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.

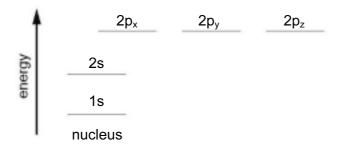
• CIE will not enter into discussions or correspondence in connection with these mark schemes.

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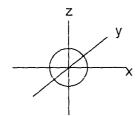
1 (a) (i)



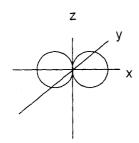
correct 1s and 2s (1)

correct 2px, 2py and 2pz (1)

(ii)

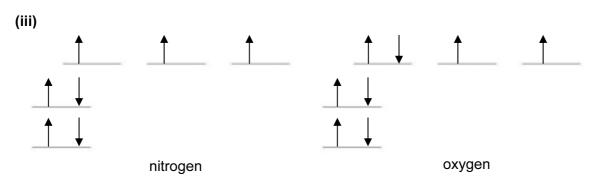


spherical s orbital (1)



double lobed p orbital along one axis (1)

both orbitals correctly labelled (1)



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)

[Total: 9]

[3]

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

element	particle	formula	
copper	cation	Cu²⁺ 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]

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

•	oxide	Na₂O	MgO	Al ₂ O ₃	SiO ₂	P ₄ O 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) Na₂O
$$\longrightarrow$$
 Na₂O + H₂O \longrightarrow 2NaOH (1) pH 10–14 (1) SO₂ \longrightarrow SO₂ + H₂O \longrightarrow H₂SO₃ (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(I) contains free/mobile ions (1)

SiO₂(I) does not conduct (1)

SiO₂(I) has no free ions (1)

[4]

[Total: 12]

Page 5	Page 5 Mark Scheme: Teachers' version		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)
$$M_{\rm r} = \frac{mRT}{pV} = \frac{0.13 \times 8.31 \times 400}{1.00 \times 10^5 \times 58.0 \times 10^{-6}}$$
 (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 ₂ CH(CH ₃) ₂	HCO ₂ CH ₂ CH ₂ CH ₃	CH ₃ CO ₂ CH ₂ CH ₃	CH ₃ CH ₂ CO ₂ CH ₃
s	т	U	V

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

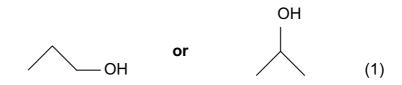
- (d) (i) H₂SO₄/HC1/mineral acid or NaOH/KOH (1)
 - (ii) carboxylic acid **not** 'acid' (1) [2]
- (e) (i) aldehyde (1)
 - (ii) must be a primary alcohol (1)
 - (iii) CH_3OH or CH_3CH_2OH or $CH_3CH_2CH_2OH$ (1) [3]
- **(f) (i) S** (1)
 - (ii) only **S** is **not** the ester of a primary alcohol **or** 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) SiO₂ (1)
 - (iv) conc. H_2SO_4 or P_4O_{10} or Al_2O_3 or H_3PO_4 (1) [5]
- (c) (i) CH₃CHBrCH₂Br (1)
 - (ii) CH₃CH(OH)CH₂OH (1)
 - (iii) CH₃CO₂H (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]