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Cambridge International Advanced Level

MARK SCHEME for the October/November 2015 series

9701 CHEMISTRY

9701/41 Paper 4 (A2 Structured Questions), maximum raw mark 100

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Question	Marking point	Marks
1 (a)	Ca $3s^2 3p^6 4s^2$ **and** Ca^{2+} $3s^2 3p^6$	1
(b)	$Ca(OH)_2 + 2HNO_3 \rightarrow Ca(NO_3)_2 + 2H_2O$ **or** $CaO + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O$	1
(c) (i)	CaO **and** brown gas	1
(ii)	the (cat)ion size / radii increases decreasing its ability to polarise the nitrate ion / N-O bond	2
(d) (i)	(energy change when) 1 mole of ions **gaseous** (ions) dissolve in **water** (to form an infinitely dilute solution) *or* **gaseous** (ions) form an **aqueous** solution	2
(ii)	$\Delta H^{\ominus}_{latt} Ca(NO_3)_2 + \Delta H^{\ominus}_{sol} Ca(NO_3)_2 = \Delta H^{\ominus}_{hyd}\ Ca^{2+} + 2\Delta H^{\ominus}_{hyd}\ NO_3^-$ $\Delta H^{\ominus}_{latt} - 19 = -1650 + (2x\ -314)$ $-2259\ kJ\ mol^{-1}$	3
1	$Ca^{(2+)}$ is a smaller (ion) ***or*** $Ca^{(2+)}$ has a larger charge density $Ca^{(2+)}$ has a stronger attraction / bond to H_2O	2
		12

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Question	Marking point	Marks
2 (a)	<table><tr><td>Na</td><td>Mg</td><td>Al</td><td>Si</td><td>P</td><td>S</td><td>Cl</td><td>Ar</td></tr><tr><td>1</td><td>0</td><td>1</td><td>2</td><td>3</td><td>2</td><td>1</td><td>0</td></tr></table>	3
(b) (i)	$SiCl_4$ white solid / ppt **or** misty / white / steamy fumes pH 0–3 PCl_5 misty / white / steamy fumes pH 0–3	3
(ii)	$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$	1
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<table>
<tr><th>Question</th><th>Marking point</th><th>Marks</th></tr>
<tr><td>3 (a)</td><td>forms (one or more) ions
with incomplete d orbital(s)/sub-shells/shells</td><td>1</td></tr>
<tr><td>(b) (i)</td><td>dative (covalent) or co-ordinate</td><td>1</td></tr>
<tr><td>(ii)</td><td>
<table>
<tr><td>species</td><td>can act as a ligand</td><td>cannot act as a ligand</td></tr>
<tr><td>NO_3^-</td><td>✓</td><td></td></tr>
<tr><td>BF_3</td><td></td><td>✓</td></tr>
<tr><td>$H_2NCH_2CH_2NH_2$</td><td>✓</td><td></td></tr>
<tr><td>NH_4^+</td><td></td><td>✓</td></tr>
</table>
</td><td>2</td></tr>
<tr><td>(c) (i)</td><td>
<table>
<tr><th></th><th>formula of manganese species formed</th><th>type of reaction</th></tr>
<tr><td>Mn^{2+} (aq) + NaOH (aq)</td><td>$Mn(OH)_2$
$Mn(H_2O)_4(OH)_2$
$Mn(OH)_3$</td><td>precipitation</td></tr>
<tr><td>Mn^{2+} (aq) + concentrated HCl</td><td>$MnCl_4^{2-}$
$MnCl_6^{4-}$</td><td>ligand exchange / substitution</td></tr>
<tr><td>Mn^{2+} (aq) + aqueous H_2O_2</td><td>Mn^{3+}</td><td>redox / oxidation</td></tr>
</table>
</td><td>5</td></tr>
<tr><td></td><td></td><td><u>9</u></td></tr>
</table>

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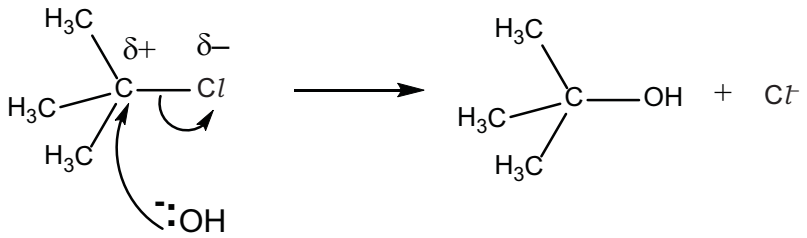
Question	Marking point	Marks
4 (a)	M1: dipole on C–C*l* bond M2: curly arrow breaking C–C*l* bond M3: curly arrow from the oxygen on $^{-}$OH (lone pair needs to be shown) to carbon in C–C*l* bond **and** C*l*$^{-}$ (ion) formed in the mechanism  	3
(b) (i)	time taken for the concentration of a reactant(s) to fall to half its original value	1
(ii)	evidence of a pair of construction lines on graph **and** $t_{½}$ = 49–53 s	1
(iii)	no effect / change	1
(c) (i)	evidence of tangent at 80 s **and** data used, e.g. 0.42 / 152 = 0.00263 units mol dm^{-3} s^{-1}	2
(ii)	correct use of answer to **(i)**/0.19 **and** s^{-1}	1
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Question	Marking point	Marks
5 (a) (i)	M1: salt bridge **and** voltmeter / M2: method of H_2 gas delivery M3: X **and** Pt electrode labelled M4: solution H^+ / HC*l*(aq) / H_2SO_4 **and** X^{2+} labelled	4
(ii)	25 °C / 298 K **and** 1 atm / 101 kPa pressure **and** 1 mol dm^{-3} (solution)	1
(iii)	solution – ions ***or*** H^+ and X^{2+} **and** wires – electrons / e^-	1
(b) (i)	$X + 2Ag^+ \rightarrow 2Ag + X^{2+}$	1
(ii)	moles Ag = 1.30 / 107.9 = 0.0120 1 moles of X react with 2 moles Ag^+ moles of X lost = 0.012 × 0.5 = 0.00602 A_r of X = 0.67/0.006 = 111–112 **and** X = Cd	4
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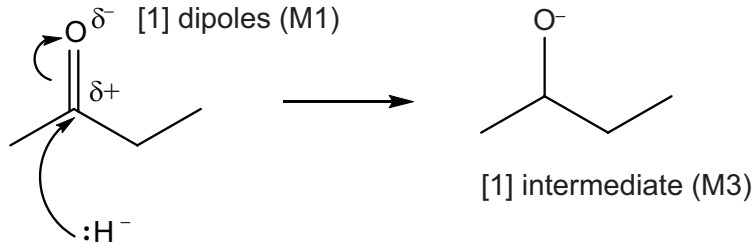
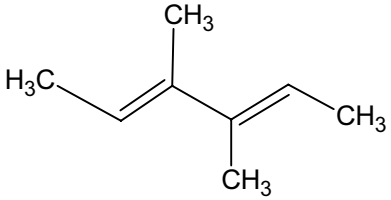
Question	Marking point	Marks
6 (a)	$4BF_3 + 3NaBH_4 \rightarrow 2B_2H_6 + 3NaBF_4$	1
(b)	 [1] dipoles (M1) [1] intermediate (M3) [1] both curly arrows (M2) arrow must come from lone pair	3
(c) (i)	(electrophilic) addition	1
(ii)		1

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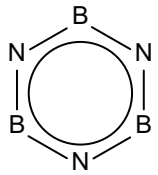
Question	Marking point	Marks
(d) (i)	*any four of* M1: σ-bonds between C–C **or** C–H M2: π-bonds formed from overlap of p-orbitals M3: (π-bonds/electrons) above and below the ring M4:bonds/electrons are delocalised M5: bond angle 120° M6: intermediate C–C bond length / all C–C same length / strength M7: carbons are sp^2 hybridised	3
(ii)	correct delocalised structure of borazine  	1
		10

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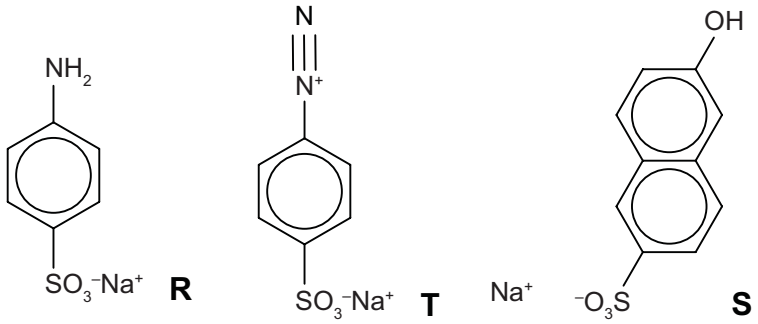
Question	Marking point	Marks
7 (a) (i)	 **R** **T** **S**	3
(ii)	Sn + HC*l* HNO_2 or $NaNO_2$ + HC*l* step 1 (linked to a reduction) reflux / heat / >50 °C **or** conc / 6M (HC*l*) **and** step 2 ⩽10 °C	3
(iii)	diazonium (group)	1
(b) (i)	σ-bonds = 14 π-bonds = 2	2

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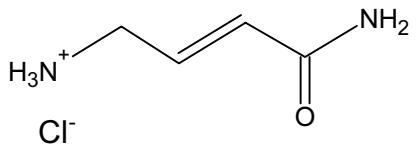
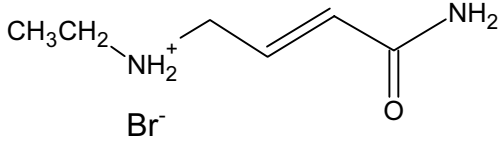
Question	Marking point	Marks
7	<table><tr><th>reagent</th><th>structure of product</th><th>type of reaction</th></tr><tr><td>HCl</td><td></td><td>acid-base **or** neutralisation</td></tr><tr><td>CH_3CH_2Br</td><td></td><td>(nucleophilic) substitution</td></tr></table>	3
		12

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Question	Marking point	Marks
8 (a) (i)	**A** = mRNA **B_1** and **B_2**, etc. = tRNA **or** tRNA-amino acid complex	2
(ii)	stage 1 = transcription **and** stage 3= translation	1
(b) (i)	$C_5H_5N_5$	1
(ii)	cytosine, thymine, guanine	1
(iii)	covalent hydrogen bonding	2
(c)	hydrolysis	1
(d) (i)	Phosphorus / P	1
(ii)	H atoms have insufficient electron density ***or*** electrons (to show up) **or** H atoms contain one e^-	1
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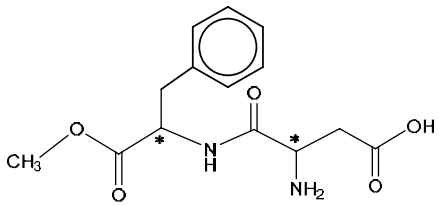
Question	Marking point	Marks
9 (a)	iron / Fe (= haemoglobin) sodium / Na **or** potassium / K (= transmission of nerve impulses) Zn **or** Cu **or** Mg **or** Mn **or** Mo **or** Ni **or** Fe **or** Co (= enzyme co-factor)	2
(b)	any three of: M1: substrate binds to / fits into the **active site** of the enzyme M2: Interaction with site causes a specific bond to be weakened, (which breaks) M3: lowers activation energy M4: products released from the enzyme/active site	3
(c) (i)	Tertiary	**1**
(ii)	2 –SH ⟶ –S – S– (+ 2H)	**1**
(iii)	oxidation	**1**
(d) (i)	**E** = CH **and** **F** = CH_2	**1**
(ii)	**E** = triplet and adjacent 2H **F** = doublet and adjacent 1H	**2**
		11
10 (a) (i)		**1**

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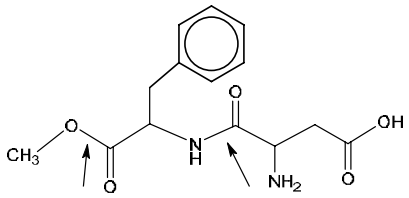
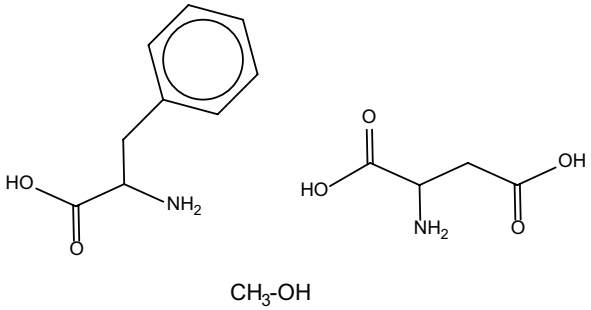
Question	Marking point	Marks
(ii)		2
(iii)		3
(b)	M1: hydrogen bonding M2: between the NH_2 groups and water **or** CO_2 / C=O / –OH groups and water (allow names) **or** lone pair on N/O with water	2
(c)	allow range 1–200 nm or 1–200 $\times$ 10^{-9} m	1
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