

GCE

Chemistry B (Salters)

Unit **F334**: Chemistry of Materials

Advanced GCE

Mark Scheme for June 2016

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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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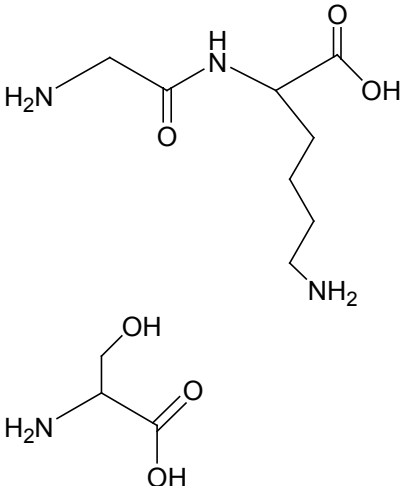
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Annotations

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

Abbreviations, annotations and conventions

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	Separates marking points
reject	Answers which are not worthy of credit
not	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

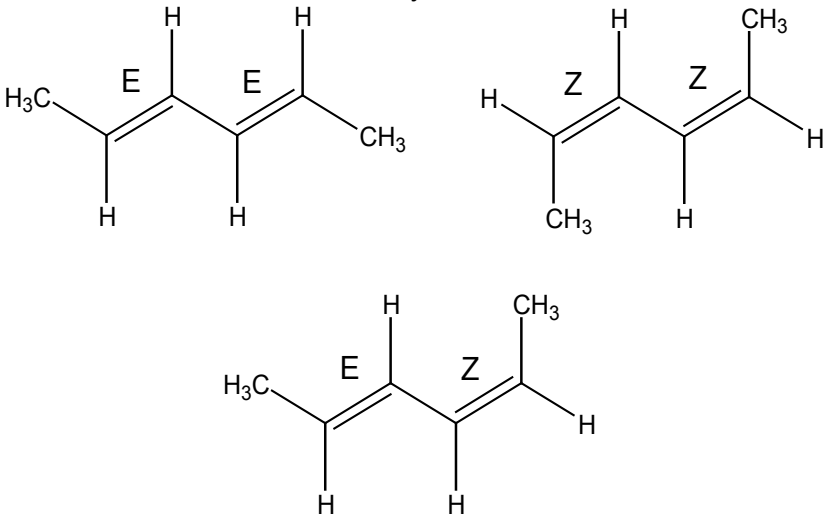
Question	Expected Answers	Marks	Additional Guidance
1 a	secondary structure: the folding of the chains OR (forms) helices or sheets ✓ tertiary structure: further folding OR (final) 3D structure ✓	2	
	b a hole / cleft / crevice / specific shape (in the enzyme structure) AW ✓ substrate/ protein binds/fits/bonds ✓ reaction/ hydrolysis occurs / substrate is broken down / conversion into products ✓	3	ALLOW part of protein tertiary structure ALLOW shape in enzyme which fits substrate ALLOW catalyse reaction between enzyme and substrate
	c  some hydrolysis at one or more amide links showing –COOH and –NH ₂ on two different molecules ✓ idea of correct (right-hand) amide link only being hydrolysed ✓ completely correct ✓	3	accept any unambiguous structures
	d <i>two marking points from:</i> trypsin is selective / specific (with hydrolysis) AW ✓ bromate /bromine /Br is toxic / forms a toxic product /dangerous or harmful to humans ✓ enzymes give better atom economy ✓	2	IGNORE any reference to ‘altering active site’ NOT cheaper ORA Trypsin and/or products are non-toxic

Question			Expected Answers	Marks	Additional Guidance
	e	i	first part of graph first order for substrate – related to shape (e.g. ‘graph shows proportional’ / ‘linear’/ ‘rate doubles as conc. doubles’/ ‘constant positive gradient’ AW) ✓ rds is equation 1 / substrate is in rds ✓ second part of graph zero order for substrate ✓ rds is equation 2 (or no longer equation 1) / substrate no longer in rds ✓ all active sites (on enzyme) full/ saturated ✓	5	QWC – to score first mark, the statement of first order must be related to the shape/attributes of the graph may write reasoning on graph but just saying 1st order is insufficient for mark NOT just ‘straight’
	e	ii	straight line (parallel to x-axis) at rate = 0 ✓ <u>active site</u> is destroyed / changes shape ✓	2	may draw a diagram ALLOW line along the x-axis IGNORE denatured
			Total	17	

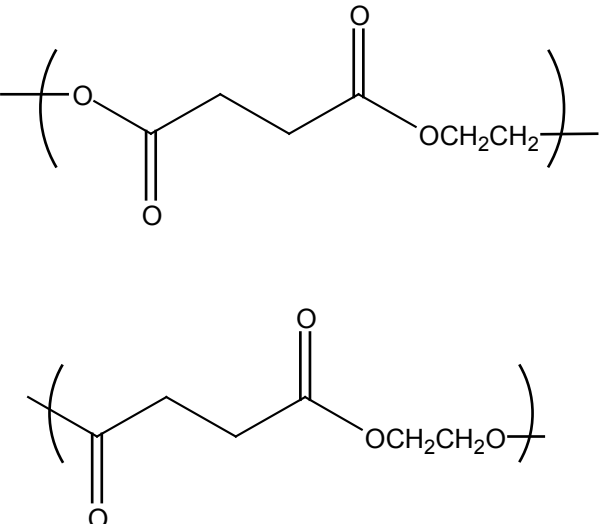
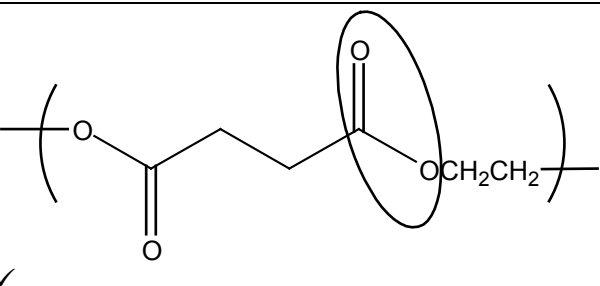
Question			Expected Answers	Marks	Additional Guidance
2	a	i	$E^\ominus$ / half-cell potential of $\text{Cr}^{3+}/\text{Cr}^{2+}$ / solution A is more negative (than $E^\ominus$ of $\text{Fe}^{3+}/\text{Fe}^{2+}$) ORA ✓ so $\text{Cr}^{3+}/\text{Cr}^{2+}$ will be the negative electrode / cathode / lose electrons ORA AND $\text{Cr}^{3+}/\text{Cr}^{2+}$ / solution A goes into tank 2 and/or $\text{Fe}^{3+}/\text{Fe}^{2+}$ / solution B into tank 1 ✓	2	IGNORE comments about reducing and oxidising agents NOT $E^\ominus_{\text{cell}}$
	a	ii	$\text{Cr}^{2+} + \text{Fe}^{3+} \rightarrow \text{Cr}^{3+} + \text{Fe}^{2+}$ ✓	1	
	a	iii	prevent corrosion/rusting/oxidation of iron/steel ✓ iron/steel would act as an electrode / react with solutions / electrolytes / forms ions ✓ polymer / plastic / paint	3	If LIST then use 1st substance ONLY NOT zinc/galvanising or grease ALLOW any named polymer ALLOW ceramic
	a	iv	allow charge flow / transfer AW or act as a salt bridge or allows ion flow ✓	1	IGNORE prevent mixing of the solutions CON electron flow NOT flow of current
	a	v	carbon / graphite / platinum ✓	1	
	b		-0.26 ✓	1	correct sign must be present

Question			Expected Answers	Marks	Additional Guidance
	c		(red brown ppt.) is $\text{Fe}(\text{OH})_3$ / iron(III) hydroxide ✓ Fe^{2+} ions will have been <u>oxidised</u> to Fe^{3+} ions by <u>oxygen</u> (from the air) ✓ $4\text{Fe}^{2+} + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{Fe}^{3+} + 4\text{OH}^-$ OR $2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^- \rightarrow 4\text{OH}^-$ AND $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-$ ✓ $\text{Fe}^{3+}(\text{aq}) + 3\text{OH}^-(\text{aq}) \rightarrow \text{Fe}(\text{OH})_3(\text{s})$ ✓ state symbols correct for species in correct precipitation equation ✓	5	Allow mark if precipitation equation has $\text{Fe}(\text{OH})_3(\text{s})$ as product ALLOW red ppt. CON is $\text{Fe}(\text{OH})_2$ is formed first oxygen may be seen in the equation
			Total	14	

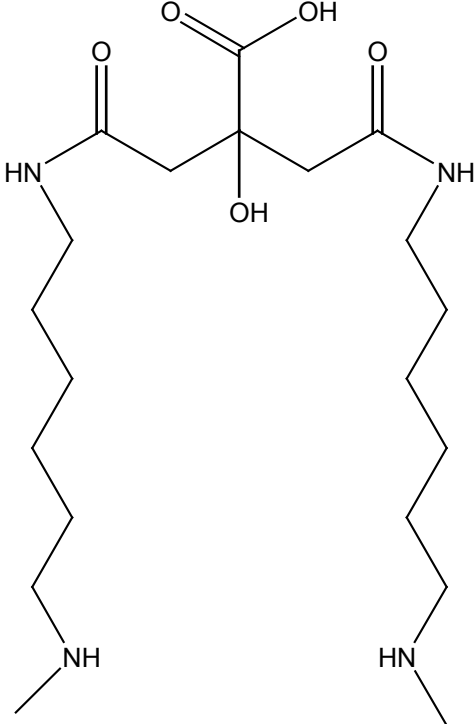
Question			Expected Answers	Marks	Additional Guidance
3	a		moles of C_6H_{10} in 100 g = 100/82.(0) = (1.22) ✓ bromine number = $100/82.0 \times 2 \times 159.8 = 390$ ✓	2	ECF ALLOW M_r for bromine = 160 IGNORE g units with answer
	b	i	Method 1 MOLES moles of BrO_3^- = 0.005 AND moles of Br^- = 0.0167 ✓ to be in excess moles of BrO_3^- has to be > (0.0167/5 =) 0.00334 mol dm^{-3} ✓ Method 2 CONCENTRATIONS $[BrO_3^-]$ = 0.0250 AND $[Br^-]$ = 0.0835 ✓ to be in excess $[BrO_3^-]$ has to be > (0.0835/5 =) 0.0167 mol dm^{-3} ✓	2	must have words as well as numbers for 2 nd mark
	b	ii	moles of Br^- (forming Br_2) = 0.167 x 100/1000 or (0.0167) ✓ moles of Br_2 reacted with 10 g sample = 0.0167 x 3/5 ✓ x 82/200 ✓ = (0.00411) mass of Br_2 reacted with 10 g sample = 0.0167 x 3/5 x 82/200 x 159.8 = (0.656 g) ✓ bromine number = 0.0167 x 3/5 x 82/200 x 159.8 x 10 = 6.56 = 7 ✓	5	Alternative method: moles of Br_2 formed in reaction in 200 cm^3 = 0.0167 x 3/5 = (0.01002) ✓ $[Br_2]$ = 0.0167 x 3/5 x 5 = (0.501) ✓ moles of Br_2 used in adding to sample = 0.501 x 82/1000 = 0.0411 ✓ mass of Br_2 added to 10.0 g sample = 0.0411 x 159.8 = (6.56) g ✓ bromine number = 7 ✓ ECF throughout calculation IGNORE g units with answer
	c	i	restrictive rotation about C=C bonds ✓ two different atoms/groups attached to both carbon atoms of the C=C bond ✓	2	ALLOW C=C bonds cannot rotate ALLOW 'lack of free rotation' NOT just 'double bonds' IGNORE functional

Question	Expected Answers	Marks	Additional Guidance
c ii	1 mark for each correct isomer provided no more than 3 ✓✓✓ 1 mark for labels drawn correctly on the 3 correct structures ✓ 	4	extra structures are each CON to one isomer mark already scored (watch out for E-Z and Z-E which is a CON) ALLOW skeletal structures
d	atoms/transition metals (on surface) can use <u>d</u> (and s) electrons / subshell / orbital(s) ✓ to form (weak) bonds to/interactions with reactants ✓ providing a route of lower E_a ✓	3	IGNORE orbital numbers ALLOW chemisorption BUT NOT adsorption
e i	bromine / Br_2 ✓ colorimetry OR titration ✓ bromine (solution) is yellow/orange/(red) brown OR bromine decolourised in titration (phenol and with methyl orange) ✓	3	Only 2nd mark is independent ALLOW titration of bromine with a solution of alkene with known bromine number DO NOT ALLOW titrate with alkali, method not appropriate ALLOW bromine is the only coloured substance / reactants are colourless bromine coloured

Question			Expected Answers	Marks	Additional Guidance
	e	ii	(Rate =) $k \times [\text{BrO}_3^-] \times [\text{Br}^-] \times [\text{H}^+]^2$ ✓✓	3	ALLOW capital K one order incorrect gets 1 mark of the last two marks ALLOW if signs missing on ions but orders are correct IGNORE bracket type
	e	iii	some bromine escapes / bromine is volatile ✓ slower/smaller value / rate (appears to) decreases ✓ since rate measured as $[\text{Br}_2] \text{ s}^{-1}$ ✓	3	IGNORE discussion of effect of temperature increase
			Total	27	

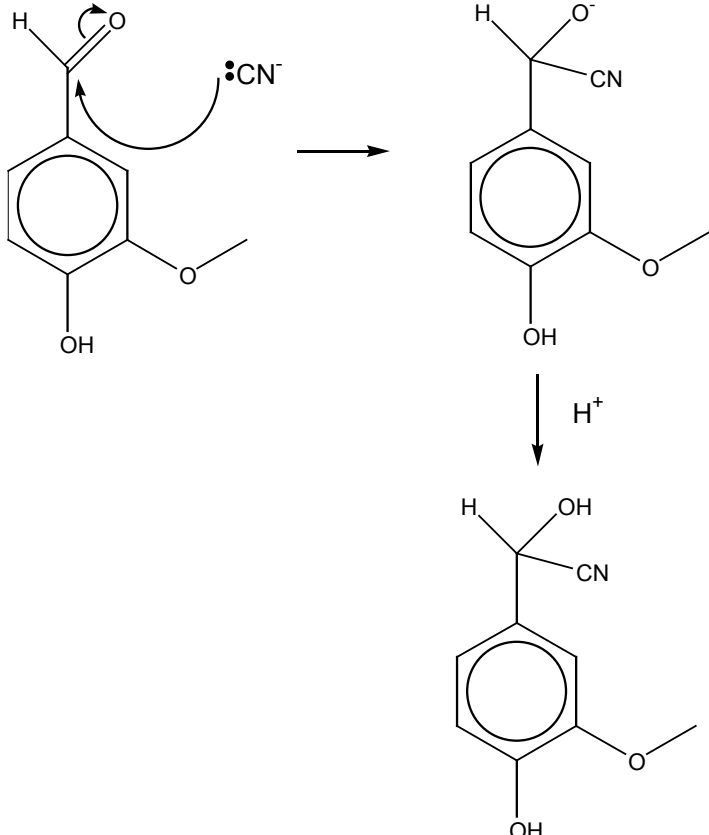
Question			Expected Answers	Marks	Additional Guidance
4	a	i	either of the following structures ✓ 	1	ALLOW any correct structure using any skeletal and/or structural formulae conventions ALLOW without brackets BUT MUST have linking bonds
	a	ii	<u>polyester</u> ✓	1	IGNORE condensation
	a	iii		1	DO NOT ALLOW if C atoms are circled

Question			Expected Answers	Marks	Additional Guidance
	b	i	imb/fs in polyesters: instantaneous (dipole)-induced dipole / Van-der-Waals AND permanent (dipole)-permanent dipole ✓ imb/fs in polyamides: instantaneous (dipole)-induced dipole AND permanent (dipole)-permanent dipole AND hydrogen bonds ✓ a <u>hydrogen</u> bond is stronger than the other correct imb/fs ✓ stronger bonds between chains/molecules (mean stronger fibres) ✓	4	DO NOT ALLOW abbreviations nor shortened names (e.g. permanent dipole bonds for bond types) UNLESS the full names have been used first ALLOW abbreviations if full names given once ALLOW hydrogen bonds are the strongest ALLOW more energy needed to break bonds between chains
	b	ii	stretching polymer AW ✓ causes chains to be aligned/lined up / makes polymer more crystalline ✓ chains are closer together so imb/fs stronger ✓	3	ALLOW 'pulled' DO NOT ALLOW stretching polymer chains IGNORE cooling NOT heating NOT more imb/fs IGNORE any references to 'energy'
	c	i	1,6-diaminohexane ✓	1	ALLOW hexane-1,6-diamine IGNORE commas, dashes and gaps.

Question	Expected Answers	Marks	Additional Guidance
c ii	 an amide group correct ✓ structure all correct ✓	2	ALLOW $\text{-NH(CH}_2\text{)}_6\text{NH}_2$ <i>i.e.</i> NH_2 at end of chain ALLOW -NH- ALLOW correct structure formed by use of central -COOH (one of the side chains will lack a $\text{-CH}_2\text{-}$ before the amide group)

Question			Expected Answers	Marks	Additional Guidance
	c	iii	(polymer) chains / molecules OR polymers have groups (unspecified or correctly specified) can <u>form hydrogen bonds with water</u> ✓	1	ANY OF secondary amide, carboxylic acids, hydroxyl and carboxyl NOT NH ₂
	c	iv	two from the following: is it safe? does it work? AW is it better than other substances? AW are they stable (in the human environment)? no / any side effects? ✓ ✓	1	NOT safe dose IGNORE is it toxic?
4	c	v	N atom has a <u>lone pair</u> (of electrons) (May be shown on formula) ✓ can accept a proton/H ⁺ ✓	2	DO NOT ALLOW H / H atom / H ion ALLOW accepts protons mark separately
			Total	17	

Question			Expected Answers	Marks	Additional Guidance
5	a	i	aldehyde/ carbonyl ether / methoxy phenol / hydroxyl ALL three correct ✓✓ TWO correct out of 2 or 3 answers ✓	2	any answer with 4 groups listed deduct 1 mark more than 4 groups award no marks DO NOT ALLOW hydroxide / hydroxy ALLOW phenolic hydroxy
	a	ii	sulfuric acid AND potassium/sodium dichromate(VI) ✓	1	ALLOW without oxidation state, but if given must be correct ALLOW 'acidified (potassium) dichromate' ALLOW sulfuric acid as the only named acid IGNORE concentration of acid
	b	i	1705 indicates C=O in ketone /or carboxylic acid thus apocynin ✓ 3310 indicates OH in phenol ✓ 3010 indicates CH in arene/benzene ring AND 2930 indicates CH in alkane ✓	3	ALLOW since NOT 1720-1700 it is not an aldehyde so must be apocynin IGNORE alcohol IGNORE alkene
	b	ii	1. compare the M^+ / molecular (ion) peaks (AW) ✓ molecular ion peak of apocynin will be at a larger m/z by 14 or molecular ion peak's m/z is in vanillin at 152, in apocynin at 166 ✓ 2. look for peak at m/z 43 or 29 ✓ due to $COCH_3^+$ / $COCH_3$ group from apocynin or due to CHO^+ /CHO from vanillin ✓	2 from	Comparison may be assumed by stating the two values ALLOW peak in vanillin at molecular ion peak's m/z -1 (loss of aldehyde H) indicates vanillin IGNORE loss of methyl group / peak at m/z =15
	b	iii	dissolve in a minimum amount of hot/warm <u>water</u> AW ✓ QWC mark leave to crystallise / crystals to form and filter ✓ wash crystals with (a little cold) water / solvent and dry ✓	3	ALLOW formation of saturated solution spelling of (re)crystallise / recrystallisation / crystals MUST BE CORRECT at least once ALLOW crystallisation / crystallize / crystallization

Question	Expected Answers	Marks	Additional Guidance
c	 2 curly arrows (1 from lone pair on C of CN⁻) AND bond polarity correct on at least one atom of C=O ($\delta^+C=O\delta^-$) ✓ correct formula for cyanide including lone pair on C and -ve charge on CN ✓ intermediate correct ✓ addition of H⁺ AND final product correct ✓	4	IGNORE any curly arrows and lone pairs involving formation of the -OH group IGNORE curly arrow from / to H⁺
	Total	15	

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