

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.

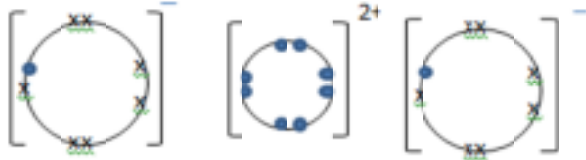
Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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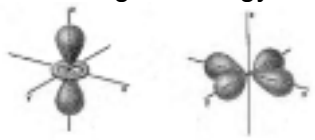
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Question	Marking point	Marks	Marks total												
1 (a) (i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>m/e</th> <th>identity</th> </tr> </thead> <tbody> <tr> <td>35</td> <td>^{35}Cl</td> </tr> <tr> <td>37</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 style="margin-left: 200px;">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 style="margin-left: 20px;">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													

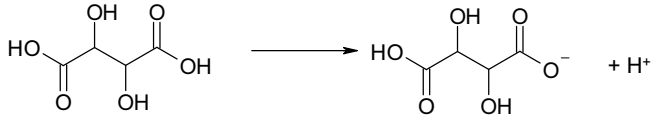
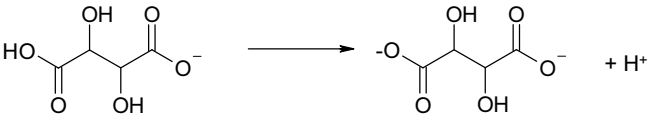
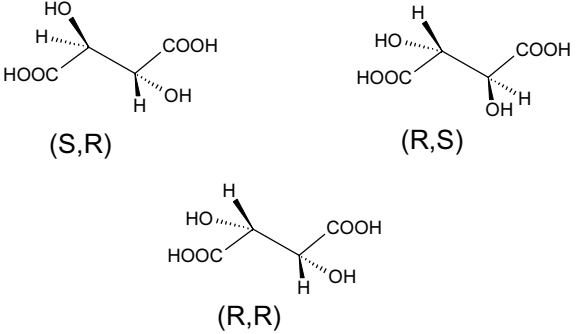
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(ii)	$\text{Sr}(\text{NO}_3)_2 \rightarrow \text{SrO} + 2\text{NO}_2 + 0.5 \text{O}_2$	1	[2]
(d)	(down the group) nitrates become more stable / require a higher temperature to decompose as size/radius of ion increases OR charge density of ion decreases 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]

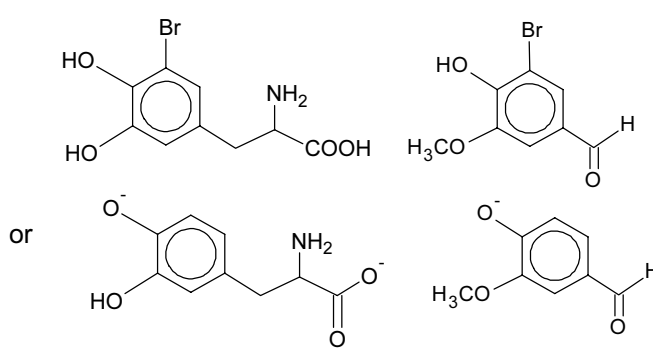
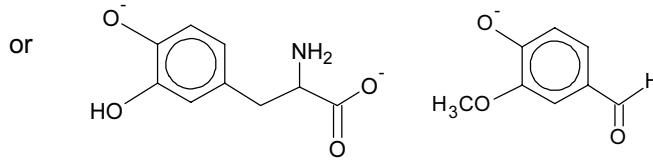
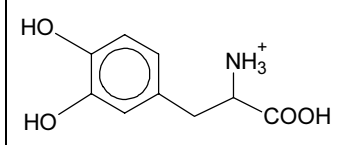
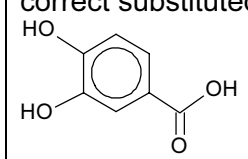
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(b) (i)	pale blue precipitate A solution B solution C	$\text{Cu}(\text{OH})_2$ OR $[\text{Cu}(\text{OH})_2(\text{H}_2\text{O})_4]$ $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ OR $[\text{Cu}(\text{NH}_3)_4]^{2+}$ $[\text{CuCl}_4]^{2-}$	1 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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(d) (i)	<p>pKa 2.99 </p> <p>pKa 4.40 </p>	1 1	
(ii)	 <p>(S,R) (R,S)</p> <p>(R,R)</p> <p>any two of the above</p>	2	[4]
5 (a)	<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 	5	[5]

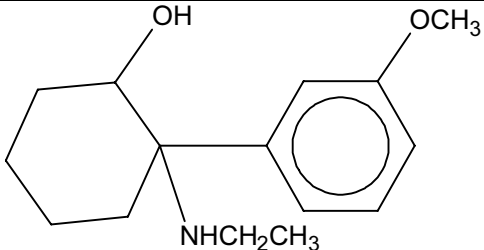
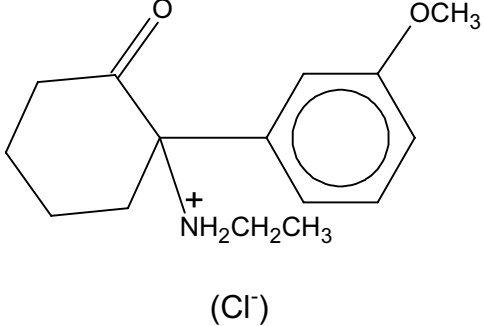
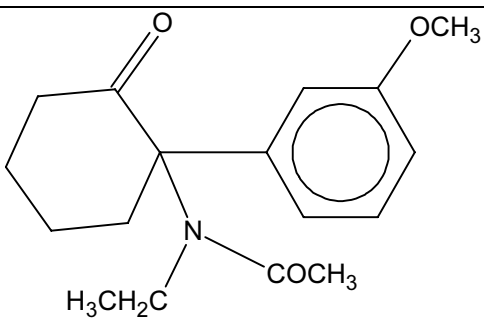
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(b)	<p>Reagent X e.g. Br₂, HNO₃, Na, NaOH, benzenediazonium salt/ion; RCOCl; Fe³⁺; H₂+Ni substituted product for L-DOPA & vanillin (examples given are for X = Br₂ and NaOH)</p>	1	
	<p>  or  </p>	2	
	<p>Reagent Y e.g. HCl; Na₂CO₃, Mg, SOCl₂, PCl₅, ROH + c.H₂SO₄; HCl+NaNO₂ / HNO₂; CH₃Cl Correct substituted product for L-DOPA</p>	1 1	[7]
	<p>  </p>		
	<p>Reagent Z e.g. acidified Cr₂O₇²⁻; 2,4-DNPH, hydrazine; Fehling's, Tollens'; HCN; HCN + NaCN; NaBH₄;</p>	1 1	
	<p>correct substituted product for vanillin</p> <p>  </p>		
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]

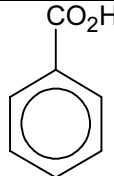
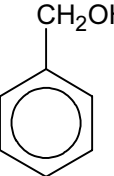
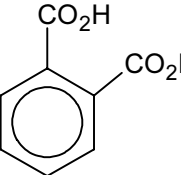
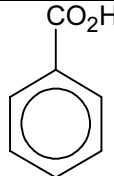
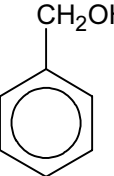
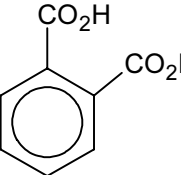
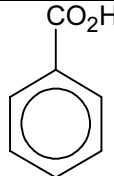
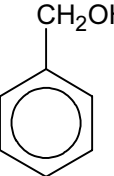
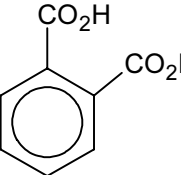
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(b)	(i) LiAlH_4		reduction / nucleophilic addition	3 3	[6]
	(ii) $\text{HCl}(\text{aq})$		acid-base / neutralisation		
	(iii) CH_3COCl		acylation / condensation allow addition + elimination allow nucleophilic substitution		
1 mark for each correct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

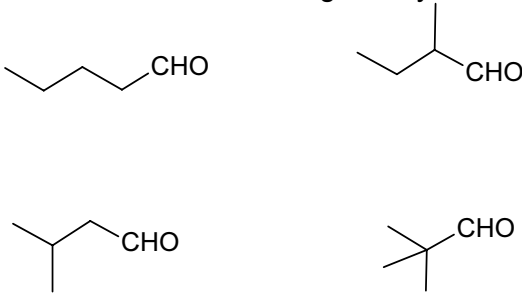
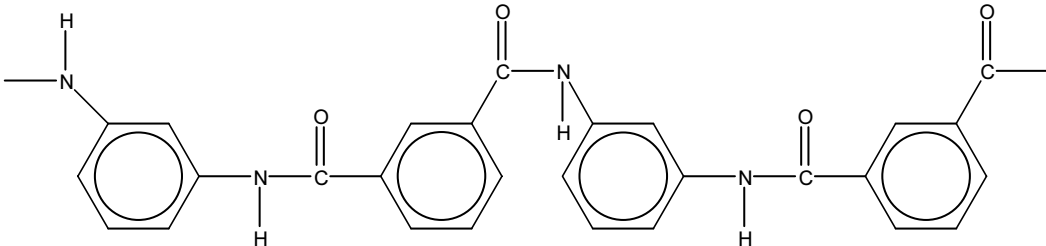
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7 (a)	(ratio of) the concentrations / distribution / amount / mass of solute in two (immiscible) solvents at equilibrium OR equilibrium constant OR includes expression with <i>K</i>	1 1	[2]
(b)	$K_{pc} = \frac{[J \text{ in ether}]}{[J \text{ in H}_2\text{O}]}$ $= \frac{(2.14/20)}{(5-2.14/75)}$ $= 2.81 \text{ OR } 2.82$	1 1	[2]
(c)	<p>1st extraction: $2.81 = \frac{(x/10)}{(5.0-x)/75}$ $2.81(5-x) = 7.5x$ $x = 1.36 \text{ g}$</p> <p>2nd extraction: $2.81 = \frac{(y/10)}{(3.64-y)/75}$ $2.81(3.64-y) = 7.5y$ $y = 0.99 \text{ g}$</p>	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]