **ALLOW** 'chlorine ions replace.....' but **NOT** 'chlorine replaces.....'
	b	**ii**	**1** choose suitable/red filter **AND** zero colorimeter with water ✓ **2** make up range of standard solutions (of $[CuCl_4]^{2-}(aq)$) ✓ **3** measure absorbance of standard solutions **AND** plot calibration curve ✓	**4**	**ALLOW** 'make .... standard solutions of blue water' **ALLOW** transmittance **QWC** absorbance/transmittance must be spelt correctly once to get marking point **3**

Question			Expected Answers	Marks	Additional Guidance
			4 measure absorbance of 'blue water' **AND** read off concentration from calibration curve ✓		
	c		2-aminoethanol ✓	**1**	**ALLOW** 2-aminoethan-1-ol **IGNORE** hyphens, gaps, commas
	d	**i**	6 ✓	**1**	
4	**d**	**ii**	Lone pairs on N and O ✓  ✓	**2**	**ALLOW** 2 lone pairs on O The rest of the diagram correct with maximum of 1 ligand shown **ALLOW** any representation of organic structure but extra CH_2 groups is **CON**
		iii	dative (covalent) /co-ordinate/coordination ✓	**1**	**IGNORE** 'ligand'
			Total	**17**	

Question			Expected Answers	Marks	Additional Guidance
5	a	i	$H_2C_2O_4$ **AND** ethanedioic acid ✓ acidic (but not so acidic as to oxidise $KMnO_4$ to Mn^{2+})✓ $E^{\ominus}$ of MnO_4^-/ MnO_2 is **more positive** than $E^{\ominus}$ of CO_2/ $H_2C_2O_4$ ORA ✓ so MnO_4^- can/will be **reduced** to MnO_2 AW✓	**4**	**ALLOW** 1,2 – ethanedioic acid **IGNORE** spaces **NOT** 'conc.' **ALLOW** hydrochloric/sulphuric **NOT** nitric $E^{\ominus}$ of CO_2/ $H_2C_2O_4$ is more negative (less positive) than $E^{\ominus}$ of MnO_4^-/ MnO_2
	a	ii	$2MnO_4^- + 3H_2C_2O_4 + 2H^+ \rightarrow 2MnO_2 + 6CO_2 + 4H_2O$ ✓	**1**	
	b		moles of Fe^{2+} in 250 cm^3 = **9.80/392** = 0.0250 ✓ $[Fe^{2+}]$ = 9.80/392 x **1000/250** = 0.100 ✓ moles of Fe^{2+} used in titration = 9.80/392 x 1000/250 x 10/1000 = **0.00100** ✓ moles of MnO_4^- used in titration = **0.00100** / **5** = 0.000200 ✓ $[MnO_4^-]$ = 0.000200 x 1000 / 17.50 = **0.0114** mol dm^{-3} ✓	**5**	Correct answer on answer line scores 5 marks Earlier marking points subsumed by later (correct) steps **ALLOW** ecf throughout **NOTE** answer to 3 sf
	c		pipette: Mohr's solution into flask/beaker **AND** burette: MnO_4^- solution ✓ add sulfuric acid/H_2SO_4 to flask ✓ end point: first permanent/persistent pink colour ✓	**3**	**DO NOT ALLOW** solutions other way round for **first mark** **BUT ALLOW** colourless / very pale yellow colour for **third mark** if solutions reversed
	d	i	green ✓ precipitate/ppt./solid ✓	**2**	**IGNORE** shade of green
	d	ii	$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$ ✓	**1**	**IGNORE** state symbols
	e		ammonium/NH_4^+ ions are proton donors/form H^+ ions in water ✓	**1**	**ALLOW** 'are acidic in solution'
			Total	**17**	

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