

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**

Cambridge International Advanced Level

## **MARK SCHEME for the October/November 2014 series**

### **9701 CHEMISTRY**

**9701/43**

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.

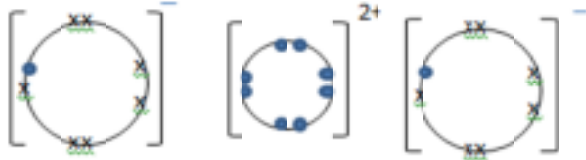
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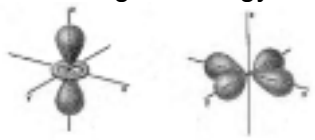
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Page 2	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	43

Question	Marking point	Marks	Marks total												
1 (a) (i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>m/e</th> <th>identity</th> </tr> </thead> <tbody> <tr> <td>35</td> <td><math>^{35}\text{Cl}</math></td> </tr> <tr> <td>37</td> <td><math>^{37}\text{Cl}</math></td> </tr> <tr> <td>70</td> <td><math>^{35}\text{Cl}^{35}\text{Cl}</math> <b>or</b> <math>^{35}\text{Cl}_2</math></td> </tr> <tr> <td>72</td> <td><math>^{37}\text{Cl}^{35}\text{Cl}</math></td> </tr> <tr> <td>74</td> <td><math>^{37}\text{Cl}^{37}\text{Cl}</math> <b>or</b> <math>^{37}\text{Cl}_2</math></td> </tr> </tbody> </table> <p>35, 37, 70, 72, 74 correct formulae at least one structure as a positive ion</p>	m/e	identity	35	$^{35}\text{Cl}$	37	$^{37}\text{Cl}$	70	$^{35}\text{Cl}^{35}\text{Cl}$ <b>or</b> $^{35}\text{Cl}_2$	72	$^{37}\text{Cl}^{35}\text{Cl}$	74	$^{37}\text{Cl}^{37}\text{Cl}$ <b>or</b> $^{37}\text{Cl}_2$	1 1 1	
m/e	identity														
35	$^{35}\text{Cl}$														
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72	$^{37}\text{Cl}^{35}\text{Cl}$														
74	$^{37}\text{Cl}^{37}\text{Cl}$ <b>or</b> $^{37}\text{Cl}_2$														
(ii)	9:6:1	1	[4]												
(b) (i)	 <p>correct charges correct electrons</p>	1 1													
(ii)	<p>Lattice energy = <math>\Delta H_f(\text{SrCl}_2) - (\Delta H_{\text{atom}}(\text{Sr}) + \Delta H_{f1}(\text{Sr}) + \Delta H_{f2}(\text{Sr}) + \Delta H_{\text{atom}}(\text{Cl}) + 2\Delta H_{\text{ea}}(\text{Cl}))</math></p> <p>= <math>+(-830) - (+164 + 548 + 1060 + 242 + (2 \times -349))</math></p> <p>= <b>-2146</b> (kJ mol<sup>-1</sup>)</p>	1 1 1	[5]												
(c) (i)	$\text{SrCO}_3 + 2\text{HNO}_3 \rightarrow \text{Sr}(\text{NO}_3)_2 + \text{CO}_2 + \text{H}_2\text{O}$	1													

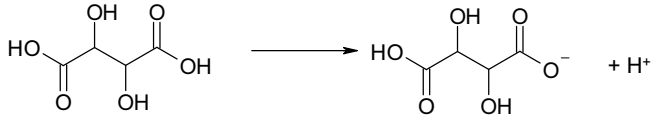
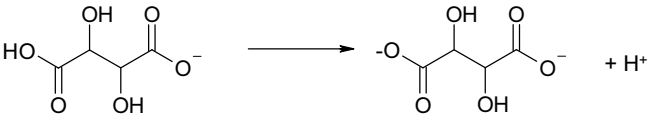
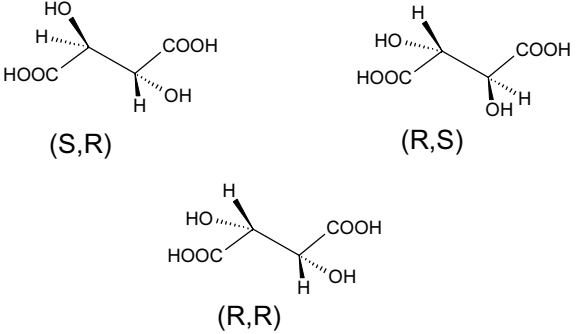
Page 3	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	43

(ii)	$\text{Sr}(\text{NO}_3)_2 \rightarrow \text{SrO} + 2\text{NO}_2 + 0.5 \text{O}_2$	1	[2]
(d)	(down the group) nitrates become more stable / require a higher temperature to decompose as size/radius of <b>ion</b> increases <b>OR</b> charge density of <b>ion</b> decreases so polarisation/distortion of anion/nitrate ion/ $\text{NO}_3^-$ /NO bond decreases	1 1 1	[3]
2 (a)	$\text{BrO}_3^- + 5\text{Br}^- + 6\text{H}^+ \rightarrow 3\text{Br}_2 + 3\text{H}_2\text{O}$ five correct species correct balancing	1 1	[2]
(b) (i)	$[\text{BrO}_3^-]$ 1 <sup>st</sup> order <b>and</b> the concentration is x2, rate doubles <b>OR</b> evidence using expt 1 & 4 eg ratios $[\text{H}^+]$ 2 <sup>nd</sup> order <b>and</b> the concentration is x2, rate x4 <b>OR</b> evidence using expt 1 & 2 $[\text{Br}^-]$ 1 <sup>st</sup> order <b>and</b> the concentration is x4, rate x4 <b>OR</b> evidence using expt 1 & 3 eg ratios	1 1 1	
(ii)	(Rate =) $k [\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^2$	1	
(iii)	$k = 1.32$ $\text{mol}^{-3} \text{dm}^9 \text{s}^{-1}$	1 1	[6]
3 (a) (i)	chromium and copper	1	
(ii)	(all orbitals have the) same energy	1	
(iii)	correct id of one higher energy d orbital the other higher energy d orbital 	1 1	[4]

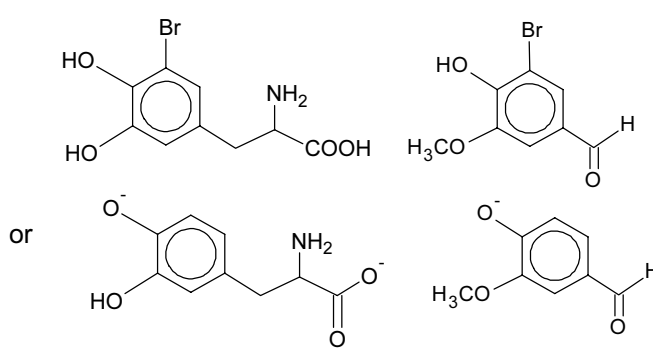
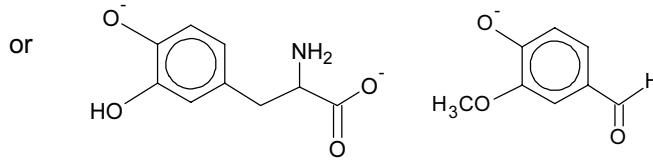
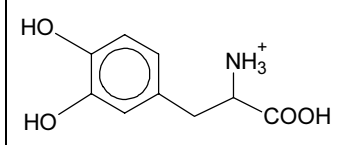
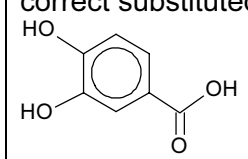
Page 4	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	43

(b) (i)	pale blue precipitate <b>A</b> solution <b>B</b> solution <b>C</b>	$\text{Cu}(\text{OH})_2$ <b>OR</b> $[\text{Cu}(\text{OH})_2(\text{H}_2\text{O})_4]$ $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ <b>OR</b> $[\text{Cu}(\text{NH}_3)_4]^{2+}$ $[\text{CuCl}_4]^{2-}$	1 1 1	
(ii)	solution <b>B</b> solution <b>C</b>	royal / deep / dark blue <b>OR</b> violet-blue yellow / green	1 1	
(iii)	redox <b>OR</b> oxidation of Cu <b>OR</b> reduction of $\text{Cu}^{2+}$ <b>AND</b> reducing agent/reductant		1	[6]
(c)	3d-shell is full / $3d^{10}$ / no vacant d-orbital / d-orbitals full electrons cannot move between orbitals <b>OR</b> transitions cannot occur		1 1	[2]
(d)	green / yellow orange / red <b>AND</b> blue / violet light is <u>absorbed</u>		1 1	[2]
4 (a)	(HCl) stronger acid / more dissociated / ionised in solution (HCl has) more ions / higher concentration of ions		1 1	[2]
(b) (i)	A solution that resists changes in the pH / keeps pH <i>fairly</i> constant when <b>small</b> quantities / amounts / vols of acid / $\text{H}^+$ or base / $\text{OH}^-$ are added		1 1	
(ii)	add (ethanoic acid) to NaOH <b>OR</b> an equation excess (ethanoic acid) <b>OR</b> mix with sodium ethanoate		1 1	[4]
(c)	$\text{CH}_3\text{CH}(\text{NH}_2)\text{COOH} + \text{H}^+ \rightarrow \text{CH}_3\text{CH}(\text{NH}_3^+)\text{COOH}$ $\text{CH}_3\text{CH}(\text{NH}_2)\text{COOH} + \text{OH}^- \rightarrow \text{CH}_3\text{CH}(\text{NH}_2)\text{COO}^- + \text{H}_2\text{O}$		1 1	[2]

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	43

<p>(d) (i)</p>	<p>pKa 2.99</p>  <p>pKa 4.40</p> 	<p>1</p> <p>1</p>	
<p>(ii)</p>	 <p>(S,R) (R,S) (R,R)</p> <p>any two of the above</p>	<p>2</p>	<p>[4]</p>
<p>5 (a)</p>	<p>any five of these seven points.</p> <ul style="list-style-type: none"> <li>• <math>\sigma</math>-bonds are between C-C OR C-H</li> <li>• carbons are <math>sp^2</math></li> <li>• rings of charge above and below the ring <b>must be in diagram</b></li> <li>• presence of <math>\sigma</math>-bonds</li> <li>• electrons/bonds are delocalised</li> <li>• planar molecule/bond angles <math>120^\circ</math></li> <li>• all C-C are the same length/have intermediate bond length between C-C &amp; C=C</li> </ul>	<p>5</p>	<p>[5]</p>

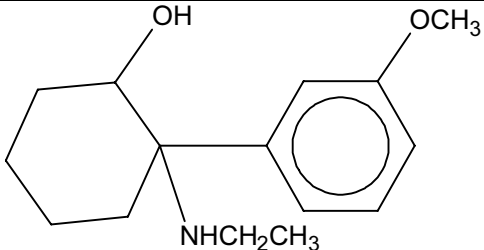
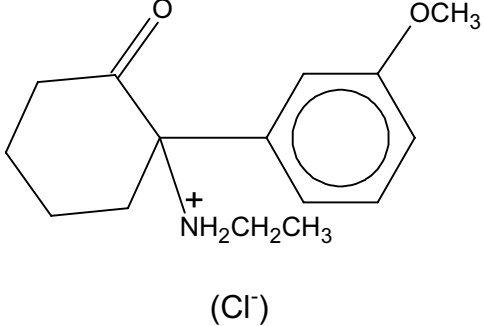
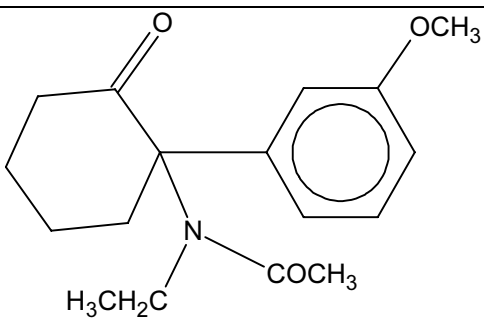
Page 6	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	43

<b>(b)</b>	<p>Reagent <b>X</b> e.g. Br<sub>2</sub>, HNO<sub>3</sub>, Na, NaOH, benzenediazonium salt/ion; RCOCl; Fe<sup>3+</sup>; H<sub>2</sub>+Ni substituted product for L-DOPA &amp; vanillin (examples given are for <b>X</b> = Br<sub>2</sub> and NaOH)</p>	1	
	<p>              or              </p>	2	
	<p>Reagent <b>Y</b> e.g. HCl; Na<sub>2</sub>CO<sub>3</sub>, Mg, SOCl<sub>2</sub>, PCl<sub>5</sub>, ROH + c.H<sub>2</sub>SO<sub>4</sub>; HCl+NaNO<sub>2</sub> / HNO<sub>2</sub>; CH<sub>3</sub>Cl Correct substituted product for L-DOPA</p>	1 1	
	<p>  </p>		
	<p>Reagent <b>Z</b> e.g. acidified Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup>; 2,4-DNPH, hydrazine; Fehling's, Tollens'; HCN; HCN + NaCN; NaBH<sub>4</sub>;</p>	1	
	<p>correct substituted product for vanillin</p> <p>  </p>	1	[7]
<b>6 (a) (i)</b>	C <sub>15</sub> H <sub>21</sub> NO <sub>2</sub>	1	

Page 7	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	43

(ii)		1	
(iii)	any <b>two</b> of ketone, amine or ether	2	[4]

Page 8	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	43

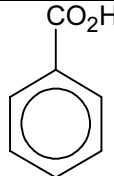
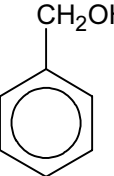
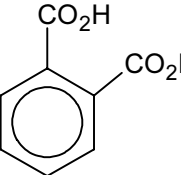
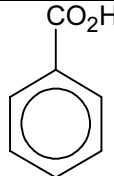
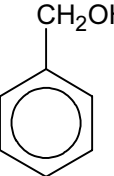
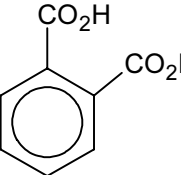
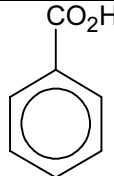
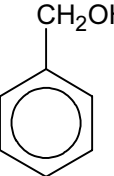
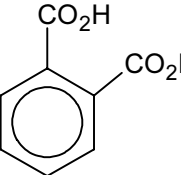
(b)	(i) $\text{LiAlH}_4$		reduction / nucleophilic addition	3 3	[6]
	(ii) $\text{HCl}(\text{aq})$		acid-base / neutralisation		
	(iii) $\text{CH}_3\text{COCl}$		acylation / condensation  <b>allow</b> addition + elimination <b>allow</b> nucleophilic substitution		
1 mark for each correct structure 1 mark for each correct reaction type					



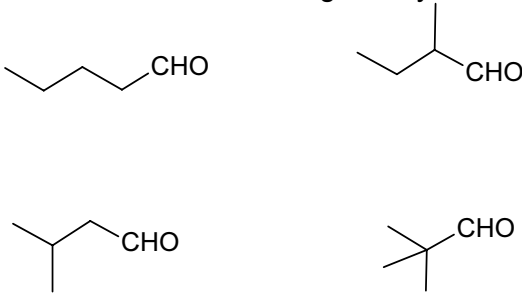
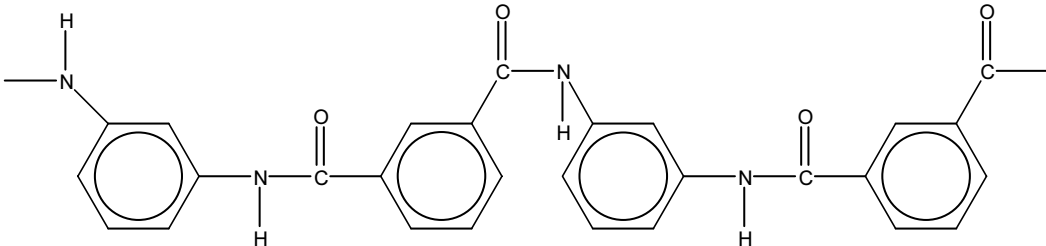
<b>Page 9</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge International A Level – October/November 2014</b>	<b>9701</b>	<b>43</b>

<b>7 (a)</b>	(ratio of) the concentrations / distribution / amount / mass of <b>solute</b> in <b>two</b> (immiscible) <b>solvents</b> at equilibrium <b>OR</b> equilibrium constant <b>OR</b> includes expression with <i>K</i>	<b>1</b> <b>1</b>	<b>[2]</b>
<b>(b)</b>	$K_{pc} = \frac{[J \text{ in ether}]}{[J \text{ in H}_2\text{O}]}$ $= \frac{(2.14/20)}{(5-2.14/75)}$ $= 2.81 \text{ OR } 2.82$	<b>1</b> <b>1</b>	<b>[2]</b>
<b>(c)</b>	<p>1<sup>st</sup> extraction:      <math>2.81 = \frac{(x/10)}{(5.0-x)/75}</math>  <math>2.81(5-x) = 7.5x</math>  <math>x = 1.36 \text{ g}</math></p> <p>2<sup>nd</sup> extraction:      <math>2.81 = \frac{(y/10)}{(3.64-y)/75}</math>  <math>2.81(3.64-y) = 7.5y</math>  <math>y = 0.99 \text{ g}</math></p>	<b>1</b> <b>1</b>	<b>[2]</b>
<b>(d) (i)</b>	water / solvent / named solvent	<b>1</b>	
<b>(ii)</b>	non-volatile liquid, for example mineral oil or at least a C <sub>15</sub> hydrocarbon oil	<b>1</b>	
<b>(iii)</b>	1. R <sub>f</sub> (retardation factor) or distance travelled by solute <b>and</b> distance by solvent 2. retention time	<b>1</b> <b>1</b>	<b>[4]</b>

Page 10	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	43

(e)	<table border="1"> <tr> <td></td> <td>2</td> </tr> <tr> <td></td> <td>1</td> </tr> <tr> <td></td> <td>3</td> </tr> </table>		2		1		3	1	[1]
	2								
	1								
	3								
8 (a)	C = 33 % A = T = 17 %	1 1	[2]						
(b) (i)	only one isomer may be active/be of therapeutic benefit	1							
(ii)	the other (stereo) isomer may cause harm/ side effects	1	[2]						

Page 11	Mark Scheme	Syllabus	Paper
	Cambridge International A Level – October/November 2014	9701	43

(c) (i)	<p>structures of the following aldehydes:</p>  <p>two correct structures = 1 mark two further correct structures – 1 mark</p>	1 1	
(ii)	3-methylbutanal	1	
(iii)	<p>pentanal                    5 absorptions 2-methylbutanal        5 absorptions dimethylpropanal       2 absorptions</p>	1 1 1	[6]
9 (a)	nylon, terylene – condensation; PVC – addition – all three correct	1	[1]
(b)	<p>correct fully displayed formula of -CO-NH- unit correct polymer structure</p> 	1 1	[2]
(c)	<b>sequence / order of amino acids</b> (in the polypeptide chain)	1	[1]
(d)	hydrogen bond C=O and N-H in two different amino acids in the backbone diagram	1 1	[2]

<b>Page 12</b>	<b>Mark Scheme</b>	<b>Syllabus</b>	<b>Paper</b>
	<b>Cambridge International A Level – October/November 2014</b>	<b>9701</b>	<b>43</b>

<b>(e) (i)</b>	disrupts hydrogen/ionic bonds as $-\text{COOH}/\text{NH}_3^+$ is deprotonated <b>OR</b> $-\text{NH}_3^+ + \text{OH}^- \rightarrow \text{NH}_2 + \text{H}_2\text{O}$ linked to hydrogen/ionic bond disrupted <b>OR</b> $-\text{COOH} + \text{OH}^- \rightarrow -\text{COO}^- + \text{H}_2\text{O}$ linked to hydrogen/ionic bond disrupted	<b>1</b>	
<b>(ii)</b>	$\text{Hg}^{2+}$ interferes with/breaks the disulfide bond/bridge <b>not</b> sulfite, sulfate, sulfur, sulfide <b>OR</b> -S-S- shown with $\text{Hg}^{2+}$ in an equation <b>OR</b> disrupting ionic interactions linked to carboxyl/ $\text{COO}^-$ groups	<b>1</b>	
<b>(iii)</b>	(Heat to $70^\circ\text{C}$ ) breaks the van der Waals' forces/hydrogen bonding	<b>1</b>	<b>[3]</b>