
CHEMISTRY

9701/42

Paper 4 A Level Structured Questions

October/November 2017

MARK SCHEME

Maximum Mark: 100

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

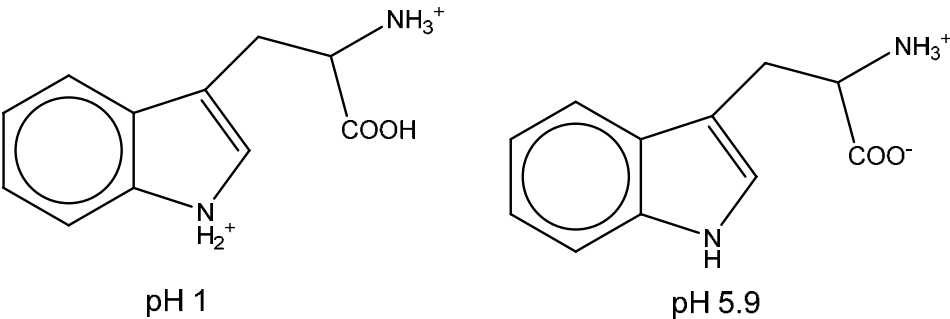
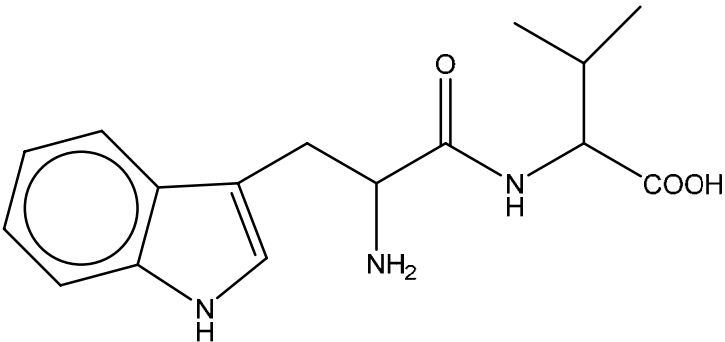
Cambridge International will not enter into discussions about these mark schemes.

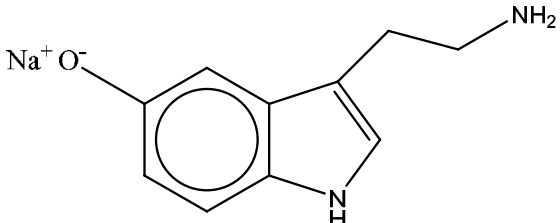
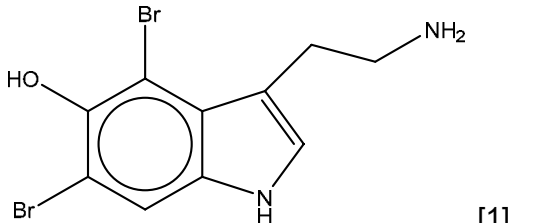
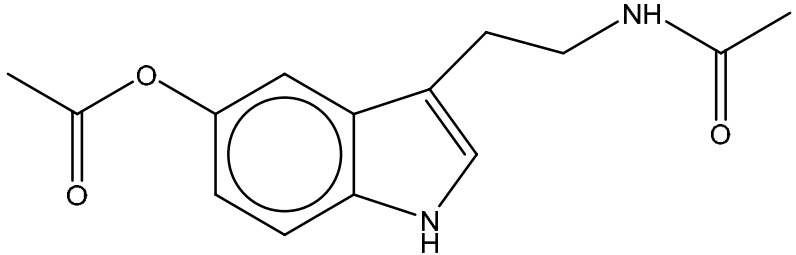
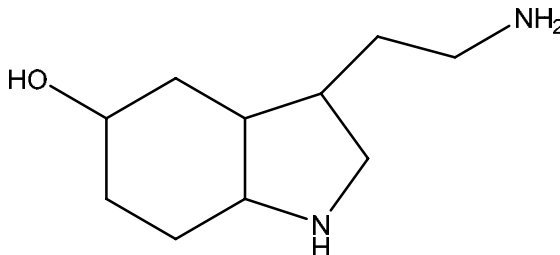
Cambridge International is publishing the mark schemes for the October/November 2017 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

Question	Answer	Marks
1(a)	Cl +3 to +4 (and oxidised)	1
	Cl 0 to -1 (and reduced)	1
1(b)	19 electrons total [1] correct diagram [1]	2
1(c)(i)	the exponent / power to which a concentration is raised in the rate equation	1
1(c)(ii)	$(0.0022 = k(0.01) \times (0.06))$ $k = 3.7$ (3.67)	1
	$\text{mol}^{-1} \text{dm}^3 \text{s}^{-1}$	1
1(c)(iii)	initial rate = 5.50×10^{-3}	1
	$[\text{ClO}_2] = 0.048$	1
1(d)(i)	slowest step (in a multi-step reaction)	1
1(d)(ii)	1 mole of F_2 and 1 mole ClO_2 reacting in the rate-determining step	1
	1st step is rate-determining step and a balanced mechanism consistent with overall equation e.g. $\text{ClO}_2 + \text{F}_2 \rightarrow \text{ClO}_2\text{F}_2$ $\text{ClO}_2 + \text{ClO}_2\text{F}_2 \rightarrow 2\text{ClO}_2\text{F}$ or $\text{ClO}_2 + \text{F}_2 \rightarrow \text{ClO}_2\text{F} + \text{F}$ $\text{ClO}_2 + \text{F} \rightarrow \text{ClO}_2\text{F}$	1
1(e)	k increases (as rate increases)	1

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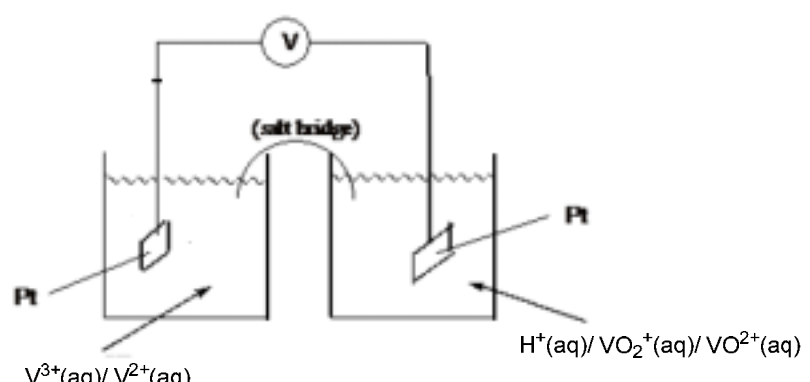
Question	Answer	Marks
2(a)(i)	$\text{Mg}_3\text{N}_2 + 6\text{H}_2\text{O} \rightarrow 3\text{Mg}(\text{OH})_2 + 2\text{NH}_3$	1
2(a)(ii)	moles of $\text{Mg}_3\text{N}_2 = 2.52 / 100.9 = 0.025$ (0.0249)	1
	(moles of $\text{Mg}(\text{OH})_2 = 0.075$ (0.0749)) mass of $\text{Mg}(\text{OH})_2 = (0.075 \times 58.3) = 4.37$ g or 4.4 g	1
2(b)	solubility increases (down the group)	1
	ΔH_{latt} and ΔH_{hyd} both decrease / less exothermic / more endothermic	1
	but ΔH_{latt} decreases more (than ΔH_{hyd} decreases)	1
	ΔH_{sol} becomes more negative / more exothermic / less endothermic	1
2(c)(i)	$K_{\text{sp}} = [\text{Mg}^{2+}][\text{OH}^-]^2$	1
2(c)(ii)	$K_{\text{sp}} = (1.7 \times 10^{-4}) \times (2 \times 1.7 \times 10^{-4})^2 = 2.0 \times 10^{-11}$ (1.97×10^{-11})	1
	$\text{mol}^3 \text{dm}^{-9}$	1
2(d)	cations become bigger / ionic radius increases	1
	polarisation/distortion of anion / hydroxide ion decreases	1

Question	Answer	Marks
3(a)(i)	 <p>pH 1</p> <p>pH 5.9</p>	2
3(a)(ii)	 <p>peptide link [1] rest of the structure [1]</p>	2

Question	Answer			Marks
3(b)	reagent	structure of product	type of organic reaction	8
	Na	 [1]	redox or reduction	
	excess Br ₂ (aq)	 [1]	(electrophilic) substitution	
	excess CH ₃ COCl	 acylated OH [1] acylated NH ₂ [1]	condensation (or addition + elimination)	
excess H ₂ / Pt catalyst	 [1]	reduction or hydrogenation or addition		

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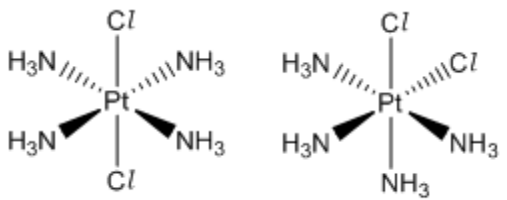
Question	Answer	Marks
3(c)(i)	(spectrum of M) contains a broad peak (for O–H) at 2500–3000 cm ⁻¹ or (spectrum of M) contains peak (for C=O) at 1640–1750 cm ⁻¹ or (spectrum of M) lacks (NH ₂ peak) at 3300–3500 cm ⁻¹	1
3(c)(ii)	5 or 6 peaks	1
	OH/NH protons exchange with deuterium or –OH/–NH + D ₂ O → –OD/–ND + DHO	1
3(d)	ester and hydrolysed	1

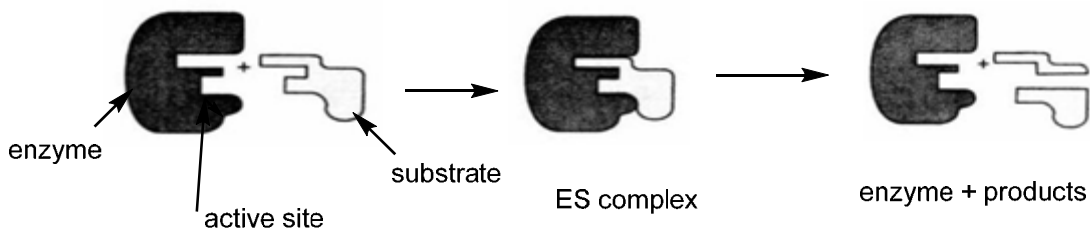
Question	Answer	Marks
4(a)(i)	$E^{\circ}_{\text{cell}} = 1.00 - (-0.26) = (+)1.26 \text{ V}$	1
4(a)(ii)	$\text{VO}_2^+ + \text{V}^{2+} + 2\text{H}^+ \rightarrow \text{VO}^{2+} + \text{V}^{3+} + \text{H}_2\text{O}$	1
4(a)(iii)	 <p> solutions labelled correctly in one half-cell [1] solutions labelled correctly in both half-cells [1] two graphite or platinum electrodes [1] salt bridge and voltmeter [1] </p>	4

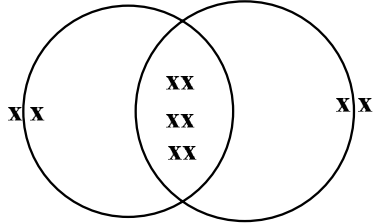
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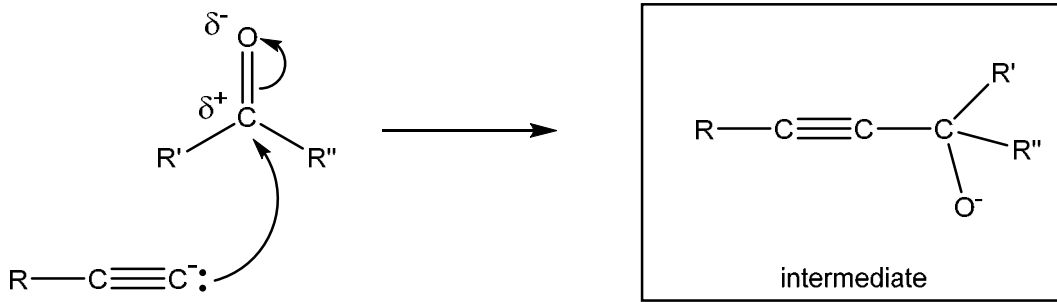
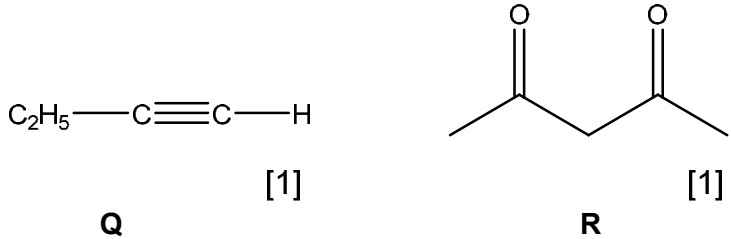
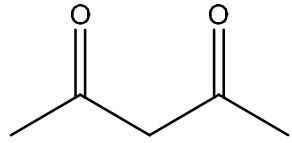
Question	Answer	Marks
4(b)	<ul style="list-style-type: none"> $V^{2+}(aq)$ and $Sn^{4+}(aq)$: yes and $E_{cell}^{\circ} = +0.15 - (-0.26) = +0.41 \text{ V}$ [1] $2V^{2+} + Sn^{4+} \rightarrow 2V^{3+} + Sn^{2+}$ [1] $VO^{2+}(aq)$ and $Fe^{3+}(aq)$ no reaction [1] 	3

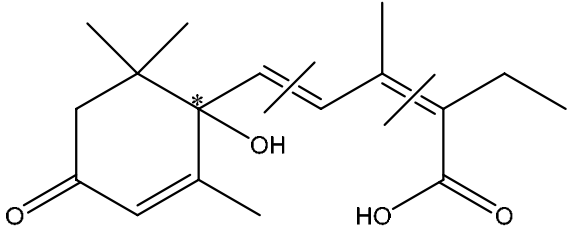
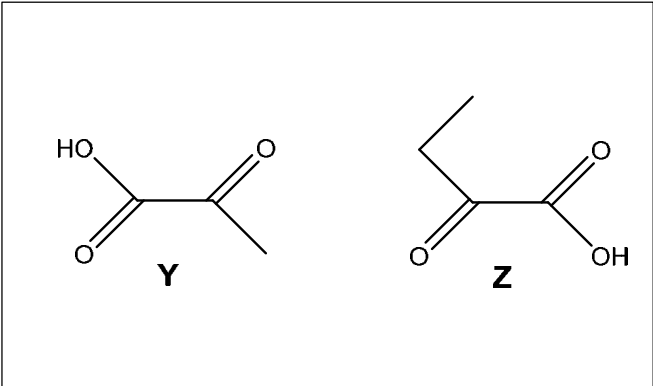
Question	Answer	Marks
5(a)	$(Na^+) 0.095 / 0.181 = 0.525$ and octahedral and co-ordination no. = 6	1
	$(Mg^{2+}) 0.065 / 0.181 = 0.359$ and tetrahedral and co-ordination no. = 4	1
5(b)	enthalpy change = $(-642) - (2 \times -106) = -430$	1
5(c)(i)	$-106 = 147 + 121 + 736 + (-349) + \text{lattice energy}$ lattice energy = -761	3
5(c)(ii)	$MgCl_2$ more exothermic / negative / bigger than $MgCl$ and $NaCl$ more exothermic / negative / bigger than $MgCl$	1
	(reason for $MgCl_2$) higher charge / lower radius of Mg^{2+} cation	1
	(reason for $NaCl$) smaller radius of Na^+ cation	1
5(d)	energy change when 1 mole of atoms / ions each gain an electron or energy change when 1 mole of atoms / ions gain 1 mole of electrons	1
	gaseous	1

Question	Answer	Marks									
6(a)	central metal atom/ion surrounded by (one or more) ligands	1									
6(b)	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 20%;"></th> <th style="width: 30%;">co-ordination number</th> <th style="width: 30%;">oxidation number</th> </tr> </thead> <tbody> <tr> <td>$[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]^{2+}$</td> <td>6</td> <td>+4</td> </tr> <tr> <td>$[\text{PtCl}_4]^{2-}$</td> <td>4</td> <td>+2</td> </tr> </tbody> </table>		co-ordination number	oxidation number	$[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]^{2+}$	6	+4	$[\text{PtCl}_4]^{2-}$	4	+2	2
	co-ordination number	oxidation number									
$[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]^{2+}$	6	+4									
$[\text{PtCl}_4]^{2-}$	4	+2									
6(c)		2									
6(d)	(HNO ₃ +) AgNO ₃ reagent	1									
	$[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]\text{Br}_2$ with cream ppt. (of AgBr) and $[\text{Pt}(\text{NH}_3)_4\text{Br}_2]\text{Cl}_2$, with white ppt. (of AgCl) observation with both	1									
6(e)	octahedral: both	1									
	square planar: geometric	1									
	tetrahedral: neither	1									

Question	Answer	Marks
6(f)	<p>diagrams</p>  <p>The diagram illustrates the enzyme action process in three stages. In the first stage, a large dark grey enzyme with a specific notch labeled 'active site' is shown next to a smaller white substrate with a complementary shape. An arrow points to the enzyme, and another points to the substrate. In the second stage, the substrate is bound within the enzyme's active site, forming an 'ES complex'. In the third stage, the enzyme is shown again with the active site, and two smaller white products are being released from the active site. An arrow points to the enzyme and products.</p> <p>Marks can be awarded from words or diagram. Any three marking points from:</p> <ul style="list-style-type: none"> • substrate shape is complementary to active site • the substrate binds / bonds / fits into the active site • products are released • lower E_A / bonds weakened in substrate 	3

Question	Answer	Marks
7(a)(i)	$\text{CaC}_2 + 2\text{H}_2\text{O} \rightarrow \text{C}_2\text{H}_2 + \text{Ca}(\text{OH})_2$	1
7(a)(ii)	 <p>A Venn diagram consisting of two overlapping circles. The intersection of the two circles contains three 'XX' marks. The left circle contains two 'x x' marks, and the right circle contains two 'x x' marks.</p>	1
7(b)	$\text{C}_n\text{H}_{2n-2}$	1
7(c)(i)	delocalised electrons	1
7(c)(ii)	CH	1
7(c)(iii)	less dense	1

Question	Answer	Marks																				
7(d)(i)	 <p>R—C≡C⁻: R'—C(=O)—R''</p> <p>2 curly arrows [1] dipole [1] intermediate [1]</p>	3																				
7(d)(ii)	nucleophilic addition	1																				
7(d)(iii)	 <p>C₂H₅—C≡C—H </p> <p>Q [1] R [1]</p>	2																				
7(e)	<table border="1" data-bbox="347 1005 1579 1244"> <thead> <tr> <th></th> <th>CH₃CHO</th> <th>HCO₂H</th> <th>CH₃COCH₃</th> <th>HO₂CCO₂H</th> </tr> </thead> <tbody> <tr> <td>hot acidified MnO₄⁻(aq)</td> <td>✓</td> <td>✓</td> <td>✗</td> <td>✓</td> </tr> <tr> <td>alkaline I₂(aq)</td> <td>✓</td> <td>✗</td> <td>✓</td> <td>✗</td> </tr> <tr> <td>Tollens' reagent</td> <td>✓</td> <td>✓</td> <td>✗</td> <td>✗</td> </tr> </tbody> </table>		CH ₃ CHO	HCO ₂ H	CH ₃ COCH ₃	HO ₂ CCO ₂ H	hot acidified MnO ₄ ⁻ (aq)	✓	✓	✗	✓	alkaline I ₂ (aq)	✓	✗	✓	✗	Tollens' reagent	✓	✓	✗	✗	4
	CH ₃ CHO	HCO ₂ H	CH ₃ COCH ₃	HO ₂ CCO ₂ H																		
hot acidified MnO ₄ ⁻ (aq)	✓	✓	✗	✓																		
alkaline I ₂ (aq)	✓	✗	✓	✗																		
Tollens' reagent	✓	✓	✗	✗																		

Question	Answer	Marks								
8(a)(i)	 <p>circle or asterisk on correct C atom only [1] lines through the two correct bonds only [1]</p>	2								
8(a)(ii)	ketone, (tertiary) alcohol, alkene, carboxylic acid two for each mark	2								
8(a)(iii)	sp carbons = 0 sp ² carbons = 8 sp ³ carbons = 9	1								
8(a)(iv)		2								
8(b)(i)	<table border="1" data-bbox="349 1225 770 1426"> <thead> <tr> <th>compound</th> <th>spot</th> </tr> </thead> <tbody> <tr> <td>J</td> <td>2</td> </tr> <tr> <td>K</td> <td>3</td> </tr> <tr> <td>L</td> <td>1</td> </tr> </tbody> </table>	compound	spot	J	2	K	3	L	1	1
compound	spot									
J	2									
K	3									
L	1									

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Question	Answer	Marks
8(b)(ii)	The more polar the compound and stronger attractive forces to the (polar) stationary phase ora: less polar compound and weaker attractive forces to the (polar) stationary phase	1
8(b)(iii)	R_f = retardation factor or retention factor or R_f = distance moved by compound from baseline over distance travelled by solvent front	1