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.

Cambridge will not enter into discussions about these mark schemes.

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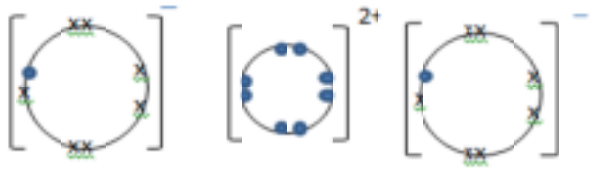
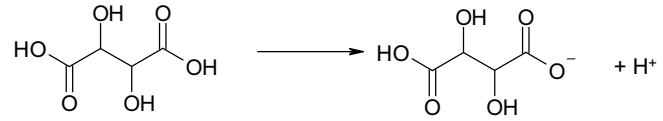
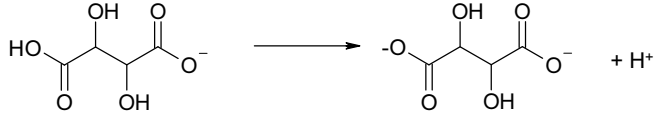
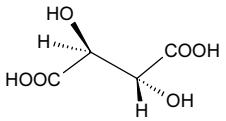
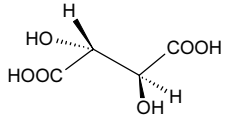
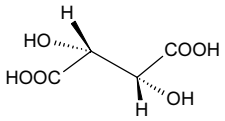
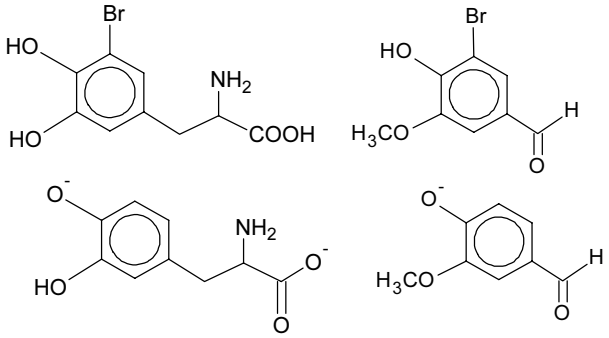
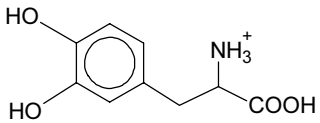
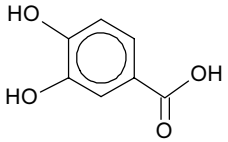
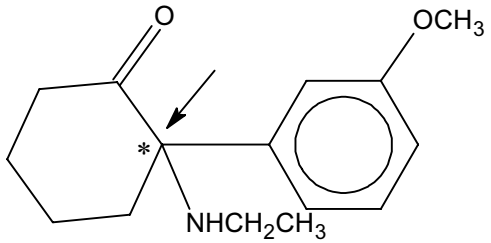
<table>
<tr><th>Question</th><th>Marking point</th><th>Marks</th><th>Marks total</th></tr>
<tr><td>1 (a) (i)</td><td>
<table>
<tr><th>m/e</th><th>identity</th></tr>
<tr><td>35</td><td>^{35}Cl</td></tr>
<tr><td>37</td><td>^{37}Cl</td></tr>
<tr><td>70</td><td>$^{35}Cl^{35}Cl$ or $^{35}Cl_2$</td></tr>
<tr><td>72</td><td>$^{37}Cl^{35}Cl$</td></tr>
<tr><td>74</td><td>$^{37}Cl^{37}Cl$ or $^{37}Cl_2$</td></tr>
</table>
35, 37, 70, 72, 74
correct formulae
at least one structure as a positive ion</td><td>1
1
1</td><td></td></tr>
<tr><td>(ii)</td><td>9:6:1</td><td>1</td><td>[4]</td></tr>
<tr><td>(b) (i)</td><td> 
correct charges
correct electrons</td><td>1
1</td><td></td></tr>
<tr><td>(ii)</td><td>Lattice energy = $\Delta H_f(SrCl_2) - (\Delta H_{atom}(Sr) + \Delta H_{i1}(Sr) + \Delta H_{i2}(Sr) + \Delta H_{atom}(Cl) + 2\Delta H_{ea}(Cl))$
$= +(-830) - (+ 164 + 548 + 1060 + 242 + (2 \times -349))$
$=$ –2146 (kJ mol^{-1})</td><td>1
1
1</td><td>[5]</td></tr>
<tr><td>(c) (i)</td><td>$SrCO_3 + 2HNO_3 \rightarrow Sr(NO_3)_2 + CO_2 + H_2O$</td><td>1</td><td></td></tr>
</table>

	(ii)	$Sr(NO_3)_2$ ➔ $SrO + 2NO_2 + 0.5\ O_2$	**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)**	$BrO_3^- + 5Br^- + 6H^+ \rightarrow 3Br_2 + 3H_2O$ five correct species correct balancing	 **1** **1**	 **[2]**
	(b) (i)	$[BrO_3^-]$ 1st order **and** the concentration is x2, rate doubles **OR** evidence using expt 1 & 4 eg ratios $[H^+]$ 2nd order **and** the concentration is x2, rate x4 **OR** evidence using expt 1 & 2 $[Br^-]$ 1st order **and** the concentration is x4, rate x4 **OR** evidence using expt 1 & 3 eg ratios	**1** **1** **1**	
	(ii)	(Rate =) $k\ [BrO_3^-][Br^-][H^+]^2$	**1**	
	(iii)	k = **1.32** $mol^{-3}\ dm^9\ s^{-1}$	**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]**

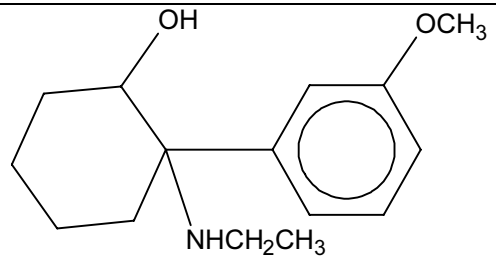
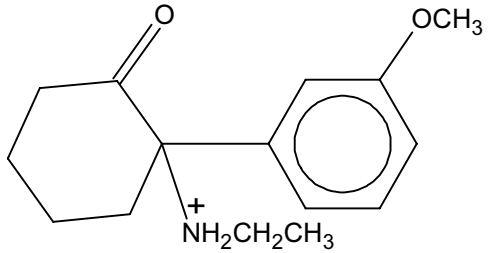
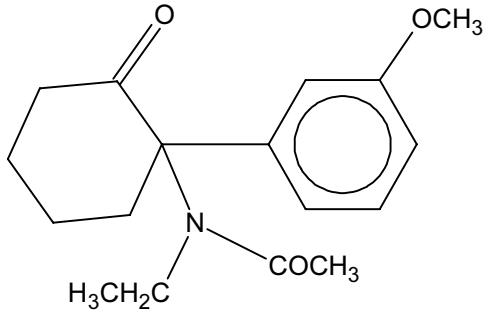
(b) (i)	pale blue precipitate **A** $Cu(OH)_2$ **OR** $[Cu(OH)_2(H_2O)_4]$ solution **B** $[Cu(NH_3)_4(H_2O)_2]^{2+}$ **OR** $[Cu(NH_3)_4]^{2+}$ solution **C** $[CuCl_4]^{2-}$		**1** **1** **1**	
(ii)	solution **B** royal / deep / dark blue **OR** violet-blue solution **C** yellow / green		**1** **1**	
(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-orbital**s** 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) strong**er** 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 *fairly* 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)	$CH_3CH(NH_2)COOH + H^+ \rightarrow CH_3CH(NH_3^+)COOH$ $CH_3CH(NH_2)COOH + OH^- \rightarrow CH_3CH(NH_2)COO^- + H_2O$		**1** **1**	**[2]**

(d) (i)	pKa 2.99  + H^+ pKa 4.40  + H^+	**1** **1**	
(ii)	 (S,R)  (R,S)  (R,R) any two of the above	**2**	**[4]**
5 (a)	*any five of these seven points.* • 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^o • all C-C are the same length/have intermediate bond length between C-C & C=C	**5**	**[5]**

(b)	Reagent **X** e.g. Br_2, HNO_3, Na, NaOH, benzenediazonium salt / ion; RCOCl ; Fe^{3+} ; H_2+Ni substituted product for L-DOPA & vanillin (examples given are for **X** = Br_2 and NaOH)  or Reagent **Y** e.g. HCl; Na_2CO_3, Mg, SOCl_2, PCl_5, ROH + c.H_2SO_4; HCl+$NaNO_2$ / HNO_2; CH_3Cl Correct substituted product for L-DOPA  Reagent **Z** e.g. acidified $Cr_2O_7^{2-}$; 2,4-DNPH, hydrazine ; Fehling's, Tollens'; HCN; HCN + NaCN; $NaBH_4$; correct substituted product for vanillin 	**1** **2** **1** **1** **1** **1**	**[7]**
6 (a) (i)	$C_{15}H_{21}NO_2$	**1**	

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

(b)

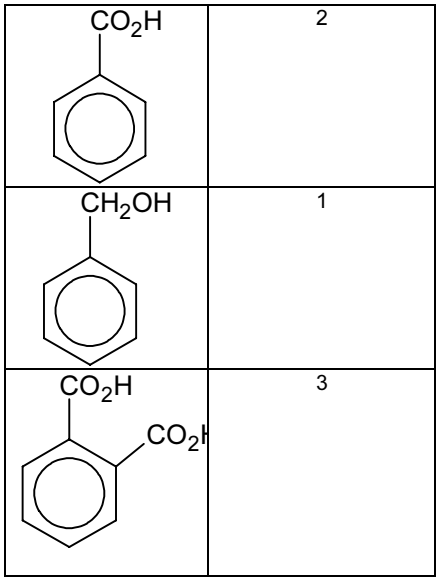
(i) $LiAlH_4$		reduction / nucleophilic addition
(ii) HCl (aq)	 (Cl^-)	acid-base / neutralisation
(iii) CH_3COCl		acylation / condensation **allow** addition + elimination **allow** nucleophilic substitution

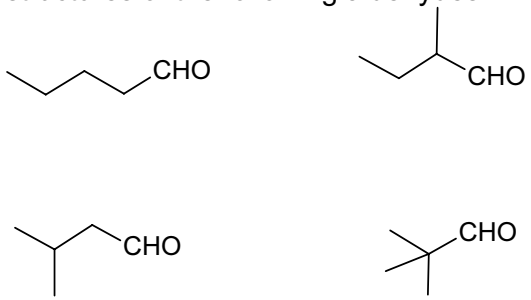
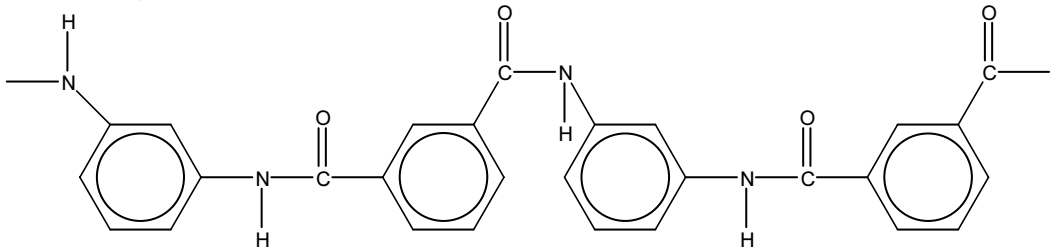
1 mark for each correct structure
1 mark for each correct reaction type

3
3

[6]

7	**(a)**	(ratio of) the concentrations / distribution / amount / mass of **solute** in **two** (immiscible) **solvents** at equilibrium **OR** equilibrium constant **OR** includes expression with *K*	**1** **1**	**[2]**
	(b)	K_{pc} = [J in ether]/[J in H_2O] = (2.14/20)/(5–2.14/75) =2.81 **OR** 2.82	**1** **1**	**[2]**
	(c)	1st extraction: 2.81 =(x/10)/(5.0–x)/75 2.81(5–x) = 7.5x x= 1.36 g 2nd extraction: 2.81 =(y/10)/(3.64–y)/75 2.81(3.64-y) = 7.5y y= 0.99 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]**

(e)			**1**	**[1]**
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]**

	(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]**

(e) (i)	disrupts hydrogen/ionic bonds as –COOH/NH_3^+ is deprotonated **OR** $–NH_3^+ + OH^- \rightarrow NH_2 + H_2O$ linked to hydrogen / ionic bond disrupted **OR** $–COOH + OH^- \rightarrow –COO^- + H_2O$ 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]**