

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

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.

® IGCSE is the registered trademark of Cambridge International Examinations.

Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2015	9701	42

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)	$\Delta H_{\text{latt}}^{\circ} \text{Ca(NO}_3)_2 + \Delta H_{\text{sol}}^{\circ} \text{Ca(NO}_3)_2 = \Delta H_{\text{hyd}}^{\circ} \text{Ca}^{2+} + 2\Delta H_{\text{hyd}}^{\circ} \text{NO}_3^-$ $\Delta H_{\text{latt}}^{\circ} - 19 = -1650 + (2x - 314)$ -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 ₂ O	2
		<u>12</u>

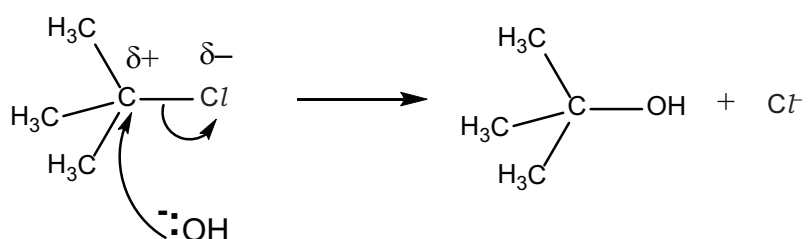
Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2015	9701	42

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>	Na	Mg	Al	Si	P	S	Cl	Ar	1	0	1	2	3	2	1	0	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																
		<u>7</u>																

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2015	9701	42

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															
NO_3^-	✓																
BF_3		✓															
$\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$	✓																
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>$\text{MnCl}_4^{2-}$ 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															
$\text{Mn}^{2+}(\text{aq}) + \text{concentrated HCl}$	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															
		9															

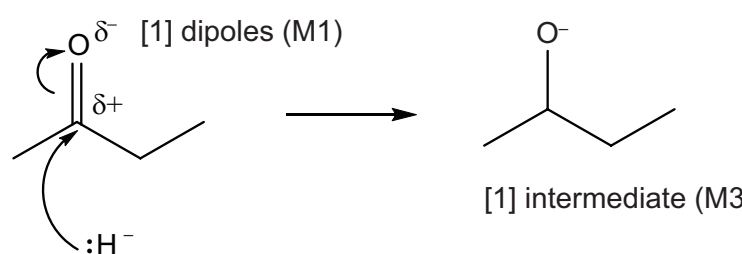
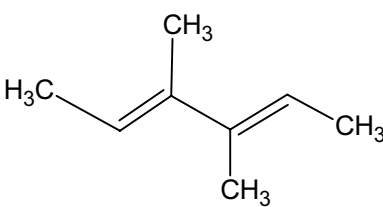
Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2015	9701	42

Question	Marking point	Marks
4 (a)	M1: dipole on C–Cl bond M2: curly arrow breaking C–Cl bond 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 	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>

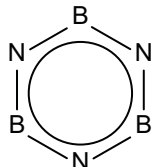
Page 6	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2015	9701	42

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>

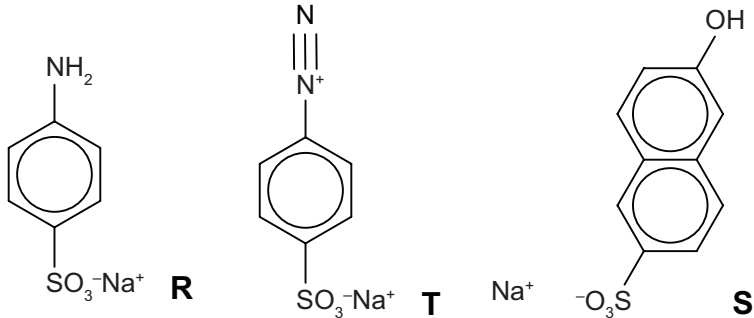
Page 7	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2015	9701	42

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)	 [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

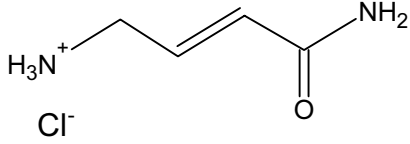
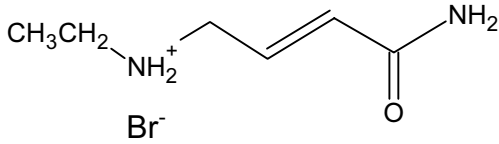
Page 8	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2015	9701	42

Question	Marking point	Marks
(d) (i)	<i>any four of</i> 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>

Page 9	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2015	9701	42

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

Page 10	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2015	9701	42

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>

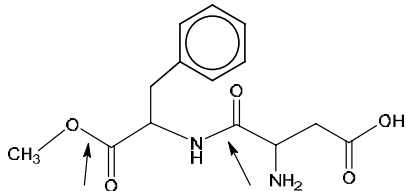
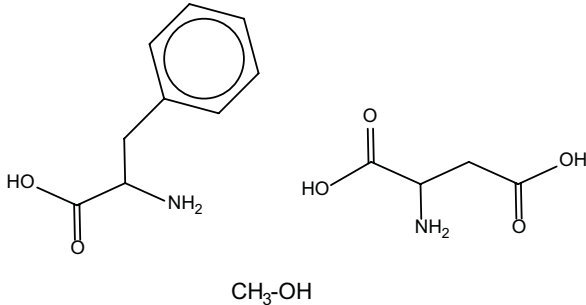
Page 11	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2015	9701	42

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
	Cambridge International A Level – October/November 2015	9701	42

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
	Cambridge International A Level – October/November 2015	9701	42

Question	Marking point	Marks
(ii)		2
(iii)		3
(b)	M1: hydrogen bonding M2: between the NH₂ groups and water or CO₂/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
		<u>9</u>