

**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.

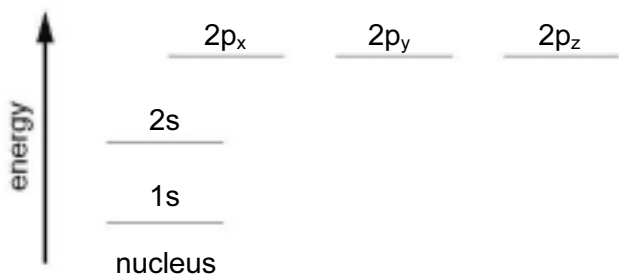
Mark schemes must be read in conjunction with the question papers and the report on the examination.

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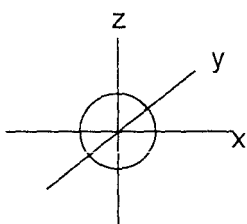
1 (a) (i)



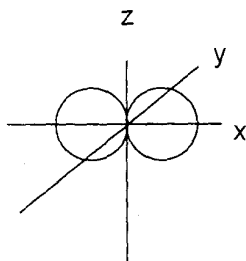
correct 1s and 2s (1)

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

(ii)



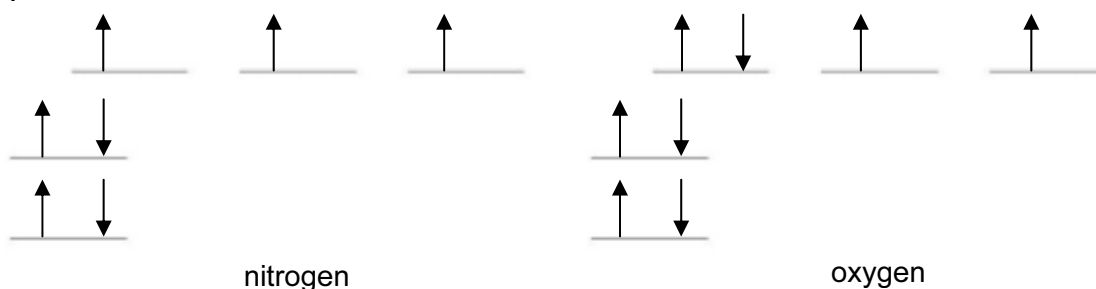
spherical s orbital (1)



double lobed p orbital along one axis (1)

both orbitals correctly labelled (1)

(iii)



both correct (1)

[6]

(b) (i) N  $1400 \text{ kJ mol}^{-1}$  O  $1310 \text{ kJ mol}^{-1}$  **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]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
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2 (a)

element	particle	formula
copper	cation	Cu <sup>2+</sup> allow Cu <sup>+</sup>
argon	atom <b>or</b> 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]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
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3 (a)

oxide	Na <sub>2</sub> O	MgO	Al <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub>	P <sub>4</sub> O <sub>6</sub>	SO <sub>2</sub>
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<sub>2</sub>O<sub>3</sub> or SiO<sub>2</sub> (1) [1]

(c) (i) Na<sub>2</sub>O    Na<sub>2</sub>O + H<sub>2</sub>O → 2NaOH (1)  
pH 10–14 (1)

SO<sub>2</sub>    SO<sub>2</sub> + H<sub>2</sub>O → H<sub>2</sub>SO<sub>3</sub> (1)  
pH 2–5 (1)

(ii) NaOH + H<sub>2</sub>SO<sub>3</sub> → NaHSO<sub>3</sub> + H<sub>2</sub>O  
or 2NaOH + H<sub>2</sub>SO<sub>3</sub> → Na<sub>2</sub>SO<sub>3</sub> + 2H<sub>2</sub>O (1) [5]

(d) MgO(l) conducts (1)  
MgO(l) contains free/mobile ions (1)  
SiO<sub>2</sub>(l) does not conduct (1)  
SiO<sub>2</sub>(l) has no free ions (1) [4]

[Total: 12]

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
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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

$HCO_2CH(CH_3)_2$	$HCO_2CH_2CH_2CH_3$	$CH_3CO_2CH_2CH_3$	$CH_3CH_2CO_2CH_3$
<b>S</b>	<b>T</b>	<b>U</b>	<b>V</b>

each correct structure is worth one mark ( $3 \times 1$ )

[3]

(d) (i)  $H_2SO_4/HCl$ /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)

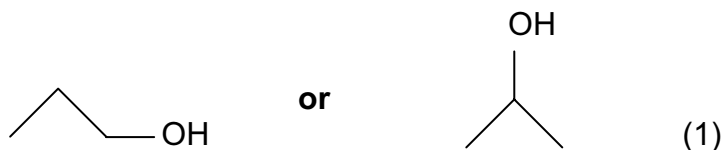
[2]

[Total: 16]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
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5 (a) (i) propan-1-ol **or** propan-2-ol (1)

(ii)



(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<sub>2</sub> (1)

(iv) conc. H<sub>2</sub>SO<sub>4</sub> **or** P<sub>4</sub>O<sub>10</sub> **or** Al<sub>2</sub>O<sub>3</sub> **or** H<sub>3</sub>PO<sub>4</sub> (1)

[5]

(c) (i) CH<sub>3</sub>CHBrCH<sub>2</sub>Br (1)

(ii) CH<sub>3</sub>CH(OH)CH<sub>2</sub>OH (1)

(iii) CH<sub>3</sub>CO<sub>2</sub>H (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]**