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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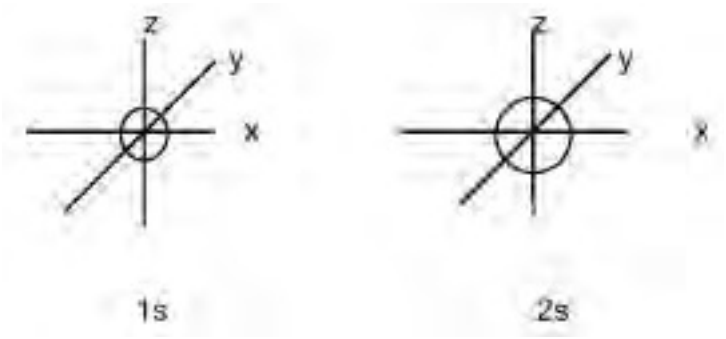
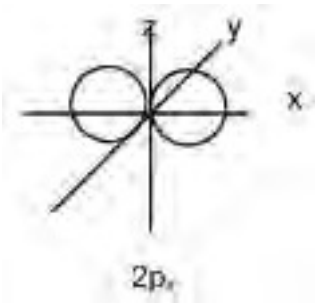
1 (a)



spherical (1) larger spherical (1)



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)

HC*l* 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 C*l* atoms have different electronegativities

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

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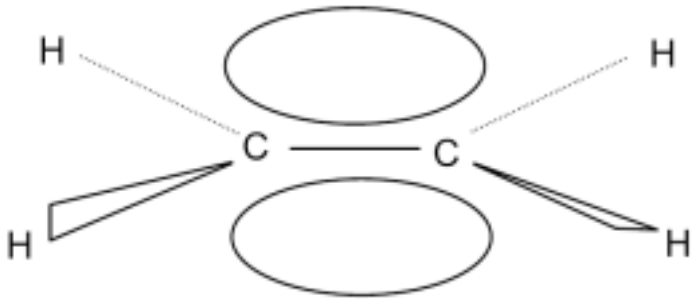
(d)



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]

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

PCl_5 pH is between 1 and 4

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

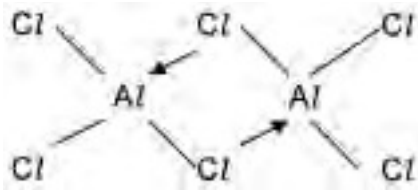
(e) **(i)** 460 K Al_2Cl_6 (1)

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]

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(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)

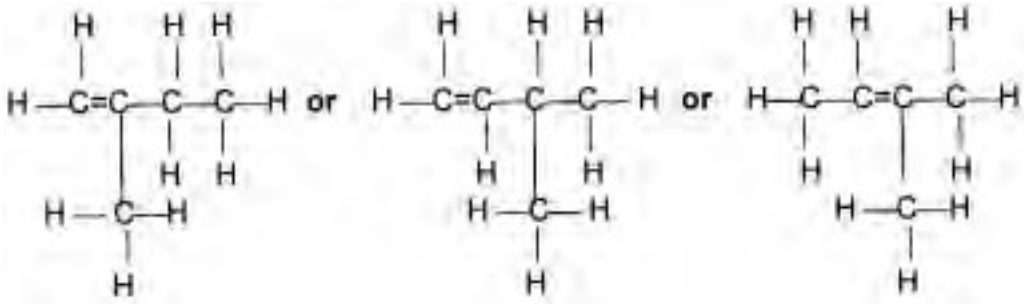
balanced equation (1) [4]

(d) oxidation product is H_2SO_3 (1)

reduction product is S (1) [2]

[Total: 12]

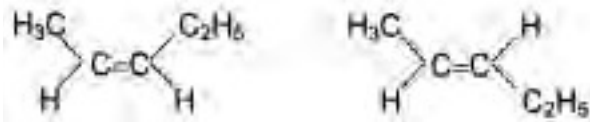
4 (a)



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]

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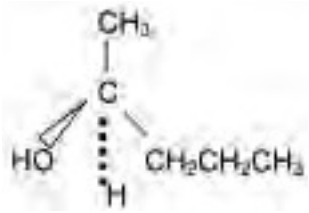
(d) 

correct compound (1)

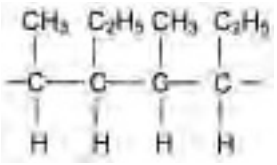
correct mirror object/mirror image relationship in 3D (1) [2]

(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]

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(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]

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