

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

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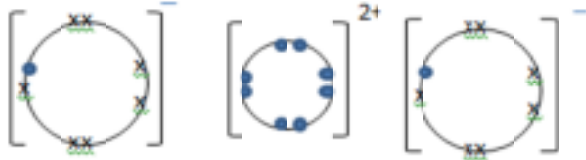
Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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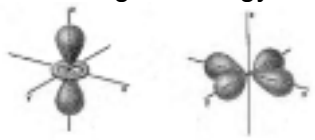
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Question	Marking point	Marks	Marks total												
1 (a) (i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>m/e</th> <th>identity</th> </tr> </thead> <tbody> <tr> <td>35</td> <td>^{35}Cl</td> </tr> <tr> <td>37</td> <td>^{37}Cl</td> </tr> <tr> <td>70</td> <td>$^{35}\text{Cl}^{35}\text{Cl}$ or $^{35}\text{Cl}_2$</td> </tr> <tr> <td>72</td> <td>$^{37}\text{Cl}^{35}\text{Cl}$</td> </tr> <tr> <td>74</td> <td>$^{37}\text{Cl}^{37}\text{Cl}$ or $^{37}\text{Cl}_2$</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}Cl	37	^{37}Cl	70	$^{35}\text{Cl}^{35}\text{Cl}$ or $^{35}\text{Cl}_2$	72	$^{37}\text{Cl}^{35}\text{Cl}$	74	$^{37}\text{Cl}^{37}\text{Cl}$ or $^{37}\text{Cl}_2$	1 1 1	
m/e	identity														
35	^{35}Cl														
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70	$^{35}\text{Cl}^{35}\text{Cl}$ or $^{35}\text{Cl}_2$														
72	$^{37}\text{Cl}^{35}\text{Cl}$														
74	$^{37}\text{Cl}^{37}\text{Cl}$ or $^{37}\text{Cl}_2$														
(ii)	9:6:1	1	[4]												
(b) (i)	 <p>correct charges correct electrons</p>	1 1													
(ii)	<p>Lattice energy = $\Delta H_f(\text{SrCO}_3) - (\Delta H_{\text{atom}}(\text{Sr}) + \Delta H_{f1}(\text{Sr}) + \Delta H_{f2}(\text{Sr}) + \Delta H_{\text{atom}}(\text{C}) + 2\Delta H_{\text{ea}}(\text{O}))$</p> <p>= $+(-830) - (+164 + 548 + 1060 + 242 + (2 \times -349))$</p> <p>= -2146 (kJ mol⁻¹)</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													

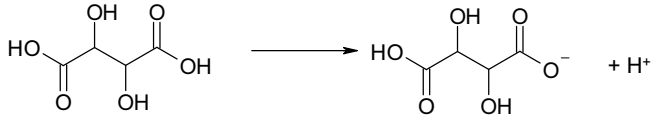
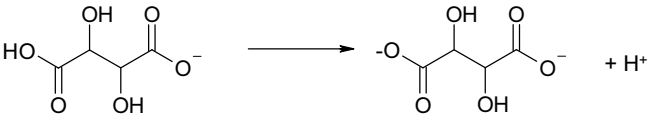
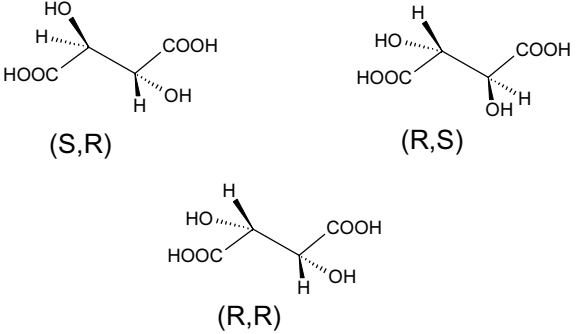
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(ii)	$\text{Sr}(\text{NO}_3)_2 \rightarrow \text{SrO} + 2\text{NO}_2 + 0.5 \text{O}_2$	1	[2]
(d)	(down the group) nitrates become more stable / require a higher temperature to decompose as size/radius of ion increases OR charge density of ion decreases so polarisation/distortion of anion/nitrate ion/ 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 st order and the concentration is x2, rate doubles OR evidence using expt 1 & 4 eg ratios $[\text{H}^+]$ 2 nd order and the concentration is x2, rate x4 OR evidence using expt 1 & 2 $[\text{Br}^-]$ 1 st order and the concentration is x4, rate x4 OR 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]

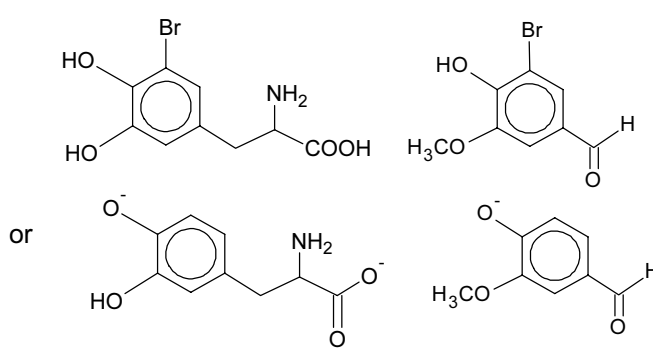
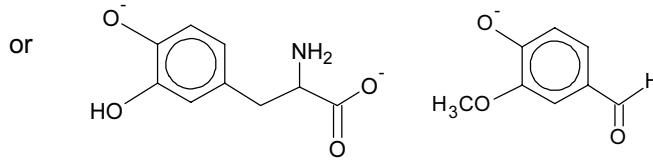
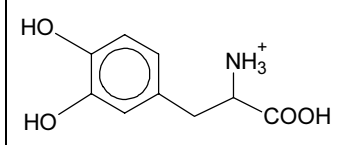
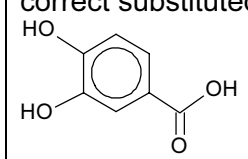
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(b) (i)	pale blue precipitate A solution B solution C	$\text{Cu}(\text{OH})_2$ OR $[\text{Cu}(\text{OH})_2(\text{H}_2\text{O})_4]$ $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ OR $[\text{Cu}(\text{NH}_3)_4]^{2+}$ $[\text{CuCl}_4]^{2-}$	1 1 1	
(ii)	solution B solution C	royal / deep / dark blue OR violet-blue yellow / green	1 1	
(iii)	redox OR oxidation of Cu OR reduction of Cu^{2+} AND reducing agent/reductant		1	[6]
(c)	3d-shell is full / $3d^{10}$ / no vacant d-orbital / d-orbitals full electrons cannot move between orbitals OR transitions cannot occur		1 1	[2]
(d)	green / yellow orange / red AND 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 small quantities / amounts / vols of acid / H^+ or base / OH^- are added		1 1	
(ii)	add (ethanoic acid) to NaOH OR an equation excess (ethanoic acid) OR 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]

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<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"> • σ-bonds are between C-C OR C-H • carbons are sp^2 • rings of charge above and below the ring must be in diagram • presence of σ-bonds • electrons/bonds are delocalised • planar molecule/bond angles 120° • all C-C are the same length/have intermediate bond length between C-C & C=C 	<p>5</p>	<p>[5]</p>

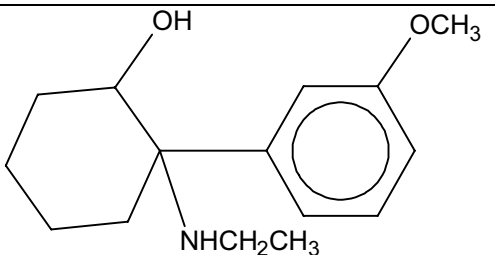
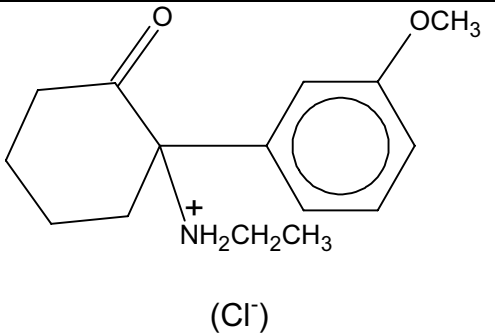
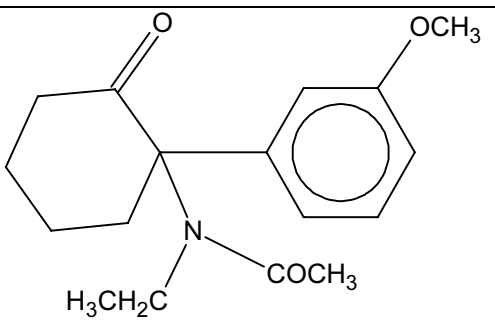
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(b)	<p>Reagent X e.g. Br₂, HNO₃, Na, NaOH, benzenediazonium salt/ion; RCOCl; Fe³⁺; H₂+Ni substituted product for L-DOPA & vanillin (examples given are for X = Br₂ and NaOH)</p>	1	
	<p>  or  </p>	2	
	<p>Reagent Y e.g. HCl; Na₂CO₃, Mg, SOCl₂, PCl₅, ROH + c.H₂SO₄; HCl+NaNO₂ / HNO₂; CH₃Cl Correct substituted product for L-DOPA</p>	1 1	
	<p>  </p>		
	<p>Reagent Z e.g. acidified Cr₂O₇²⁻; 2,4-DNPH, hydrazine; Fehling's, Tollens'; HCN; HCN + NaCN; NaBH₄;</p>	1	
	<p>correct substituted product for vanillin</p> <p>  </p>	1	[7]
6 (a) (i)	C ₁₅ H ₂₁ NO ₂	1	

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

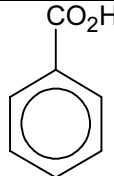
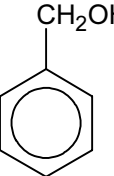
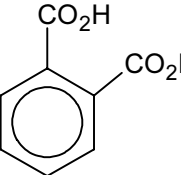
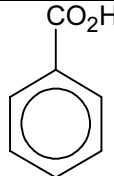
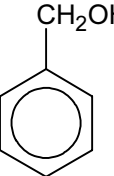
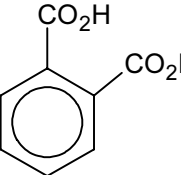
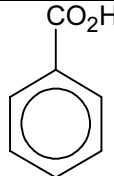
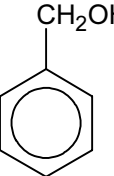
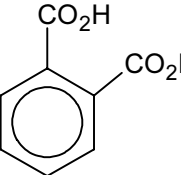
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(b)	(i) LiAlH_4		reduction / nucleophilic addition	3 3	[6]
	(ii) $\text{HCl}(\text{aq})$		acid-base / neutralisation		
	(iii) CH_3COCl		acylation / condensation allow addition + elimination allow nucleophilic substitution		
1 mark for each correct structure 1 mark for each correct reaction type					

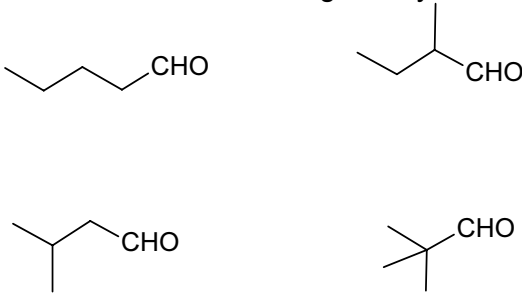
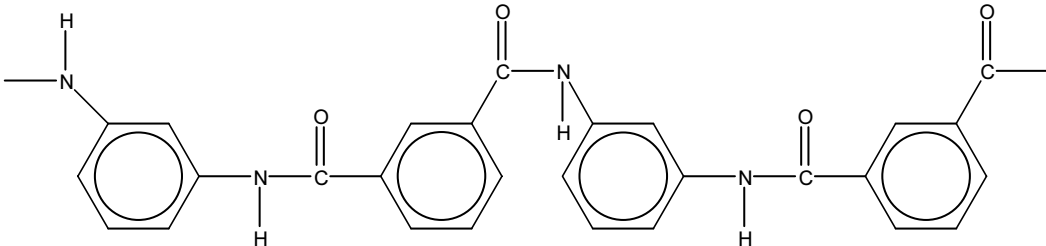
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7 (a)	(ratio of) the concentrations / distribution / amount / mass of solute in two (immiscible) solvents at equilibrium OR equilibrium constant OR includes expression with <i>K</i>	1 1	[2]
(b)	$K_{pc} = [J \text{ in ether}]/[J \text{ in H}_2\text{O}]$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

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(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]						

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(c) (i)	structures of the following aldehydes:  two correct structures = 1 mark two further correct structures – 1 mark	1 1	
(ii)	3-methylbutanal	1	
(iii)	pentanal 5 absorptions 2-methylbutanal 5 absorptions dimethylpropanal 2 absorptions	1 1 1	[6]
9 (a)	nylon, terylene – condensation; PVC – addition – all three correct	1	[1]
(b)	correct fully displayed formula of -CO-NH- unit correct polymer structure 	1 1	[2]
(c)	sequence / order of amino acids (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]

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