

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.

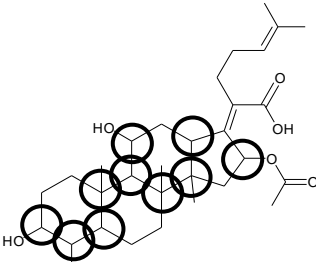
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

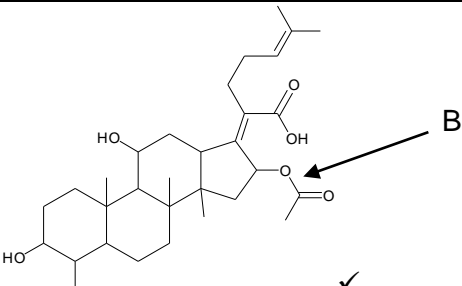
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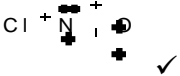
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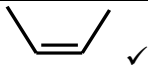
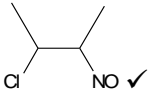
1 Annotations: the following annotations are available on RM ASSESSOR.

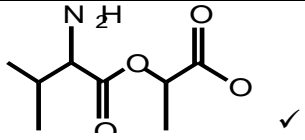
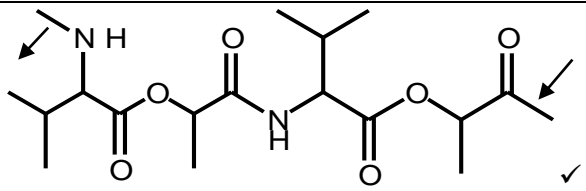
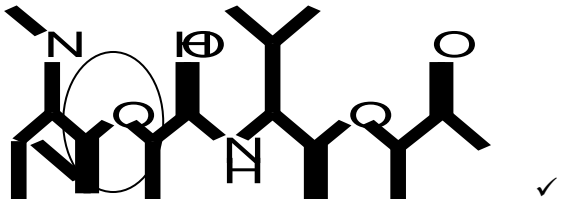
Annotation	Meaning
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Transcription error
	Benefit of doubt not given
	Power of 10 error
	Omission mark
	Error in number of significant figures
	Correct response
	Wrong physics or equation

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 2 nd and 3 rd 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 3 rd 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		4	
		with Pd H_2 adds on to the terminal $C=C$ ✓ forming structure $(CH_3)_2CHCH_2-$ in which neither carbon is asymmetric AW ✓ with Pt H_2 also adds on to the $C=C$ bonded to $COOH$ group ✓ forming structure $(R_1(COOH)CHCHR_2R_3-)$ where both carbons are now asymmetric AW ✓		ALLOW any unambiguous identification of the two double bonds For 2 nd 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 <u>ester</u> 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 3 rd 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	$\text{rate} = k \times [\text{NO}]^2 \times [\text{Cl}_2]$ ✓ From expt. 1: $(2.06 \times 10^{-7} = k \times (0.15)^2 \times (0.10))$ so $k = 9.2 \times 10^{-5}$ ✓ units: $\text{mol}^{-2} \text{ dm}^{(+6)} \text{ s}^{-1}$ ✓ $\text{rate} = (9.2 \times 10^{-5} \times (0.1)^2 \times 0.10) = 9.2 \times 10^{-8}$ ✓ both k and rate given to 2 s.f. ✓	5	ALLOW ecf from rate equation ALLOW ecf from 2 nd to 4 th marking point NOTE Expts. 2 and 3 also give 9.2×10^{-5} and 9.2×10^{-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 ($\text{rate} = k \times [\text{NO}]^2 \times [\text{Cl}_2]$) 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 1 st fast – 2 nd slow which between them involve 2 molecules of NO and one of Cl ₂ ✓ given by equations eg fast or slow $\text{NO} + \text{Cl}_2 \rightarrow \text{NOCl}_2$	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 2 nd and 3 rd marking point

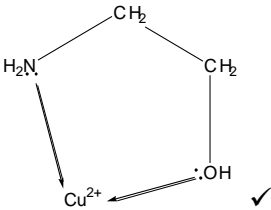
Question			Expected Answers	Marks	Additional Guidance
			slow $\text{NOCl}_2 + \text{NO} \rightarrow 2\text{NOCl}$ ✓		
2	c	i	^+NO ✓	1	positive charge MUST be on N
	c	ii	 ✓  ✓	2	ALLOW any unambiguous formulae ALLOW ecf from first part of cii only
			Total	17	

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	<p>1 draw pencil-line near bottom of <u>paper</u> ✓</p> <p>2 place (a small amount of) unknown amino acid aqueous solution (and a small amount each of aqueous alanine and valine) on the line ✓</p> <p>3 place paper in water/solvent, line above solvent level AND add lid/cover ✓</p> <p>4 when solvent nears top of plate (after a suitable time), remove/dry AND locate spots with ninhydrin ✓</p> <p>5 compare heights/position/migration of spot from unknown with the 2 known amino acids</p> <p>OR calculate R_f value of spot and compare with those of alanine and valine ✓</p>	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	$4\text{Cu(s)} + \text{O}_2(\text{aq}) \rightarrow 2\text{Cu}_2\text{O(s)}$ $2\text{Cu}_2\text{O(s)} + \text{O}_2(\text{aq}) \rightarrow 4\text{CuO(s)}$ both equations correct ✓ state symbols correct ✓	2	ALLOW multiples or halves 2 nd 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	$\text{Cu } 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$ ✓ $\text{Cu}^+ 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} (4s^0)$ $\text{Cu}^{2+} 1s^2 2s^2 2p^6 3s^2 3p^6 3d^9 (4s^0)$ Cu⁺ AND Cu²⁺ correct ✓	2	NOTE 4s written before 3d MAX 1
	b	i	$[\text{CuCl}_4]^{2-}$ ✓ ligand transfer/ ligand substitution/ligand exchange ✓ chloride ions/Cl ⁻ replace water/H ₂ O 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 $[\text{CuCl}_4]^{2-}(\text{aq})$) ✓ 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	<p>$\text{H}_2\text{C}_2\text{O}_4$ AND ethanedioic acid ✓</p> <p>acidic (but not so acidic as to oxidise KMnO_4 to Mn^{2+}) ✓</p> <p>E^\ominus of $\text{MnO}_4^- / \text{MnO}_2$ is more positive than E^\ominus of $\text{CO}_2 / \text{H}_2\text{C}_2\text{O}_4$ ORA ✓ so MnO_4^- can/will be reduced to MnO_2 AW ✓</p>	4	<p>ALLOW 1,2 – ethanedioic acid IGNORE spaces NOT 'conc.' ALLOW hydrochloric/sulphuric NOT nitric</p> <p>E^\ominus of $\text{CO}_2 / \text{H}_2\text{C}_2\text{O}_4$ is more negative (less positive) than E^\ominus of $\text{MnO}_4^- / \text{MnO}_2$</p>
	a ii	$2\text{MnO}_4^- + 3\text{H}_2\text{C}_2\text{O}_4 + 2\text{H}^+ \rightarrow 2\text{MnO}_2 + 6\text{CO}_2 + 4\text{H}_2\text{O}$ ✓	1	
	b	<p>moles of Fe^{2+} in $250 \text{ cm}^3 = 9.80/392 = 0.0250$ ✓</p> <p>$[\text{Fe}^{2+}] = 9.80/392 \times 1000/250 = 0.100$ ✓</p> <p>moles of Fe^{2+} used in titration = $9.80/392 \times 1000/250 \times 10/1000 = 0.00100$ ✓</p> <p>moles of MnO_4^- used in titration = $0.00100 / 5 = 0.000200$ ✓</p> <p>$[\text{MnO}_4^-] = 0.000200 \times 1000 / 17.50 = 0.0114 \text{ mol dm}^{-3}$ ✓</p>	5	<p>Correct answer on answer line scores 5 marks Earlier marking points subsumed by later (correct) steps ALLOW ecf throughout</p> <p>NOTE answer to 3 sf</p>
	c	<p>pipette: Mohr's solution into flask/beaker AND burette: MnO_4^- solution ✓</p> <p>add sulfuric acid/H_2SO_4 to flask ✓</p> <p>end point: first permanent/persistent pink colour ✓</p>	3	<p>DO NOT ALLOW solutions other way round for first mark BUT ALLOW colourless / very pale yellow colour for third mark if solutions reversed</p>
	d i	green ✓ precipitate/ppt./solid ✓	2	IGNORE shade of green
	d ii	$\text{Fe}^{2+} + 2\text{OH}^- \rightarrow \text{Fe}(\text{OH})_2$ ✓	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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