Cambridge International AS & A Level

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CHEMISTRY **9701/42**

Paper 4 A Level Structured Questions **October/November 2017**

MARK SCHEME

Maximum Mark: 100

Published

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

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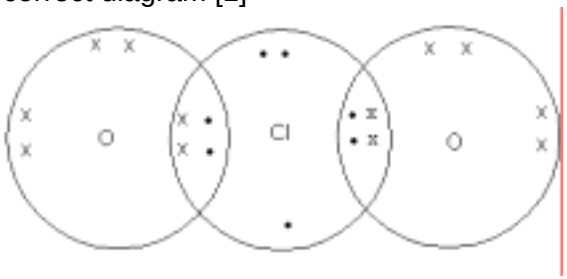
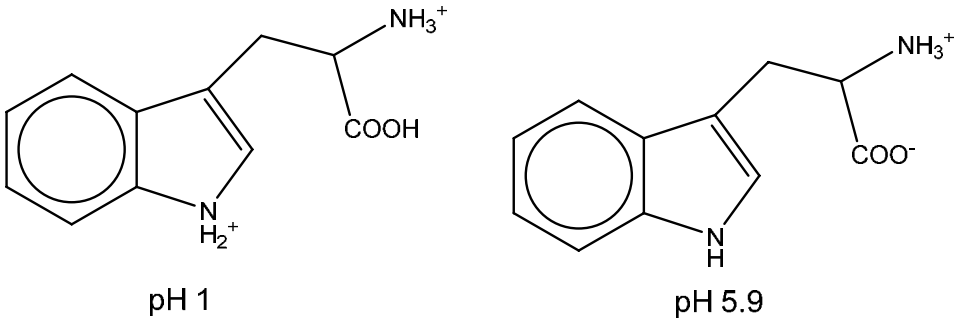
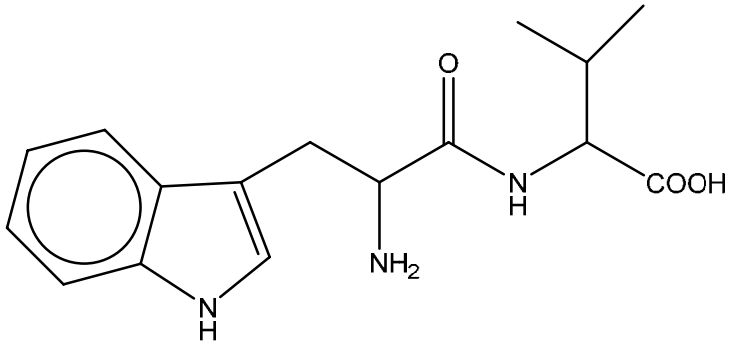
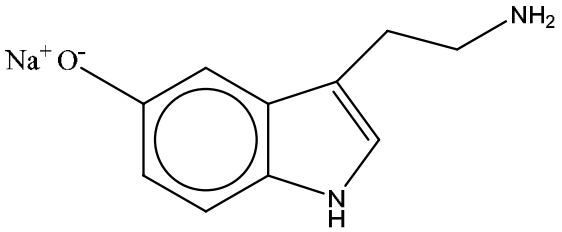
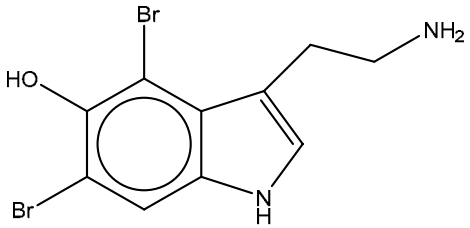
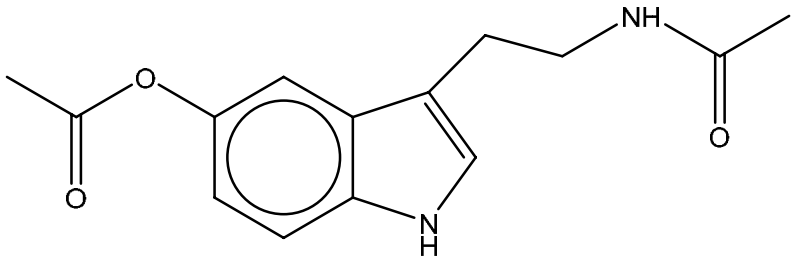
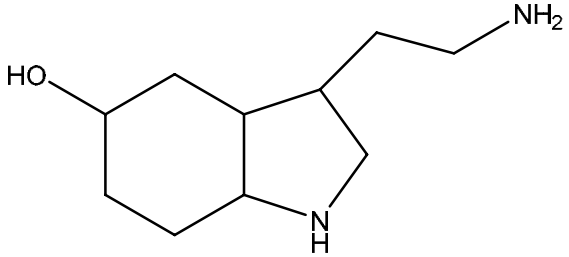
Question	Answer	Marks
1(a)	C*l* +3 to +4 (and oxidised)	**1**
	C*l* 0 to –1 (and reduced)	**1**
1(b)	19 electrons total [1] correct diagram [1] 	**2**
1(c)(i)	the exponent / power to which a concentration is raised in the rate equation	**1**
1(c)(ii)	(0.0022 = *k* (0.01) × (0.06)) k = 3.7 (3.67)	**1**
	$mol^{-1}\ dm^3\ s^{-1}$	**1**
1(c)(iii)	initial rate = 5.50×10^{-3}	**1**
	[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. $ClO_2 + F_2 \rightarrow ClO_2F_2$ $\quad$ $ClO_2 + ClO_2F_2 \rightarrow 2ClO_2F$ **or** $ClO_2 + F_2 \rightarrow ClO_2F + F$ $\quad$ $ClO_2 + F \rightarrow ClO_2F$	**1**
1(e)	k increases (as rate increases)	**1**

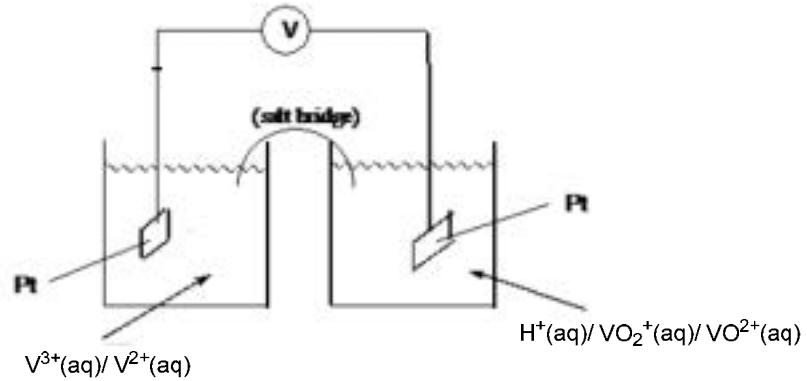
Question	Answer	Marks
2(a)(i)	$Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$	**1**
2(a)(ii)	moles of Mg_3N_2 = 2.52 / 100.9 = 0.025 (0.0249)	**1**
	(moles of $Mg(OH)_2$ = 0.075 (0.0749)) mass of $Mg(OH)_2$ = (0.075 × 58.3) = 4.37 g or 4.4 g	**1**
2(b)	solubility increases (down the group)	**1**
	ΔH_{latt} 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)	$K_{sp} = [Mg^{2+}] [OH^-]^2$	**1**
2(c)(ii)	$K_{sp} = (1.7 \times 10^{-4}) \times (2 \times 1.7 \times 10^{-4})^2 = 2.0 \times 10^{-11}$ (1.97×10^{-11})	**1**
	$mol^3\ dm^{-9}$	**1**
2(d)	cations become bigger / ionic radius increases	**1**
	polarisation/distortion of anion / hydroxide ion decreases	**1**

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

Question	Answer	Marks
3(b)		**8**

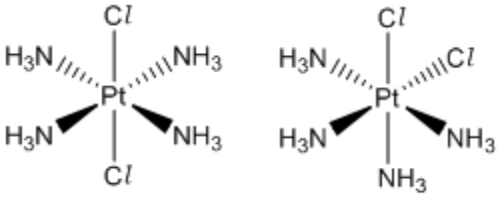
reagent	structure of product	type of organic reaction
Na	 [1]	redox or reduction
excess $Br_2(aq)$	 [1]	(electrophilic) substitution
excess CH_3COCl	 acylated OH [1] acylated NH(2) [1]	condensation (or addition + elimination)
excess H_2 / Pt catalyst	 [1]	reduction or hydrogenation or addition

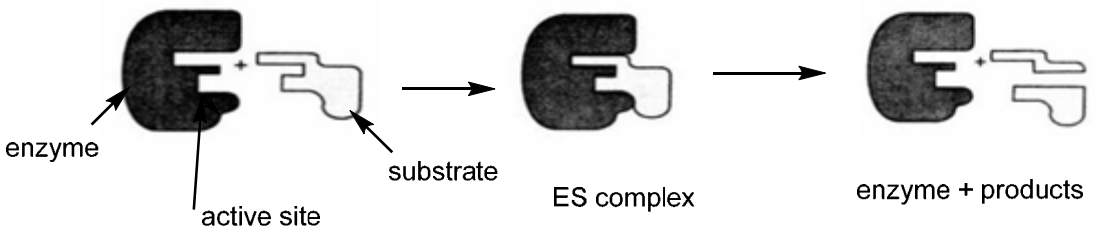
Question	Answer	Marks
3(c)(i)	(spectrum of M) contains a broad peak (for O–H) at 2500–3000 cm^{-1} ***or*** (spectrum of M) contains peak (for C=O) at 1640–1750 cm^{-1} ***or*** (spectrum of M) lacks (NH_2 peak) at 3300–3500 cm^{-1}	**1**
3(c)(ii)	5 or 6 peaks	**1**
	OH/NH protons exchange with deuterium ***or*** –OH / –NH + D_2O → –OD / –ND + DHO	**1**
3(d)	ester **and** hydrolysed	**1**

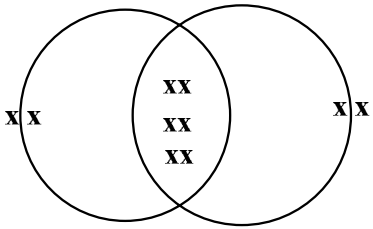
Question	Answer	Marks
4(a)(i)	$E^{\ominus}_{cell}$ = 1.00 – (–0.26) = (+)1.26 V	**1**
4(a)(ii)	$VO_2^+ + V^{2+} + 2H^+ \rightarrow VO^{2+} + V^{3+} + H_2O$	**1**
4(a)(iii)	 solutions labelled correctly in one half-cell [1] solutions labelled correctly in both half-cells [1] two graphite or platinum electrodes [1] salt bridge and voltmeter [1]	**4**

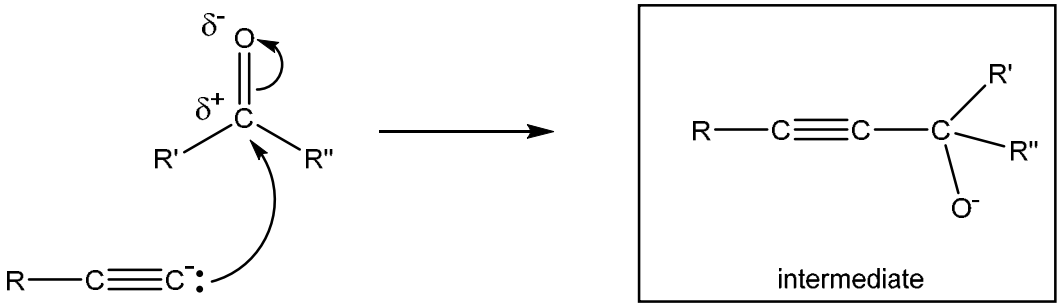
Question	Answer	Marks
4(b)	• $V^{2+}(aq)$ and $Sn^{4+}(aq)$: yes and $E^{\ominus}_{cell}$ = +0.15 – (–0.26) = +0.41 V [1] $2V^{2+} + Sn^{4+} \rightarrow 2V^{3+} + Sn^{2+}$ [1] • $VO^{2+}(aq)$ and $Fe^{3+}(aq)$ no reaction [1]	**3**

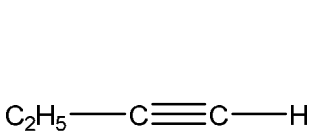
Question	Answer	Marks
5(a)	(Na^{+}) 0.095 / 0.181 = 0.525 **and** octahedral **and** co-ordination no. = 6	**1**
	(Mg^{2+}) 0.065 / 0.181 = 0.359 **and** tetrahedral **and** co-ordination no. = 4	**1**
5(b)	enthalpy change = (–642) – (2 × –106) = –**430**	**1**
5(c)(i)	–106 = 147 + 121 + 736 + (–349) + lattice energy lattice energy = –761	**3**
5(c)(ii)	$MgCl_2$ more exothermic / negative / bigger than $MgCl$ **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**

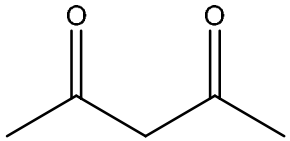
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>6(a)</td><td>central metal atom/ion surrounded by (one or more) ligands</td><td>1</td></tr>
<tr><td>6(b)</td><td>
<table>
<tr><td></td><td>co-ordination number</td><td>oxidation number</td></tr>
<tr><td>$[Pt(NH_3)_4Cl_2]^{2+}$</td><td>6</td><td>+4</td></tr>
<tr><td>$[PtCl_4]^{2-}$</td><td>4</td><td>+2</td></tr>
</table>
</td><td>2</td></tr>
<tr><td>6(c)</td><td> 
</td><td>2</td></tr>
<tr><td rowspan="2">6(d)</td><td>(HNO_3 +) $AgNO_3$ reagent</td><td>1</td></tr>
<tr><td>$[Pt(NH_3)_4Cl_2]Br_2$ with cream ppt. (of AgBr) and $[Pt(NH_3)_4Br_2]Cl_2$, with white ppt. (of AgCl) observation with both</td><td>1</td></tr>
<tr><td rowspan="3">6(e)</td><td>octahedral: both</td><td>1</td></tr>
<tr><td>square planar: geometric</td><td>1</td></tr>
<tr><td>tetrahedral: neither</td><td>1</td></tr>
</table>

Question	Answer	Marks
6(f)	diagrams  Marks can be awarded from words or diagram. Any three marking points from: • 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**

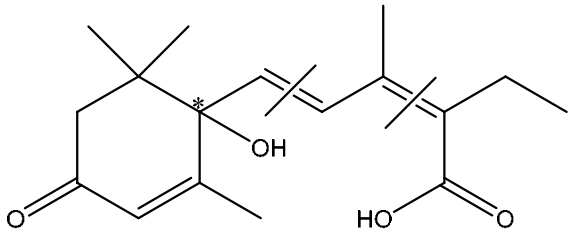
Question	Answer	Marks
7(a)(i)	$CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$	**1**
7(a)(ii)	 	**1**
7(b)	C_nH_{2n-2}	**1**
7(c)(i)	delocalised electrons	**1**
7(c)(ii)	CH	**1**
7(c)(iii)	less dense	**1**

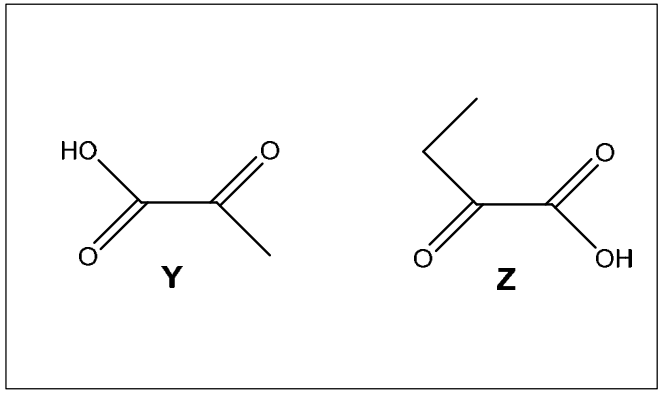
<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>7(d)(i)</td><td> 

2 curly arrows [1]
dipole [1]
intermediate [1]</td><td>3</td></tr>
<tr><td>7(d)(ii)</td><td>nucleophilic addition</td><td>1</td></tr>
<tr><td>7(d)(iii)</td><td> 

[1]
Q
 

[1]
R</td><td>2</td></tr>
<tr><td>7(e)</td><td>
<table>
<tr><th></th><th>CH_3CHO</th><th>HCO_2H</th><th>CH_3COCH_3</th><th>HO_2CCO_2H</th></tr>
<tr><td>hot acidified MnO_4^-(aq)</td><td>✓</td><td>✓</td><td>×</td><td>✓</td></tr>
<tr><td>alkaline I_2(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>
</table>
</td><td>4</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>8(a)(i)</td><td> 

circle or asterisk on correct C atom only [1]
lines through the two correct bonds only [1]</td><td>2</td></tr>
<tr><td>8(a)(ii)</td><td>ketone, (tertiary) alcohol, alkene, carboxylic acid
two for each mark</td><td>2</td></tr>
<tr><td>8(a)(iii)</td><td>sp carbons = 0 sp^2 carbons = 8 sp^3 carbons = 9</td><td>1</td></tr>
<tr><td>8(a)(iv)</td><td> 
</td><td>2</td></tr>
<tr><td>8(b)(i)</td><td><table><tr><th>compound</th><th>spot</th></tr><tr><td>J</td><td>2</td></tr><tr><td>K</td><td>3</td></tr><tr><td>L</td><td>1</td></tr></table></td><td>1</td></tr>
</table>

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**