

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Level

MARK SCHEME for the October/November 2014 series

9701 CHEMISTRY

9701/41

Paper 4 (A2 Structured Questions), maximum raw mark 100

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.

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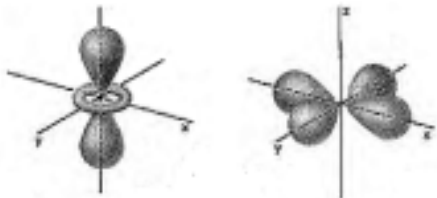
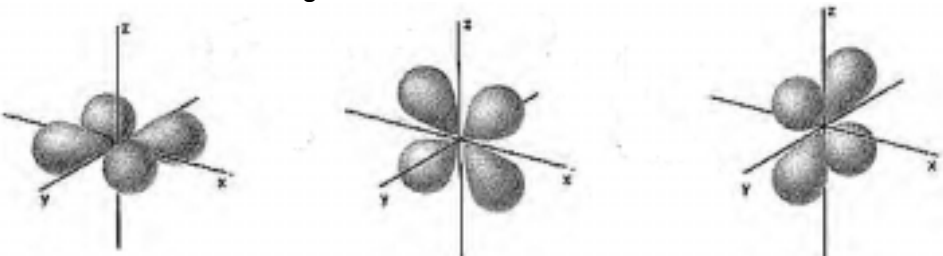
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Page 2	Mark Scheme	Syllabus	Paper
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Question	Marking point	Marks	Marks total
1 (a) (i)	[NO] 2 nd order and the concentration is $\times 2$, rate $\times 4$	1	
	[O ₂] 1 st order and evidence of using expt 1 & 2 when the concentration is $\times 2$, rate doubles	1	
(ii)	(0.00408 $\times$ 27) rate = 0.11 (mol dm ⁻³ s ⁻¹) to 2sf	1	
(iii)	(Rate =) $k [\text{O}_2][\text{NO}]^2$	1	
(iv)	$k = 332(.03125)$ mol ⁻² dm ⁶ s ⁻¹	1 1	[6]
(b) (i)	labelled axes x-axis: energy (KE) and y-axis: molecules or particles two curves: starts origin; not touching x-axis again; no levelling out; curves only intersecting once curves labelled and T2 is to the right and lower max than T1	1 1 1	
(ii)	rate increases and energy of the particles increases more particles have E_a	1 1	[5]
(c)	1 mole of F ₂ and 1 mole NO reacting in the slow step a balanced mechanism consistent with overall equation e.g. $\text{F}_2 + \text{NO} \rightarrow \text{NOF} + \text{F}$ OR $\text{F}_2 + \text{NO} \rightarrow \text{NOF}_2$ $\text{NO} + \text{F} \rightarrow \text{NOF}$ $\text{NO} + \text{NOF}_2 \rightarrow 2\text{NOF}$	1 1	[2]
Total			[13]

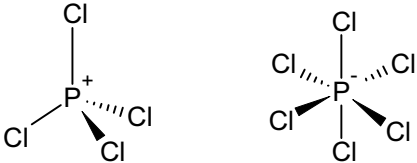
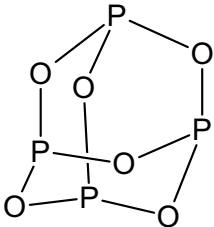
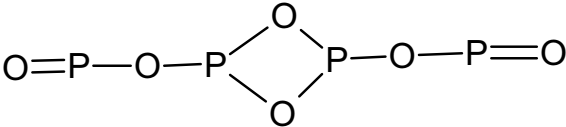
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2 (a)	3d <table><tr><td>(Ni)</td><td>↑↓</td><td>↑↓</td><td>↑↓</td><td>↑</td><td>↑</td></tr><tr><td>(Ni²⁺)</td><td>↑↓</td><td>↑↓</td><td>↑↓</td><td>↑</td><td>↑</td></tr></table> 4s <table><tr><td>↑↓</td></tr><tr><td></td></tr></table>	(Ni)	↑↓	↑↓	↑↓	↑	↑	(Ni ²⁺)	↑↓	↑↓	↑↓	↑	↑	↑↓		1	[2]
(Ni)	↑↓	↑↓	↑↓	↑	↑												
(Ni ²⁺)	↑↓	↑↓	↑↓	↑	↑												
↑↓																	
	1																
(b) (i)	degenerate	1															
(ii)	2 upper orbitals and 3 lower orbitals	1															
(iii)	correct upper orbital diagram  correct lower orbital diagram 	1	[4]														
	1																
(c)	electron(s) move from lower to upper level absorb (red/blue) light/photon complementary colour (green) is seen OR green light is transmitted	1	[3]														
		1															
		1															

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(d)	A $\text{Ni}(\text{OH})_2$ OR $\text{Ni}(\text{OH})_2(\text{H}_2\text{O})_4$	1	
	B $[\text{Ni}(\text{NH}_3)_6]^{2+}$ OR $[\text{Ni}(\text{NH}_3)_n(\text{H}_2\text{O})_{6-n}]^{2+}$ OR $[\text{Ni}(\text{NH}_3)_n(\text{H}_2\text{O})_{4-n}]^{2+}$	1	
	$\text{Ni}^{2+} + 2\text{OH}^- \rightarrow \text{Ni}(\text{OH})_2$ OR $[\text{Ni}(\text{H}_2\text{O})_6]^{2+} + 2\text{OH}^- \rightarrow \text{Ni}(\text{OH})_2 + 6\text{H}_2\text{O}$ OR $[\text{Ni}(\text{H}_2\text{O})_6]^{2+} + 2\text{NH}_3 \rightarrow \text{Ni}(\text{OH})_2 + 4\text{H}_2\text{O} + 2\text{NH}_4^+$ OR $[\text{Ni}(\text{H}_2\text{O})_6]^{2+} + 2\text{OH}^- \rightarrow \text{Ni}(\text{OH})_2(\text{H}_2\text{O})_4 + 2\text{H}_2\text{O}$	1	
	$\text{Ni}(\text{OH})_2 + 6\text{NH}_3 \rightarrow [\text{Ni}(\text{NH}_3)_6]^{2+} + 2\text{OH}^-$ OR $[\text{Ni}(\text{H}_2\text{O})_6]^{2+} + 6\text{NH}_3 \rightarrow [\text{Ni}(\text{NH}_3)_6]^{2+} + 6\text{H}_2\text{O}$	1	
Total			[13]

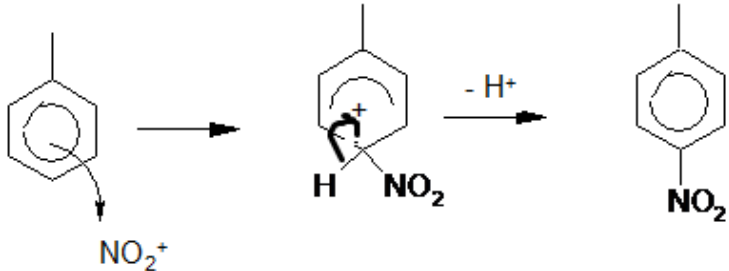
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3	(a) (i)	$101 = \text{P}^{35}\text{Cl}^{35}\text{Cl}$ $103 = \text{P}^{35}\text{Cl}^{37}\text{Cl}$ $105 = \text{P}^{37}\text{Cl}^{37}\text{Cl}$	1 1 1	
	(ii)	9:6:1	1	[4]
	(b) (i)	PCl_5 5 bonding pairs around P	1	
	(ii)		1 1	[3]
	(c) (i)	 P_4O_6 structure where each P has three P-O bonds and each O has two P-O bonds e.g. 	1	
	(ii)	(molecule/ion/species) that donates a lone pair of electrons (to a central transition metal atom or ion)	1	[2]
(d)	(i)	$K_{\text{sp}} = [\text{Ca}^{2+}]^3[\text{PO}_4^{3-}]^2$	1	

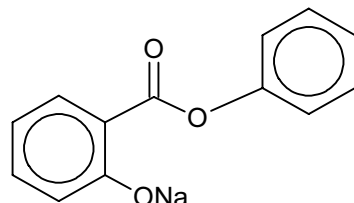
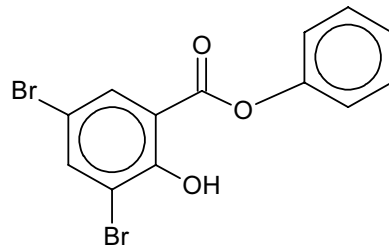
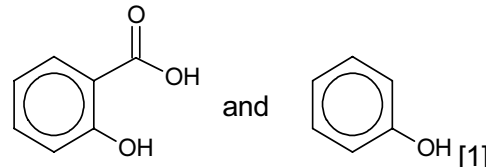
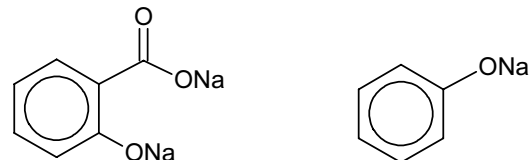
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(ii)	$[Ca^{2+}] = 3 \times 2.50 \times 10^{-6} = 7.50 \times 10^{-6} \text{ mol dm}^{-3}$ $[PO_4^{3-}] = 2 \times 2.50 \times 10^{-6} = 5.00 \times 10^{-6} \text{ mol dm}^{-3}$ $= (7.50 \times 10^{-6})^3 (5.00 \times 10^{-6})^2$ $= 1.05(1.1) \times 10^{-26}$ $\text{mol}^5 \text{dm}^{-15}$	1 1 1	[4]
(e) (i)	(enthalpy change) when 1 mole of an ionic compound is formed from its gaseous ions	1 1	
(ii)	Mg ²⁺ has a smaller (ionic) radii than Ca ²⁺ OR Mg ²⁺ is smaller than Ca ²⁺	1	[3]
Total			[16]
4 (a) (i)	$2H_2SO_4 + HNO_3 \rightarrow 2HSO_4^- + NO_2^+ + H_3O^+$ OR $H_2SO_4 + HNO_3 \rightarrow HSO_4^- + NO_2^+ + H_2O$	1	

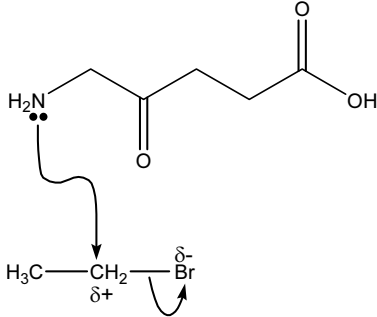
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(ii)	any three of - curly arrow from inside the benzene ring to NO_2^+ group - intermediate – penalise NO_2 connectivity or missing methyl group (once) - curly arrow from C-H bond into ring - product + H^+ (or as diagram $-\text{H}^+$) allow 2- and 3-substituted nitromethylbenzene) 	3	[4]
(b) (i)	acidity of $\text{ClCH}_2\text{CO}_2\text{H} > \text{CH}_3\text{CO}_2\text{H}$ AND ($\text{ClCH}_2\text{CO}_2\text{H}$) as an electronegative/electron withdrawing Cl	1	
(ii)	acidity of phenol $> \text{CH}_3\text{CH}_2\text{OH}$ AND electrons on oxygen (on phenol) delocalised into ring OR benzene ring withdraws electrons from oxygen stronger acid linked to weakening O-H bond/anion being stabilised	1 1	
		1	[3]

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(c)	Na	 (or ionic)	redox/reduction				
	Br ₂		(electrophilic) substitution				
	NaOH	 and [1] or ionic 	hydrolysis/ acid-base/				
1 mark for each correct structure for reaction types, 2 correct = 1 mark, 3 correct = 2 marks						4 2	[6]

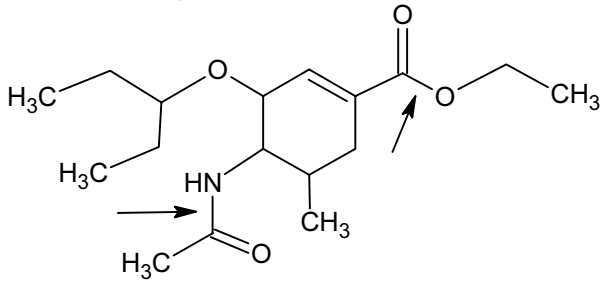
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Total			13
5 (a)	$\text{CH}_3\text{CH}_2\text{COCl} > \text{CH}_3\text{CH}_2\text{CH}_2\text{Cl} > \text{C}_6\text{H}_5\text{Cl}$ any two of: - C-Cl bond strength is weakest in $\text{CH}_3\text{CH}_2\text{COCl}$ or a - In $\text{C}_6\text{H}_5\text{Cl}$ (no hydrolysis) C-Cl bond is part of delocalised system OR p-orbital on Cl overlaps with π system OR electrons from Cl overlap with π system $\text{CH}_3\text{CH}_2\text{COCl}$ carbon in C-Cl bond is more electron deficient since it is also attached to an oxygen atom or a	1 1+1	[3]
(b)	ketone, amine, carboxylic acid two correct 1 mark, all three 2	2	[2]
(c) (i)	dipole on C-Br curly arrow breaking C-Br bond curly arrow from lone pair on N to carbon in C-Br bond 	1 1 1	
(ii)	nucleophilic substitution	1	
(iii)	HBr or hydrogen bromide	1	[5]

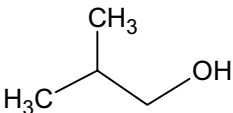
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(d)	Y = W = X = each structure 1 mark	3	[3]
(e)	correct displayed amide formula correct polyamide with two repeat units	1 1	[2]
Total			15
6 (a)	• (move in different directions) some amino acids have a different charge • (move at different speeds) some amino acids have a different size/different charge • (some amino acids do not move at all) some amino acids exist as a zwitterions/have no net(overall) charge/neutral/both NH₂/COOH are charged in amino acids	1 1 1	[3]
(b) (i)	mobile – solvent or water stationary – alumina/silica (supported on glass/plastic/Al)	1 1	
(ii)	by adsorption	1	[3]

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(c)	any three of: (all can be awarded from a clear, labelled diagram) • (base pairing) A to T OR C to G • H-bonds between bases • two/double stranded/chains • anti-parallel strands • (general structure) sugar-phosphate backbone OR BASE-SUGAR-PHOSPHATE bonded in a diagram	3	[3]
(d)	van der Waals' forces lost (in val) H-bonding gained (in ser)	1 1	[2]
Total			11
7 (a)	amide group circled OR indicated as diagram ester group circled OR indicated as diagram 	1 1	[2]
(b)	lower doses of the drug required OR improved activity of the drug OR reduced side effects	1	[1]

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(c)	decreases enzyme activity OR decreases rate at which product is formed	1	
	binds with the enzyme's active site OR has a complementary shape to active site OR similar shape to substrate	1	
	(competitive inhibition can be overcome by) increasing [substrate] OR increasing substrate concentration	1	[3]
(d)	energy source/carrier OR releases energy when hydrolysed	1	[1]
Total			7
8 (a)	M:M+1 = 100/(1.1 x n)	1	
	20.4/0.9 = 100/(1.1 x n) x = 4	1	
(ii)	C ₄ H ₁₀ O	1	[3]
(b) (i)	2-methylpropan-1-ol OR correct structure 	1	
(ii)	0.9-1.0 is (2 x)CH ₃ R/CH ₃ /RCH multiplet/1.8 is CHR/R ₃ CH singlet/2.5 is OH 3.4 is CH ₂ O/CH ₃ O	1 1 1 1	
(iii)	doublet 1H/one proton on adjacent carbon	1 1	

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(iv)	OH peak or one peak disappears	1	[9]
	OH proton is labile or exchanges for D of D ₂ O or as an equation e.g. $\text{D}_2\text{O} + \text{OH} \rightarrow \text{DOH} + \text{OD}$ as a minimum	1	
Total			12
			100

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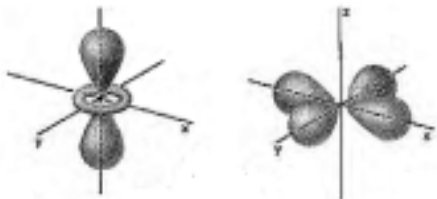
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Question	Marking point	Marks	Marks total
1 (a) (i)	[NO] 2 nd order and the concentration is $\times 2$, rate $\times 4$	1	
	[O ₂] 1 st order and evidence of using expt 1 & 2 when the concentration is $\times 2$, rate doubles	1	
(ii)	(0.00408 $\times$ 27) rate = 0.11 (mol dm ⁻³ s ⁻¹) to 2sf	1	
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		1 1	
(ii)	rate increases and energy of the particles increases more particles have E_a	1	[5]
		1	
(c)	1 mole of F ₂ and 1 mole NO reacting in the slow step a balanced mechanism consistent with overall equation e.g. $\text{F}_2 + \text{NO} \rightarrow \text{NOF} + \text{F}$ OR $\text{F}_2 + \text{NO} \rightarrow \text{NOF}_2$ $\text{NO} + \text{F} \rightarrow \text{NOF}$ $\text{NO} + \text{NOF}_2 \rightarrow 2\text{NOF}$	1	[2]
		1	
Total			[13]

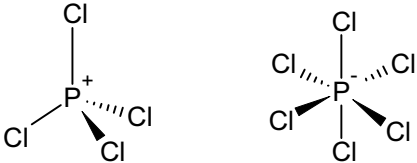
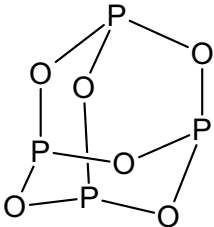
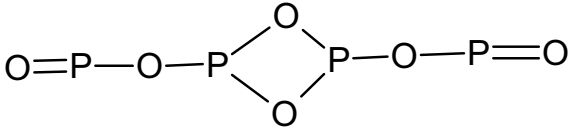
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(Ni)	↑↓	↑↓	↑↓	↑	↑												
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(ii)	2 upper orbitals and 3 lower orbitals	1															
(iii)	correct upper orbital diagram	1	[4]														
	 correct lower orbital diagram	1															
(c)	electron(s) move from lower to upper level	1	[3]														
	absorb (red/blue) light/photon	1															
	complementary colour (green) is seen OR green light is transmitted	1															

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(d)	A $\text{Ni}(\text{OH})_2$ OR $\text{Ni}(\text{OH})_2(\text{H}_2\text{O})_4$	1	
	B $[\text{Ni}(\text{NH}_3)_6]^{2+}$ OR $[\text{Ni}(\text{NH}_3)_n(\text{H}_2\text{O})_{6-n}]^{2+}$ OR $[\text{Ni}(\text{NH}_3)_n(\text{H}_2\text{O})_{4-n}]^{2+}$	1	
	$\text{Ni}^{2+} + 2\text{OH}^- \rightarrow \text{Ni}(\text{OH})_2$ OR $[\text{Ni}(\text{H}_2\text{O})_6]^{2+} + 2\text{OH}^- \rightarrow \text{Ni}(\text{OH})_2 + 6\text{H}_2\text{O}$ OR $[\text{Ni}(\text{H}_2\text{O})_6]^{2+} + 2\text{NH}_3 \rightarrow \text{Ni}(\text{OH})_2 + 4\text{H}_2\text{O} + 2\text{NH}_4^+$ OR $[\text{Ni}(\text{H}_2\text{O})_6]^{2+} + 2\text{OH}^- \rightarrow \text{Ni}(\text{OH})_2(\text{H}_2\text{O})_4 + 2\text{H}_2\text{O}$	1	
	$\text{Ni}(\text{OH})_2 + 6\text{NH}_3 \rightarrow [\text{Ni}(\text{NH}_3)_6]^{2+} + 2\text{OH}^-$ OR $[\text{Ni}(\text{H}_2\text{O})_6]^{2+} + 6\text{NH}_3 \rightarrow [\text{Ni}(\text{NH}_3)_6]^{2+} + 6\text{H}_2\text{O}$	1	[4]
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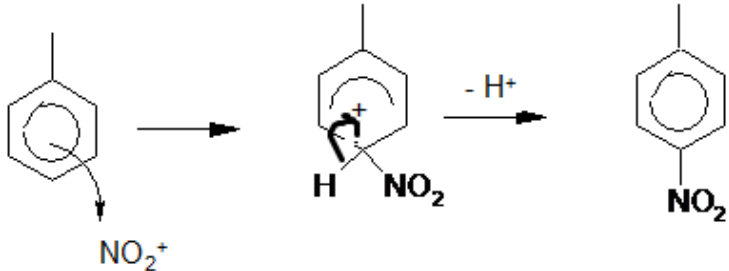
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	(ii)	9:6:1	1	[4]
	(b) (i)	PCl_5 5 bonding pairs around P	1	
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	(c) (i)	 P_4O_6 structure where each P has three P-O bonds and each O has two P-O bonds e.g. 	1	
	(ii)	(molecule/ion/species) that donates a lone pair of electrons (to a central transition metal atom or ion)	1	[2]
(d)	(i)	$K_{\text{sp}} = [\text{Ca}^{2+}]^3[\text{PO}_4^{3-}]^2$	1	

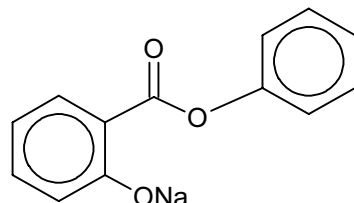
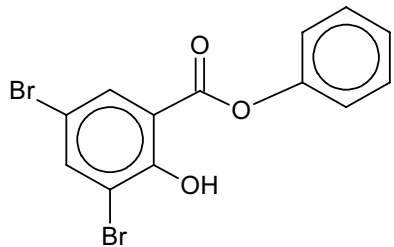
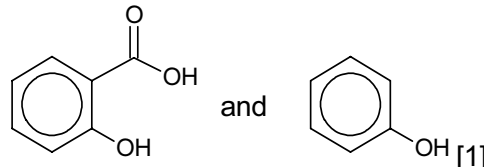
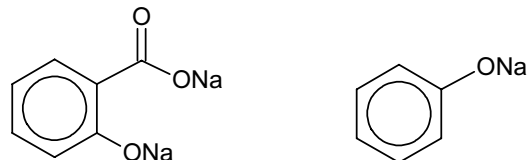
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(ii)	$[\text{Ca}^{2+}] = 3 \times 2.50 \times 10^{-6} = 7.50 \times 10^{-6} \text{ mol dm}^{-3}$ $[\text{PO}_4^{3-}] = 2 \times 2.50 \times 10^{-6} = 5.00 \times 10^{-6} \text{ mol dm}^{-3}$ $= (7.50 \times 10^{-6})^3 (5.00 \times 10^{-6})^2$ $= \mathbf{1.05(1.1) \times 10^{-26}}$ $\text{mol}^5 \text{dm}^{-15}$	1 1 1	 [4]
(e) (i)	(enthalpy change) when 1 mole of an ionic compound is formed from its gaseous ions	1 1	
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(ii)	any three of • curly arrow from inside the benzene ring to NO_2^+ group • intermediate – penalise NO_2 connectivity or missing methyl group (once) • curly arrow from C-H bond into ring • product + H^+ (or as diagram $-\text{H}^+$) allow 2- and 3-substituted nitromethylbenzene) 	3	[4]
(b) (i)	acidity of $\text{ClCH}_2\text{CO}_2\text{H} > \text{CH}_3\text{CO}_2\text{H}$ AND ($\text{ClCH}_2\text{CO}_2\text{H}$) as an electronegative/electron withdrawing Cl	1	[3]
(ii)	acidity of phenol $> \text{CH}_3\text{CH}_2\text{OH}$ AND electrons on oxygen (on phenol) delocalised into ring	1	
	OR benzene ring withdraws electrons from oxygen stronger acid linked to weakening O-H bond/anion being stabilised	1	

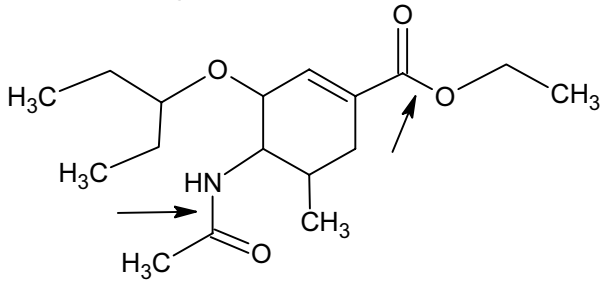
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(c)	Na	 (or ionic)	redox/reduction				
	Br ₂		(electrophilic) substitution				
	NaOH	 and or ionic 	hydrolysis/ acid-base/				
1 mark for each correct structure for reaction types, 2 correct = 1 mark, 3 correct = 2 marks						4 2	[6]

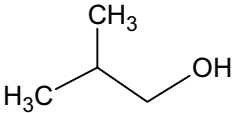
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(d)	Y = W = X = each structure 1 mark	3	[3]
(e)	correct displayed amide formula correct polyamide with two repeat units	1 1	[2]
Total			15
6 (a)	• (move in different directions) some amino acids have a different charge • (move at different speeds) some amino acids have a different size/different charge • (some amino acids do not move at all) some amino acids exist as a zwitterions/have no net(overall) charge/neutral/both NH₂/COOH are charged in amino acids	1 1 1	[3]
(b) (i)	mobile – solvent or water stationary – alumina/silica (supported on glass/plastic/Al)	1 1	
(ii)	by adsorption	1	[3]

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(c)	any three of: (all can be awarded from a clear, labelled diagram) • (base pairing) A to T OR C to G • H-bonds between bases • two/double stranded/chains • anti-parallel strands • (general structure) sugar-phosphate backbone OR BASE-SUGAR-PHOSPHATE bonded in a diagram	3	[3]
(d)	van der Waals' forces lost (in val) H-bonding gained (in ser)	1 1	[2]
Total			11
7 (a)	amide group circled OR indicated as diagram ester group circled OR indicated as diagram 	1 1	[2]
(b)	lower doses of the drug required OR improved activity of the drug OR reduced side effects	1	[1]

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(c)	decreases enzyme activity OR decreases rate at which product is formed	1	
	binds with the enzyme's active site OR has a complementary shape to active site OR similar shape to substrate	1	
	(competitive inhibition can be overcome by) increasing [substrate] OR increasing substrate concentration	1	[3]
(d)	energy source/carrier OR releases energy when hydrolysed	1	[1]
Total			7
8 (a)	M:M+1 = 100/(1.1 x n)	1	
	20.4/0.9 = 100/(1.1 x n) x = 4	1	
(ii)	C ₄ H ₁₀ O	1	[3]
(b) (i)	2-methylpropan-1-ol OR correct structure 	1	
(ii)	0.9-1.0 is (2 x)CH ₃ R/CH ₃ /RCH multiplet/1.8 is CHR/R ₃ CH singlet/2.5 is OH 3.4 is CH ₂ O/CH ₃ O	1 1 1 1	
(iii)	doublet 1H/one proton on adjacent carbon	1 1	

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(iv)	OH peak or one peak disappears	1	[9]
	OH proton is labile or exchanges for D of D ₂ O or as an equation e.g. $\text{D}_2\text{O} + \text{OH} \rightarrow \text{DOH} + \text{OD}$ as a minimum	1	
Total			12
			100

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Level

MARK SCHEME for the October/November 2014 series

9701 CHEMISTRY

9701/43

Paper 4 (A2 Structured Questions), maximum raw mark 100

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.

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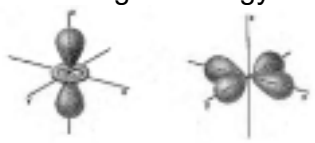
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Page 2	Mark Scheme	Syllabus	Paper
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Question	Marking point	Marks	Marks total												
1 (a) (i)	<table><thead><tr><th>m/e</th><th>identity</th></tr></thead><tbody><tr><td>35</td><td>^{35}Cl</td></tr><tr><td>37</td><td>^{37}Cl</td></tr><tr><td>70</td><td>$^{35}\text{Cl}^{35}\text{Cl}$ or $^{35}\text{Cl}_2$</td></tr><tr><td>72</td><td>$^{37}\text{Cl}^{35}\text{Cl}$</td></tr><tr><td>74</td><td>$^{37}\text{Cl}^{37}\text{Cl}$ or $^{37}\text{Cl}_2$</td></tr></tbody></table> 35, 37, 70, 72, 74 correct formulae at least one structure as a positive ion	m/e	identity	35	^{35}Cl	37	^{37}Cl	70	$^{35}\text{Cl}^{35}\text{Cl}$ or $^{35}\text{Cl}_2$	72	$^{37}\text{Cl}^{35}\text{Cl}$	74	$^{37}\text{Cl}^{37}\text{Cl}$ or $^{37}\text{Cl}_2$	1 1 1	
m/e	identity														
35	^{35}Cl														
37	^{37}Cl														
70	$^{35}\text{Cl}^{35}\text{Cl}$ or $^{35}\text{Cl}_2$														
72	$^{37}\text{Cl}^{35}\text{Cl}$														
74	$^{37}\text{Cl}^{37}\text{Cl}$ or $^{37}\text{Cl}_2$														
(ii)	9:6:1	1	[4]												
(b) (i)	 correct charges correct electrons	1 1													
(ii)	Lattice energy = $\Delta H_f(\text{SrCl}_2) - (\Delta H_{\text{atom}}(\text{Sr}) + \Delta H_{i1}(\text{Sr}) + \Delta H_{i2}(\text{Sr}) + \Delta H_{\text{atom}}(\text{Cl}) + 2\Delta H_{\text{ea}}(\text{Cl}))$ = $+(-830) - (+164 + 548 + 1060 + 242 + (2 \times -349))$ = -2146 (kJ mol ⁻¹)	1 1 1	[5]												
(c) (i)	$\text{SrCO}_3 + 2\text{HNO}_3 \rightarrow \text{Sr}(\text{NO}_3)_2 + \text{CO}_2 + \text{H}_2\text{O}$	1													

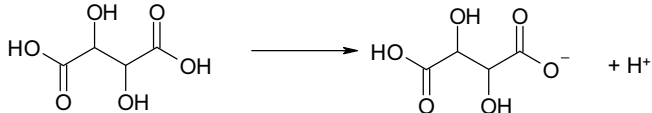
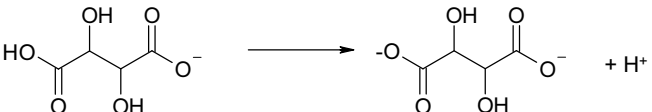
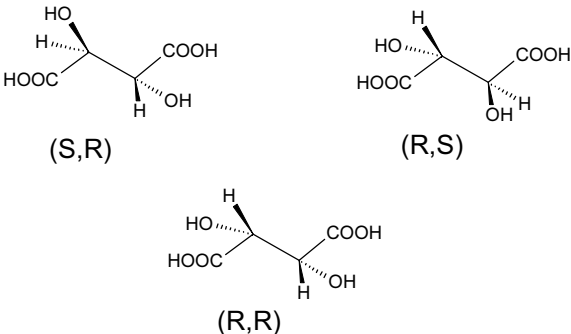
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(ii)	$\text{Sr}(\text{NO}_3)_2 \rightarrow \text{SrO} + 2\text{NO}_2 + 0.5 \text{O}_2$	1	[2]
(d)	(down the group) nitrates become more stable / require a higher temperature to decompose as size/radius of ion increases OR charge density of ion decreases so polarisation/distortion of anion/nitrate ion/ NO_3^- /NO bond decreases	1 1 1	[3]
2 (a)	$\text{BrO}_3^- + 5\text{Br}^- + 6\text{H}^+ \rightarrow 3\text{Br}_2 + 3\text{H}_2\text{O}$ five correct species correct balancing	1 1	[2]
(b) (i)	$[\text{BrO}_3^-]$ 1 st order and the concentration is x2, rate doubles OR evidence using expt 1 & 4 eg ratios $[\text{H}^+]$ 2 nd order and the concentration is x2, rate x4 OR evidence using expt 1 & 2 $[\text{Br}^-]$ 1 st order and the concentration is x4, rate x4 OR evidence using expt 1 & 3 eg ratios	1 1 1	
(ii)	(Rate =) $k [\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^2$	1	
(iii)	$k = 1.32$ $\text{mol}^{-3} \text{dm}^9 \text{s}^{-1}$	1 1	[6]
3 (a) (i)	chromium and copper	1	
(ii)	(all orbitals have the) same energy	1	
(iii)	correct id of one higher energy d orbital the other higher energy d orbital 	1 1	[4]

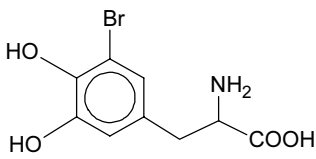
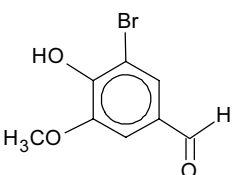
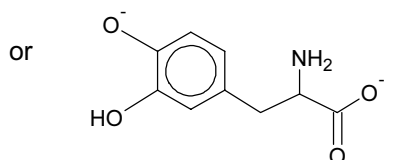
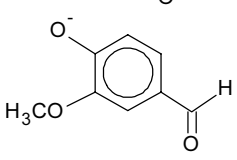
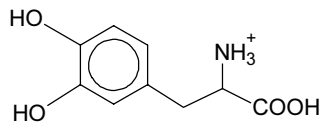
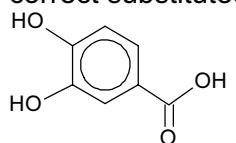
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(b) (i)	pale blue precipitate A solution B solution C	$\text{Cu}(\text{OH})_2$ OR $[\text{Cu}(\text{OH})_2(\text{H}_2\text{O})_4]$ $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ OR $[\text{Cu}(\text{NH}_3)_4]^{2+}$ $[\text{CuCl}_4]^{2-}$	1 1 1	
(ii)	solution B solution C	royal / deep / dark blue OR violet-blue yellow / green	1 1	
(iii)	redox OR oxidation of Cu OR reduction of Cu^{2+} AND reducing agent/reductant		1	[6]
(c)	3d-shell is full / $3d^{10}$ / no vacant d-orbital / d-orbitals full electrons cannot move between orbitals OR transitions cannot occur		1 1	[2]
(d)	green / yellow orange / red AND blue / violet light is <u>absorbed</u>		1 1	[2]
4 (a)	(HCl) stronger acid / more dissociated / ionised in solution (HCl has) more ions / higher concentration of ions		1 1	[2]
(b) (i)	A solution that resists changes in the pH / keeps pH <i>fairly</i> constant when small quantities / amounts / vols of acid / H^+ or base / OH^- are added		1 1	
(ii)	add (ethanoic acid) to NaOH OR an equation excess (ethanoic acid) OR mix with sodium ethanoate		1 1	[4]
(c)	$\text{CH}_3\text{CH}(\text{NH}_2)\text{COOH} + \text{H}^+ \rightarrow \text{CH}_3\text{CH}(\text{NH}_3^+)\text{COOH}$ $\text{CH}_3\text{CH}(\text{NH}_2)\text{COOH} + \text{OH}^- \rightarrow \text{CH}_3\text{CH}(\text{NH}_2)\text{COO}^- + \text{H}_2\text{O}$		1 1	[2]

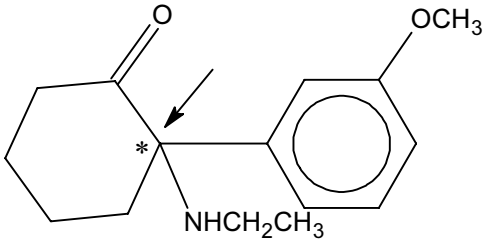
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(d) (i)	pKa 2.99  pKa 4.40 	1 1	
(ii)	 (S,R) (R,S) (R,R) any two of the above	2	[4]
5 (a)	any five of these seven points. • σ-bonds are between C-C OR C-H • carbons are sp^2 • rings of charge above and below the ring must be in diagram • presence of σ-bonds • electrons/bonds are delocalised • planar molecule/bond angles 120° • all C-C are the same length/have intermediate bond length between C-C & C=C	5	[5]

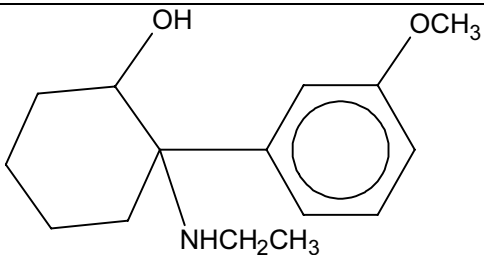
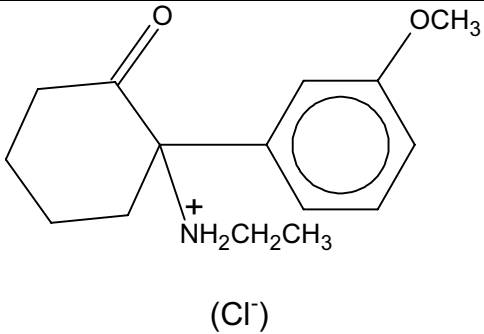
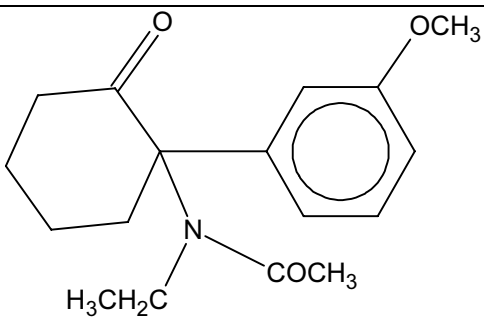
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(b)	Reagent X e.g. Br_2, HNO_3, Na, NaOH, benzenediazonium salt/ion; RCOCl; Fe^{3+}; H_2+Ni substituted product for L-DOPA & vanillin (examples given are for X = Br_2 and NaOH)   or  	1	[7]
	Reagent Y e.g. HCl; Na_2CO_3, Mg, SOCl_2, PCl_5, ROH + c.H_2SO_4; HCl+NaNO_2 / HNO_2; CH_3Cl Correct substituted product for L-DOPA 	1 1	
	Reagent Z e.g. acidified $\text{Cr}_2\text{O}_7^{2-}$; 2,4-DNPH, hydrazine; Fehling's, Tollens'; HCN; HCN + NaCN; NaBH_4; correct substituted product for vanillin 	1 1	
6 (a) (i)	$\text{C}_{15}\text{H}_{21}\text{NO}_2$	1	

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(ii)		1	
(iii)	any two of ketone, amine or ether	2	[4]

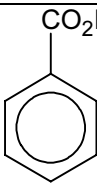
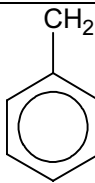
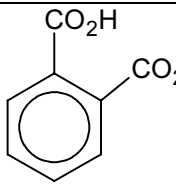
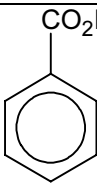
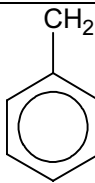
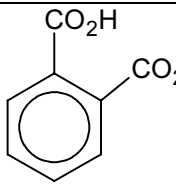
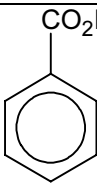
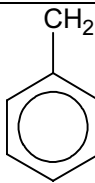
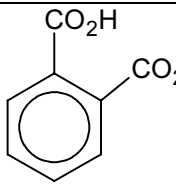
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(b)	(i) LiAlH_4		reduction / nucleophilic addition		
	(ii) HCl (aq)		acid-base / neutralisation		
	(iii) CH_3COCl		acylation / condensation allow addition + elimination allow nucleophilic substitution		
	1 mark for each correct structure 1 mark for each correct reaction type			3 3	[6]

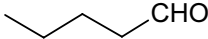
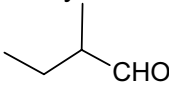
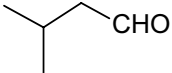
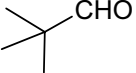
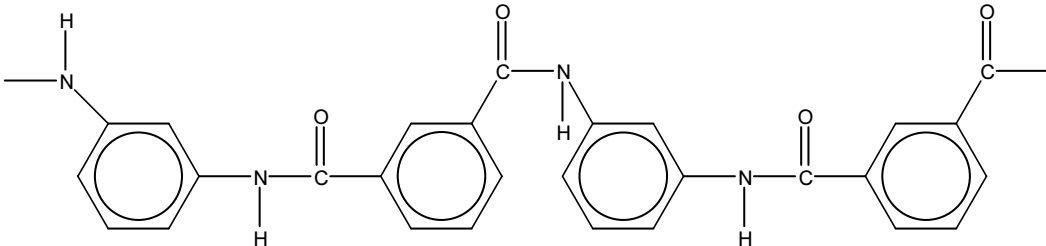
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7 (a)	(ratio of) the concentrations / distribution / amount / mass of solute in two (immiscible) solvents at equilibrium OR equilibrium constant OR includes expression with <i>K</i>	1 1	[2]
(b)	$K_{pc} = [J \text{ in ether}]/[J \text{ in H}_2\text{O}]$ $= (2.14/20)/(5-2.14/75)$ $= 2.81 \text{ OR } 2.82$	1 1	[2]
(c)	1 st extraction: $2.81 = (x/10)/(5.0-x)/75$ $2.81(5-x) = 7.5x$ $x = 1.36 \text{ g}$ 2 nd extraction: $2.81 = (y/10)/(3.64-y)/75$ $2.81(3.64-y) = 7.5y$ $y = 0.99 \text{ g}$	1 1	[2]
(d) (i)	water / solvent / named solvent	1	
(ii)	non-volatile liquid, for example mineral oil or at least a C ₁₅ hydrocarbon oil	1	
(iii)	1. R _f (retardation factor) or distance travelled by solute and distance by solvent 2. retention time	1 1	[4]

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(e)	<table><tr><td></td><td>2</td></tr><tr><td></td><td>1</td></tr><tr><td></td><td>3</td></tr></table>		2		1		3	1	[1]
	2								
	1								
	3								
8 (a)	C = 33 % A = T = 17 %	1 1	[2]						
(b) (i)	only one isomer may be active / be of therapeutic benefit	1							
(ii)	the other (stereo) isomer may cause harm / side effects	1	[2]						

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(c) (i)	structures of the following aldehydes:     two correct structures = 1 mark two further correct structures – 1 mark	1 1	
(ii)	3-methylbutanal	1	
(iii)	pentanal 5 absorptions 2-methylbutanal 5 absorptions dimethylpropanal 2 absorptions	1 1 1	[6]
9 (a)	nylon, terylene – condensation; PVC – addition – all three correct	1	[1]
(b)	correct fully displayed formula of -CO-NH- unit correct polymer structure 	1 1	[2]
(c)	sequence / order of amino acids (in the polypeptide chain)	1	[1]
(d)	hydrogen bond C=O and N-H in two different amino acids in the backbone diagram	1 1	[2]

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(e) (i)	disrupts hydrogen/ionic bonds as -COOH/NH_3^+ is deprotonated OR $\text{-NH}_3^+ + \text{OH}^- \rightarrow \text{NH}_2 + \text{H}_2\text{O}$ linked to hydrogen/ionic bond disrupted OR $\text{-COOH} + \text{OH}^- \rightarrow \text{-COO}^- + \text{H}_2\text{O}$ linked to hydrogen/ionic bond disrupted	1	
(ii)	Hg^{2+} interferes with/breaks the disulfide bond/bridge not sulfite, sulfate, sulfur, sulfide OR -S-S- shown with Hg^{2+} in an equation OR disrupting ionic interactions linked to carboxyl/ COO^- groups	1	
(iii)	(Heat to 70°C) breaks the van der Waals' forces/hydrogen bonding	1	[3]