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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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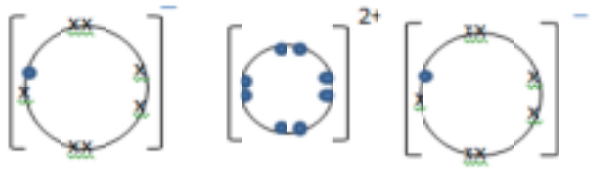
Question	Marking point	Marks	Marks total
1 (a) (i)	<table><tr><th>m/e</th><th>identity</th></tr><tr><td>35</td><td>^{35}Cl</td></tr><tr><td>37</td><td>^{37}Cl</td></tr><tr><td>70</td><td>$^{35}Cl^{35}Cl$ ***or*** $^{35}Cl_2$</td></tr><tr><td>72</td><td>$^{37}Cl^{35}Cl$</td></tr><tr><td>74</td><td>$^{37}Cl^{37}Cl$ ***or*** $^{37}Cl_2$</td></tr></table> 35, 37, 70, 72, 74 correct formulae at least one structure as a positive ion	**1** **1** **1**	
(ii)	9:6:1	**1**	**[4]**
(b) (i)	 correct charges correct electrons	**1** **1**	
(ii)	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 × –349)) = **–2146** (kJ mol^{-1})	**1** **1** **1**	**[5]**
(c) (i)	$SrCO_3$ + $2HNO_3$ ➔ $Sr(NO_3)_2$ + CO_2 + H_2O	**1**	

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	(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]**

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(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]**

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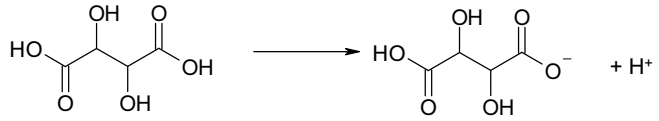
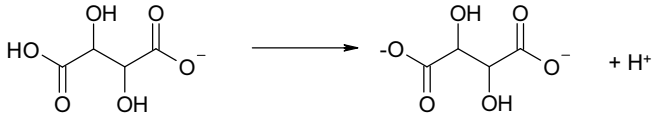
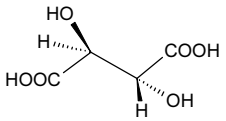
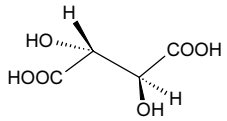
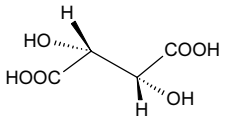
(d) (i)	pKa 2.99  + H^+ pKa 4.40  + H^+	**1** **1**	
(ii)	 (S,R)  (R,S)  (R,R) any two of the above	**2**	**[4]**
5 (a)	*any five of these seven points.* • σ-bonds are between C-C **OR** C-H • carbons are sp^2 • rings of charge above and below the ring **must be in diagram** • presence of σ-bonds • electrons/bonds are delocalised • planar molecule/bond angles 120° • all C-C are the same length/have intermediate bond length between C-C & C=C	**5**	**[5]**

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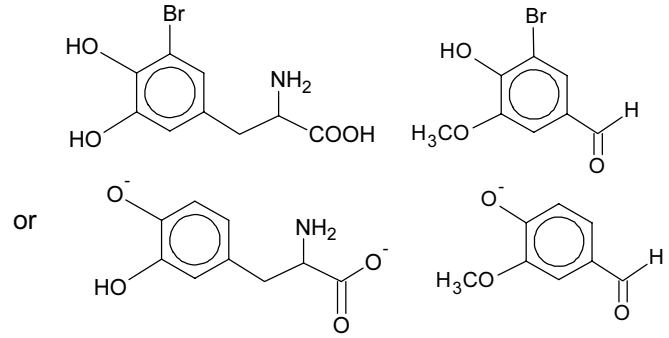
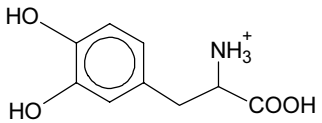
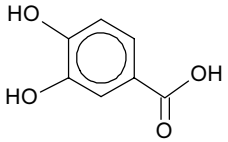
(b)	Reagent **X** e.g. Br_2, HNO_3, Na, NaOH, benzenediazonium salt / ion; RCOCl ; Fe^{3+} ; H_2+Ni substituted product for L-DOPA & vanillin (examples given are for **X** = Br_2 and NaOH)  or Reagent **Y** e.g. HCl; Na_2CO_3, Mg, SOCl_2, PCl_5, ROH + c.H_2SO_4; HCl+$NaNO_2$ / HNO_2; $CH_3C$$l$ Correct 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**	

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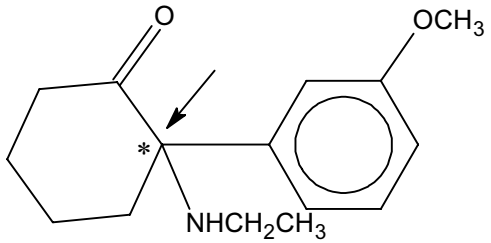
(ii)		**1**	
(iii)	any **two** of ketone, amine or ether	**2**	**[4]**

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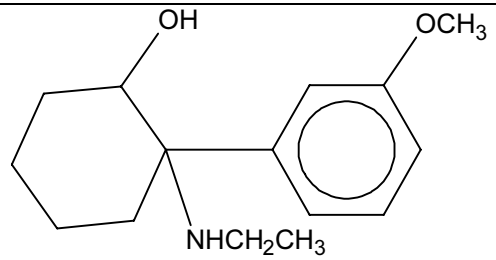
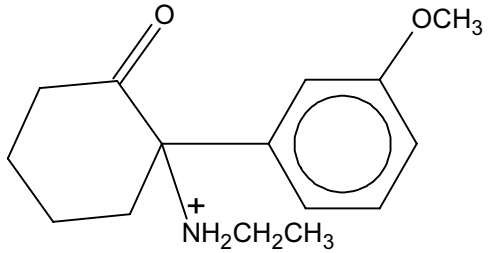
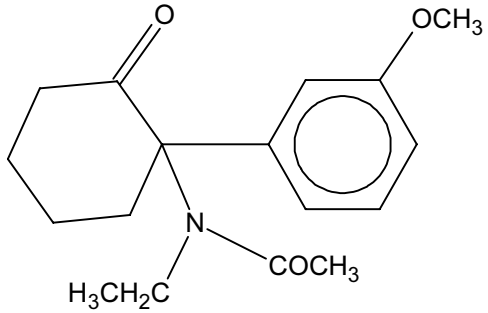
(b)

(i) $LiAlH_4$		reduction / nucleophilic addition		
(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]

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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 *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]**

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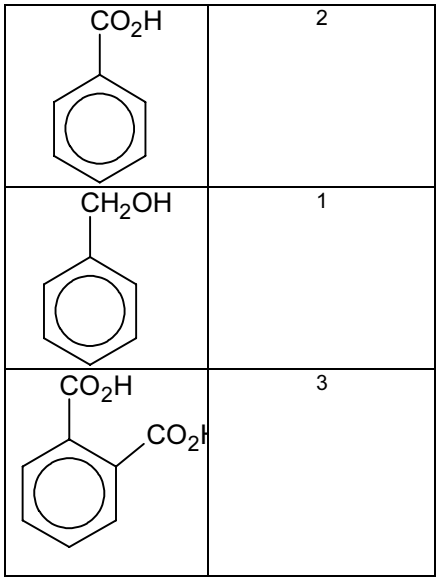
(e)			**1**	**[1]**
8 **(a)**	C = 33 % A = T = 17 %		**1** **1**	**[2]**
(b) **(i)**	only one isomer may be active / be of therapeutic benefit		**1**	
(ii)	the other (stereo) isomer may cause harm / side effects		**1**	**[2]**

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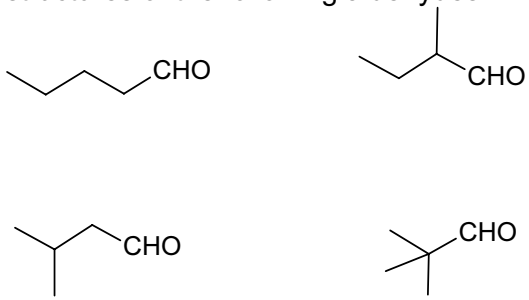
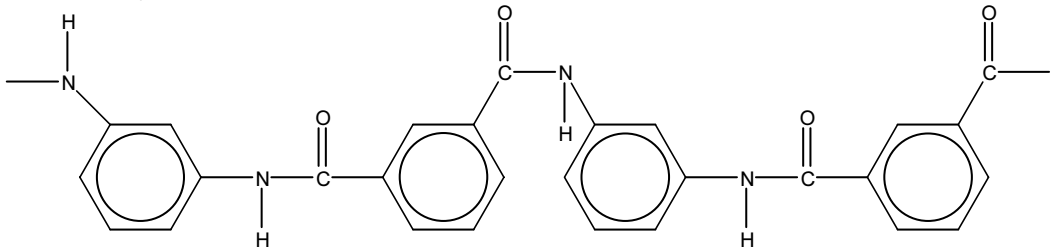
	(c) (i)	structures of the following aldehydes:  two correct structures = 1 mark two further correct structures – 1 mark	**1** **1**	
	(ii)	3-methylbutanal	**1**	
	(iii)	pentanal 5 absorptions 2-methylbutanal 5 absorptions dimethylpropanal 2 absorptions	**1** **1** **1**	**[6]**
9	**(a)**	nylon, terylene – 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 –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]**

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