

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Level

MARK SCHEME for the October/November 2014 series

9701 CHEMISTRY

9701/42

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.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2014 series for most Cambridge IGCSE[®], Cambridge International A and AS Level components and some Cambridge O Level components.

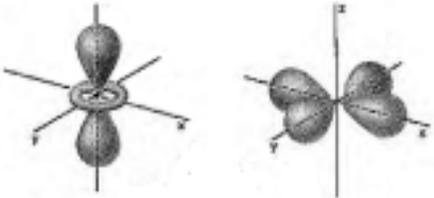
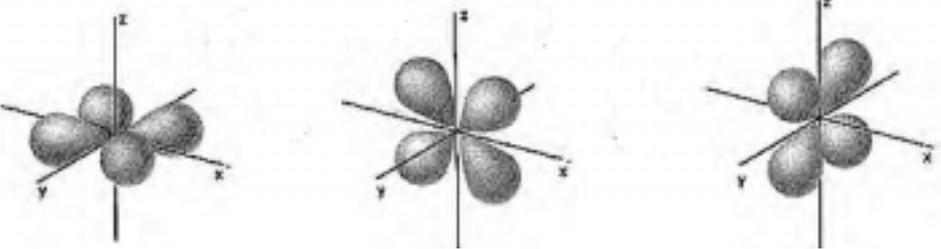
bestexamhelp.com

® IGCSE is the registered trademark of Cambridge International Examinations.

Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	42

Question	Marking point	Marks	Marks total
1 (a) (i)	[NO] 2 nd order and the concentration is ×2, rate × 4	1	
	[O ₂] 1 st order and evidence of using expt 1 & 2 when the concentration is ×2, rate doubles	1	
(ii)	(0.00408 × 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	1	
	two curves: starts origin; not touching x-axis again; no levelling out; curves only intersecting once	1	
	curves labelled and T2 is to the right and lower max than T1	1	
(ii)	rate increases and energy of the particles increases	1	
	more particles have E_a	1	[5]
(c)	1 mole of F ₂ and 1 mole NO reacting in the slow step	1	
	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]
Total			[13]

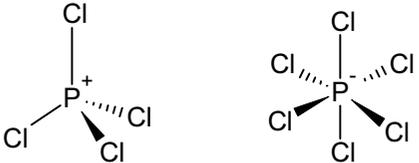
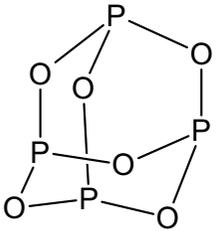
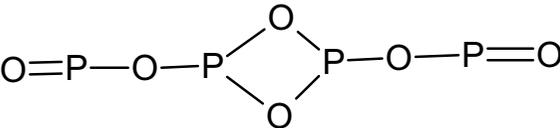
Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	42

2 (a)	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>3d</p> <table border="1" style="border-collapse: collapse; text-align: center;"> <tr> <td style="padding: 5px;">(Ni)</td> <td style="padding: 5px;">↑↓</td> <td style="padding: 5px;">↑↓</td> <td style="padding: 5px;">↑↓</td> <td style="padding: 5px;">↑</td> <td style="padding: 5px;">↑</td> </tr> <tr> <td style="padding: 5px;">(Ni²⁺)</td> <td style="padding: 5px;">↑↓</td> <td style="padding: 5px;">↑↓</td> <td style="padding: 5px;">↑↓</td> <td style="padding: 5px;">↑</td> <td style="padding: 5px;">↑</td> </tr> </table> </div> <div style="text-align: center;"> <p>4s</p> <table border="1" style="border-collapse: collapse; text-align: center;"> <tr> <td style="padding: 5px;">↑↓</td> </tr> <tr> <td style="padding: 5px;"> </td> </tr> </table> </div> </div>	(Ni)	↑↓	↑↓	↑↓	↑	↑	(Ni ²⁺)	↑↓	↑↓	↑↓	↑	↑	↑↓		1 1	[2]
(Ni)	↑↓	↑↓	↑↓	↑	↑												
(Ni ²⁺)	↑↓	↑↓	↑↓	↑	↑												
↑↓																	
(b) (i)	degenerate	1															
(ii)	2 upper orbitals and 3 lower orbitals	1															
(iii)	<p>correct upper orbital diagram</p> <div style="text-align: center;">  </div> <p>correct lower orbital diagram</p> <div style="text-align: center;">  </div>	1 1	[4]														
(c)	<p>electron(s) move from lower to upper level</p> <p>absorb (red/blue) light/photon</p> <p>complementary colour (green) is seen OR green light is transmitted</p>	1 1 1	[3]														

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	42

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

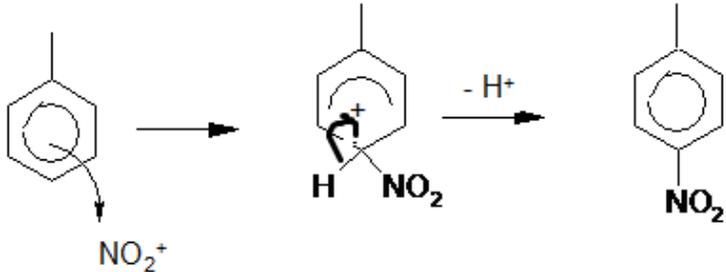
Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	42

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	

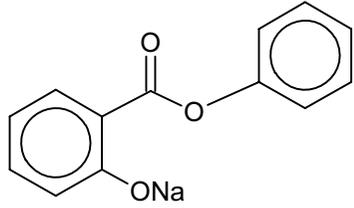
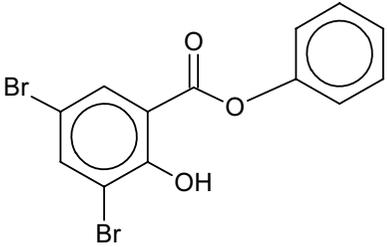
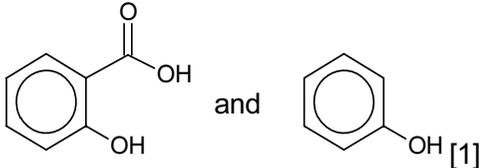
Page 6	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	42

(ii)	$[Ca^{2+}] = 3 \times 2.50 \times 10^{-6} = 7.50 \times 10^{-6} \text{ mol dm}^{-3}$ $[PO_4^{3-}] = 2 \times 2.50 \times 10^{-6} = 5.00 \times 10^{-6} \text{ mol dm}^{-3}$ $= (7.50 \times 10^{-6})^3 (5.00 \times 10^{-6})^2$ $= \mathbf{1.05(1.1) \times 10^{-26}}$ $\text{mol}^5 \text{dm}^{-15}$	1 1 1	[4]
(e) (i)	(enthalpy change) when 1 mole of an ionic compound is formed from its gaseous ions	1 1	
(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	

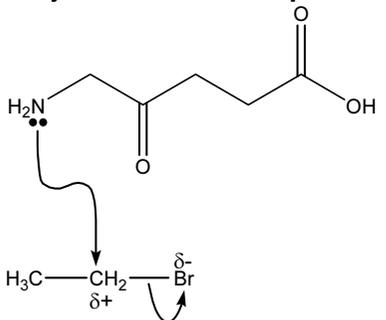
Page 7	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	42

<p>(ii)</p>	<p>any three of</p> <ul style="list-style-type: none"> • 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 $-\text{H}^+$) <p>allow 2- and 3-substituted nitromethylbenzene)</p> 	<p>3</p>	<p>[4]</p>
<p>(b) (i)</p>	<p>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</p>	<p>1</p>	
	<p>(ii)</p>	<p>1</p>	
	<p>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</p>	<p>1</p>	<p>[3]</p>

Page 8	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	42

(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]

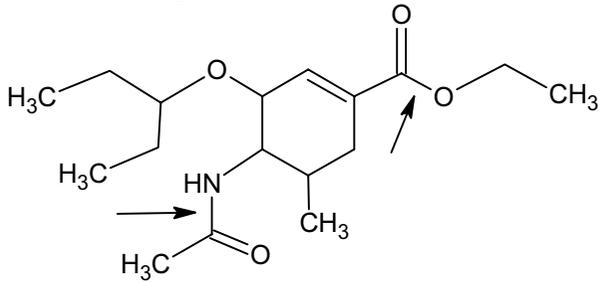
Page 9	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	42

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: <ul style="list-style-type: none"> C-Cl bond strength is weakest in $\text{CH}_3\text{CH}_2\text{COCl}$ ora 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 ora 	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]

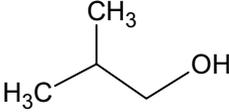
Page 10	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	42

(d)	<p>Y = </p> <p>W = </p> <p>X = </p> <p>each structure 1 mark</p>	3	[3]
(e)	<p></p> <p>correct displayed amide formula correct polyamide with two repeat units</p>	1 1	[2]
Total			15
6 (a)	<ul style="list-style-type: none"> • (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]

Page 11	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	42

(c)	<p>any three of: (all can be awarded from a clear, labelled diagram)</p> <ul style="list-style-type: none"> • (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)	<p>van der Waals' forces lost (in val) H-bonding gained (in ser)</p>	1 1	[2]
Total			11
7 (a)	<p>amide group circled OR indicated as diagram ester group circled OR indicated as diagram</p> 	1 1	[2]
(b)	<p>lower doses of the drug required OR improved activity of the drug OR reduced side effects</p>	1	[1]

Page 12	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	42

(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) 20.4/0.9 = 100/(1.1 x n) x = 4	1	
		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	1	
	multiplet/1.8 is CHR/R ₃ CH	1	
	singlet/2.5 is OH	1	
	3.4 is CH ₂ O/CH ₃ O	1	
(iii)	doublet 1H/one proton on adjacent carbon	1	
		1	

Page 13	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	42

(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. D ₂ O + OH → DOH + OD as a minimum	1	
Total			12
			100