CAMBRIDGE INTERNATIONAL EXAMINATIONS

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

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 2015 series for most Cambridge IGCSE®, Cambridge International A and AS Level components and some Cambridge O Level components.

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)	$\Delta H^{\circ}_{latt} Ca(NO_3)_2 + \Delta H^{\circ}_{sol} Ca(NO_3)_2 = \Delta H^{\circ}_{hyd} Ca^{2+} + 2\Delta H^{\circ}_{hyd} NO_3^-$ $\Delta H^{\circ}_{latt} - 19 = -1650 + (2x -314)$ -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
		<u>12</u>

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
		7

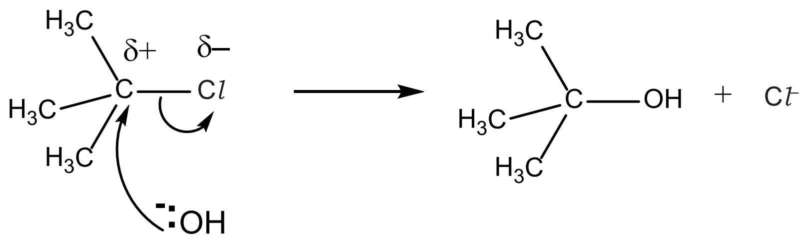
Question	Marking point	Marks
3 (a)	forms (one or more) ions with incomplete d orbital(s)/sub-shells/shells	1
(b) (i)	dative (covalent) ***or*** co-ordinate	1
(ii)	see table below	2
(c) (i)	see table below	5
		<u>**9**</u>

(b) (ii)

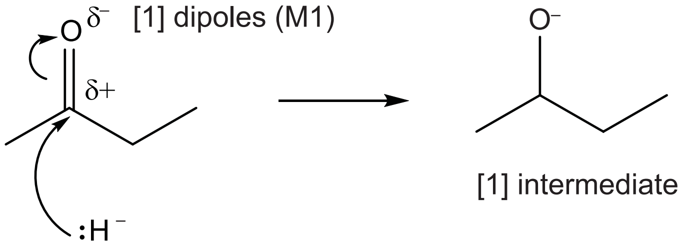
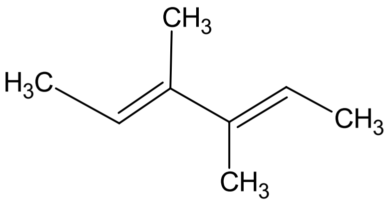
species	can act as a ligand	cannot act as a ligand
NO_3^-	✓	
BF_3		✓
$H_2NCH_2CH_2NH_2$	✓	
NH_4^+		✓

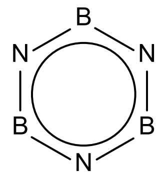
(c) (i)

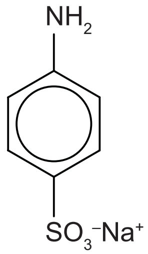
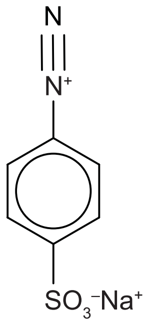
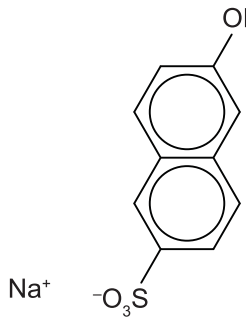
	formula of manganese species formed	**type of reaction**
Mn^{2+} (aq) + NaOH (aq)	$Mn(OH)_2$ $Mn(H_2O)_4(OH)_2$ $Mn(OH)_3$	precipitation
Mn^{2+} (aq) + concentrated HCl	$MnCl_4^{2-}$ $MnCl_6^{4-}$	ligand exchange / substitution
Mn^{2+} (aq) + aqueous H_2O_2	Mn^{3+}	redox / oxidation

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
		<u>9</u>

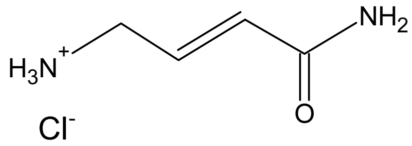
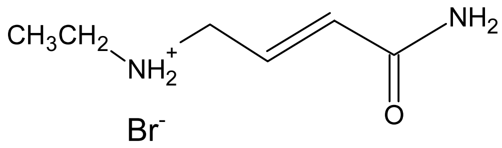
Question	Marking point	Marks
5 (a) (i)	M1: salt bridge **and** voltmeter / M2: method of H_2 gas delivery M3: X **and** Pt electrode labelled M4: solution H^+ / $HCl(aq)$ / H_2SO_4 **and** X^{2+} labelled	4
(ii)	25 °C / 298 K **and** 1 atm / 101 kPa pressure **and** 1 mol dm^{-3} (solution)	1
(iii)	solution – 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
		11

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 <u>must</u> come from lone pair	**3**
(c) (i)	(electrophilic) addition	**1**
(ii)		**1**

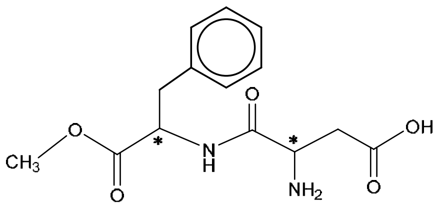
Question	Marking point	Marks
(d) (i)	*any four of* M1: σ-bonds between C–C **or** C–H M2: π-bonds formed from overlap of p-orbitals M3: (π-bonds/electrons) above and below the ring M4:bonds/electrons are delocalised M5: bond angle 120° M6: intermediate C–C bond length / all C–C same length / strength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

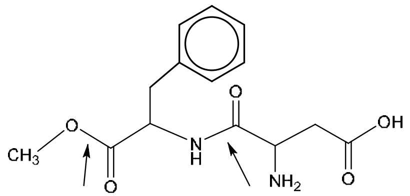
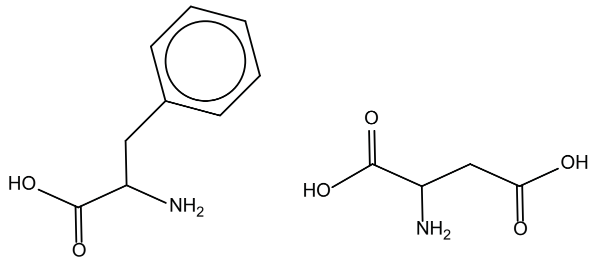
Question	Marking point	Marks
7 (a) (i)	 **R**  **T**  **S**	3
(ii)	Sn + HC*l* HNO_2 or $NaNO_2$ + HC*l* step 1 (linked to a reduction) reflux / heat / >50 °C **or** conc / 6M (HC*l*) **and** step 2 ⩽10 °C	3
(iii)	diazonium (group)	1
(b) (i)	σ-bonds = 14 π-bonds = 2	2

Question	Marking point	Marks
7	(see table below)	3
		<u>12</u>

reagent	structure of product	type of reaction
HC*l*		acid-base **or** neutralisation
CH_3CH_2Br		(nucleophilic) substitution

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
		<u>10</u>

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**
		<u>11</u>
10 (a) (i)		**1**

Question	Marking point	Marks
(ii)		2
(iii)	 CH_3-OH	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 × 10^{-9} m	1
		<u>**9**</u>