

Chemistry B (Salters)

Advanced GCE **F334**

Chemistry of Materials

Mark Scheme for June 2010

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Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

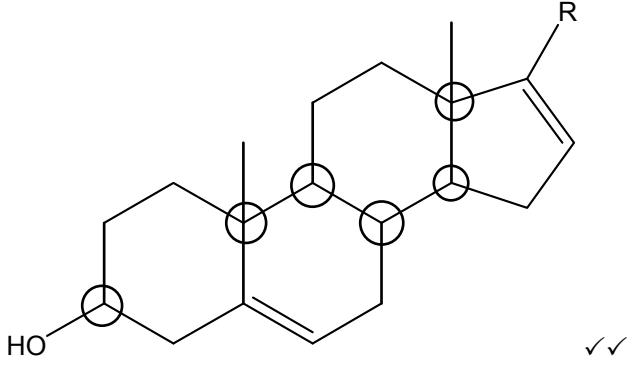
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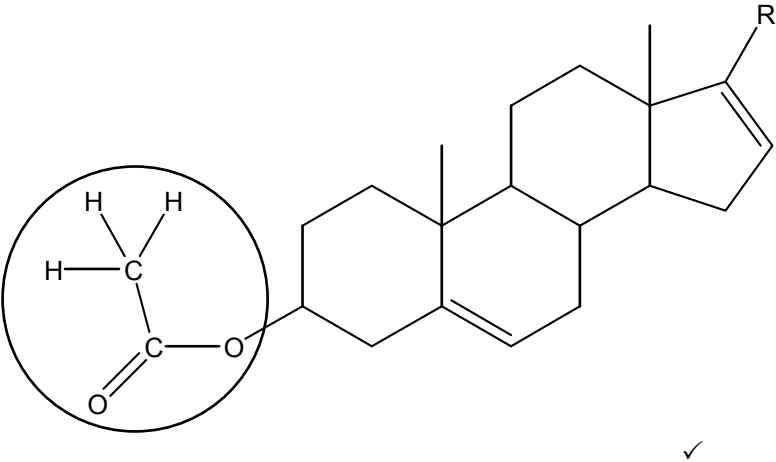
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Question	Expected Answers	Marks	Additional Guidance
1 (a)	Alkene / carbon-carbon double bond / C=C ✓ alcohol / hydroxyl / hydroxy ✓	2	Double bond alone does NOT score. ALLOW secondary alcohol but not primary or tertiary. Do NOT allow hydroxide.
1 (b) (i)		2	<i>If more than 3 circles,</i> any surplus INCORRECT ones are CON IGNORE surplus CORRECT circles 2 marks for 3 correct 1 mark for 2 correct 0 marks for only 1 correct
1 (b) (ii)	(The mirror images / molecules / structures / enantiomers / they) are non-superimposable / cannot be superimposed ✓	1	
1 (c) (i)	The masses of the different types of atom present are not integers / masses are measured relative to carbon-12 (12.00000) ✓ OR different compounds with the same whole number molecular mass will have different M_r values from high resolution spectra / AW ✓ AND Comparison of M_r with database / list of formulae/ M_r values ✓	2	<i>mark independently</i> ALLOW high resolution MS gives accurate M_r to 4 decimal places ALLOW calculate molecular formula by using masses of atoms involved
1 (c) (ii)	Peak: CH ₃ ⁺ ✓ species lost = OH ✓	2	MUST have correct charge for first mark MUST be neutral for the second mark

Question	Expected Answers	Marks	Additional Guidance
1 (d) (i)		1	ALLOW this, though not full structural! DO NOT ALLOW skeletal formula
1 (d) (ii)	ethanoic acid ✓ <u>concentrated</u> sulfuric acid / <u>concentrated</u> hydrochloric acid ✓	2	<i>Mark separately</i> IGNORE conc./ dil. / aq. for ethanoic acid Moderately is CON for acid ALLOW correct formula. e.g. CH ₃ COOH and conc H ₂ SO ₄
1 (e)	$\text{C}_{24}\text{H}_{31}\text{NO} + 2\text{Br}_2 \rightarrow \text{C}_{24}\text{H}_{31}\text{NOBr}_4 \quad \checkmark$	1	ALLOW correct formula to be given in any order of atoms

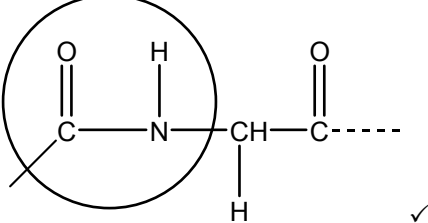
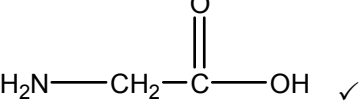
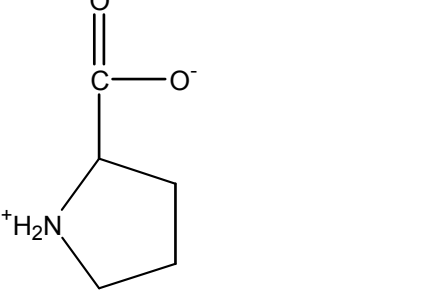
Question	Expected Answers	Marks	Additional Guidance
1 (f)	<p>Any four from:</p> <ol style="list-style-type: none"> 1. Heat the (impure) sample with solvent / use hot/warm solvent ✓ 2. with a minimum amount (of solvent) / add solvent to solid until just dissolves ✓ 3. filter ✓ 4. leave filtrate/solution/mixture to cool / leave to crystallise ✓ 5. filter off crystals, wash and dry ✓ <p>AND for QWC mark:</p> <p>EITHER First filtration / filtration of hot solution removes insoluble impurities</p> <p>OR after crystallisation soluble impurities stay in solution / AW</p> <p>(QWC) ✓</p>	5	<p>Please annotate with ticks to show where ALL marks are awarded</p> <p>IGNORE <i>extra points after 4 have been scored</i></p> <p>IGNORE name of solvent</p> <p>If no solvent is used then no marks can be scored similarly if 4. is incorrect then 5. cannot be scored</p> <p>QWC only one statement required for this mark</p> <p>ALLOW 'impurities which do NOT dissolve' / solid impurities</p> <p>ALLOW 'impurities which dissolve'</p>

Question	Expected Answers	Marks	Additional Guidance
1 (g)	<p>1. Is the drug safe (to be used in humans)? ✓</p> <p>2 Does it do the job it is designed to do? ✓</p> <p>3 Is it better than the standard treatment being used? ✓</p>	3	<p><i>Alternative answers to the 3 answers on the left:</i> IGNORE incorrect answers, including 'is it toxic/harmful?', 'is it cost-effective?' 'can it be modified?' NOTE only one mark can be scored for each of the candidate's questions (e.g. 'effective and better' in one question only scores 1)</p> <p>1. Are there any side-effects? / AW</p> <p>1. What is the safe-dose? / AW</p> <p>2. Is it effective? / does it work AW</p> <p>3. Is it an improvement on other drugs? / AW</p> <p>3. Can it be used to treat other symptoms/health problems / diseases? / AW ALLOW specific examples <i>e.g. can it be used to treat cancer?</i></p>
	Total	21	

Question	Expected Answers	Marks	Additional Guidance
2 (a)	$\text{Fe} + 2\text{CH}_3\text{COOH} \rightarrow \text{Fe}(\text{CH}_3\text{COO})_2 + \text{H}_2$ ✓✓	2	<p>Correct formula for H_2 or formula of salt ✓</p> <p>correct formulae AND balanced ✓</p> <p>ALLOW $\text{Fe}(\text{C}_2\text{H}_3\text{O}_2)_2$ or $\text{Fe}^{2+}(\text{CH}_3\text{COO}^-)_2$</p> <p>DO NOT ALLOW $\text{Fe}(\text{II})(\text{CH}_3\text{COO})_2$</p>
2 (b) (i)	<p>Fe atom: $3d^6 4s^2$ OR $4s^2 3d^6$ ✓</p> <p>Fe(II) ion: $3d^6$</p> <p>Fe(III) ion: $3d^5$ ✓</p>	2	<p>Fe atom correct ✓</p> <p>BOTH ions correct ✓</p> <p>IGNORE '$4s^0$' for ions</p>
2 (b) (ii)	<p>Half-filled d-shell / Half-filled d-orbitals (more stable) ✓</p> <p>OR</p> <p>$3d^5$ configuration / $3d^5$ arrangement is (more) stable (than $3d^6$) ✓</p>	1	<p>ALLOW 'paired electrons are less stable than if unpaired' ORA</p> <p>ALLOW in $3d^5$ electrons are in separate orbitals/d-subshells</p>
2 (c) (i)	$\text{Fe}^{2+}(\text{aq}) + 2\text{OH}^-(\text{aq}) \rightarrow \text{Fe}(\text{OH})_2(\text{s})$ ✓✓	2	<p>Formulae correct and balanced ✓</p> <p>ALLOW $\text{Fe}^{2+}(\text{OH}^-)_2$</p> <p>correct state symbols ✓</p> <p><i>if first mark not gained:</i></p> <p>must be $(\text{aq}) + (\text{aq}) \rightarrow (\text{s})$ or $(\text{aq}) + (\text{aq}) \rightarrow (\text{s}) + (\text{aq})$</p>
2 (c) (ii)	<p>Red-brown ppt is iron(III) hydroxide / (hydrated) iron(III) oxide ✓</p> <p>Fe^{2+} / Fe(II) ions/$\text{Fe}(\text{OH})_2$ are oxidised / lose electrons ✓</p> <p>(by) oxygen ✓ THIS IS DEPENDENT ON Fe(II) ion/compound being oxidised</p>	3	<p>ALLOW correct formula, $\text{Fe}(\text{OH})_3$ / Fe_2O_3 / $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$</p> <p>ALLOW names</p> <p>May be shown by an equation:</p> <p>e.g. $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}^-$</p> <p>$\text{Fe}(\text{OH})_2 + \text{O}_2 \rightarrow \text{Fe}_2\text{O}_3$</p> <p>IGNORE 'by air'</p>

2 (d) (i)	Ce(SO ₄) ₂ ✓	1										
2 (d) (ii)	1. moles of Ce ⁴⁺ in titre = 0.100 x (18.5/1000) (= 0.00185) ✓ 2. moles of Fe ²⁺ in 25.0 cm ³ = 0.00185 moles of Fe ²⁺ in 1000 cm ³ = 0.00185 x 1000 / 25.0 = 0.0740 ✓	2	The mark is for the working shown in bold ALLOW answer to 2 sig figs i.e. 0.074 and ecf from 1									
2 (e) (i)	1. moles of A in 100 cm ³ = 0.1(0) / 213 (= 4.695 x 10 ⁻⁴) ✓ 2. moles of A in 1000 cm ³ = 10 x 0.10 / 213 = 4.7 x 10⁻³ / 0.0047 ✓ 2sf	2	<i>Remember that in calculations correct answer gets full marks with or without working</i> ALLOW 4.70 x 10 ⁻³ (3 sf)									
2 (e) (ii)	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 25%;">wavenumber / cm⁻¹</th> <th style="width: 25%;">bond</th> <th style="width: 50%;">location</th> </tr> </thead> <tbody> <tr> <td>3150</td> <td>O-H</td> <td>carboxylic acid</td> </tr> <tr> <td>1715</td> <td>C=O</td> <td>ketone AND/OR carboxylic acid</td> </tr> </tbody> </table> <div style="text-align: center; margin-top: 10px;"> ✓ ✓ </div>	wavenumber / cm ⁻¹	bond	location	3150	O-H	carboxylic acid	1715	C=O	ketone AND/OR carboxylic acid	2	BOTH bonds correct ✓ BOTH locations correct ✓
wavenumber / cm ⁻¹	bond	location										
3150	O-H	carboxylic acid										
1715	C=O	ketone AND/OR carboxylic acid										
2 (e) (iii)	1. COOH / carboxylic (acid) / carboxyl group ✓ (reacts with alkali) to form: 2. ions in solution / a soluble salt / salt that dissolves / soluble carboxylate (allow formula) ✓ OR 2. carboxylate/anion of carboxylic acid (allow formula) forms bonds with water	2	IGNORE references to intermolecular bonding									

2 (f)	<p>Any 5 from the following 6 marking points but if no QWC maximum mark is 4</p> <ol style="list-style-type: none"> 1. Use an appropriate/suitable filter OR a filter having the complementary colour (if named must be yellow/green) ✓ 2. (Put a sample of the reaction mixture into the colorimeter and) take absorbance readings at set (time/regular) intervals AW ✓ 3. convert absorbance readings to concentrations using the calibration curve ✓ 4. plot graph of concentration v time OR 1/time for reaction ✓ 5. determine/measure /find half-lives from graph ✓ 6. constant half-life = first order ✓ 	5	<p>Please annotate with ticks to show marks awarded</p> <p>If complementary ignore any other colour</p> <p>QWC 'absorbance' must be spelt correctly in either mark 2. or 3. for that mark to be allowed (this is NOT an extra mark) ALLOW 'absorbency' but NOT 'absorbancy' NOTE if no 'absorbance', max mark = 4</p> <ol style="list-style-type: none"> 3. ALLOW for only one absorbance reading 4. IGNORE rate <p>ALLOW points 5. and 6. may be shown using labelled diagrams</p> <ol style="list-style-type: none"> 5. 'graph' must refer to concentration v time plot 5. find rate of reaction by drawing tangents on graph ✓ 6. if concentration doubles and rate doubles = first order / plot of rate v [B] gives (diagonal) line (through the origin) / directly proportional ✓
Total		24	

Question	Expected Answers	Marks	Additional Guidance
3 (a) (i)		1	ALLOW the linkage to proline ring (C,O and N atoms circled) DO NOT ALLOW if only the bond in C-N is circled
3 (a) (ii)		1	ALLOW H ₂ N-CH ₂ -COOH / full structure
3 (a) (iii)	 COO ⁻ ✓ ring structure with NH ₂ ⁺ ✓	2	Structure must be a zwitterion to score ALLOW COO ⁻ ALLOW + charge on H or N
3 (b) (i)	(at high temperatures / 50°C) intramolecular/hydrogen bonds break ✓ and active site lost/altered/changed ✓	2	IGNORE intermolecular / any other types of intramolecular force / changing hydrogen bonds ALLOW bonds in tertiary structure IGNORE references to denaturing ALLOW 'active site is deformed/distorted' / no longer complementary/fits substrate ALLOW 'tertiary structure' for 'active site'

Question	Expected Answers	Marks	Additional Guidance
3 (b) (ii)	(change of pH) affects charges on polar/some/certain groups/ active site OR ionisable groups are altered ✓ prevents correct interactions/bonds between enzyme and substrate AW ✓	2	ALLOW a correct example (e.g. COOH, COO ⁻ , NH ₂ , NH ₃ ⁺) IGNORE references to denaturing ALLOW ionic interactions/bonds are disrupted between enzyme and substrate ALLOW substrate does not fit/bind/react
3 (c) (i)	Rate = k x [P] x [enzyme] ✓ mol ⁻¹ dm ⁺³ s ⁻¹ ✓	2	ALLOW 'hydroxylase' or E or enz or complete name for enzyme ALLOW '(rate equation) = k x [P] x [enzyme]'; must have '=' ALLOW units in any order and dm ³ ALLOW '/' for '-1' e.g. dm ⁺³ / mol/ s and sec ⁻¹ ecf for units
3 (c) (ii)	(When [P] is low) not all enzyme active sites are filled/saturated OR P can form a P-enzyme substrate (can be given as an equation) OR active sites available for substrates OR P can bind to active sites AW ✓ (as [P] increases) rate increases in proportion (so first order) AW ✓	2	DO NOT ALLOW 'there are an excess of enzymes' ALLOW the rate determining step is the formation of P- enzyme substrate / rds involves <u>one molecule</u> of P DO NOT ALLOW 'as [P] increases rate increases' alone. There must be some indication of how the rate increases e.g. rate doubles as [P]/conc. of P/amount of P/number of molecules of P/P doubles
3 (c) (iii)	all the <u>active sites</u> are filled/saturated (any increase in [P] will not affect the reaction rate) OR no <u>active site</u> is available for P to bind to/react with ✓ (so) order becomes/is zero ✓	2	ALLOW rds involves the breakdown of the enzyme-substrate complex (which does not depend on the concentration of P)

Question	Expected Answers	Marks	Additional Guidance
3 (d)	Any two from: speeds up reaction rate reduces the number of steps in a synthesis ✓ improves the atom economy AW ✓ reduces the amount of energy/heat required AW ✓ easier separation methods ✓ enzymes can be reused/recycled ✓ uses less toxic solvents/producing less hazardous waste no/fewer organic solvents used ✓ reduces use of more toxic catalysts ✓	2	ALLOW it is a one step process ALLOW lower temperature/pressure used/needed/required IGNORE renewed
	Total	16	

Question	Expected Answers	Marks	Additional Guidance
4 (a)	1,4-diaminobutane ✓✓	2	1,4-diamino ✓ ALLOW 1,4-diamine DO NOT ALLOW 1,4-butandiamine butane ✓ ALLOW butan (often in middle of name) but DO NOT ALLOW buta 1,6-diaminohexane scores 1 mark IGNORE gaps, commas and dashes
4 (b)		2	extra H ⁺ on one amino group ✓ all correct ✓ ALLOW +ve charge on N or H IGNORE length of carbon chains / missing Hs on carbons ALLOW 1 mark if ALL 3 amino group Hs are correct but positive charge missing
4 (c) (i)		2	amide group correct ✓ completely correct (including carbon chains) ✓ ACCEPT molecule the other way around. ALLOW structural formula or without brackets
4 (c) (ii)	(Secondary) amide ✓	1	DO NOT ALLOW peptide
4 (c) (iii)	Hydrogen chloride / HCl ✓ a small molecule/HCl has been eliminated/formed ✓	2	DO NOT ALLOW hydrochloric acid for the first mark IGNORE 'water formed'

4 (d)	<p>Water (rather than HCl) is formed in the reaction ✓</p> <p>HCl is toxic/harmful/dangerous/polluting (to the environment) / HCl needs to be disposed of ORA ✓</p> <p>ALTERNATIVE ANSWER C contains chlorine ✓ which requires extra energy/resources to make AW ✓</p>	2	<p><i>mark independently</i></p> <p>ALLOW HCl causes acid rain / is corrosive</p> <p><i>second mark depends on first</i></p>
4 (e) (i)	<p><i>Stanyl</i>: hydrogen bond(ing) ✓</p> <p><i>poly(ethene)</i>: instantaneous (dipole)-induced dipole (bonds) ✓</p>	2	<p>ALLOW id-id bonding / van der Waals forces</p>
4 (e) (ii)	<p>intermolecular bonds in polythene are weaker than those in <i>Stanyl</i> ✓ ORA</p> <p>less energy / lower temperatures needed to break the imb in poly(ethene) / separate chains / enable chains to slide ORA ✓</p> <p>chains can move / slide over each other (and polymer softens) ✓</p>	3	<p>Please annotate with ticks to show where ALL marks are awarded</p> <p>ALLOW intermolecular forces ALLOW for both marks named imb from 4 (e) (i), provided <i>Stanyl</i> bonds are stronger</p> <p>ALLOW less heat</p>
Total		16	

Question	Expected Answers	Marks	Additional Guidance												
5 (a) (i)	<p>Since E^\ominus for Cu(/Cu²⁺) is more negative than Ag(/Ag⁺) ORA ✓</p> <p>electrons will flow/move (from Cu) to Ag / from Cu(/Cu²⁺ to Ag/Ag⁺ ✓</p>	2	<p><i>mark independently</i></p> <p>ALLOW smaller/larger since both E^\ominus are positive IGNORE lower/higher OR references to redox processes ALLOW 'E^\ominus_{cell}' for 'E^\ominus', E^\ominus for Cu(/Cu²⁺) is less positive than Ag(/Ag⁺) ALLOW 'from copper to silver' or 'Cu to Ag⁺' IGNORE 'electrons flow through water' / attract / gain DO NOT ALLOW 'from Cu²⁺'</p>												
5 (a) (ii)	0.46 V ✓	1	ALLOW + or – 0.46												
5 (a) (iii)	$\text{Cu} + 2\text{Ag}^+ \rightarrow \text{Cu}^{2+} + 2\text{Ag}$ ✓	1	IGNORE state symbols												
5 (b) (i)	<p>Oxidising agent = H⁺ /H₃O⁺ ✓</p> <p>E^\ominus values are measured with respect/compared to the (standard) H₂/H⁺ half-cell AW / E^\ominus H₂/H⁺ = 0 ✓</p> <p>metals with a negative electrode potential value will be oxidised by / will react with H⁺ ions/HCl AW ORA ✓</p>	3	<p>ALLOW hydrogen ions</p> <p>ALLOW one mark for saying acids/H⁺ can oxidise Zn but not Cu</p>												
5 (b) (ii)	<p>1. Moles of Cu²⁺ in 250 cm³ = 0.150 x (250/1000) ✓</p> <p>2. Mass of copper in sample = 0.0375 x 63.5 = 2.381 ✓</p> <p>3. % of Cu in brass = 2.381 / 3.97 x 100 = 60 ✓</p>	3	<p>1. The mark is for the working shown in bold</p> <p>ALLOW any number of sig. figs. ALLOW ecf from 1. and 2. DO NOT ALLOW 59</p>												
5 (b) (iii)	<table border="1"> <tr> <td></td> <td>copper(II) complex formed with EDTA⁴⁻</td> <td></td> </tr> <tr> <td>formula</td> <td>[Cu(EDTA)]²⁻</td> <td>✓</td> </tr> <tr> <td>shape</td> <td>octahedral</td> <td>✓</td> </tr> <tr> <td>coordination number</td> <td>6</td> <td>✓</td> </tr> </table>		copper(II) complex formed with EDTA ⁴⁻		formula	[Cu(EDTA)] ²⁻	✓	shape	octahedral	✓	coordination number	6	✓	3	<p><i>Mark separately</i></p> <p>1 mark for each correct answer</p> <p>ALLOW without square brackets</p>
	copper(II) complex formed with EDTA ⁴⁻														
formula	[Cu(EDTA)] ²⁻	✓													
shape	octahedral	✓													
coordination number	6	✓													
Total		13													

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