

**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.

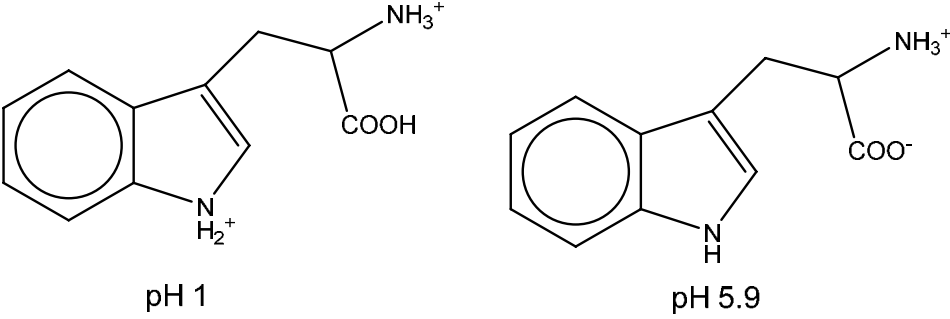
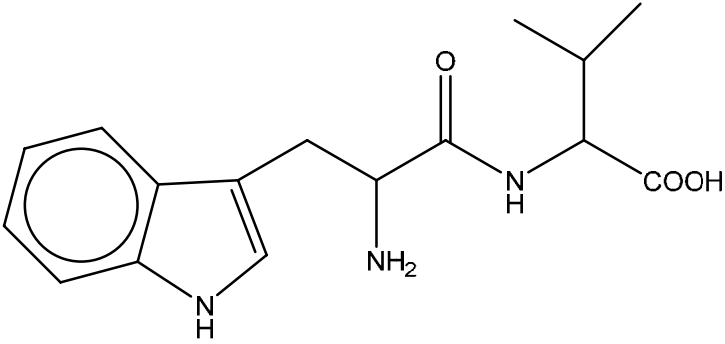
Cambridge International is publishing the mark schemes for the October/November 2017 series for most Cambridge IGCSE<sup>®</sup>, Cambridge International A and AS Level components and some Cambridge O Level components.

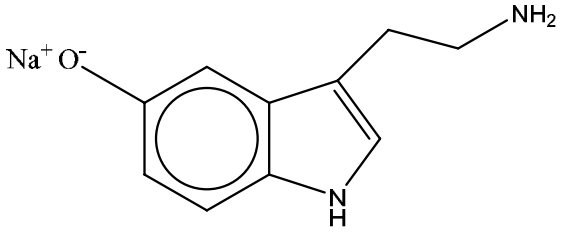
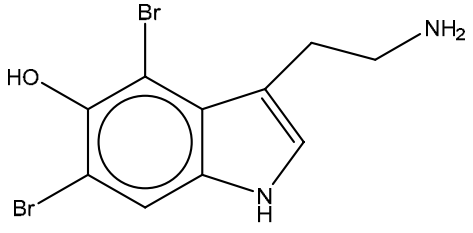
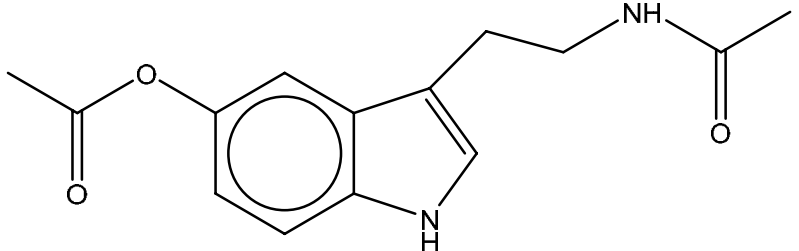
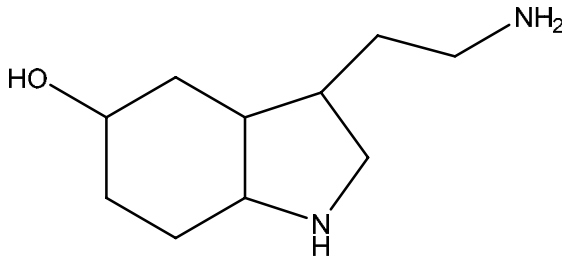
© IGCSE is a registered trademark.

This document consists of **12** printed pages.

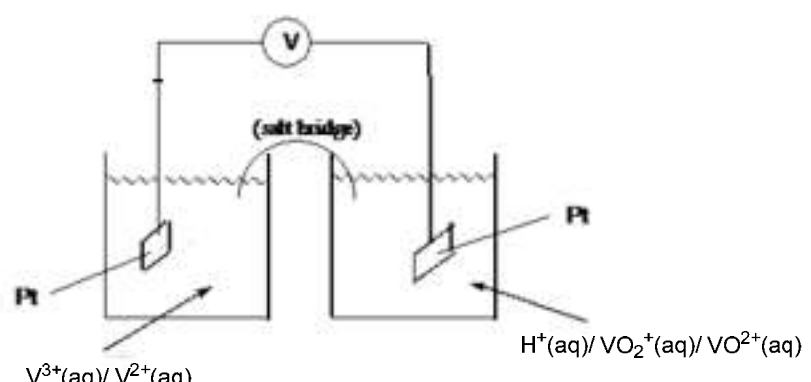
Question	Answer	Marks
1(a)	Cl +3 to +4 (and oxidised)	1
	Cl 0 to -1 (and reduced)	1
1(b)	19 electrons total [1] correct diagram [1]	2
1(c)(i)	the exponent / power to which a concentration is raised in the rate equation	1
1(c)(ii)	$(0.0022 = k(0.01) \times (0.06))$ $k = 3.7$ (3.67)	1
	$\text{mol}^{-1}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

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
	$\Delta H_{\text{latt}}$ and $\Delta H_{\text{hyd}}$ both decrease / less exothermic / more endothermic	1
	but $\Delta H_{\text{latt}}$ decreases more (than $\Delta H_{\text{hyd}}$ decreases)	1
	$\Delta H_{\text{sol}}$ becomes more negative / more exothermic / less endothermic	1
2(c)(i)	$K_{\text{sp}} = [\text{Mg}^{2+}][\text{OH}^-]^2$	1
2(c)(ii)	$K_{\text{sp}} = (1.7 \times 10^{-4}) \times (2 \times 1.7 \times 10^{-4})^2 = 2.0 \times 10^{-11}$ ( $1.97 \times 10^{-11}$ )	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

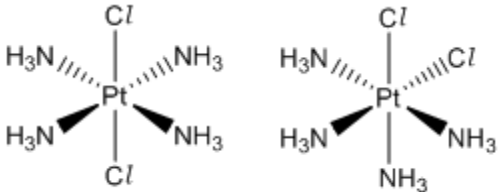
Question	Answer			Marks
3(b)	reagent	structure of product	type of organic reaction	8
	Na	 <p style="text-align: right;">[1]</p>	redox or reduction	
	excess Br <sub>2</sub> (aq)	 <p style="text-align: right;">[1]</p>	(electrophilic) substitution	
	excess CH <sub>3</sub> COCl	 <p>acylated OH [1] acylated NH<sub>2</sub> [1]</p>	condensation (or addition + elimination)	
excess H <sub>2</sub> / Pt catalyst	 <p style="text-align: right;">[1]</p>	reduction or hydrogenation or addition		

Question	Answer	Marks
3(c)(i)	(spectrum of M) contains a broad peak (for O–H) at 2500–3000 $\text{cm}^{-1}$ <b>or</b> (spectrum of M) contains peak (for C=O) at 1640–1750 $\text{cm}^{-1}$ <b>or</b> (spectrum of M) lacks (NH <sub>2</sub> peak) at 3300–3500 $\text{cm}^{-1}$	1
3(c)(ii)	5 or 6 peaks	1
	OH/NH protons exchange with deuterium <b>or</b> $-\text{OH} / -\text{NH} + \text{D}_2\text{O} \rightarrow -\text{OD} / -\text{ND} + \text{DHO}$	1
3(d)	ester <b>and</b> hydrolysed	1

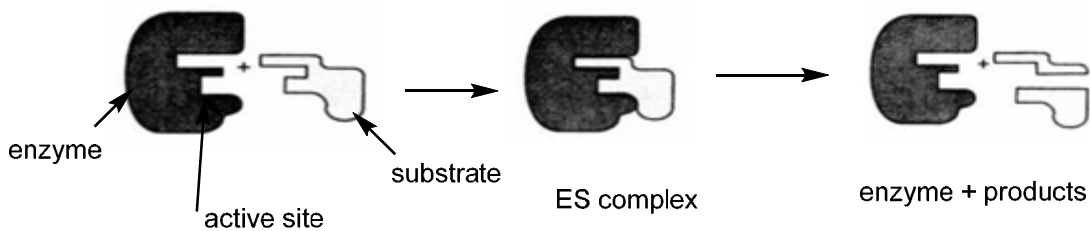
Question	Answer	Marks
4(a)(i)	$E^\ominus_{\text{cell}} = 1.00 - (-0.26) = (+)1.26 \text{ V}$	1
4(a)(ii)	$\text{VO}_2^+ + \text{V}^{2+} + 2\text{H}^+ \rightarrow \text{VO}^{2+} + \text{V}^{3+} + \text{H}_2\text{O}$	1
4(a)(iii)	 <p> <math>\text{V}^{3+}(\text{aq}) / \text{V}^{2+}(\text{aq})</math> </p> <p> <math>\text{H}^+(\text{aq}) / \text{VO}_2^+(\text{aq}) / \text{VO}^{2+}(\text{aq})</math> </p> <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

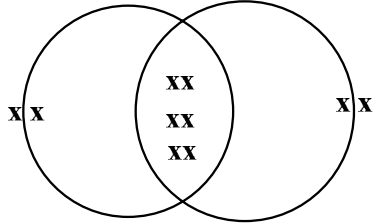
Question	Answer	Marks
4(b)	<ul style="list-style-type: none"> <li><math>V^{2+}(aq)</math> and <math>Sn^{4+}(aq)</math>: yes and <math>E^{\circ}_{cell} = +0.15 - (-0.26) = +0.41 V</math> [1] <math>2V^{2+} + Sn^{4+} \rightarrow 2V^{3+} + Sn^{2+}</math> [1]</li> <li><math>VO^{2+}(aq)</math> and <math>Fe^{3+}(aq)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

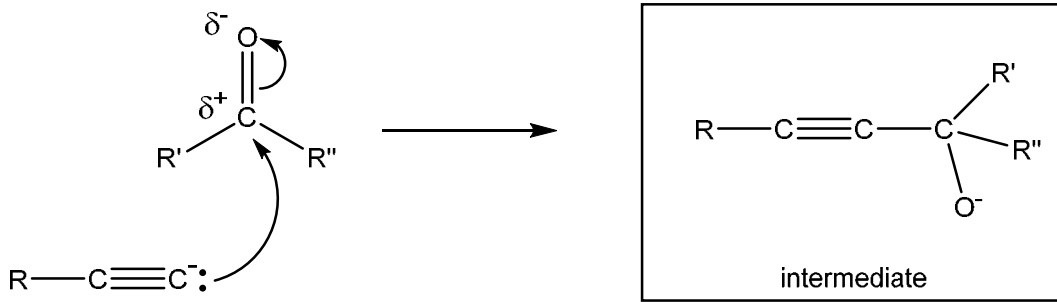
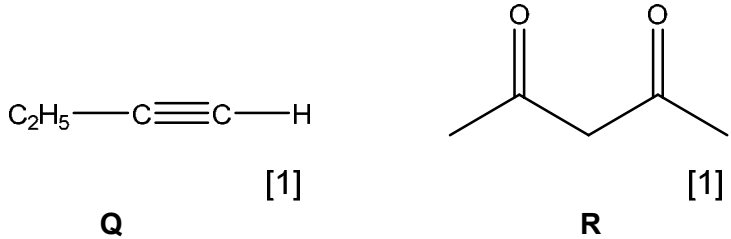
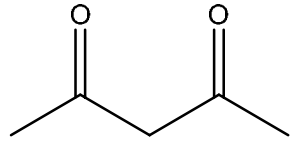
Question	Answer	Marks
5(a)	$(Na^+) 0.095 / 0.181 = 0.525$ <b>and</b> octahedral <b>and</b> co-ordination no. = 6	1
	$(Mg^{2+}) 0.065 / 0.181 = 0.359$ <b>and</b> tetrahedral <b>and</b> co-ordination no. = 4	1
5(b)	enthalpy change = $(-642) - (2 \times -106) = -430$	1
5(c)(i)	$-106 = 147 + 121 + 736 +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

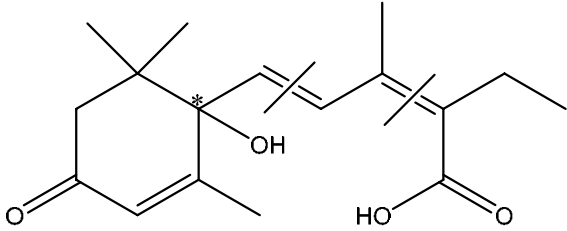
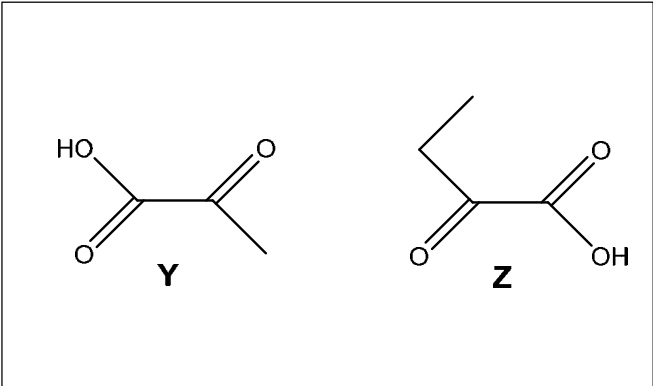
Question	Answer	Marks									
6(a)	central metal atom/ion surrounded by (one or more) ligands	1									
6(b)	<table border="1" data-bbox="349 284 1115 472"> <thead> <tr> <th></th> <th>co-ordination number</th> <th>oxidation number</th> </tr> </thead> <tbody> <tr> <td><math>[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]^{2+}</math></td> <td>6</td> <td>+4</td> </tr> <tr> <td><math>[\text{PtCl}_4]^{2-}</math></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 <sub>3</sub> +) AgNO <sub>3</sub> reagent	1									
	$[\text{Pt}(\text{NH}_3)_4\text{Cl}_2]\text{Br}_2$ with cream ppt. (of AgBr) <b>and</b> $[\text{Pt}(\text{NH}_3)_4\text{Br}_2]\text{Cl}_2$ , 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>enzyme active site substrate ES complex enzyme + products</p> <p>Marks can be awarded from words or diagram. Any three marking points from:</p> <ul style="list-style-type: none"> <li>• substrate shape is complementary to active site</li> <li>• the substrate binds / bonds / fits into the active site</li> <li>• products are released</li> <li>• lower <math>E_A</math> / bonds weakened in substrate</li> </ul>	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)		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<sup>⊖</sup>:      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>C<sub>2</sub>H<sub>5</sub>—C≡C—H      </p> <p>Q      R</p> <p>[1]      [1]</p>	2																				
7(e)	<table border="1" data-bbox="347 1005 1579 1244"> <thead> <tr> <th></th> <th>CH<sub>3</sub>CHO</th> <th>HCO<sub>2</sub>H</th> <th>CH<sub>3</sub>COCH<sub>3</sub></th> <th>HO<sub>2</sub>CCO<sub>2</sub>H</th> </tr> </thead> <tbody> <tr> <td>hot acidified MnO<sub>4</sub><sup>-</sup>(aq)</td> <td>✓</td> <td>✓</td> <td>✗</td> <td>✓</td> </tr> <tr> <td>alkaline I<sub>2</sub>(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 <sub>3</sub> CHO	HCO <sub>2</sub> H	CH <sub>3</sub> COCH <sub>3</sub>	HO <sub>2</sub> CCO <sub>2</sub> H	hot acidified MnO <sub>4</sub> <sup>-</sup> (aq)	✓	✓	✗	✓	alkaline I <sub>2</sub> (aq)	✓	✗	✓	✗	Tollens' reagent	✓	✓	✗	✗	4
	CH <sub>3</sub> CHO	HCO <sub>2</sub> H	CH <sub>3</sub> COCH <sub>3</sub>	HO <sub>2</sub> CCO <sub>2</sub> H																		
hot acidified MnO <sub>4</sub> <sup>-</sup> (aq)	✓	✓	✗	✓																		
alkaline I <sub>2</sub> (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 <sup>2</sup> carbons = 8      sp <sup>3</sup> 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									

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