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

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.

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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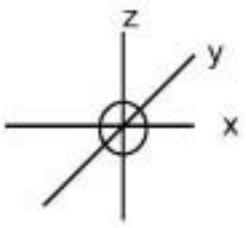
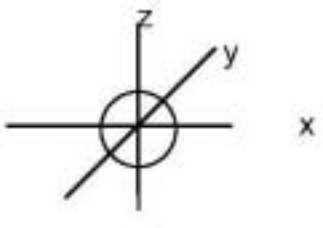
UNIVERSITY of CAMBRIDGE
International Examinations

1 (a)



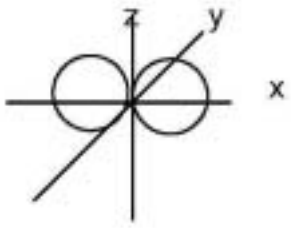
1s

spherical (1)



2s

larger spherical (1)



$2p_x$

double lobes along the *x*-axis (1) [3]

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

attraction is electrostatic (1)

(ii) H_2 s-s **overlap** clearly shown

must **not** be normal dot/cross diagram (1)

HCl s-p **overlap** clearly shown

overlap must involve s and p orbitals (1) [4]

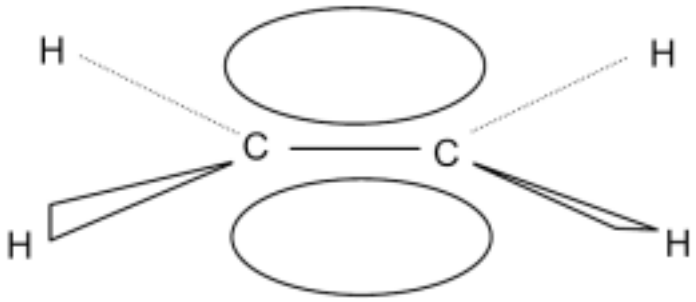
(c) (i) bonding electrons are unequally shared **or**

the molecule has a dipole/δ+ and δ- ends to molecule (1)

(ii) the H and Cl atoms have different electronegativities

or chlorine is more electronegative than hydrogen (1) [2]

(d)



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

or two p orbitals **overlapping** sideways
to form one (localised) π bond over two carbon atoms (1) [1]

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

$= +\ 51.8\ kJ\ mol^{-1}$ (units given in qu.) (3)

penalise errors: no 2 for –393.7
no 2 for –285.9
wrong sign for –(–1411) [3]

[Total: 13]

2 **(a)** $P_4(s) + 10Cl_2(g) \rightarrow 4PCl_5(s)$

or $2P(s) + 5Cl_2(g) \rightarrow 2PCl_5(s)$

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 **<u>weak</u>** intermolecular forces **or**

<u>weak</u> van der Waals' forces

between them (1) [4]

(c) $SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$

or $SiCl_4 + 4H_2O \rightarrow Si(OH)_4 + 4HCl$

or $SiCl_4 + 4H_2O \rightarrow SiO_2.2H_2O + 4HCl$ (1) [1]

(d) NaCl pH is 7 allow neutral (1)

PCl_5 pH is between 1 and 4

do **not** allow acidic (1) [2]

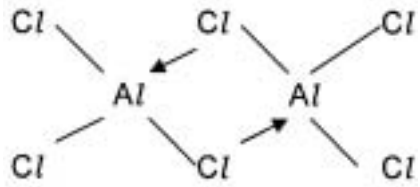
(e) **(i)** 460 K Al_2Cl_6 (1)

1150 K $AlCl_3$ (1)

(ii) correct **dot-and-cross** diagram for $AlCl_3$ (1)

(iii) correct displayed structure for Al_2Cl_6 (1)

two correct co-ordinate bonds (1)



[5]

[Total: 14]

3 **(a)** P_4 (1)

S_8 (1)

Cl_2 (1) [3]

(b) **(i)** highest S_8 ..... P_4..... Cl_2 lowest

allow S ... P ... Cl **or** names (1)

(ii) from S_8 to P_4 to Cl_2

there are fewer electrons in each molecule (1)

hence weaker van der Waals' forces (1) [3]

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

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

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

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

(iii) $2S_2Cl_2 + 3H_2O \rightarrow 3S + H_2SO_3 + 4HCl$

correct products (1)

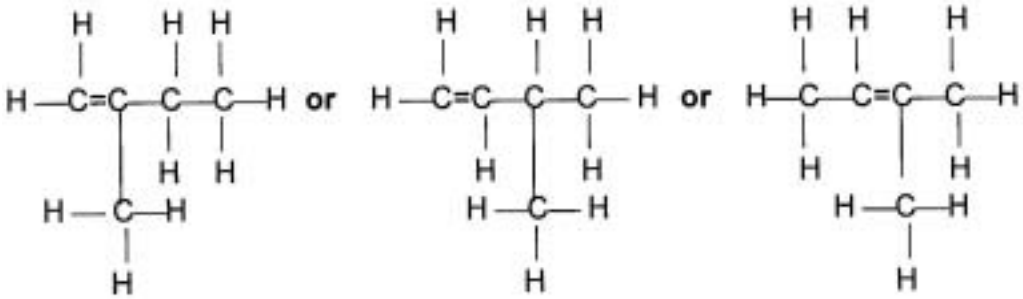
balanced equation (1) [4]

(d) oxidation product is H_2SO_3 (1)

reduction product is S (1) [2]

[Total: 12]

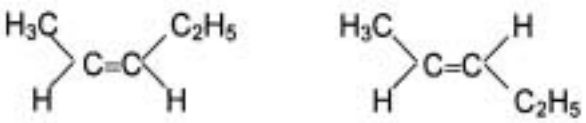
4 (a)



H atoms must be shown.

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

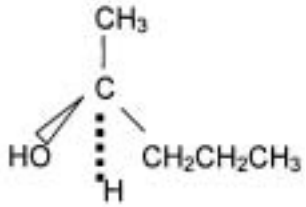
(b)



cis *trans* (1) [2]

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

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

(d) 

correct compound (1)

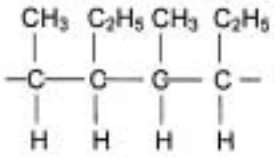
correct mirror object/mirror image relationship in 3D (1) [2]

(e) 

e.g. cyclopentane structure

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

(f) e.g.



two repeat units must be shown
relative positions of $–CH_3$ and $–C_2H_5$ may differ from those shown above (1) [1]

[Total: 9]

5 **(a)** **(i)** $Cr_2O_7^{2–}/H^+$ allow $MnO_4^–/H^+$ (1)

(ii) from orange to **or** purple to colourless

green **or** green/blue (1) [2]

(b) **(i)** to ensure complete oxidation of $–CH_2OH$

or to keep reactants in the reaction flask (1)

(ii) CH_3CHO/ethanal (1) [2]

(c) **(i)** CH_3I/iodomethane (1)

(ii) nucleophilic substitution **or** hydrolysis (1) [2]

(d) step I

red P + I_2 **or** HI(aq) **or** KBr/conc H_3PO_4 **or** PI_3 (1)

heat **but** room temperature for PI_3 (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]