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.

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

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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)	$\Delta H^{\ominus}_{latt}\ MgCl_2 + \Delta H^{\ominus}_{sol}\ MgCl_2 = \Delta H^{\ominus}_{hyd}\ Mg^{2+} + 2\Delta H^{\ominus}_{hyd}\ Cl^-$ $-2524 - 155 = -1925 + 2\Delta H^{\ominus}_{hyd}\ Cl^-$ $= -377\ kJ\,mol^{-1}$	**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)	• 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 $3s^2 3p^6 3d^7 4s^2$ [1] Co^{3+} $3s^2 3p^6 3d^6$ [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**	

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<table>
<tr><th>Question</th><th>Marking Point</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>(c)</td><td>
<table>
<tr><th></th><th>transition element species formed</th><th>type of reaction</th></tr>
<tr><td>$Co^{2+}(aq)$ + an excess of $NH_3(aq)$</td><td>$[Co(NH_3)_6]^{2+}$ or
$[Co(NH_3)_4]^{2+}$ or
$[Co(NH_3)_4(H_2O)_2]^{2+}$</td><td>ligand exchange</td></tr>
<tr><td>$Co^{2+}(aq)$ + $OH^-(aq)$</td><td>$Co(OH)_2$ or
$Co(OH)_2(H_2O)_4$</td><td>precipitation or
acid-base</td></tr>
<tr><td>$Co^{2+}(aq)$ + $S_2O_8^{2-}(aq)$</td><td>$[Co(H_2O)_6]^{3+}$ or
Co^{3+} or
$Co_2(SO_4)_3$</td><td>redox or
oxidation or
reduction of $S_2O_8^{2-}$</td></tr>
</table>
</td><td>5</td><td></td></tr>
<tr><td>(d) (i)</td><td>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</td><td>1</td><td></td></tr>
<tr><td>(ii)</td><td>= 7 / 3 or (+) 2.3</td><td>1</td><td></td></tr>
<tr><td>(iii)</td><td>two Cu are + 2 and one Cu is + 3</td><td>1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>[Total: 13]</td></tr>
</table>

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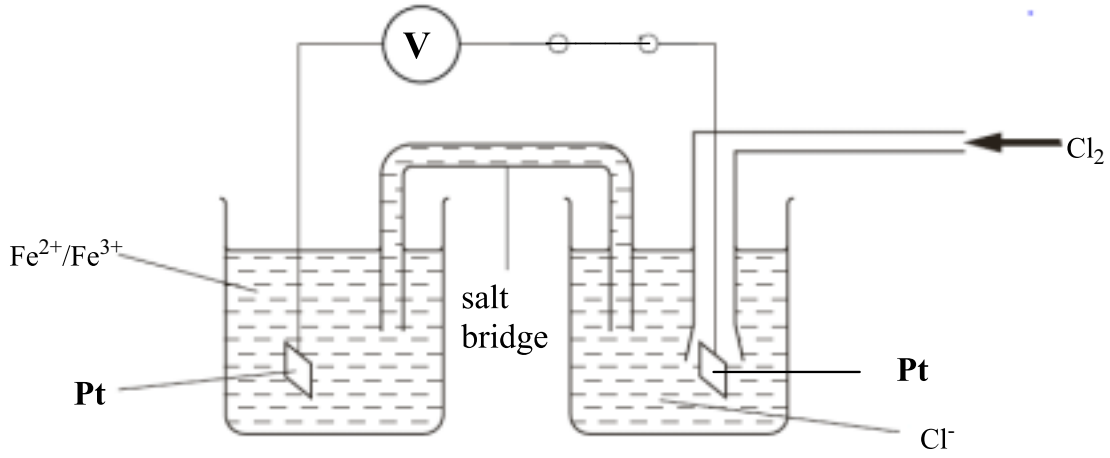
Question	Marking Point	Marks	Total Marks
3 (a) (i)	• Fe^{2+} and Fe^{3+} (or suitable compounds), • salt bridge labelled, • one electrode Pt labelled, • one sol^{n} 1 mol dm^{-3} • Cl^- (or suitable compound), • voltmeter, labelled or V • Cl_2, • 1 atm or 298K 2 or 3 marking points = [1] 4 or 5 marking points = [2] 6 or 7 marking points = [3] 8 marking points = [4]	**4**	
(ii)	$E^{\ominus}_{cell}$ = 1.36 – 0.77 = 0.59 V	**1**	
(b)	yellow / orange / brown	**1**	
(c)	cell voltage increases or becomes more positive Cl_2 / Cl^- electrode potential increases	**2**	



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Question	Marking Point	Marks	Total Marks
(d) (i)	$H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$ $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$	**2**	
(ii)	$2H_2 + O_2 \rightarrow 2H_2O$	**1**	
(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)	$SnO_2 + 2NaOH \rightarrow Na_2SnO_3 + H_2O$ **or** $SnO_2 + 2NaOH + 2H_2O \rightarrow Na_2Sn(OH)_6$	**1**	
(c) (i)	$E^\ominus_{cell}$ = + 1.18 or $E^\ominus$ $Cr_2O_7^{2-}$ greater / more positive than Sn^{4+} **or** $E^\ominus$ $(Cr_2O_7^{2-}/Cr^{3+})$ + 1.33 **and** $E^\ominus$ (Sn^{4+}/Sn^{2+}) + 0.15	**1**	
(ii)	$Cr_2O_7^{2-} + 3Sn^{2+} + 14H^+ \rightarrow 2\,Cr^{3+} + 3Sn^{4+} + 7H_2O$ 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)	$(CN)_2 + 2NaOH \rightarrow NaOCN / NaCNO + NaCN + H_2O$	**1**	

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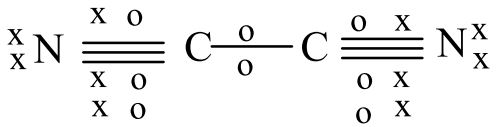
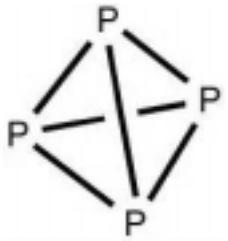
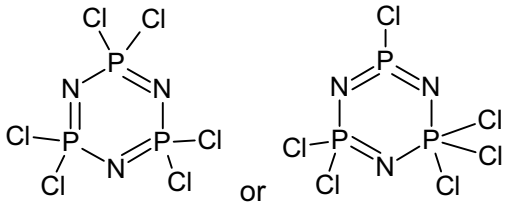
Question	Marking Point	Marks	Total Marks
(iii)		1	
(e) (i)		1	
(ii)	$2P_2$: $2 \times P{\equiv}P = 2 \times 489 = 978\ kJ\,mol^{-1}$ **and** P_4: $6 \times P-P = 6 \times -98 = -1188\ kJ\,mol^{-1}$ $\Delta H = 978 - 1188 = -210\ kJ\,mol^{-1}$	2	
(f) (i)	$3NH_4Cl + 3PCl_5 \rightarrow 12HCl + P_3N_3Cl_6$	1	
(ii)	 or	1	
			[Total: 15]
5 (a) (i)	**L** 2,4-DNPH or Brady's reagent or $LiAlH_4$ or $NaBH_4$ **M** Fehling's solution or Tollens' reagent or acidified $K_2Cr_2O_7$ or MnO_4^- **N** alkaline I_2	3	
(ii)	$CH_3CH_2CH_2CO_2Na$ or $CH_3CH_2CH_2CO_2^-Na^+$ or $CH_3CH_2CH_2CO_2H$	1	

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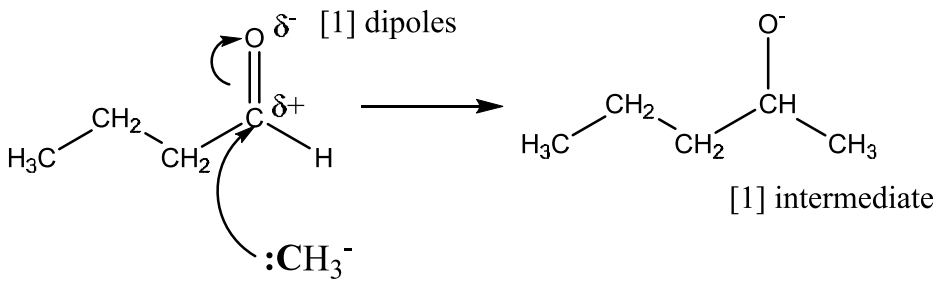
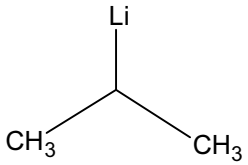
Question	Marking Point	Marks	Total Marks
(iii)	yellow precipitate	**1**	
(iv)	redox or oxidation	**1**	
(b) (i)	 [1] both curly arrows two curly arrows [1] dipole [1] intermediate [1]	**3**	
(ii)		**1**	
			[Total: 10]

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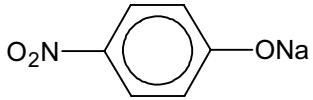
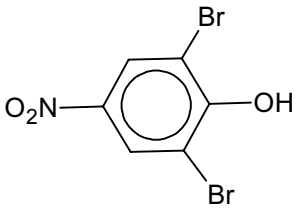
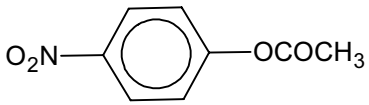
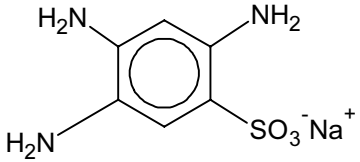
Question	Marking Point	Marks	Total Marks

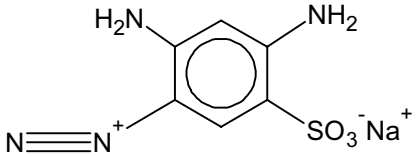
6 (a)

reagent	organic product	non-organic product
Na		H_2 / hydrogen
Br_2 (aq)	 2 or 3 Br's any position	HBr
CH_3COCl (l)		HCl

(b) (i)



E



F

4

2

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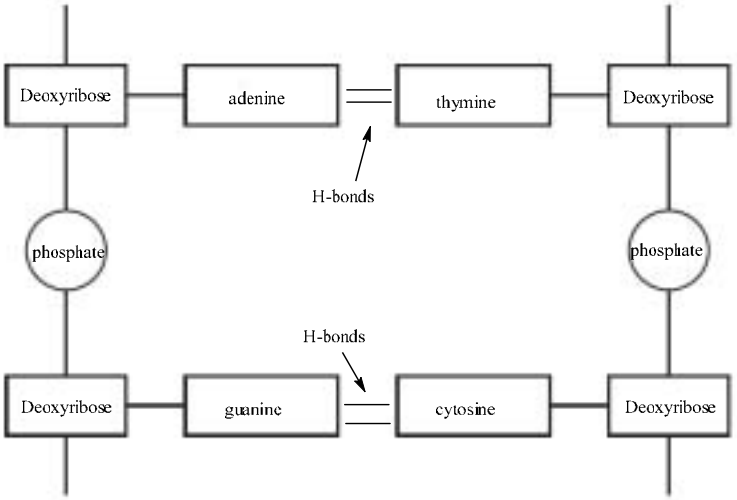
Question	Marking Point	Marks	Total Marks
(b) (ii)	step 1: $NaNO_2$ + HCl or HNO_2 step 1: T ⩽ 10 °C step 2: alkaline or NaOH(aq) or NaOH solution	**3**	
			[Total: 9]
7 (a)	• backbone of sugar-phosphate-sugar-phosphate • base bonded to sugar • deoxyribose correct label • two complementary base pairings e.g A–T or C–G • hydrogen bonding / H–bonding between bases, labelled  	**5**	
(b)	any **two** of • DNA uncoils or unzips • hydrogen bonds break or weaken • complementary bases join to form a new strand of DNA	**2**	

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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 × 22 / 76) **= 29** (28.9)	**1**	
(b) (i)	TMS or tetramethylsilane or $Si(CH_3)_4$	**1**	

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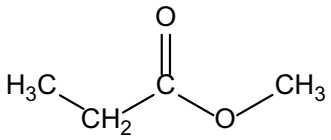
<table>
<tr><th>Question</th><th>Marking Point</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>(ii)

(iii)</td><td>
<table>
<tr><th>chemical shift δ / ppm</th><th>type of proton(s)</th><th>number of protons</th><th>splitting pattern</th></tr>
<tr><td>1.0</td><td>CH_3-R</td><td>3</td><td>triplet</td></tr>
<tr><td>2.3</td><td>CH_2CO</td><td>2</td><td>quartet</td></tr>
<tr><td>3.7</td><td>CH_3O</td><td>3</td><td>singlet</td></tr>
</table>
structure / name of methyl propanoate


</td><td>4

1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>[Total: 11]</td></tr>
<tr><td>9 (a)</td><td>$C_{24}(H_{34})N_2O_3$</td><td>1</td><td></td></tr>
<tr><td>(b)</td><td>ketone amine ester</td><td>2</td><td></td></tr>
</table>

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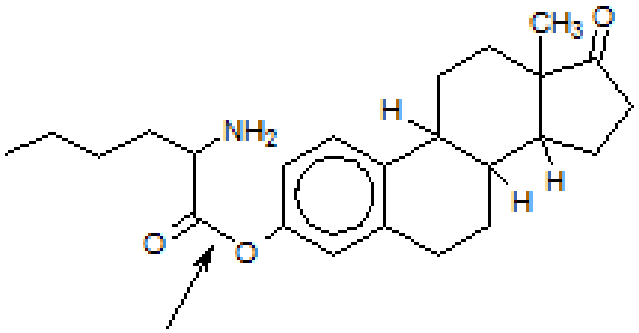
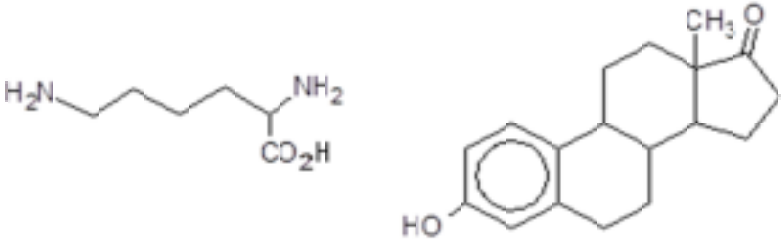
Question	Marking Point	Marks	Total Marks
(c) (i)		**1**	
(ii)		**2**	
(d)	hydrogen bonding **or** ion-dipole forces involving lone pair on N atoms, or lone pair on O atoms, or NH_2 groups, or CO_2 groups, or C=O groups, with water	**2**	**[Total: 8]**

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