

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Level

MARK SCHEME for the October/November 2015 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.

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Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2015	9701	43

Question	Marking Point	Marks	Total Marks
1	(a) ionic bonds break / bonds between Mg^{2+} and Cl^- break forces / bonds / attractions form between the ions and water	2	
	(b) (i) (the energy change) when 1 mole of a substance dissolves in water / becomes aq	1	
	(ii) $\Delta H_{latt}^{\ominus} MgCl_2 + \Delta H_{sol}^{\ominus} MgCl_2 = \Delta H_{hyd}^{\ominus} Mg^{2+} + 2\Delta H_{hyd}^{\ominus} Cl^-$ $-2524 - 155 = -1925 + 2\Delta H_{hyd}^{\ominus} Cl^-$ $= -377 \text{ kJ mol}^{-1}$	2	
	(iii) magnesium / Mg is higher charge / sodium / Na is smaller charge magnesium / Mg is smaller / sodium / Na is larger Mg stronger attraction for water / Na weaker attraction for water any two	2	
	(c) <ul style="list-style-type: none">• solubility decreases• lattice energy and hydration enthalpy decrease• hydration enthalpy decreases more rapidly / is dominant factor• so (enthalpy change of) solution becomes less exothermic / more endothermic	4	
			[Total: 11]
2	(a) Co $3s^2 3p^6 3d^7 4s^2$ Co ³⁺ $3s^2 3p^6 3d^6$	[1] [1]	2
	(b) (i) atom or ion, bonded to (one or more), ligands		1
	(ii) any two from: two (or more) oxidation states, catalytic activity, coloured ions or compounds		2

Page 3	Mark Scheme	Syllabus	Paper
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Question	Marking Point	Marks	Total Marks		
(c)		5			
				transition element species formed	type of reaction
	$\text{Co}^{2+}(\text{aq}) + \text{an excess of NH}_3(\text{aq})$			$[\text{Co}(\text{NH}_3)_6]^{2+}$ or $[\text{Co}(\text{NH}_3)_4]^{2+}$ or $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$	ligand exchange
	$\text{Co}^{2+}(\text{aq}) + \text{OH}^-(\text{aq})$			$\text{Co}(\text{OH})_2$ or $\text{Co}(\text{OH})_2(\text{H}_2\text{O})_4$	precipitation or acid-base
	$\text{Co}^{2+}(\text{aq}) + \text{S}_2\text{O}_8^{2-}(\text{aq})$	$[\text{Co}(\text{H}_2\text{O})_6]^{3+}$ or Co^{3+} or $\text{Co}_2(\text{SO}_4)_3$	redox or oxidation or reduction of $\text{S}_2\text{O}_8^{2-}$		
(d) (i)	Y 13.4/88.9 or 0.15 Ba 41.2/137 or 0.3 Cu 28.6/63.5 or 0.45 O 16.8/16 or 1	1			
(ii)	= 7/3 or (+) 2.3	1			
(iii)	two Cu are + 2 and one Cu is + 3	1			
			[Total: 13]		

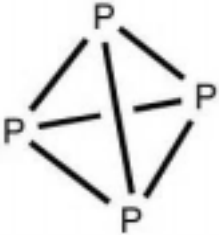
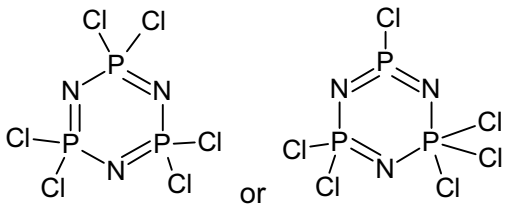
Page 4	Mark Scheme	Syllabus	Paper
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Question	Marking Point	Marks	Total Marks
3 (a) (i)	<ul style="list-style-type: none"> • Fe^{2+} and Fe^{3+} (or suitable compounds), • salt bridge labelled, • one electrode Pt labelled, • one solⁿ 1 mol dm⁻³ • Cl^- (or suitable compound), • voltmeter, labelled or V • Cl_2, • 1 atm or 298K 	2 or 3 marking points = [1] 4 or 5 marking points = [2] 6 or 7 marking points = [3] 8 marking points = [4]	4
	<p>The diagram shows two beakers connected by a salt bridge. The left beaker contains a solution labeled $\text{Fe}^{2+}/\text{Fe}^{3+}$ and a Pt electrode. The right beaker contains a solution labeled Cl^- and a Pt electrode. A gas inlet tube labeled Cl_2 with an arrow pointing into the right beaker is shown. The two Pt electrodes are connected by a wire that passes through a voltmeter labeled 'V' and a switch.</p>		
(ii)	$E^\ominus_{\text{cell}} = 1.36 - 0.77 = 0.59 \text{ V}$		1
(b)	yellow/orange/brown		1
(c)	cell voltage increases or becomes more positive Cl_2/Cl^- electrode potential increases		2

Page 5	Mark Scheme	Syllabus	Paper
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Question	Marking Point	Marks	Total Marks
(d) (i)	$\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2\text{e}^-$	2	
	$\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$		
	(ii) $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$		
(iii)	rechargeable/refillable/longer time between charges/longer battery life/less pollution because H_2O is the product/ O_2 can be got from the air	1	
			[Total: 12]
4	(a) (i) sketch graph to show a general decrease in m.p	1	
	(ii) giant covalent (C or Si) to metal/metallic (Sn or Pb)	1	
	(b) (i) can react with an acid or base/alkali or can act as an acid or base or has acidic and basic properties	1	
	(ii) $\text{SnO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SnO}_3 + \text{H}_2\text{O}$ or $\text{SnO}_2 + 2\text{NaOH} + 2\text{H}_2\text{O} \rightarrow \text{Na}_2\text{Sn}(\text{OH})_6$	1	
	(c) (i) $E^\ominus_{\text{cell}} = +1.18$ or $E^\ominus \text{Cr}_2\text{O}_7^{2-}$ greater/more positive than Sn^{4+} or $E^\ominus (\text{Cr}_2\text{O}_7^{2-}/\text{Cr}^{3+}) + 1.33$ and $E^\ominus (\text{Sn}^{4+}/\text{Sn}^{2+}) + 0.15$	1	
	(ii) $\text{Cr}_2\text{O}_7^{2-} + 3\text{Sn}^{2+} + 14\text{H}^+ \rightarrow 2\text{Cr}^{3+} + 3\text{Sn}^{4+} + 7\text{H}_2\text{O}$ green	2	
	(d) (i) the same substance gets both oxidised and reduced in the reaction or Ge changes oxid. no. +2 to 0 and changes oxid. no. +2 to +4	1	
	(ii) $(\text{CN})_2 + 2\text{NaOH} \rightarrow \text{NaOCN}/\text{NaCNO} + \text{NaCN} + \text{H}_2\text{O}$	1	

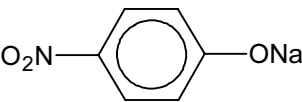
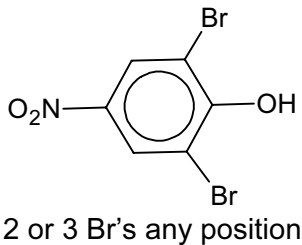
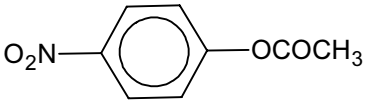
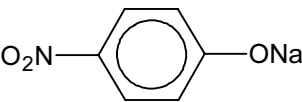
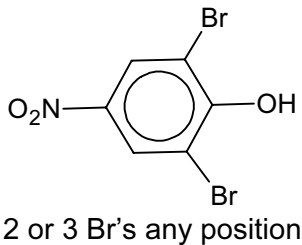
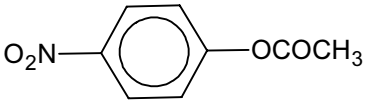
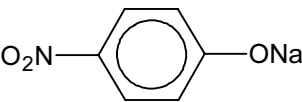
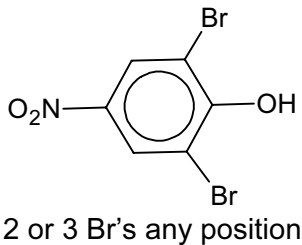
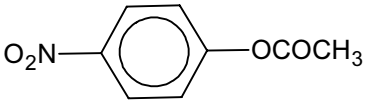
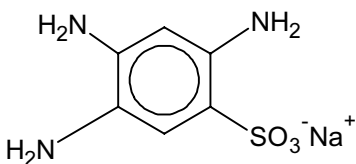
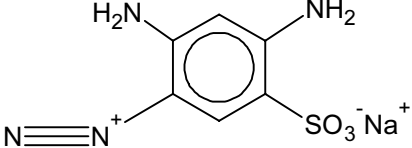
Page 6	Mark Scheme	Syllabus	Paper
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Question	Marking Point	Marks	Total Marks
(iii)	$\begin{array}{c} \times \quad \times \quad 0 \\ \times \text{N} \quad \equiv \quad \text{C} \quad \frac{0}{0} \quad \text{C} \quad \equiv \quad \text{N} \quad \times \\ \times \quad \times \quad 0 \\ \times \quad \times \quad 0 \end{array}$	1	
(e) (i)		1	
(ii)	<p>2P_2: $2 \times \text{P}\equiv\text{P} = 2 \times 489 = 978 \text{ kJ mol}^{-1}$ and</p> <p>P_4: $6 \times \text{P}-\text{P} = 6 \times -98 = -1188 \text{ kJ mol}^{-1}$</p> <p>$\Delta H = 978 - 1188 = -210 \text{ kJ mol}^{-1}$</p>	2	
(f) (i)	$3\text{NH}_4\text{Cl} + 3\text{PCl}_5 \rightarrow 12\text{HCl} + \text{P}_3\text{N}_3\text{Cl}_6$	1	
(ii)		1	
			[Total: 15]
5 (a) (i)	<p>L 2,4-DNPH or Brady's reagent or LiAlH_4 or NaBH_4</p> <p>M Fehling's solution or Tollens' reagent or acidified $\text{K}_2\text{Cr}_2\text{O}_7$ or MnO_4^-</p> <p>N alkaline I_2</p>	3	
(ii)	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{Na}$ or $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2^-\text{Na}^+$ or $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$	1	

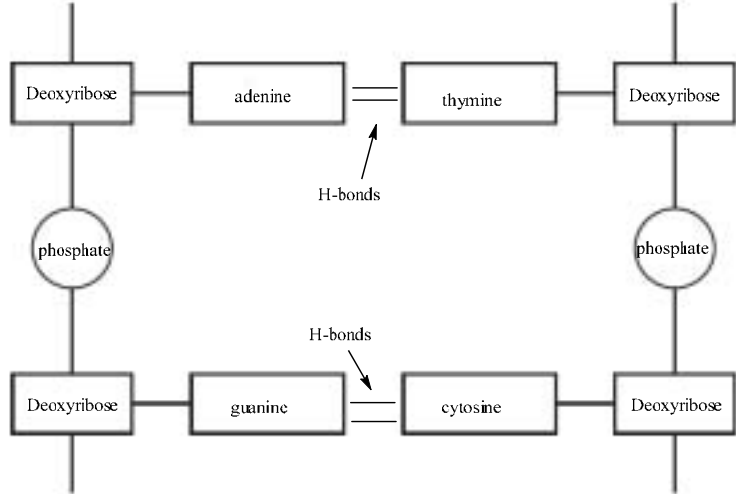
Page 7	Mark Scheme	Syllabus	Paper
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Question	Marking Point	Marks	Total Marks
(iii)	yellow precipitate	1	
(iv)	redox or oxidation	1	
(b) (i)	<p>[1] both curly arrows</p> <p>[1] dipoles</p> <p>[1] intermediate</p> <p>two curly arrows [1] dipole [1] intermediate [1]</p>	3	
(ii)		1	
			[Total: 10]

Page 8	Mark Scheme	Syllabus	Paper
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Question	Marking Point	Marks	Total Marks												
6 (a)	<table border="1"> <thead> <tr> <th>reagent</th> <th>organic product</th> <th>non-organic product</th> </tr> </thead> <tbody> <tr> <td>Na</td> <td>  </td> <td>H₂/hydrogen</td> </tr> <tr> <td>Br₂ (aq)</td> <td>  2 or 3 Br's any position </td> <td>HBr</td> </tr> <tr> <td>CH₃COCl (l)</td> <td>  </td> <td>HCl</td> </tr> </tbody> </table>	reagent	organic product	non-organic product	Na		H ₂ /hydrogen	Br ₂ (aq)	 2 or 3 Br's any position	HBr	CH ₃ COCl (l)		HCl	4	
	reagent	organic product	non-organic product												
Na		H ₂ /hydrogen													
Br ₂ (aq)	 2 or 3 Br's any position	HBr													
CH ₃ COCl (l)		HCl													
(b) (i)	 E  F	2													

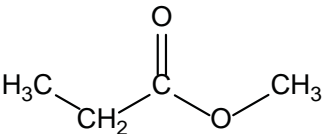
Page 9	Mark Scheme	Syllabus	Paper
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Question	Marking Point	Marks	Total Marks
(b) (ii)	step 1: $\text{NaNO}_2 + \text{HCl}$ or HNO_2 step 1: $T \leq 10^\circ\text{C}$ step 2: alkaline or $\text{NaOH}(\text{aq})$ or NaOH solution	3	
			[Total: 9]
7 (a)	<ul style="list-style-type: none"> backbone of sugar-phosphate-sugar-phosphate base bonded to sugar deoxyribose correct label two complementary base pairings e.g A–T or C–G hydrogen bonding/H–bonding between bases, labelled 	5	
(b)	any two of <ul style="list-style-type: none"> DNA uncoils or unzips hydrogen bonds break or weaken complementary bases join to form a new strand of DNA 	2	

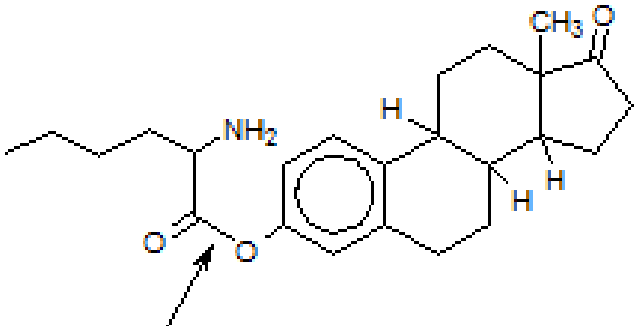
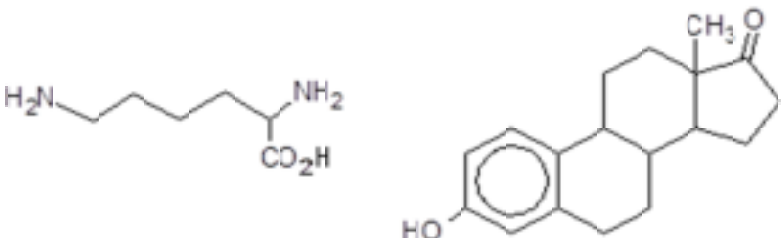
Page 10	Mark Scheme	Syllabus	Paper
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Question	Marking Point	Marks	Total Marks
(c)	(i) restriction enzymes	1	
	(ii) electrophoresis	1	
	(iii) radioactive substance	1	
	(iv) suspect 3	1	
			[Total: 11]
8	(a) (i) time taken for a compound to travel through the column	1	
	(ii) hydrogen or helium or nitrogen	1	
	(iii) it is more soluble in the stationary phase	1	
	(iv) same functional group or same IMF with stationary phase or same polarity	1	
	(v) % X (= $100 \times 22/76$) = 29 (28.9)	1	
	(b) (i) TMS or tetramethylsilane or Si(CH ₃) ₄	1	

Page 11	Mark Scheme	Syllabus	Paper
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Question	Marking Point	Marks	Total Marks																
(ii)	<table border="1"> <thead> <tr> <th>chemical shift δ/ppm</th> <th>type of proton(s)</th> <th>number of protons</th> <th>splitting pattern</th> </tr> </thead> <tbody> <tr> <td>1.0</td> <td>CH₃-R</td> <td>3</td> <td>triplet</td> </tr> <tr> <td>2.3</td> <td>CH₂CO</td> <td>2</td> <td>quartet</td> </tr> <tr> <td>3.7</td> <td>CH₃O</td> <td>3</td> <td>singlet</td> </tr> </tbody> </table>	chemical shift δ /ppm	type of proton(s)	number of protons	splitting pattern	1.0	CH ₃ -R	3	triplet	2.3	CH ₂ CO	2	quartet	3.7	CH ₃ O	3	singlet	4	
	chemical shift δ /ppm	type of proton(s)	number of protons	splitting pattern															
1.0	CH ₃ -R	3	triplet																
2.3	CH ₂ CO	2	quartet																
3.7	CH ₃ O	3	singlet																
(iii)	structure / name of methyl propanoate 	1																	
			[Total: 11]																
9 (a)	C ₂₄ (H ₃₄)N ₂ O ₃	1																	
(b)	ketone amine ester	2																	

Page 12	Mark Scheme	Syllabus	Paper
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Question	Marking Point	Marks	Total Marks
(c) (i)		1	
(ii)		2	
(d)	hydrogen bonding or ion-dipole forces involving lone pair on N atoms, or lone pair on O atoms, or NH ₂ groups, or CO ₂ groups, or C=O groups, with water	2	[Total: 8]