UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2010 question paper

for the guidance of teachers

9701 CHEMISTRY

9701/22 Paper 2 (AS Structured Questions), maximum raw mark 60

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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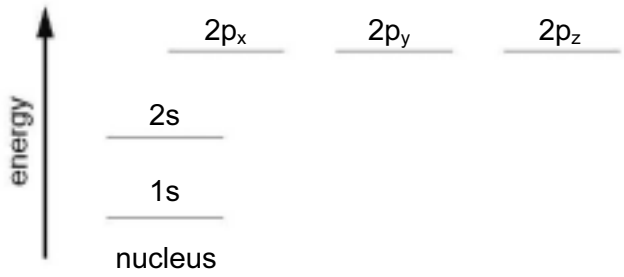
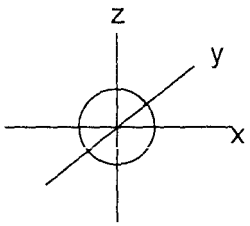
1 (a) (i)



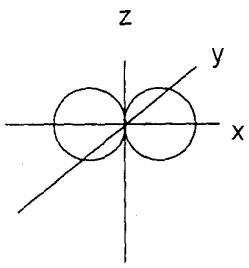
correct 1s and 2s (1)

correct $2p_x$, $2p_y$ and $2p_z$ (1)

(ii)



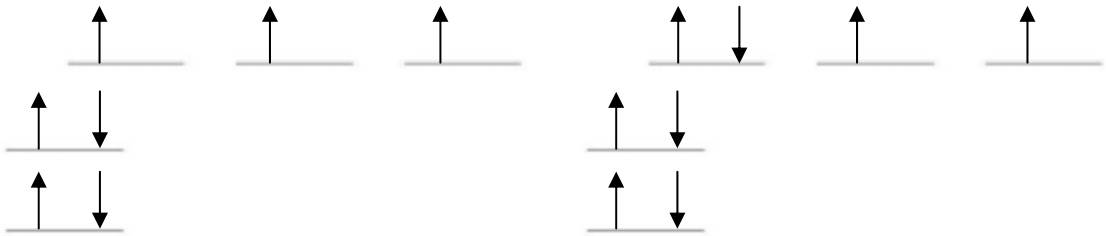
spherical s orbital (1)



double lobed p orbital along one axis (1)

both orbitals correctly labelled (1)

(iii)



nitrogen oxygen

both correct (1) [6]

(b) (i) N 1400 kJ mol^{-1} O 1310 kJ mol^{-1} **both** (1)

(ii) N is all singly filled 2p orbitals **or** O has one filled/paired 2p orbital (1)
these paired 2p electrons in the O atom repel one another (1) [3]

[Total: 9]

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2 (a)

element	particle	formula
copper	cation	Cu^{2+} allow Cu^{+}
argon	atom **or** molecule	Ar

one mark for each correct row **or** column (2 × 1) [2]

(b) **Cu** cations held in 'sea' of delocalised electrons (1)
by strong metallic bonds (1)
Ar van der Waals' forces between molecules (1)
which are weak (1) [4]

(c) **(i)** oxidising agent **or** electron acceptor (1)
Ar has very high first I.E
or E_a for reaction is very high
or Ar has full valency shell/complete octet (1) [2]

(d) from Ne to Xe more electrons in atom (1)
hence more induced dipoles/van der Waals' forces (1) [2]

[Total: 10]

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3 (a)

oxide	Na_2O	MgO	Al_2O_3	SiO_2	P_4O_6	SO_2
bonding	ionic	ionic	ionic/covalent	covalent	covalent	covalent
structure	giant	giant	giant	giant	simple	simple

(i) fully correct 'bonding' row (1)

(ii) fully correct 'structure' row (1) [2]

(b) Al_2O_3 **or** SiO_2 (1) [1]

(c) (i) **Na_2O** $Na_2O + H_2O \rightarrow 2NaOH$ (1)
pH 10–14 (1)
SO_2 $SO_2 + H_2O \rightarrow H_2SO_3$ (1)
pH 2–5 (1)

(ii) $NaOH + H_2SO_3 \rightarrow NaHSO_3 + H_2O$
or $2NaOH + H_2SO_3 \rightarrow Na_2SO_3 + 2H_2O$ (1) [5]

(d) MgO(l) conducts (1)
MgO(l) contains free/mobile ions (1)
SiO_2(l) does not conduct (1)
SiO_2(l) has no free ions (1) [4]

[Total: 12]

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4 **(a)** C : H : O = $\frac{48.7}{12} : \frac{8.1}{1} : \frac{43.2}{16}$ (1)

= 4.06 : 8.1 : 2.70

= 1.5 : 3 : 1

= 3 : 6 : 2

empirical formula is $C_3H_6O_2$ (1) [2]

(b) **(i)** $M_r = \frac{mRT}{pV} = \frac{0.13 \times 8.31 \times 400}{1.00 \times 10^5 \times 58.0 \times 10^{-6}}$ (1)

= 74.5 (1)

(ii) $C_3H_6O_2$ = 36 + 6 + 32 = 74 (1)

$n(C_3H_6O_2)$ = 74.5

hence molecular formula of **E** is $C_3H_6O_2$ (1) [4]

(c) structures of **F** are

$HCO_2CH(CH_3)_2$	$HCO_2CH_2CH_2CH_3$	$CH_3CO_2CH_2CH_3$	$CH_3CH_2CO_2CH_3$
S	**T**	**U**	**V**

each correct structure is worth one mark (3 × 1) [3]

(d) **(i)** H_2SO_4/HC*l*/mineral acid **or** NaOH/KOH (1)

(ii) carboxylic acid **not** 'acid' (1) [2]

(e) **(i)** aldehyde (1)

(ii) must be a primary alcohol (1)

(iii) CH_3OH **or** CH_3CH_2OH **or** $CH_3CH_2CH_2OH$ (1) [3]

(f) **(i)** **S** (1)

(ii) only **S** is **not** the ester of a primary alcohol
or only **S** is the ester of a secondary alcohol (1) [2]

[Total: 16]

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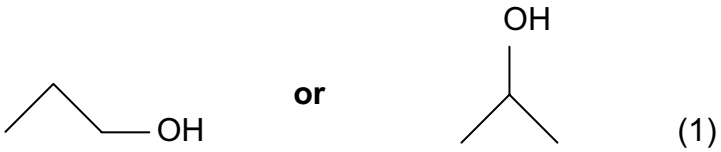
5 (a) (i) propan-1-ol **or** propan-2-ol (1)

(ii)



(1)

(iii) dehydration **or** elimination (1) [3]

(b) (i) carbon (1)
by decomposition/cracking of the alcohol (1)

(ii) to avoid 'sucking back' of water into the hot tube (1)

(iii) SiO_2 (1)

(iv) conc. H_2SO_4 **or** P_4O_{10} **or** Al_2O_3 **or** H_3PO_4 (1) [5]

(c) (i) $CH_3CHBrCH_2Br$ (1)

(ii) $CH_3CH(OH)CH_2OH$ (1)

(iii) CH_3CO_2H (1) [3]

(d) (i) (very) high pressure **or** Ziegler-Natta catalyst (1)

(ii) does not biodegrade **or** gives harmful combustion products (1) [2]

[Total: 13]

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