

**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Subsidiary Level and GCE Advanced Level**

**MARK SCHEME for the October/November 2007 question paper**

**9701 CHEMISTRY**

**9701/02**

Paper 2 (Theory 1), maximum raw mark 60

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All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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

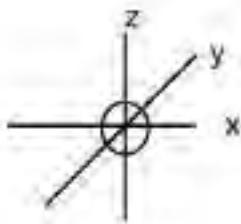
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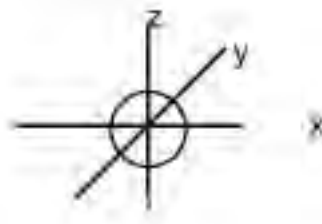
Page 2	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2007	9701	02

1 (a)



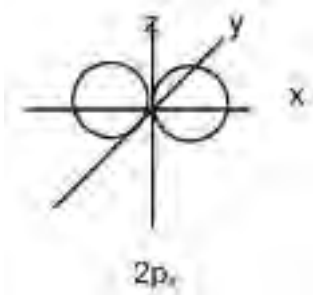
1s

spherical (1)



2s

larger spherical (1)

2p<sub>x</sub>

double lobes along the x-axis (1)

[3]

(b) (i) attraction between bonding electrons and nuclei (1)

attraction is electrostatic (1)

(ii) H<sub>2</sub> s-s **overlap** clearly shownmust **not** be normal dot/cross diagram (1)HCl s-p **overlap** clearly shown

overlap must involve s and p orbitals (1)

[4]

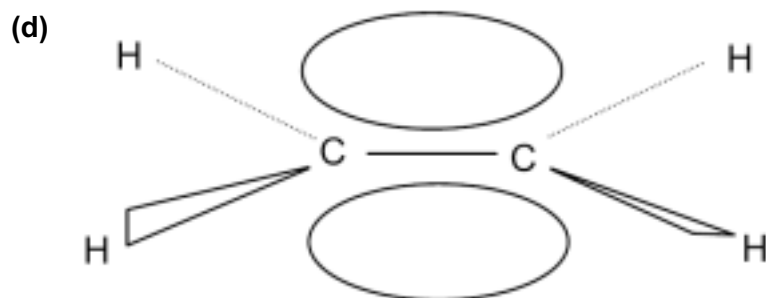
(c) (i) bonding electrons are unequally shared **or**the molecule has a dipole/ $\delta^+$  and  $\delta^-$  ends to molecule (1)

(ii) the H and Cl atoms have different electronegativities

**or** chlorine is more electronegative than hydrogen (1)

[2]

Page 3	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2007	9701	02



**allow** two 'sausages' above **and** below the C-C axis

**or** two p orbitals **overlapping** sideways

to form one (localised)  $\pi$  bond over two carbon atoms

(1) [1]

(e)  $\Delta H_f^\ominus = 2(-393.7) + 2(-285.9) - (-1411)$

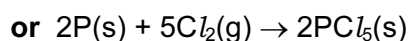
$= + 51.8 \text{ kJ mol}^{-1}$  (units given in qu.)

(3)

penalise errors:      no 2 for  $-393.7$   
                                  no 2 for  $-285.9$   
                                  wrong sign for  $-(-1411)$

[3]

**[Total: 13]**



equation

(1)

state symbols

(1) [2]

(b) (i) giant ionic lattice (may be in diag.)

(1)

strong ionic bonds

(1)

(ii) simple molecular **or** discrete molecules

(may be shown in a diagram)

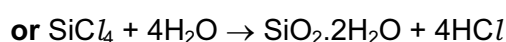
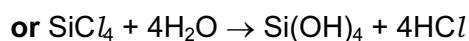
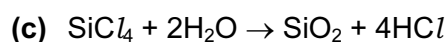
(1)

with **weak** intermolecular forces **or**

**weak** van der Waals' forces

between them

(1) [4]

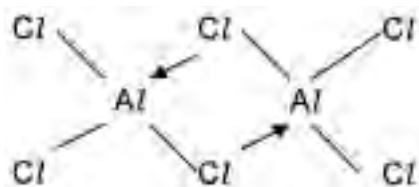


(1) [1]

Page 4	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2007	9701	02

- (d)  $\text{NaCl}$  pH is 7 allow neutral (1)
- $\text{PCl}_5$  pH is between 1 and 4
- do **not** allow acidic (1) [2]

- (e) (i) 460 K  $\text{Al}_2\text{Cl}_6$  (1)
- 1150 K  $\text{AlCl}_3$  (1)
- (ii) correct **dot-and-cross** diagram for  $\text{AlCl}_3$  (1)
- (iii) correct displayed structure for  $\text{Al}_2\text{Cl}_6$  (1)
- two correct co-ordinate bonds (1)



[5]

**[Total: 14]**

- 3 (a)  $\text{P}_4$  (1)
- $\text{S}_8$  (1)
- $\text{Cl}_2$  (1) [3]
- (b) (i) highest  $\text{S}_8$  .....  $\text{P}_4$  .....  $\text{Cl}_2$  lowest
- allow S ... P ... Cl **or** names (1)
- (ii) from  $\text{S}_8$  to  $\text{P}_4$  to  $\text{Cl}_2$
- there are fewer electrons in each molecule (1)
- hence weaker van der Waals' forces (1) [3]

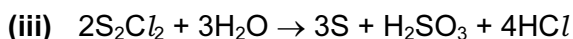
Page 5	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2007	9701	02

(c) (i)  $S_2Cl_2 = (2 \times 32.1) + (2 \times 35.5) = 135.2$

$$n(S_2Cl_2) = \frac{2.7}{135.2} = 0.0199 = 0.02 \quad (1)$$

$$0.02 \text{ mol } S_2Cl_2 \rightarrow \frac{0.96}{32.1} = 0.03 \text{ mol S}$$

$$1.0 \text{ mol } S_2Cl_2 \rightarrow \frac{0.03 \times 1.0}{0.02} = 1.5 \text{ mol S} \quad (1)$$



correct products (1)

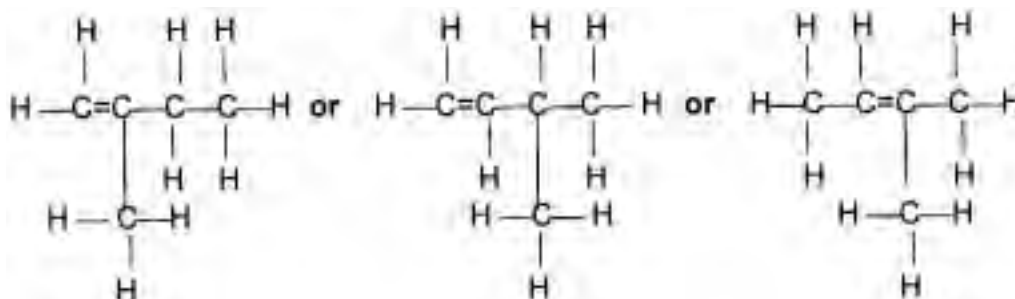
balanced equation (1) [4]

(d) oxidation product is  $H_2SO_3$  (1)

reduction product is S (1) [2]

[Total: 12]

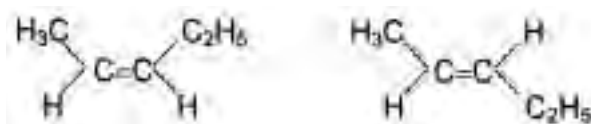
4 (a)



H atoms must be shown.

Structure must not contain any  $CH_3$  groups (1) [1]

(b)



*cis*

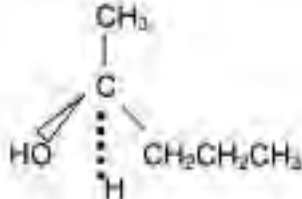
*trans*


(1) [2]

(c)  $CH_3CH(OH)CH_2CH_2CH_3$  (1)

$CH_3CH_2CH(OH)CH_2CH_3$  (1) [2]

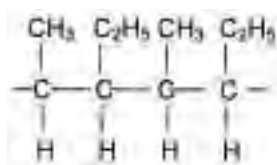
Page 6	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2007	9701	02

- (d)  correct compound (1)
- correct mirror object/mirror image relationship in 3D (1) [2]

- (e)  e.g. cyclopentane structure

allow methylcyclobutane **or** dimethylcyclopropane (1) [1]

- (f) e.g.



two repeat units must be shown  
relative positions of  $-\text{CH}_3$  and  $-\text{C}_2\text{H}_5$  may differ from those shown above (1) [1]

[Total: 9]

- 5 (a) (i)  $\text{Cr}_2\text{O}_7^{2-}/\text{H}^+$  allow  $\text{MnO}_4^-/\text{H}^+$  (1)
- (ii) from orange to **or** purple to colourless  
green **or** green/blue (1) [2]
- (b) (i) to ensure complete oxidation of  $-\text{CH}_2\text{OH}$   
**or** to keep reactants in the reaction flask (1)
- (ii)  $\text{CH}_3\text{CHO}$ /ethanal (1) [2]
- (c) (i)  $\text{CH}_3\text{I}$ /iodomethane (1)
- (ii) nucleophilic substitution **or** hydrolysis (1) [2]

Page 7	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2007	9701	02

**(d) step I**

red P + I<sub>2</sub> **or** HI(aq) **or** KBr/conc H<sub>3</sub>PO<sub>4</sub> **or** PI<sub>3</sub> (1)

heat **but** room temperature for PI<sub>3</sub> (1)

**step II**

KCN in aqueous ethanol (1)

in aqueous ethanol, heat under reflux (1)

allow aqueous ethanol in either place

**step III**

aqueous mineral acid (**not** nitric acid)

**or** NaOH(aq) then aqueous mineral acid (1)

heat (1) [6]

**[Total: 12]**