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

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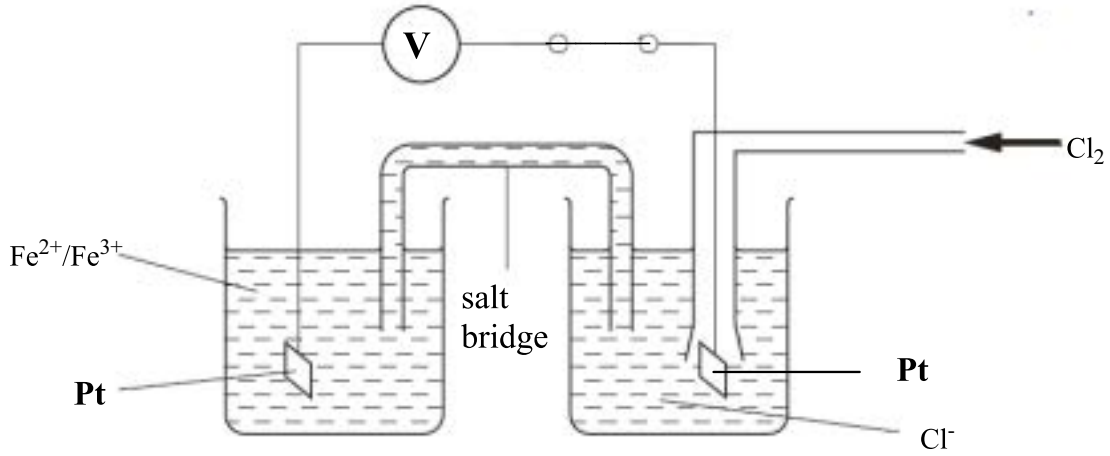
Question	Marking Point	Marks	Total Marks
1 (a)	ionic bonds break / bonds between Mg^{2+} and Cl^- break	**2**	
	forces / bonds / attractions form between the ions and water		
(b) (i)	(the energy change) when 1 mole of a substance dissolves in water / becomes aq	**1**	
(ii)	$\Delta H^{\ominus}_{latt}\ MgCl_2 + \Delta H^{\ominus}_{sol}\ MgCl_2 = \Delta H^{\ominus}_{hyd}\ Mg^{2+} + 2\Delta H^{\ominus}_{hyd}\ Cl^-$ $-2524 - 155 = -1925 + 2\Delta H^{\ominus}_{hyd}\ Cl^-$ $= -377\ kJ\,mol^{-1}$	**2**	
(iii)	magnesium / Mg is higher charge / sodium / Na is smaller charge	**2**	
	magnesium / Mg is smaller / sodium / Na is larger		
	Mg stronger attraction for water / Na weaker attraction for water any two		
(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>
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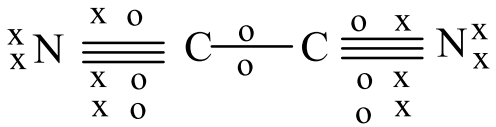
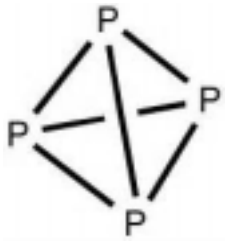
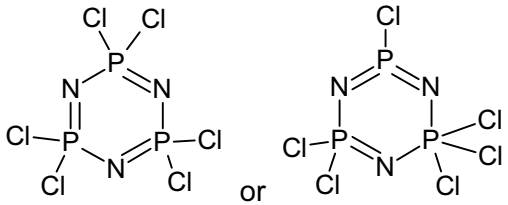
Question	Marking Point	Marks	Total Marks
3 (a) (i)	• Fe^{2+} and Fe^{3+} (or suitable compounds), • salt bridge labelled, • one electrode Pt labelled, • one sol^{n} 1 mol dm^{-3} • Cl^- (or suitable compound), • voltmeter, labelled or V • Cl_2, • 1 atm or 298K 2 or 3 marking points = [1] 4 or 5 marking 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**	



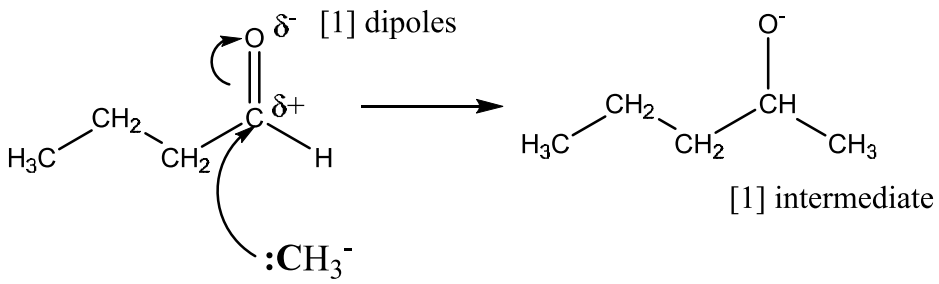
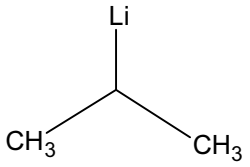
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Question	Marking Point	Marks	Total Marks
(d) (i)	$H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$ $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$	**2**	
(ii)	$2H_2 + O_2 \rightarrow 2H_2O$	**1**	
(iii)	rechargeable / refillable / longer time between charges / longer 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	

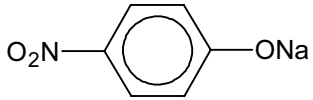
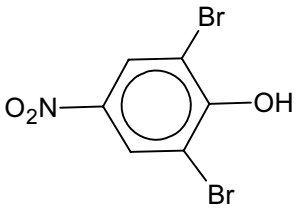
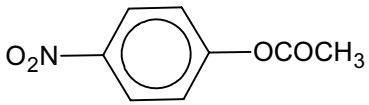
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Question	Marking Point	Marks	Total Marks
(iii)	yellow precipitate	**1**	
(iv)	redox or oxidation	**1**	
(b) (i)	 two curly arrows [1] dipole [1] intermediate [1]	**3**	
(ii)		**1**	
			[Total: 10]

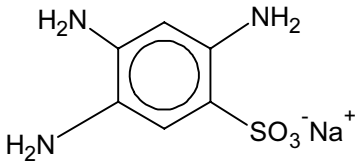
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Question	Marking Point	Marks	Total Marks

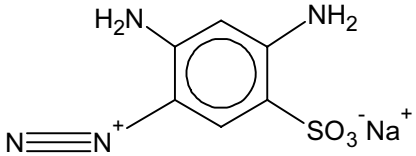
6 (a) **4**

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) **2**

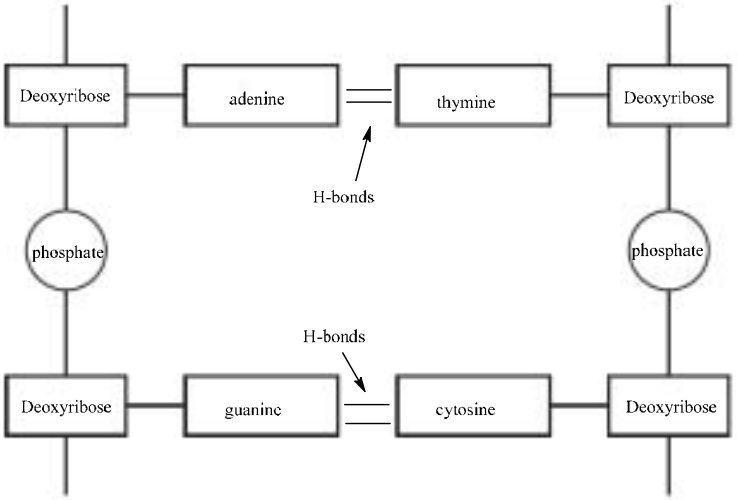


E



F

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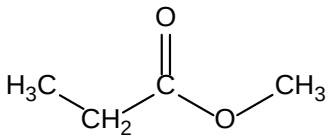
Question	Marking Point	Marks	Total Marks
(b) (ii)	step 1: $NaNO_2$ + HCl or HNO_2 step 1: T ⩽ 10 °C step 2: alkaline or NaOH(aq) or NaOH solution	**3**	
			[Total: 9]
7 (a)	• backbone of sugar-phosphate-sugar-phosphate • base bonded to sugar • deoxyribose correct label • two complementary base pairings 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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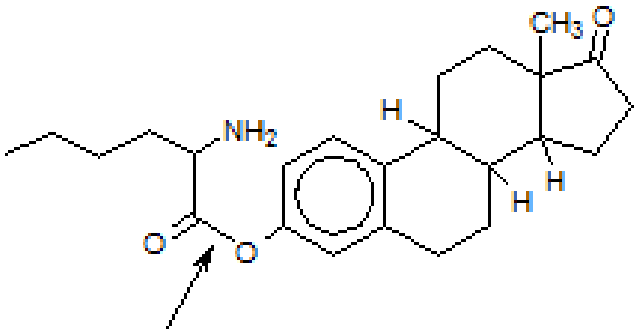
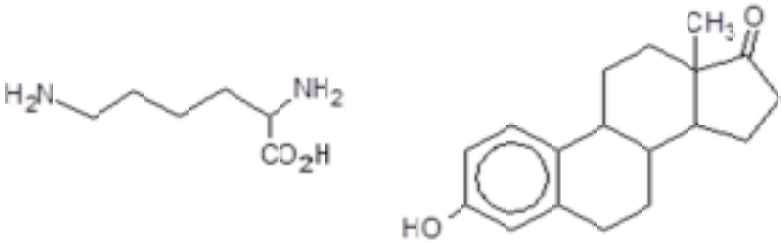
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<tr><th>Question</th><th>Marking Point</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>(ii)

(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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