

**MARK SCHEME for the October/November 2010 question paper
for the guidance of teachers**

9701 CHEMISTRY

9701/41

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.

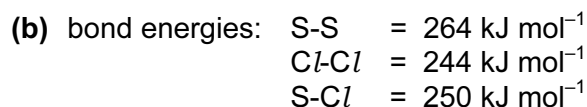
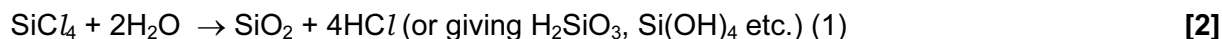
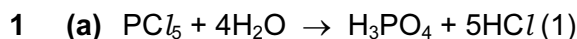
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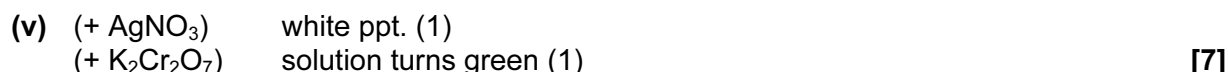
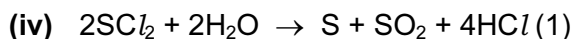
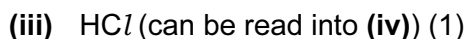
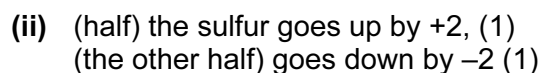
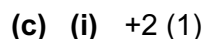
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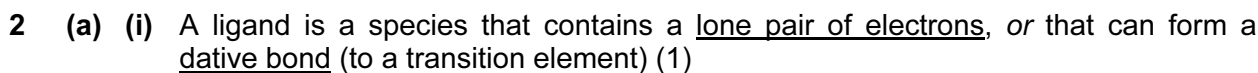
Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2010	9701	41



$\Delta H = 8 \times 264 + 8 \times 244 - 16 \times 250 = +64 \text{ kJ mol}^{-1}$ (2) [2]



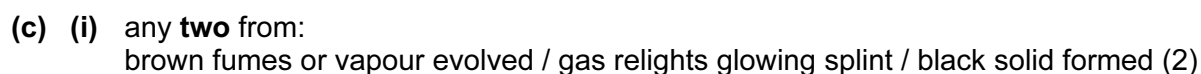
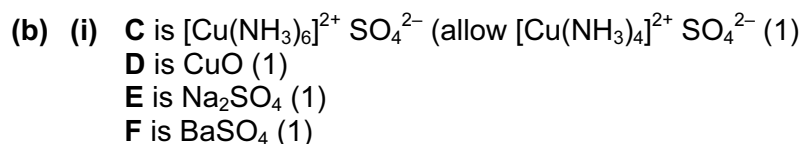
[Total: 11]



(ii)

species	can be a ligand	cannot be a ligand
OH ⁻	✓	
NH ₄ ⁺		✓
CH ₃ OH	✓	
CH ₃ NH ₂	✓	

(4 × ½) [3]



[Total: 11 max 10]

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- 3 (a) (i) $\text{Cu(s)} - 2\text{e}^- \rightarrow \text{Cu}^{2+}(\text{aq})$ allow electrons on RHS (1)
- (ii) E° for Ag^+/Ag is +0.80V which is more positive than +0.34V for Cu^{2+}/Cu , (1)
so it's less easily oxidised (owtte) (1)
- (iii) E° for Ni^{2+} is -0.25V, (1)
Ni is readily oxidised and goes into solution as $\text{Ni}^{2+}(\text{aq})$ (1) [Mark (ii) and (iii) to max 3]
- (iv) $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Cu(s)}$ (1)
- (v) E° for Zn^{2+}/Zn is negative / = -0.76V, so Zn^{2+} is not easily reduced. (1)
- (vi) The blue colour fades because $\text{Cu}^{2+}(\text{aq})$ is being replaced by $\text{Zn}^{2+}(\text{aq})$ or $\text{Ni}^{2+}(\text{aq})$ or $[\text{Cu}^{2+}]$ decreases (1) [7]

- (b) amount of copper = $225/63.5 = 3.54(3)$ mol (1)
amount of electrons needed = $2 \times 3.54 = 7.08/9$ (7.087) mol (1)
- no. of coulombs = $20 \times 10 \times 60 \times 60 = 7.2 \times 10^5$ C
no. of moles of electrons = $7.2 \times 10^5 / 9.65 \times 10^4 = 7.46$ mol (1)
- percentage "wasted" = $100 \times (7.461 - 7.087) / 7.461 = 5.01$ (5.0)% (accept 4.98–5.10) (1) [4]

- (c) E° data: $\text{Ni}^{2+}/\text{Ni} = -0.25\text{V}$
 $\text{Fe}^{2+}/\text{Fe} = -0.44\text{V}$ (1)

Because the Fe potential is more negative than the Ni potential, the iron will dissolve (1) [2]

[Total: 13]

- 4 (a) (i) SnO_2 Can be read into equation (1)
 $2\text{NaOH} + \text{SnO}_2 \rightarrow \text{Na}_2\text{SnO}_3 + \text{H}_2\text{O}$ (1)
- (ii) PbO Can be read into equation (1)
 $\text{PbO} + 2\text{HCl} \rightarrow \text{PbCl}_2 + \text{H}_2\text{O}$ (1) [4]

- (b) moles of oxygen = $9.3/16 = 0.581$ mol
moles of lead = $90.7/207 = 0.438$ mol (both 3 s.f.) (1)
- so formula is Pb_3O_4 (1) [2]

- (c) (i) $K_{\text{sp}} = [\text{Pb}^{2+}][\text{Cl}^-]^2$ (1) units = $\text{mol}^3 \text{dm}^{-9}$ (1)
- (ii) if $[\text{Pb}^{2+}] = x$, $K_{\text{sp}} = 4x^3$, so $x = \sqrt[3]{\{K_{\text{sp}}/4\}}$
 $[\text{Pb}^{2+}] = \sqrt[3]{\{2 \times 10^{-5}/4\}} = 1.71 \times 10^{-2} \text{mol dm}^{-3}$ (1)
- (iii) $[\text{Pb}^{2+}] = 2 \times 10^{-5} / (0.5)^2 = 8.0 \times 10^{-5} \text{mol dm}^{-3}$ (1)
- (iv) common ion effect, or increased $[\text{Cl}^-]$ forces solubility equilibrium over to the left (1)

[Max 4]

[Total: 10]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2010	9701	41

5 (a) (i) ester (1)

(ii) H is nitrobenzene – structure needed here (1)

J is phenyldiazonium chloride – structure needed here (1)

(iii) step 2 $\text{Sn/Zn} + \text{HCl} / \text{H}_2 + \text{named cat} / \text{NaBH}_4 / \text{LiAlH}_4 / \text{Na} + \text{ethanol}$ (1)

step 3 $\text{HNO}_2/\text{NaNO}_2 + \text{HCl}$ at $T = 10^\circ\text{C}$ or less (1)

step 4 heat/warm to $T > 10^\circ\text{C}$ (1)

step 5 $\text{CH}_3\text{COCl} / \text{CH}_3\text{COCOCOCH}_3$ (1)

[7]

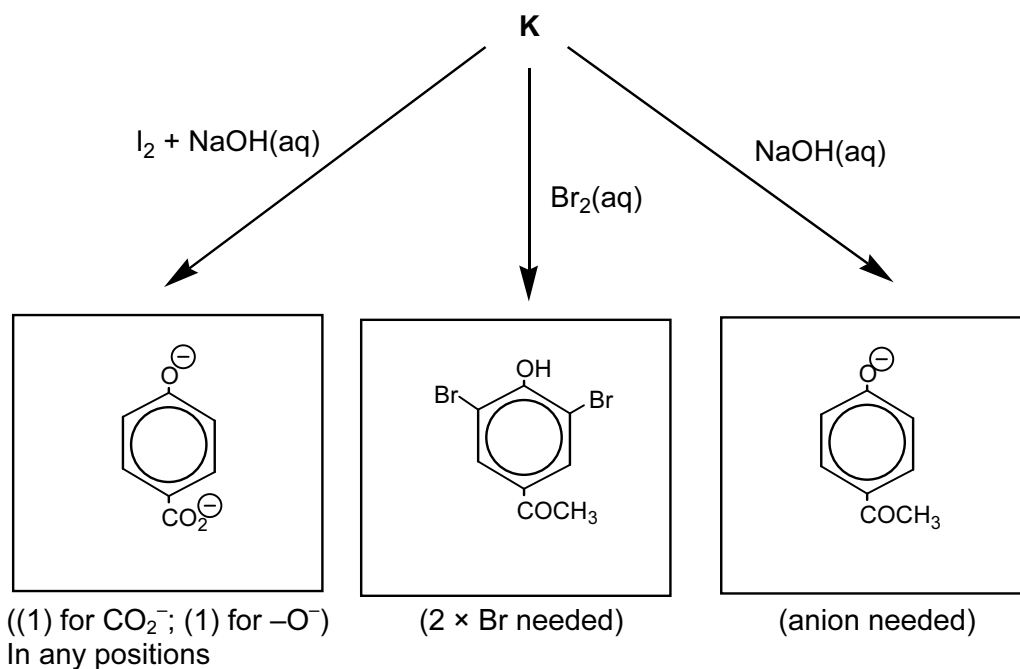
(b) (i) compounds that have the same molecular formula, but different structures (1)

(ii) phenol (NOT hydroxy) (1)

(methyl) ketone *or* carbonyl (1)

(iii) K is 4-ethanoylphenol, $\text{HO-C}_6\text{H}_4\text{-COCH}_3$ (must be 1,4- disubstituted isomer) (1)

(iv)

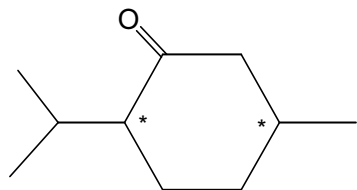


[4]
[8 max 7]

[Total: 14]

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6 (a)

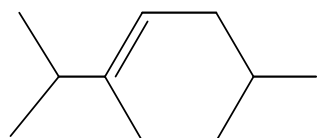


(1) for each centre – more than 2 centres shown deduct 1 mark

[2]

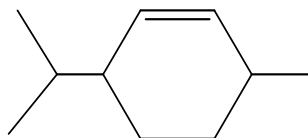
- (b) (i) step 1 LiAlH_4 or NaBH_4 or $\text{Na} + \text{ethanol}$ or $\text{H}_2 + \text{Ni}$ (1)
 step 2 heat with Al_2O_3 / porous pot or conc. H_2SO_4 / H_3PO_4 (1)

(ii)



L (1)

(letters may be reversed)

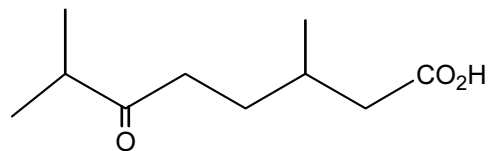


M (1)

[4]

- (c) (i) **M** (no mark)

(ii)



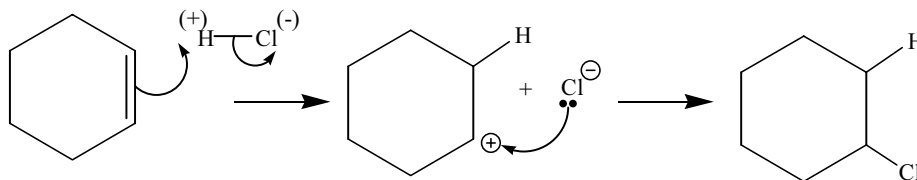
P

i.e. 3,7-dimethyl-6-oxo-octanoic acid (1)

- (iii) 2,4-DNPH (1) orange ppt. with **P** (none with **N**) (1)
 Mark ecf from candidates' P

[3]

(d)



2 curly arrows (1)
 carbocation intermediate + Cl^- (1)
 lone pair on Cl^- and last curly arrow (1)

[3]

[Total: 12]

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- 7 (a) (i) Disulfide bond / group / bridge (1)
- (ii) The tertiary structure (1)
- (iii) The substrate will no longer bond to / fit into the active site (1)
or shape of active site is changed [3]
- (b) (i) Acid-base / proton donor / neutralisation / salt formation (1)
- (ii) The ability of the $-\text{CO}_2\text{H}$ group to form hydrogen bonds (1) and ionic interactions (1)
The $-\text{CO}_2\text{H}/-\text{CO}_2^-$ group is no longer able to interact with $-\text{NH}_2/-\text{NH}_3^+$ (1)
The Ag^+ forms a strong bond with $-\text{COO}^-$ (1) [5] max [4]
- (c) (i) 8 but allow 4O_2 if specified as molecules (1)
- (ii) Dative / co-ordinate (1)
- (iii) Octahedral / 6 co-ordinate (1) [3]
- [Total: 10]
- 8 (a) Protons (1)
in NMR, energy is absorbed due to the two spin states (1)
Electrons (1)
in X-ray crystallography, X-rays are diffracted (by regions of high electron density) (1) [4]
- (b) (i) 1 – no mark
The spectrum of alcohol / **Y** contains different peaks
Alcohol / **Y** contains different chemical environments
Spectrum 2 contains only one peak (1)
- (ii) Spectrum 2 only shows 1 peak so **Z** must be a ketone (1)
Hence **Y** must be a 2° alcohol (1)
Number of carbon atoms present $= \frac{0.6 \times 100}{17.6 \times 1.1} = 3$ (1)
Thus **Z** must be CH_3COCH_3 (1)
Hence **Y** must be propan-2-ol, $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$ (1)
- (iii)
- $$\begin{array}{c} \text{H} \\ | \\ \text{Y is } \text{CH}_3 - \text{C} - \text{CH}_3 \\ | \\ \text{OH} \end{array} \quad (1)$$
- (iv) All of the protons in **Z** are in the same chemical environment (1) [8] max [7]
- [Total: 11]

Page 7	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2010	9701	41

- 9 (a) (i) A few nanometres (accept 0.5–10 nm) (1)
- (ii) Graphite/graphene (1)
- (iii) van der Waals' (1)
Carbon atoms in the nanotubes are joined by covalent bonds (1)
(as are the hydrogen atoms in a hydrogen molecule)
or no dipoles on C or H₂ or the substances are non-polar [4]
- (b) More hydrogen can be packed into the same space/volume (1) [1]
- (c) If a system at equilibrium is disturbed, the equilibrium moves in the direction which tends to reduce the disturbance (owtte) (1)
- When H₂ is removed the pressure drops and more H₂ is released from that adsorbed (1)
- The equilibrium $\text{H}_{2\text{adsorbed}} \rightleftharpoons \text{H}_{2\text{gaseous}}$ (1)
- Equilibrium shifts to the right as pressure drops (1) [4]
- [Total: 9]

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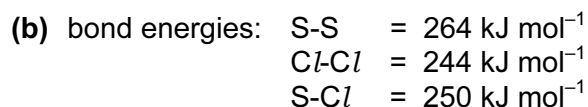
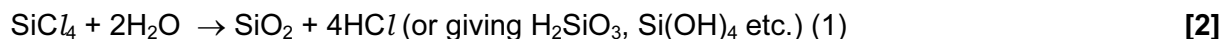
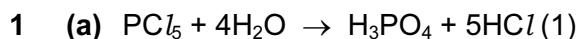
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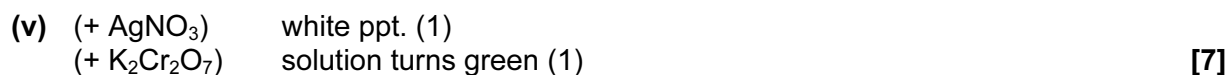
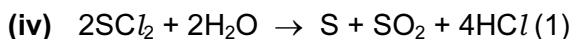
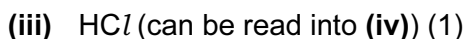
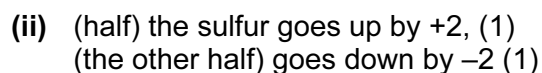
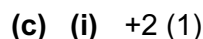
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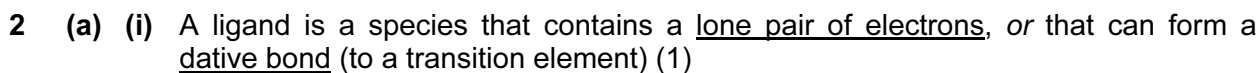
Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2010	9701	42



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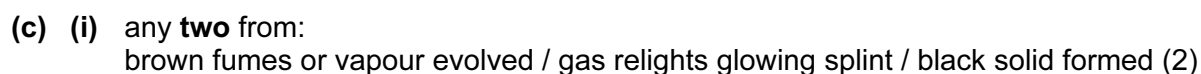
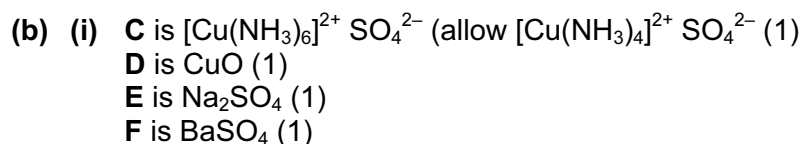
[Total: 11]



(ii)

species	can be a ligand	cannot be a ligand
OH ⁻	✓	
NH ₄ ⁺		✓
CH ₃ OH	✓	
CH ₃ NH ₂	✓	

(4 × ½) [3]



[Total: 11 max 10]

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- (vi) The blue colour fades because $\text{Cu}^{2+}(\text{aq})$ is being replaced by $\text{Zn}^{2+}(\text{aq})$ or $\text{Ni}^{2+}(\text{aq})$ or $[\text{Cu}^{2+}]$ decreases (1) [7]

- (b) amount of copper = $225/63.5 = 3.54(3)$ mol (1)
amount of electrons needed = $2 \times 3.54 = 7.08/9$ (7.087) mol (1)
- no. of coulombs = $20 \times 10 \times 60 \times 60 = 7.2 \times 10^5$ C
no. of moles of electrons = $7.2 \times 10^5 / 9.65 \times 10^4 = 7.46$ mol (1)
- percentage "wasted" = $100 \times (7.461 - 7.087) / 7.461 = 5.01$ (5.0)% (accept 4.98–5.10) (1) [4]

- (c) E° data: $\text{Ni}^{2+}/\text{Ni} = -0.25\text{V}$
 $\text{Fe}^{2+}/\text{Fe} = -0.44\text{V}$ (1)

Because the Fe potential is more negative than the Ni potential, the iron will dissolve (1) [2]

[Total: 13]

- 4 (a) (i) SnO_2 Can be read into equation (1)
 $2\text{NaOH} + \text{SnO}_2 \rightarrow \text{Na}_2\text{SnO}_3 + \text{H}_2\text{O}$ (1)
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moles of lead = $90.7/207 = 0.438$ mol (both 3 s.f.) (1)
- so formula is Pb_3O_4 (1) [2]

- (c) (i) $K_{\text{sp}} = [\text{Pb}^{2+}][\text{Cl}^-]^2$ (1) units = $\text{mol}^3 \text{dm}^{-9}$ (1)
- (ii) if $[\text{Pb}^{2+}] = x$, $K_{\text{sp}} = 4x^3$, so $x = \sqrt[3]{\{K_{\text{sp}}/4\}}$
 $[\text{Pb}^{2+}] = \sqrt[3]{\{2 \times 10^{-5}/4\}} = 1.71 \times 10^{-2} \text{mol dm}^{-3}$ (1)
- (iii) $[\text{Pb}^{2+}] = 2 \times 10^{-5} / (0.5)^2 = 8.0 \times 10^{-5} \text{mol dm}^{-3}$ (1)
- (iv) common ion effect, or increased $[\text{Cl}^-]$ forces solubility equilibrium over to the left (1)

[Max 4]

[Total: 10]

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	GCE A LEVEL – October/November 2010	9701	42

5 (a) (i) ester (1)

(ii) H is nitrobenzene – structure needed here (1)

J is phenyldiazonium chloride – structure needed here (1)

(iii) step 2 $\text{Sn/Zn} + \text{HCl} / \text{H}_2 + \text{named cat} / \text{NaBH}_4 / \text{LiAlH}_4 / \text{Na} + \text{ethanol}$ (1)

step 3 $\text{HNO}_2/\text{NaNO}_2 + \text{HCl}$ at $T = 10^\circ\text{C}$ or less (1)

step 4 heat/warm to $T > 10^\circ\text{C}$ (1)

step 5 $\text{CH}_3\text{COCl} / \text{CH}_3\text{COCOCOCOCH}_3$ (1)

[7]

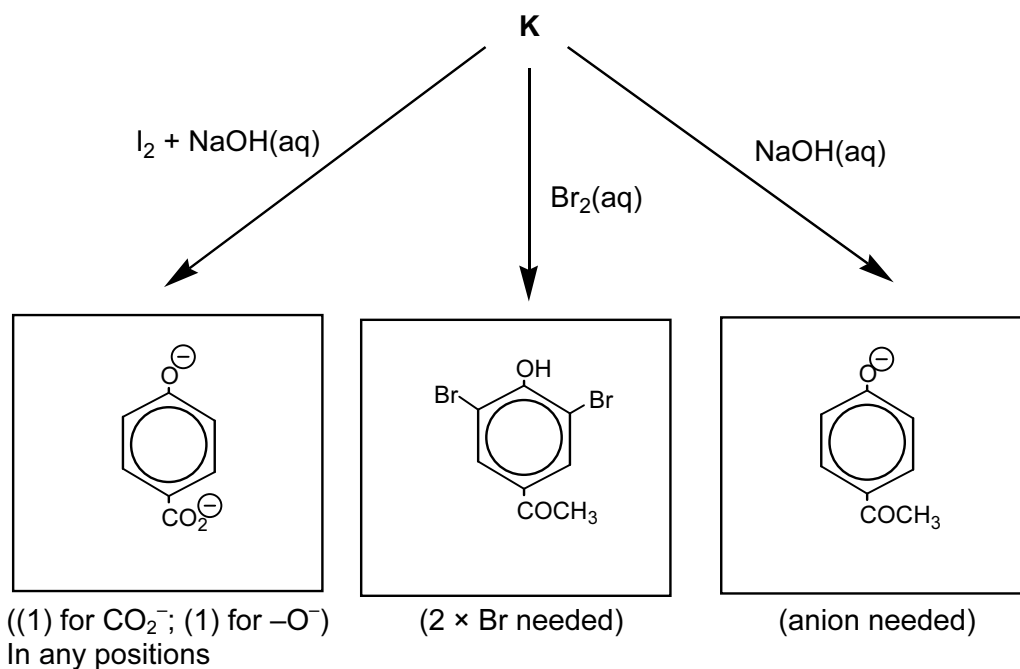
(b) (i) compounds that have the same molecular formula, but different structures (1)

(ii) phenol (NOT hydroxy) (1)

(methyl) ketone *or* carbonyl (1)

(iii) K is 4-ethanoylphenol, $\text{HO-C}_6\text{H}_4\text{-COCH}_3$ (must be 1,4- disubstituted isomer) (1)

(iv)

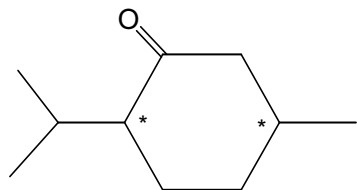


[4]
[8 max 7]

[Total: 14]

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2010	9701	42

6 (a)

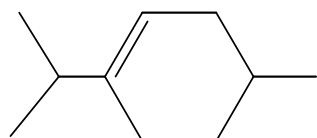


(1) for each centre – more than 2 centres shown deduct 1 mark

[2]

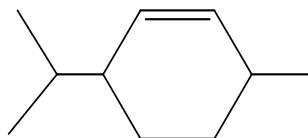
- (b) (i) step 1 LiAlH_4 or NaBH_4 or $\text{Na} + \text{ethanol}$ or $\text{H}_2 + \text{Ni}$ (1)
 step 2 heat with Al_2O_3 / porous pot or conc. H_2SO_4 / H_3PO_4 (1)

(ii)



L (1)

(letters may be reversed)

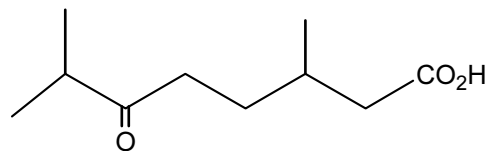


M (1)

[4]

- (c) (i) **M** (no mark)

(ii)



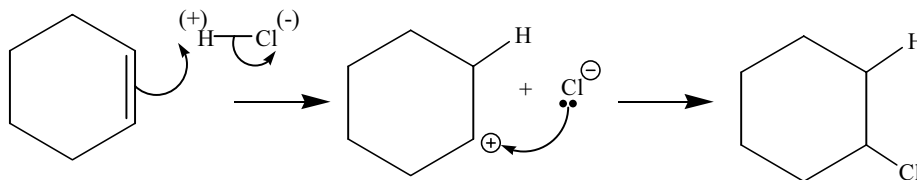
P

i.e. 3,7-dimethyl-6-oxo-octanoic acid (1)

- (iii) 2,4-DNPH (1) orange ppt. with **P** (none with **N**) (1)
 Mark ecf from candidates' P

[3]

(d)



2 curly arrows (1)

carbocation intermediate + Cl^- (1)

lone pair on Cl^- and last curly arrow (1)

[3]

[Total: 12]

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or shape of active site is changed [3]
- (b) (i) Acid-base / proton donor / neutralisation / salt formation (1)
- (ii) The ability of the $-\text{CO}_2\text{H}$ group to form hydrogen bonds (1) and ionic interactions (1)
The $-\text{CO}_2\text{H}/-\text{CO}_2^-$ group is no longer able to interact with $-\text{NH}_2/-\text{NH}_3^+$ (1)
The Ag^+ forms a strong bond with $-\text{COO}^-$ (1) [5] max [4]
- (c) (i) 8 but allow 4O_2 if specified as molecules (1)
- (ii) Dative / co-ordinate (1)
- (iii) Octahedral / 6 co-ordinate (1) [3]
- [Total: 10]
- 8 (a) Protons (1)
in NMR, energy is absorbed due to the two spin states (1)
Electrons (1)
in X-ray crystallography, X-rays are diffracted (by regions of high electron density) (1) [4]
- (b) (i) 1 – no mark
The spectrum of alcohol / **Y** contains different peaks
Alcohol / **Y** contains different chemical environments
Spectrum 2 contains only one peak (1)
- (ii) Spectrum 2 only shows 1 peak so **Z** must be a ketone (1)
Hence **Y** must be a 2° alcohol (1)
- Number of carbon atoms present $= \frac{0.6 \times 100}{17.6 \times 1.1} = 3$ (1)
- Thus **Z** must be CH_3COCH_3 (1)
- Hence **Y** must be propan-2-ol, $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$ (1)
- (iii)
- $$\begin{array}{c} \text{H} \\ | \\ \text{Y is } \text{CH}_3 - \text{C} - \text{CH}_3 \\ | \\ \text{OH} \end{array} \quad (1)$$
- (iv) All of the protons in **Z** are in the same chemical environment (1) [8] max [7]
- [Total: 11]

Page 7	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A LEVEL – October/November 2010	9701	42

- 9 (a) (i) A few nanometres (accept 0.5–10 nm) (1)
- (ii) Graphite/graphene (1)
- (iii) van der Waals' (1)
Carbon atoms in the nanotubes are joined by covalent bonds (1)
(as are the hydrogen atoms in a hydrogen molecule)
or no dipoles on C or H₂ or the substances are non-polar [4]
- (b) More hydrogen can be packed into the same space/volume (1) [1]
- (c) If a system at equilibrium is disturbed, the equilibrium moves in the direction which tends to reduce the disturbance (owtte) (1)
- When H₂ is removed the pressure drops and more H₂ is released from that adsorbed (1)
- The equilibrium $\text{H}_{2\text{adsorbed}} \rightleftharpoons \text{H}_{2\text{gaseous}}$ (1)
- Equilibrium shifts to the right as pressure drops (1) [4]
- [Total: 9]

**MARK SCHEME for the October/November 2010 question paper
for the guidance of teachers**

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 must be read in conjunction with the question papers and the report on the examination.

- CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the October/November 2010 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.



Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2010	9701	43

- 1 (a) (i) $\text{P}_2\text{O}_5 + 3\text{H}_2\text{O} \rightarrow 2\text{H}_3\text{PO}_4$ (or similar) or $\text{P}_4\text{O}_{10} + 6\text{H}_2\text{O} \rightarrow 4\text{H}_3\text{PO}_4$ (1)
 $\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3$ (1)
- (ii) $2\text{NO}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_2 + \text{HNO}_3$ (1)
- (iii) $2\text{ClO}_2 + 2\text{NaOH} \rightarrow \text{NaClO}_2 + \text{NaClO}_3 + \text{H}_2\text{O}$ or ionic eqn (1) [4]
- (b) (i) $2\text{CH}_4 + \text{C}_2\text{H}_6 + \text{H}_2\text{S} + 9\text{O}_2 \rightarrow 4\text{CO}_2 + \text{SO}_2 + 8\text{H}_2\text{O}$
 Formulae (1), balanced (1)
- (ii) (The SO_2 produced) causes acid rain (1)
 or consequence of acid rain – defoliation etc. – or respiratory problem
- (iii) 1000 dm^3 contains 50 dm^3 of H_2S
 this is $50/24$ (= **2.083** moles) (1)
 $M_r(\text{ethanolamine}) = 24 + 7 + 14 + 16 = \mathbf{61}$
 therefore mass = $2.083 \times 61 = \mathbf{127(.1)g}$ (1) (or ecf)
- (iv) acid-base (1)
- (v) $\Delta H = \Delta H_f(\text{rhs}) - \Delta H_f(\text{lhs})$
 $= \{(3 \times 11 - 2 \times 242)\} - \{(2 \times -21 - 297)\} - 1$ for each { } in which there is an error
 $= -451 + 339$
 $= -112 \text{ (kJ mol}^{-1}\text{)}$ (2) [8]

[Total: 12]

- 2 (a) any **three** from:
d-orbitals / sub-shells / energy levels are split or equivalent * (1)
colour due to absorption of light (1)
 when e promoted to higher orbital * (1)
 $\Delta E = hf$ or $h\nu$ or h/λ (marks * could be in labelled diagram) (1) [3]
- (b) blue is $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ (or full correct name of ion) (1)
 ligand exchange/displacement/replacement (1)
 $(\text{NH}_4)_2\text{CuCl}_4$ contains $[\text{CuCl}_4]^{2-}$ (1)
 CuSO_4 is white as it has no ligands (1) [max 3]
- (c) $n(\text{thio}) = 0.02 \times 19.5/1000 = 3.9 \times 10^{-4} \text{ mol}$ (1)
- $n(\text{thio}) = n(\text{Cu}^{2+})$, so $n(\text{Cu}^{2+})$ in $50 \text{ cm}^3 = 3.9 \times 10^{-4} \text{ mol}$
 so $[\text{Cu}^{2+}] = 3.9 \times 10^{-4} \times \frac{1000}{50} = \mathbf{(7.8 \times 10^{-3} \text{ (mol dm}^{-3}\text{)})}$ (1)
 {or all-in-one-line: $n(\text{thio}) = n(\text{Cu}^{2+})$, so $[\text{Cu}^{2+}] = 0.02 \times 19.5/50 = \mathbf{(7.8 \times 10^{-3} \text{ mol dm}^{-3})}$ } (2)
- in 100 cm^3 , there will be $7.8 \times 10^{-4} \text{ mol}$, which is $63.5 \times 7.8 \times 10^{-4} = \mathbf{0.049 - 0.050\%}$ (1) [3]
 Allow ecf on 2nd and 3rd marks 0.5 gets 2 marks only

[Total: 9]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2010	9701	43

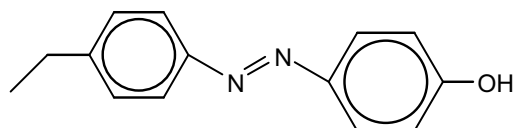
- 3 (a) reaction I: reduction or hydrogenation (1)
 reaction II: oxidation or redox (1) [2]

- (b) thymol: $\text{Br}_2(\text{aq})$ (1) decolourises or white ppt (1)
 or $\text{NaOH}(\text{aq})$ (1) dissolves (1)
 or $\text{FeCl}_3(\text{aq})$ (1) violet/purple (colour) (1)
 menthol: $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$ (1) orange $\rightarrow$ green (1)
 or Lucas test or ZnCl_2/HCl (1) cloudy or white ppt (1)
 menthone: 2,4-DNPH/Brady's reagent (1) orange ppt (1) [6]

[Total: 8]

- 4 reaction I: Cl_2 + light (1) (not aq)
 reaction II: Br_2 + AlBr_3 or Fe or FeBr_3 (1) (not aq)
 reaction III: NaOH , heat in ethanol (1) (allow aqueous EtOH)
 reaction IV: HNO_3 + H_2SO_4 (1) conc and $< 60^\circ\text{C}$ (1) (2 marks)
 reaction V: KMnO_4 + H^+/OH^- + heat (1)
 reaction VI: Sn + HCl (1)
 reaction VII: HNO_2 + HCl , $< 10^\circ\text{C}$ (1)

X is

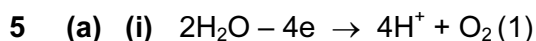


(1) allow $-\text{N}_2-$ and $-\text{ONa}$

[max 8]

[Total: 8]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2010	9701	43

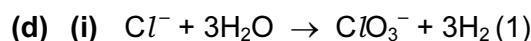


(b) (i) $E^\circ = (1.23 - (-0.83)) = \underline{2.06\text{V}}(1)$

(ii) $E^\circ = (1.36 - (-0.83)) = \underline{2.19\text{V}}(1)$
 (in (i) if (a)(i) as $4(\text{OH}^-) - 4\text{e}^- \rightarrow 2\text{H}_2\text{O} + \text{O}_2$ ecf is $\underline{0.4 - (-0.83) = 1.23}(1)$ – needs working shown) [2]

(c) (i) no change (because $[\text{H}_2\text{O}]$ does not change) (1)
 smaller/less positive (1)

(ii) The (overall) E° for Cl_2 production will decrease, (whereas that) for O_2 production will stay the same. (answer could be in terms of 1st E° decreasing and becoming lower than 2nd)(or E° for Cl_2 becomes less than for O_2) (1) [3]



(ii) $n(\text{C}) = 250 \times 60 \times 60 = (\mathbf{9 \times 10^5} \text{ C})(1)$
 $n(\text{e}^-) = 9 \times 10^5 / 96500 = 9.33 \text{ mol}$
 $n(\text{NaClO}_3) = 9.33 / 6 = (\mathbf{1.55} \text{ mol}) - \text{allow ecf}(1)$
 $\text{Mr}(\text{NaClO}_3) = 106.5$
 $\text{mass}(\text{NaClO}_3) = 1.55 \times 106.5 = \mathbf{165.5} \text{ g}(1)$ (165 – 166 gets 3 marks, 993 gets 2 marks as ecf) [4]

[Total: 11]

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2010	9701	43

- 6 (a) (i) Br_2 (ignore solvent, but do not credit AlCl_3 or HCl or light) (1)
- (ii) curly arrow from $\text{C}=\text{C}$ to Br (1)
another one breaking $\text{Br}-\text{Br}$ bond. (1)
correct intermediate cation and Br^- produced (not $\text{Br}^{\delta-}$) (1) [max 3]
- (b) B is $\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$ (1)
C is $\text{NCCH}_2\text{CH}_2\text{CN}$ (1)
E is $\text{ClCOCH}_2\text{CH}_2\text{COCl}$ (1) [3]
(Allow $(\text{CH}_2)_2$ or C_2H_4 . Allow correct atoms in any order on LHS but order must be correct on RHS)
- (c) reaction II: heat, dilute $\text{H}^+(\text{aq})$ or $\text{HCl}(\text{aq})$ or $\text{HCl}(\text{conc})$ or $\text{H}_2\text{SO}_4(\text{aq})$ (1)
reaction III: $\text{H}_2 + \text{Ni}$ (or other named catalyst) or LiAlH_4 or Na in ethanol (1) [2]
- (d) NH_4^+ (1) [1]
- (e) (i) $[-\text{NHCH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}-\text{COCH}_2\text{CH}_2\text{CO}-]$ (1)
(allow $(\text{CH}_2)_4$ and $(\text{CH}_2)_2$)
(not dimer, needs bonds both ends)
- (ii) HCl (1) [2]
- (f) (i) $[\text{H}^+] = 10^{-\text{pH}} = 10^{-2.6} = 2.51 \times 10^{-3} \text{ (mol dm}^{-3}\text{)}$ (1)
- (ii) $K_a = [\text{H}^+]^2/c = 6.31 \times 10^{-5} \text{ (mol dm}^{-3}\text{)}$ (allow ecf from (i)) (1) [2]
- [Total: 13]
- 7 (a) $\text{NH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2 + \text{HCl} \rightarrow \text{NH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_3^+ \text{Cl}^-$ (1)
 $\text{NH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_3^+ \text{Cl}^- + \text{HCl} \rightarrow \text{Cl}^- \text{NH}_3+\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_3^+ \text{Cl}^-$ (1) [2]
(Deduct 1 only, if Cl^- omitted twice but allow with H^+)
- (b) starts at 11.3 and finished as 1.6 (1)
steep portions at 10 cm^3 and 20 cm^3 volume added (1) [2]
- [Total: 4]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2010	9701	43

- 8 (a) (i) diagram to show tetrahedral arrangement (3D or bond angle marked) (1)
- (ii) 4 covalent bonds/bond pairs (with Cl) **only** or **no lone pairs**. (1) [2]
- (b) (i) steamy/white fumes/gas or heat evolved (1)
(fumes are) HCl (from hydrolysis of Sn-Cl bonds) or exothermic reaction/bond breaking (1)
(can award second mark for HCl (g) in eqn.)
- (ii) $\text{SnCl}_4 + 2\text{H}_2\text{O} \rightarrow \text{SnO}_2 + 4\text{HCl}$ etc. (allow partial hydrolysis and with OHs) (1) [3]
- [Total: 5]
- 9 (a) Sugar/deoxyribose, phosphate, base (or better)(not ribose) (1) [1]
- (b) Diagram showing sugar-phosphate backbone (chain) (1)
- Bases on side-chain (1)
Base paired – A-T or G-C (1)
- H-bonds shown and labelled (1) [4]
- (c) mRNA, ribosome, tRNA all three correct (2)
(mRNA first allow 1 mark) [2]
- (d) (i) $(4 \times 4 \times 4) = 64$ (1)
- (ii) START (or Met) – ser – arg – leu – asp – val (2)
(5 correct order score (1))
- (iii) Amino acid leu is changed to pro (1) [4]
- [Total: 11]

Page 7	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2010	9701	43

- 10 (a) (i)** Partition – substance is distributed between the stationary and mobile phase *or* has different solubility in each phase (1)
 Adsorption – substances form bonds of varying strength with *or* are attracted to *or* are held on to stationary phase. (1)

(ii)

Technique	Separation method
Paper chromatography	Partition
Thin-layer chromatography	Adsorption
Gas/liquid chromatography	Partition

3 correct → (2)

2 correct → (1)

- (iii)** %X = 44% (±2) %; %Y = 56% (±2%) (1)

[5]

- (b) (i)** They are largely composed of (carbon and) hydrogen which are active in the NMR (owtte) *or* protons/H⁺/H exist in different chemical environments (with characteristic absorptions) (1)

- (ii)** 2 correct displayed formulae (1)

In propanone all the protons are in a similar chemical environment (and hence there will be one proton peak.) (1)

In propanal there are (three) different chemical environments and hence there will be (three) proton peaks *or* three different chemical environments *or* three proton peaks (1)

[4]

[Total: 9]

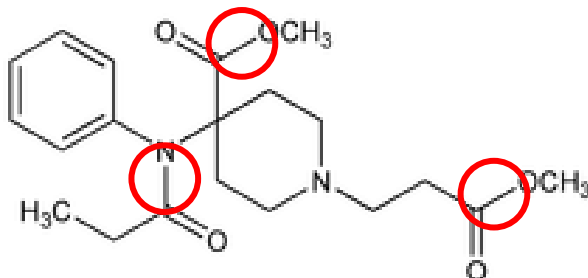
Page 8	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2010	9701	43

11 (a) Any **two** from:

- The drug can be localised in a part of the body (1)
- Smaller doses can be given reducing cost (1)
- Smaller doses can be given with fewer possible side effects (1)
- More immediate action / acts faster (1)

[2]

(b)



(May circle whole functional group)
Any 2 circles (2)

[2]

(c) (i) Must not react with the drug *or* must not breakdown too easily/quickly (1)

(ii) The swelling/hydrolysis would begin in the stomach (and the drug would be released too soon) *or* stomach is acidic or has low pH (1)

[2]

(d) Addition, condensation (1)

Suitable equation for addition (1)

Suitable equation for condensation (1)

(Addition equation must show polymerisation and balance – allow $nX \rightarrow X_{2n}$ or X_n or $X_{n/2}$)

(Condensation can be simple reaction e.g. to single ester or amide but must balance – 2 products)

(If polymerisation RHS must show a repeat unit but can leave out other product – HCl etc.)

[3]

(e) Hydrolysis (1)

[1]

[Total: 11]