

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

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

9701 CHEMISTRY

9701/42

Paper 4 (A2 Structured Questions), maximum raw mark 100

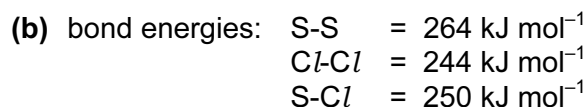
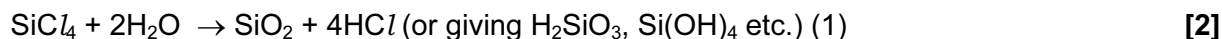
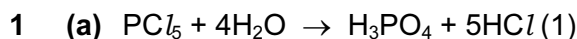
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Mark schemes must be read in conjunction with the question papers and the report on the examination.

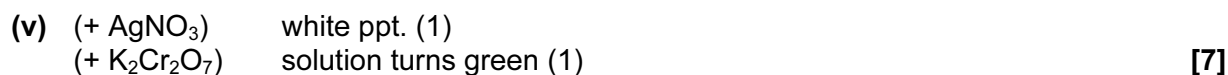
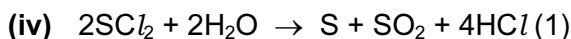
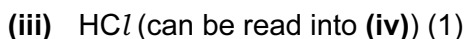
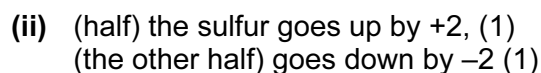
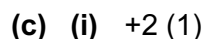
- CIE will not enter into discussions or correspondence in connection with these mark schemes.

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.

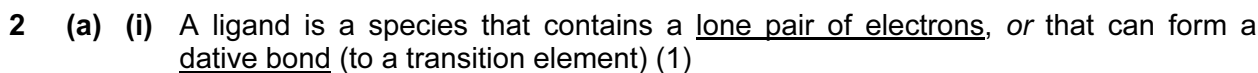
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$\Delta H = 8 \times 264 + 8 \times 244 - 16 \times 250 = +64 \text{ kJ mol}^{-1}$ (2) [2]



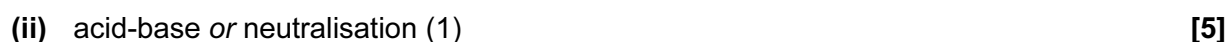
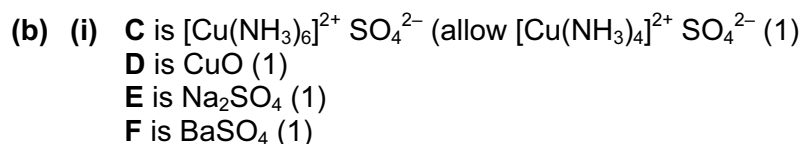
[Total: 11]



(ii)

species	can be a ligand	cannot be a ligand
OH^-	✓	
NH_4^+		✓
CH_3OH	✓	
CH_3NH_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]

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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]

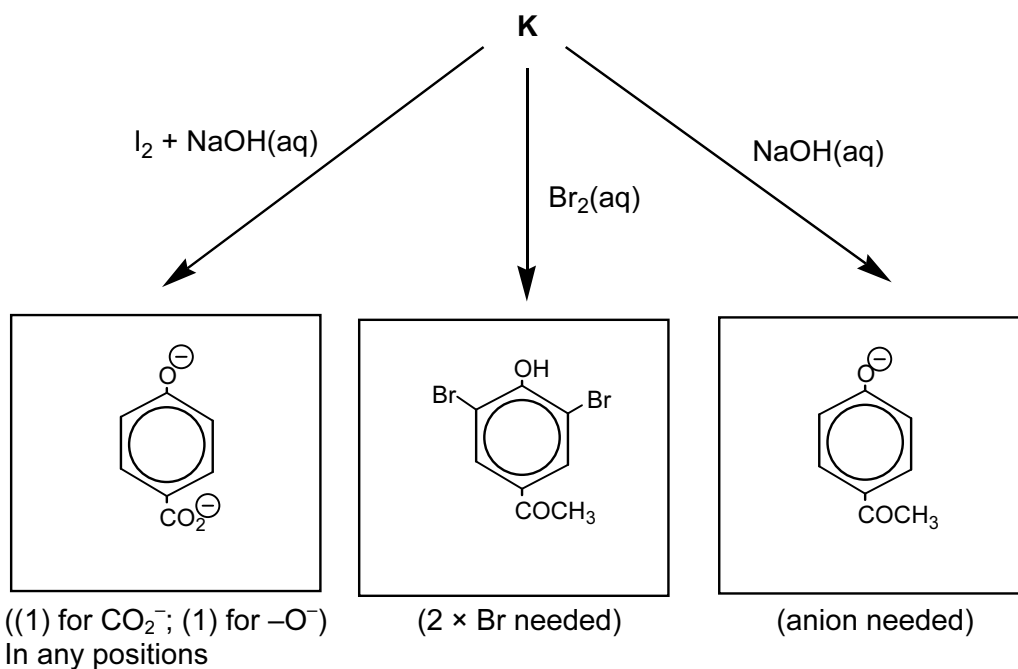
(b) (i) compounds that have the same molecular formula, but different structures (1)

(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)



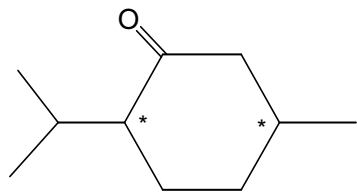
[4]

[8 max 7]

[Total: 14]

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6 (a)

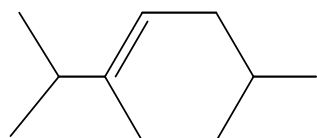


(1) for each centre – more than 2 centres shown deduct 1 mark

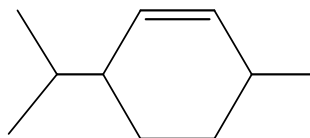
[2]

- (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)

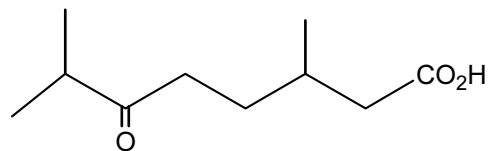
(letters may be reversed)

**M** (1)

[4]

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

(ii)

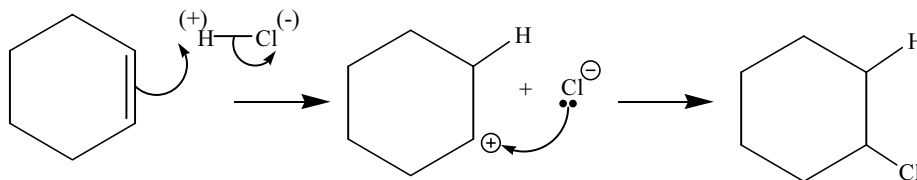
**P**

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]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
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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]

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- 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]