

Chemistry B (Salters)

Advanced GCE

Unit **F334**: Chemistry of Materials

Mark Scheme for January 2013

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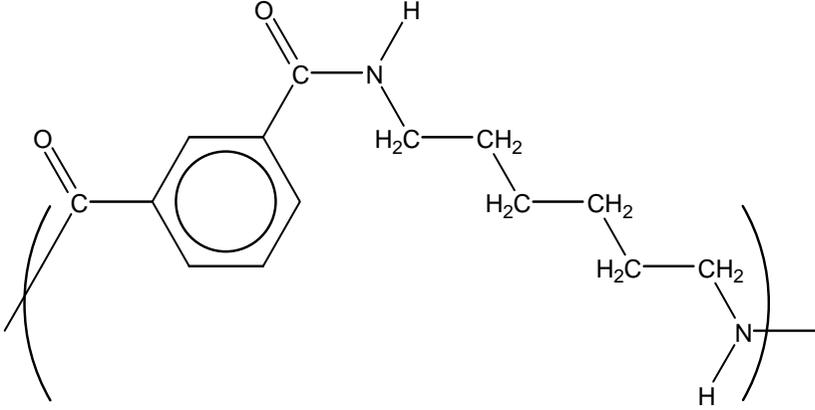
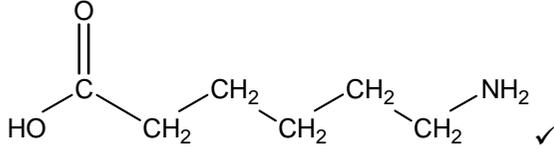
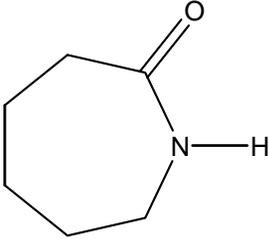
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Annotations used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

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:

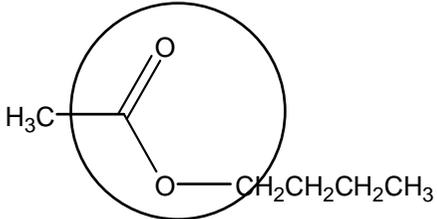
Annotation	Meaning
	correct response
	incorrect response
	benefit of the doubt
	benefit of the doubt not given
	error carried forward
	information omitted
	Ignore
	Reject

Question		Answer	Marks	Guidance
1	(a) (i)	 <p>all correct 2 marks ✓✓ amide link only ✓</p>	2	<p>ALLOW</p> <ul style="list-style-type: none"> any correct structural formula including skeletal mixtures of structural and skeletal -CONH- Cs and Hs on ring <p>IGNORE brackets and n etc</p>
	(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)	 <p>✓</p>	1	<p>ALLOW any formula that makes structure clear</p> <p>ALLOW cyclic amide</p> 

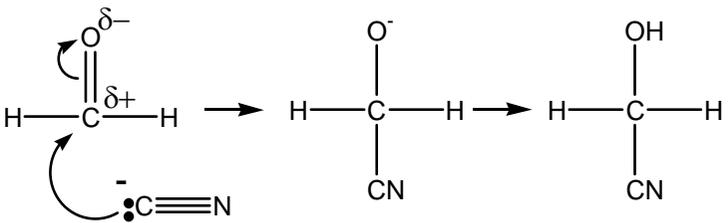
Question		Answer	Marks	Guidance
	(ii)	condensation AND water is eliminated/formed/lost ✓ IF cyclic amide in 1b(i) THEN addition AND hydrolysis (of ring) / water added	1	'addition' or 'addition polymerisation' is a CON ALLOW 'small molecule' instead of water any other named small molecule is a CON
(c)	(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'

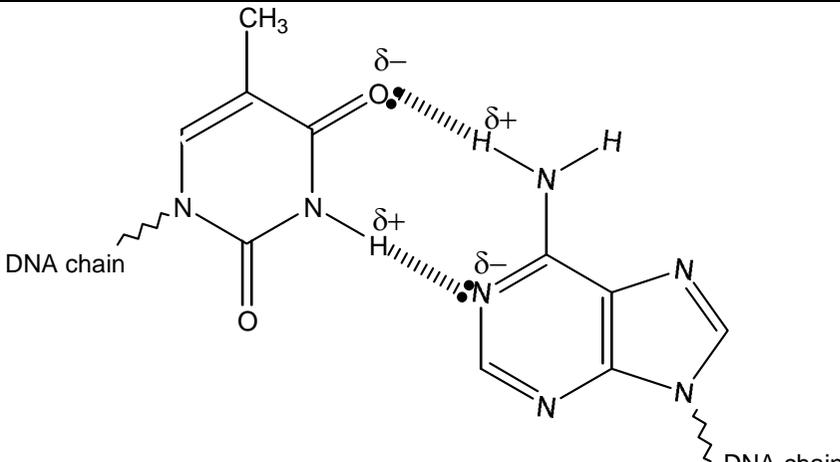
Question		Answer	Marks	Guidance
(d)	(i)	1. elimination ✓ 2. addition ✓ 3. addition ✓	3	IGNORE 'nucleophilic'
	(ii)	can be used in step 3 AW ✓	1	NOT step 2 ALLOW <ul style="list-style-type: none"> • can be sold • can be used as a source of energy • can be recycled
(e)		acidified dichromate ✓	1	IGNORE <ul style="list-style-type: none"> • metal cation • name of acid • wrong formulae if name given • oxidation state of 'dichromate' ALLOW H ₂ SO ₄ /H ⁺ and Cr ₂ O 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^+ ' <i>Mark separately</i>
	(b) (i)	$\text{CH}_2\text{OHCOOH} + \text{NaOH} \rightarrow \text{CH}_2\text{OHCOONa} + \text{H}_2\text{O}$ ✓	1	ALLOW $\text{CH}_2\text{OHCOO}^- \text{Na}^+$, $\text{Na}^+ \text{CH}_2\text{OHCOO}^-$ OR $\text{Na}(\text{CH}_2\text{OHCOO})$ IGNORE state symbols NOT $\text{CH}_2\text{OHNaCOO}$
	(ii)	1. moles of NaOH used in titration = 16.00/1000 x 0.250 ✓ = 0.00400 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) ✓	6	<i>There are several possible routes through this question after point 2, the 'mole route' A, the 'mass route' B and the 'concentration route' C</i> 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

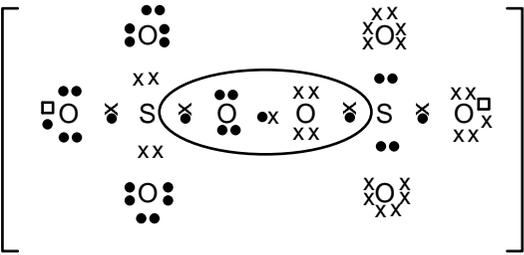
Question	Answer	Marks	Guidance
	5A. moles of glycolic acid in 100 cm ³ = (answer from 3A) x 100/14 ✓ 0.286 mol OR 5Bi. mass of glycolic acid in 250 cm ³ = (answer from 3A) x <i>M_r</i> of glycolic acid ✓ 3.04 g OR 5Bii. mass of glycolic in 250 cm ³ = (answer from 3B) x 10 = ✓ 3.04 g OR 5C. concentration 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 <i>M_r</i> of glycolic acid OR = (answer from 5B) x 100/14 OR = (answer from 5C /10) x <i>M_r</i> 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 <i>The following on the answer line with correct corresponding comment, score as follows, irrespective of working or lack of it:</i> 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) <i>these to other sf OR with incorrect comment score one mark less</i> 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 ₂ SO ₄ as long as it is clear

Question		Answer	Marks	Guidance
	(iii)	<p>ethanoic acid: hydrogen bonding ✓ IGNORE pd-pd</p> <p>compound D: pd-pd ✓ hydrogen bonding is CON</p> <p>instantaneous dipole – induced dipole / id-id in both ✓</p>	3	<p>ALLOW 'pd-pd' / id-id abbreviations here</p> <p>ALLOW Van der Waals for id-id</p>
(d)	(i)	<p><i>The answer requires a comment for a carboxylic acid AND an alcohol so award ONE mark from each section below:</i></p> <p>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 <u>broad</u> peak at 2500 – 3200 (cm^{-1}) shows no O–H in acid ✓</p> <p>ALCOHOL no peak greater than 3000 / in range 3200 – 3600 (allow 3640) so no O–H in alcohol ✓</p>	2	<p>answers may be given on spectrum</p> <p>to score each point, range, bond and group in which it is found must be given</p> <p>ALLOW carboxyl or carboxylic acid or COOH or ethanoic acid (or formula) for 'acid'</p> <p>FOR O–H ALLOW OH / hydroxyl FOR C=O ALLOW carbonyl NOT CO</p>
	(ii)	<p>peak at m/z 73: $\text{CH}_3\text{COOCH}_2$ / $\text{C}_3\text{H}_5\text{O}_2$ ✓ positive charge on any formula ✓</p> <p>species lost: $\text{CH}_2\text{CH}_2\text{CH}_3$ / C_3H_7 (NO charge) ✓</p>	3	<p>ALLOW any correct structural or molecular formula for both answers</p> <p>ALLOW $\text{C}_4\text{H}_9\text{O}^+$</p> <p>IF $\text{C}_4\text{H}_9\text{O}^+$ given above THEN species lost must be $\text{C}_2\text{H}_3\text{O}$ / CH_3CO</p>
(e)	(i)	nucleophilic ✓ addition ✓	2	

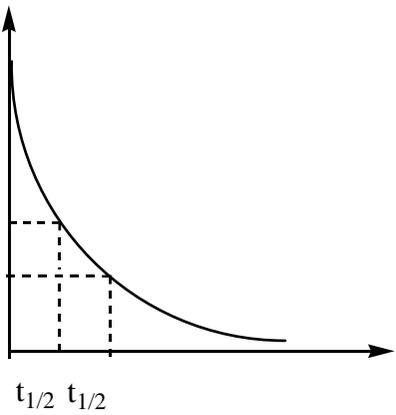
Question	Answer	Marks	Guidance
(ii)	<p style="text-align: center;">H^+ or H_2O or HCN</p>  <p>HCHO with bond polarity correct ✓ CN⁻ with lone pair of electrons on C ✓</p> <p>both curly arrows correct (lower one must be from C of CN) ✓ intermediate ion correct ✓ gain of H⁺ from water, HCN or direct to form the cyanohydrin ✓</p>	5	<p>ALLOW CN⁻ without triple bond ALLOW -ve charge on N of CN⁻</p> <p>IGNORE any arrow used to add H⁺ etc to the intermediate</p>
	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	<i>mark separately</i> 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)	 <p>correct formula completed for adenine AND both H bonds between correct atoms ✓ correct polarities for one hydrogen bond ✓ lone pair for one hydrogen bond ✓</p>	3	

Question		Answer	Marks	Guidance
(c)	(i)	<p>ANY TWO of the THREE CORRECT chiral Cs ONLY ✓</p>	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)	<p>correct amino acid (see opposite) ✓</p> <p>correct formula of ion ✓</p>	2	IGNORE any cations ALLOW any correct structural formula IGNORE species formed from amino acids to right and left IGNORE <ul style="list-style-type: none"> added H⁺ to –NH₂ negative charge on alcohol i.e. –O[–] –COOH instead NO ecf IF anion formed at CH ₂ O [–] then 1 mark max for amino acid
	(iv)	<p>secondary: folding/twisting of polypeptide/amino acid chains/primary structure ✓</p> <p>tertiary: further/final folding OR 3D shape/structure ✓</p>	2	ALLOW (alpha)-helix/coiled OR (beta)-sheets / pleated sheets ALLOW overall/global structure
Total			14	

Question		Answer	Marks	Guidance
4	(a) (i)	 <p>correct inside oval (around peroxy Os) ✓ rest correct ✓</p>	2	<p>ALLOW another symbol for S electrons</p> <p>second mark depends on first</p>
	(ii)	$(\text{NH}_4)_2 \text{S}_2\text{O}_8$ ✓	1	<p>ALLOW</p> <ul style="list-style-type: none"> with correct charges $\text{S}_2\text{O}_8(\text{NH}_4)_2$
	(b)	<p>$\text{S}_2\text{O}_8^{2-}$ (is the stronger oxidising agent) because $\text{S}_2\text{O}_8^{2-}$ has a more positive E^\ominus value ✓ indicates a greater tendency AW to gain/attract/accept electrons/to be reduced ✓</p> <p>ORA ie: $\text{S}_2\text{O}_8^{2-}$ (is the stronger oxidising agent) because $\text{Cr}_2\text{O}_7^{2-}$ has a less positive / more negative E^\ominus value ✓</p> <p>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 ✓</p>	2	<p>without reference to oxidising strength of $\text{S}_2\text{O}_8^{2-}$ only scores 1 as it doesn't answer the question</p> <p>NOT 'higher' for 'more positive' both statements MUST BE comparative</p>
	(c) (i)	$\text{S}_2\text{O}_8^{2-} + 2\text{I}^- \rightarrow 2\text{SO}_4^{2-} + \text{I}_2$ correct equation balanced ✓	1	IGNORE state symbols

Question	Answer	Marks	Guidance
	<p>(ii)</p> <ol style="list-style-type: none"> 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 time – may state units of time) ✓ 6. convert absorbance readings to iodine concentrations using the calibration curve ✓ <p>QWC: In order to gain the mark for point 3, 5 or 6, absorbance must be used AND spelled correctly at least once</p>	6	<p>Using starch ANYWHERE is a CON and CANNOT gain marking point 3</p> <p>ALLOW</p> <ul style="list-style-type: none"> • filter/wavelength giving maximum absorption/absorbance • green/blue filter • suitable filter <p>orange/yellow/brown is CON NOT 'solvent' instead of 'water'</p> <p>IGNORE references to quenching procedures</p>

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

Question	Answer	Marks	Guidance
	<p>(iii) 1. Fe^{3+} reacts with/oxidises I^- ORA ✓</p> $2\text{Fe}^{3+} + 2\text{I}^- \rightarrow 2\text{Fe}^{2+} + \text{I}_2 \quad \checkmark$ <p><i>explanation:</i> the E^\ominus of $\text{Fe}^{3+}/\text{Fe}^{2+}$ half-cell is more positive / less negative than that of the I^-/I_2 half-cell ORA ✓ AW</p> <p>2. Fe^{2+} reacts with/reduces $\text{S}_2\text{O}_8^{2-}$ ORA ✓</p> $\text{S}_2\text{O}_8^{2-} + 2\text{Fe}^{2+} \rightarrow 2\text{SO}_4^{2-} + 2\text{Fe}^{3+} \quad \checkmark$ <p><i>explanation:</i> the E^\ominus of $\text{S}_2\text{O}_8^{2-}/\text{SO}_4^{2-}$ half-cell is more positive than that of the $\text{Fe}^{3+}/\text{Fe}^{2+}$ half-cell ORA ✓ AW</p> <p>QWC: to gain the explanation mark for either 1 or 2, the data has to be linked correctly to the reaction</p>	6	<p>IGNORE references to activation enthalpy OR variable valency/oxidation states</p> <p>ALLOW E^\ominus of Fe^{3+} is more positive etc</p> <p>ALLOW E^\ominus of $\text{S}_2\text{O}_8^{2-}$ is more positive etc</p> <p>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</p>
(e)	(i) Rate = $k \times [\text{S}_2\text{O}_8^{2-}] \checkmark \times [\text{I}^-] \checkmark$	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. $k = 1.0 \times 10^{-5} / (0.075 \times 0.020) \checkmark$ $k = \mathbf{0.0067} \checkmark$ $\text{mol}^{-1} \text{dm}^3 \text{s}^{-1} \checkmark$	3	<p>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</p> <p>NO ecf from first mark to second</p> <p>ALLOW any number of sig figs e.g. 0.007, 0.00667 NOT 0.006 NOR 0.0066</p> <p>ALLOW units in any order, e.g. $\text{dm}^3 \text{s}^{-1} \text{mol}^{-1}$</p>
	(iii) $2.0 \times 10^{-5} \checkmark$ $\text{mol dm}^{-3} \text{s}^{-1} \checkmark$	2	<i>Mark separately</i>
Total		31	

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