

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.

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

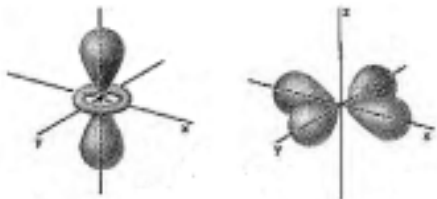
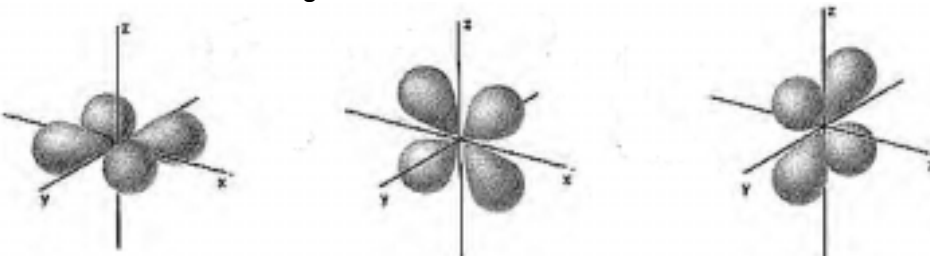
Cambridge will not enter into discussions about these mark schemes.

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.

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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]

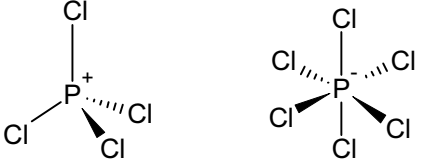
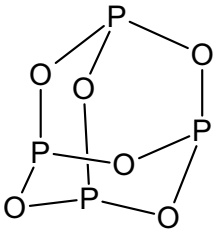
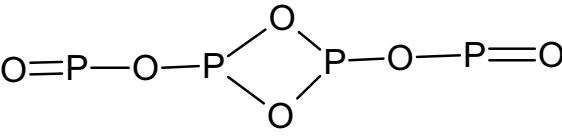
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2 (a)	3d <table><tr><td>(Ni)</td><td>↑↓</td><td>↑↓</td><td>↑↓</td><td>↑</td><td>↑</td></tr><tr><td>(Ni²⁺)</td><td>↑↓</td><td>↑↓</td><td>↑↓</td><td>↑</td><td>↑</td></tr></table> 4s <table><tr><td>↑↓</td></tr><tr><td> </td></tr></table>	(Ni)	↑↓	↑↓	↑↓	↑	↑	(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 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]

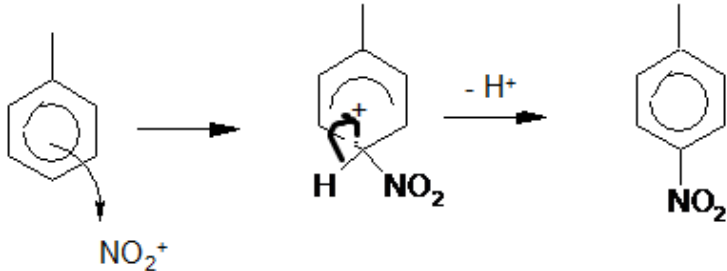
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3	(a) (i)	$101 = \text{P}^{35}\text{Cl}^{35}\text{Cl}$ $103 = \text{P}^{35}\text{Cl}^{37}\text{Cl}$ $105 = \text{P}^{37}\text{Cl}^{37}\text{Cl}$	1 1 1	
	(ii)	9:6:1	1	[4]
	(b) (i)	PCl_5 5 bonding pairs around P	1	
	(ii)		1 1	[3]
	(c) (i)	 P_4O_6 structure 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	

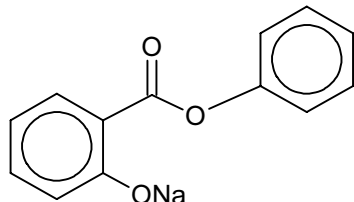
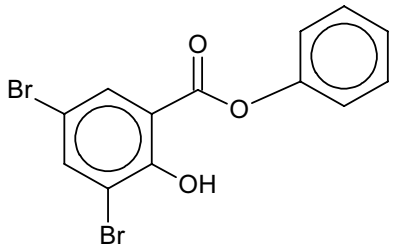
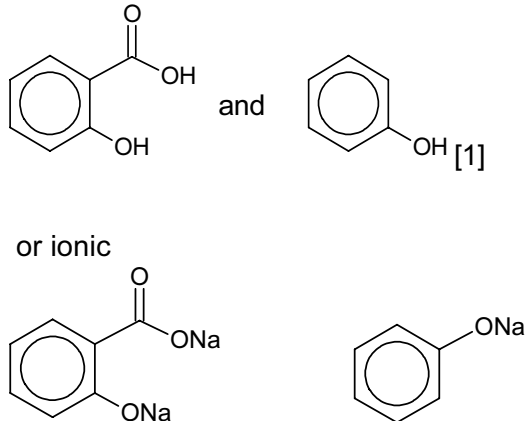
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(ii)	$[Ca^{2+}] = 3 \times 2.50 \times 10^{-6} = 7.50 \times 10^{-6} \text{ mol dm}^{-3}$ $[PO_4^{3-}] = 2 \times 2.50 \times 10^{-6} = 5.00 \times 10^{-6} \text{ mol dm}^{-3}$ $= (7.50 \times 10^{-6})^3 (5.00 \times 10^{-6})^2$ $= 1.05(1.1) \times 10^{-26}$ $\text{mol}^5 \text{dm}^{-15}$	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	

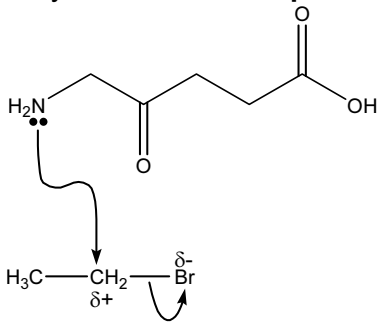
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(ii)	any three of • curly arrow from inside the benzene ring to NO_2^+ group • intermediate – penalise NO_2 connectivity or missing methyl group (once) • curly arrow from C-H bond into ring • product + H^+ (or as diagram $-\text{H}^+$) allow 2- and 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	[3]

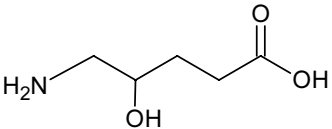
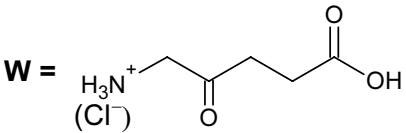
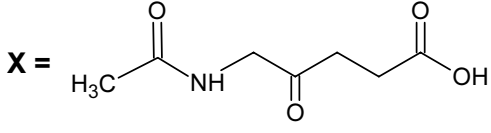
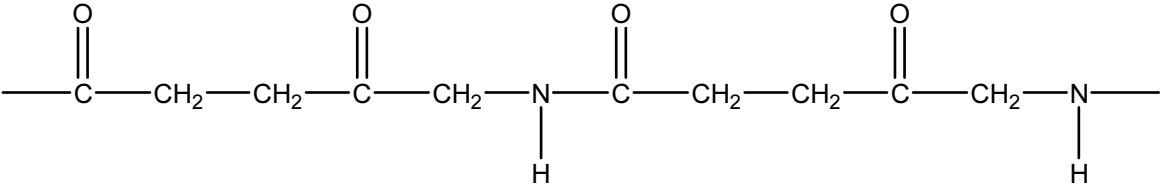
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(c)	Na	 (or ionic)	redox/reduction		
	Br ₂		(electrophilic) substitution		
	NaOH	 or ionic	hydrolysis/ acid-base/		
	1 mark for each correct structure for reaction types, 2 correct = 1 mark, 3 correct = 2 marks			4 2	[6]

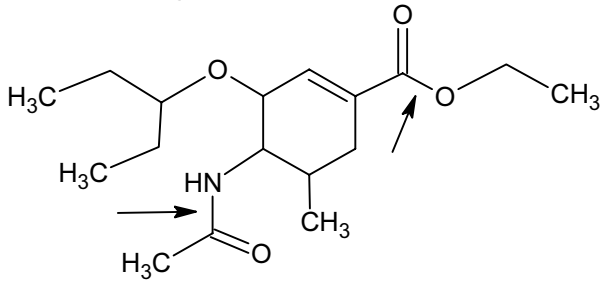
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Total			13
5 (a)	$\text{CH}_3\text{CH}_2\text{COCl} > \text{CH}_3\text{CH}_2\text{CH}_2\text{Cl} > \text{C}_6\text{H}_5\text{Cl}$ any two of: - C-Cl bond strength is weakest in $\text{CH}_3\text{CH}_2\text{COCl}$ or a - In $\text{C}_6\text{H}_5\text{Cl}$ (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]

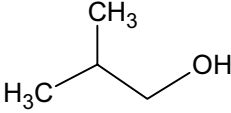
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(d)	Y =  W =  X =  each structure 1 mark	3	[3]
(e)	 correct displayed amide formula correct polyamide with two repeat units	1 1	[2]
Total			15
6 (a)	• (move in different directions) some amino acids have a different charge • (move at different speeds) 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