

CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International Advanced Level

MARK SCHEME for the October/November 2015 series

9701 CHEMISTRY

9701/42

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

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Page 2	Mark Scheme	Syllabus	Paper
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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 → Ca(NO ₃) ₂ + 2H ₂ O or CaO + 2HNO ₃ → Ca(NO ₃) ₂ + H ₂ O	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)	$\Delta H_{\text{latt}}^{\ominus} \text{Ca(NO}_3)_2 + \Delta H_{\text{sol}}^{\ominus} \text{Ca(NO}_3)_2 = \Delta H_{\text{hyd}}^{\ominus} \text{Ca}^{2+} + 2\Delta H_{\text{hyd}}^{\ominus} \text{NO}_3^-$ $\Delta H_{\text{latt}}^{\ominus} - 19 = -1650 + (2x - 314)$ $-2259 \text{ kJ mol}^{-1}$	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 ₂ O	2
		<u>12</u>

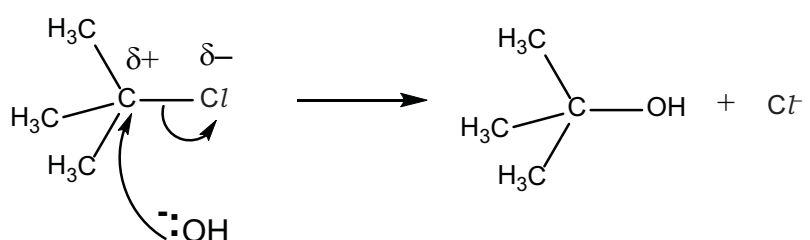
Page 3	Mark Scheme	Syllabus	Paper
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Question	Marking point								Marks
2 (a)									3
	Na	Mg	Al	Si	P	S	Cl	Ar	
	1	0	1	2	3	2	1	0	
(b) (i)	SiCl ₄ white solid /ppt or misty / white / steamy fumes pH 0–3 PCl ₅ misty / white / steamy fumes pH 0–3								3
(ii)	SiCl ₄ + 2H ₂ O → SiO ₂ + 4HCl								1
									7

Page 4	Mark Scheme	Syllabus	Paper
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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)	<table border="1"> <tr> <th>species</th><th>can act as a ligand</th><th>cannot act as a ligand</th></tr> <tr> <td>NO_3^-</td><td>✓</td><td></td></tr> <tr> <td>BF_3</td><td></td><td>✓</td></tr> <tr> <td>$\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$</td><td>✓</td><td></td></tr> <tr> <td>NH_4^+</td><td></td><td>✓</td></tr> </table>	species	can act as a ligand	cannot act as a ligand	NO_3^-	✓		BF_3		✓	$\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$	✓		NH_4^+		✓	2
species	can act as a ligand	cannot act as a ligand															
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NH_4^+		✓															
(c) (i)	<table border="1"> <tr> <th></th><th>formula of manganese species formed</th><th>type of reaction</th></tr> <tr> <td>$\text{Mn}^{2+}(\text{aq}) + \text{NaOH}(\text{aq})$</td><td> $\text{Mn}(\text{OH})_2$ $\text{Mn}(\text{H}_2\text{O})_4(\text{OH})_2$ $\text{Mn}(\text{OH})_3$ </td><td>precipitation</td></tr> <tr> <td>$\text{Mn}^{2+}(\text{aq}) + \text{concentrated HCl}$</td><td> MnCl_4^{2-} MnCl_6^{4-} </td><td>ligand exchange / substitution</td></tr> <tr> <td>$\text{Mn}^{2+}(\text{aq}) + \text{aqueous H}_2\text{O}_2$</td><td>$\text{Mn}^{3+}$</td><td>redox / oxidation</td></tr> </table>		formula of manganese species formed	type of reaction	$\text{Mn}^{2+}(\text{aq}) + \text{NaOH}(\text{aq})$	$\text{Mn}(\text{OH})_2$ $\text{Mn}(\text{H}_2\text{O})_4(\text{OH})_2$ $\text{Mn}(\text{OH})_3$	precipitation	$\text{Mn}^{2+}(\text{aq}) + \text{concentrated HCl}$	MnCl_4^{2-} MnCl_6^{4-}	ligand exchange / substitution	$\text{Mn}^{2+}(\text{aq}) + \text{aqueous H}_2\text{O}_2$	Mn^{3+}	redox / oxidation	5			
	formula of manganese species formed	type of reaction															
$\text{Mn}^{2+}(\text{aq}) + \text{NaOH}(\text{aq})$	$\text{Mn}(\text{OH})_2$ $\text{Mn}(\text{H}_2\text{O})_4(\text{OH})_2$ $\text{Mn}(\text{OH})_3$	precipitation															
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		9															

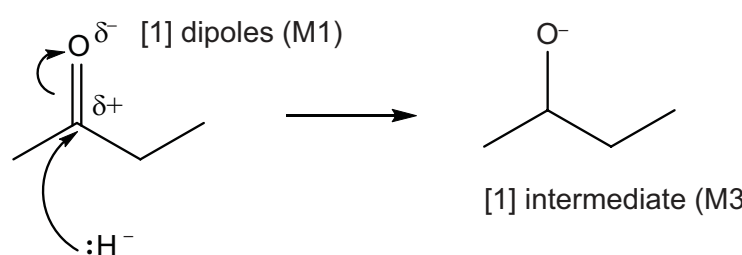
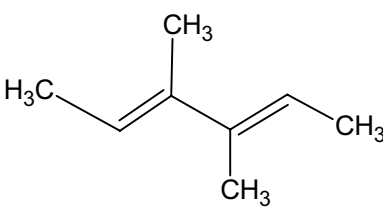
Page 5	Mark Scheme	Syllabus	Paper
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Question	Marking point	Marks
4 (a)	<p>M1: dipole on C–Cl bond</p> <p>M2: curly arrow breaking C–Cl bond</p> <p>M3: curly arrow from the oxygen on OH^- (lone pair needs to be shown) to carbon in C–Cl bond and Cl^- (ion) formed in the mechanism</p> 	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 $t_{1/2} = 49\text{--}53\text{ s}$	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 $\text{mol dm}^{-3} \text{s}^{-1}$	2
(ii)	correct use of answer to (i)/0.19 and s^{-1}	1
		<u>9</u>

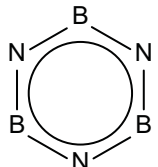
Page 6	Mark Scheme	Syllabus	Paper
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Question	Marking point	Marks
5 (a) (i)	M1: salt bridge and voltmeter/ M2: method of H ₂ gas delivery M3: X and Pt electrode labelled M4: solution H ⁺ /HCl(aq)/H ₂ SO ₄ and X ²⁺ labelled	4
(ii)	25 °C/298 K and 1 atm/101 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
		<u>11</u>

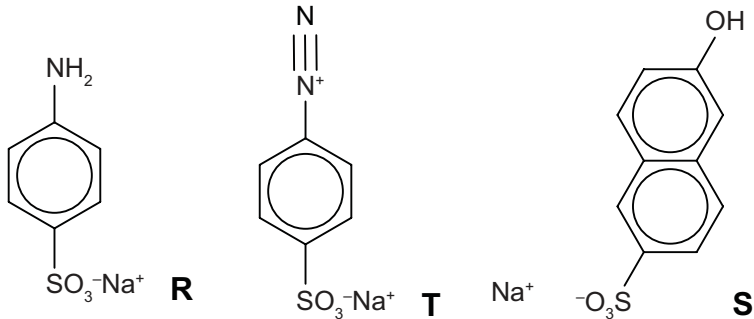
Page 7	Mark Scheme	Syllabus	Paper
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Question	Marking point	Marks
6 (a)	$4\text{BF}_3 + 3\text{NaBH}_4 \rightarrow 2\text{B}_2\text{H}_6 + 3\text{NaBF}_4$	1
(b)	 <p>[1] dipoles (M1)</p> <p>[1] intermediate (M3)</p> <p>[1] both curly arrows (M2) arrow <u>must</u> come from lone pair</p>	3
(c) (i)	(electrophilic) addition	1
(ii)		1

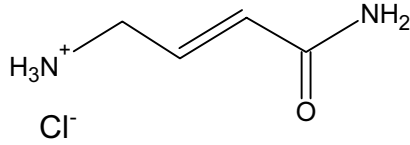
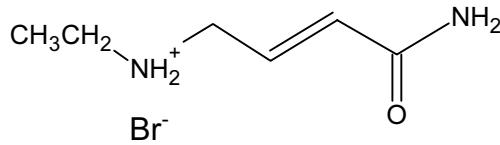
Page 8	Mark Scheme	Syllabus	Paper
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Question	Marking point	Marks
(d) (i)	<p><i>any four of</i></p> <p>M1: σ-bonds between C–C or C–H</p> <p>M2: π-bonds formed from overlap of p-orbitals</p> <p>M3: (π-bonds/electrons) above and below the ring</p> <p>M4: bonds/electrons are delocalised</p> <p>M5: bond angle 120°</p> <p>M6: intermediate C–C bond length / all C–C same length / strength</p> <p>M7: carbons are sp^2 hybridised</p>	3
(ii)	<p>correct delocalised structure of borazine</p> 	1
		10

Page 9	Mark Scheme	Syllabus	Paper
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Question	Marking point	Marks
7 (a) (i)	 <p>R T S</p>	3
(ii)	<p>Sn + HCl</p> <p>HNO₂ or NaNO₂ + HCl</p> <p>step 1 (linked to a reduction) reflux/heat/>50 °C or conc/6M (HCl)</p> <p>and step 2 ≤10 °C</p>	3
(iii)	diazonium (group)	1
(b) (i)	<p>σ-bonds = 14</p> <p>π-bonds = 2</p>	2

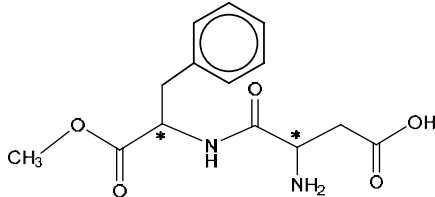
Page 10	Mark Scheme	Syllabus	Paper
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Question	Marking point			Marks
7	reagent	structure of product	type of reaction	3
	HCl		acid-base or neutralisation	
	CH ₃ CH ₂ Br		(nucleophilic) substitution	
				<u>12</u>

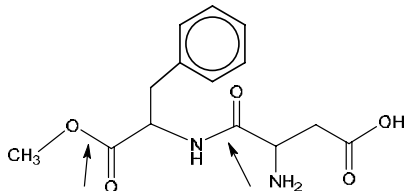
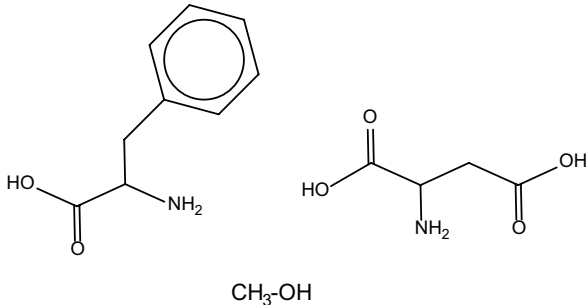
Page 11	Mark Scheme	Syllabus	Paper
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Question	Marking point	Marks
8 (a) (i)	A = mRNA B ₁ and B ₂ , etc. = tRNA or tRNA-amino acid complex	2
(ii)	stage 1 = transcription and stage 3= translation	1
(b) (i)	C ₅ H ₅ N ₅	1
(ii)	cytosine, thymine, guanine	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>

Page 12	Mark Scheme	Syllabus	Paper
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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)	$2 -SH \rightarrow -S - S- (+ 2H)$	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

Page 13	Mark Scheme	Syllabus	Paper
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Question	Marking point	Marks
(ii)		2
(iii)		3
(b)	<p>M1: hydrogen bonding</p> <p>M2: between the NH₂ groups and water</p> <p>or CO₂/C=O/-OH groups and water (allow names)</p> <p>or lone pair on N/O with water</p>	2
(c)	allow range 1–200 nm or $1-200 \times 10^{-9}$ m	1
		<u>9</u>