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

9701/21 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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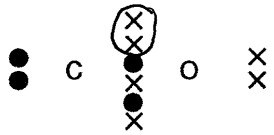
UNIVERSITY of CAMBRIDGE
International Examinations

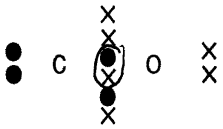
1 **(a)** fewer electrons in Cl_2 than in Br_2 (1)
smaller van der Waals' forces in Cl_2 **or** stronger van der Waals' forces in Br_2 (1) [2]

(b) CO has a permanent dipole **or** N_2 does not (1)
permanent dipole-permanent dipole interactions are stronger than those from induced dipoles (1) [2]

(c) **(i)** a co-ordinate bond (1)



(ii) a covalent bond (1)



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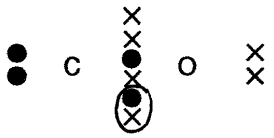
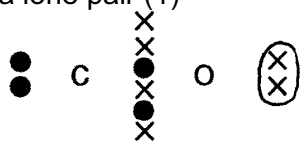


(iii) a lone pair (1)



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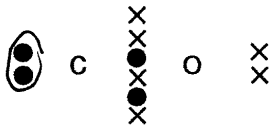
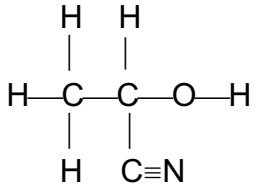


penalise any groups of 3 or 4 electrons that are circled [3]

(d) CO and HCN both have a dipole **or** N_2 does not have a dipole (1) [1]

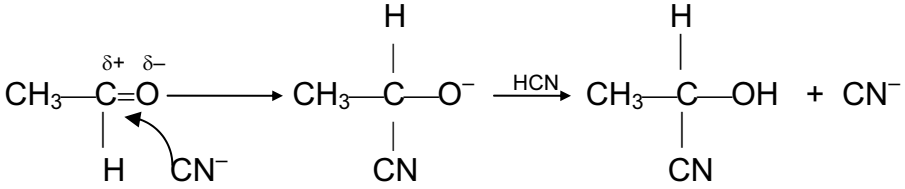
(e) (i)



C≡N must be shown (1)

(ii) nucleophilic addition (1)

(iii)



C=O dipole correctly shown **or** correct curly arrow on C=O (1)
attack on $C^{\delta+}$ by C of CN^- (1)
correct intermediate (1)
CN^- regenerated (1) [5 max]

[Total: 13]

2 (a) (i) new graph has **lower** maximum (1)
maximum is **to the right of** previous maximum (1)

(ii) **H** is at E_a (1) [3]

(b) the minimum amount of energy molecules must have **or** energy required (1)
in order for the reaction to take place (1) [2]

(c) (i) iron **or** iron oxide (1)
100 to 500 atm **and** 400–550°C
units necessary – allow other correct values and units (1)

(ii) **C** is placed to the left of **H** (1)

(iii) more molecules now have energy $>E_a$ (1) [4]

(d) reaction 1
has greater E_a (1)
because energy is needed to break covalent bonds (1)
reaction 2
has lower E_a
or actual reaction is $H^+ + OH^- \rightarrow H_2O$
or reaction involves ions (1)
opposite charges attract (1) [4]

[Total: max 12]

3 **(a)** Accept only symbols.

(i) S or S_8 (1)

(ii) K or K^+ (1)

(iii) Na – allow K or Li (1)

(iv) C*l* **or** Br **or** F (1)

(v) Mg **or** Ca **or** Li
allow Ni, Cu, or Zn (1) [5]

(b) Accept only formulae.

(i) F_2O (1)

(ii) SO_2 **and** SO_3
or P_2O_3/P_4O_6 **and** P_2O_5/P_4O_{10}
or any two from N_2O_3, NO_2/N_2O_4, N_2O_5
or any two from C*l*$_2$O, C*l*O$_2$, C*l*O$_3$, C*l*$_2$O$_7$ (1+1) [3]

(c) **(i)** NaF, MgF_2, A*l*F_3 – any two (1)

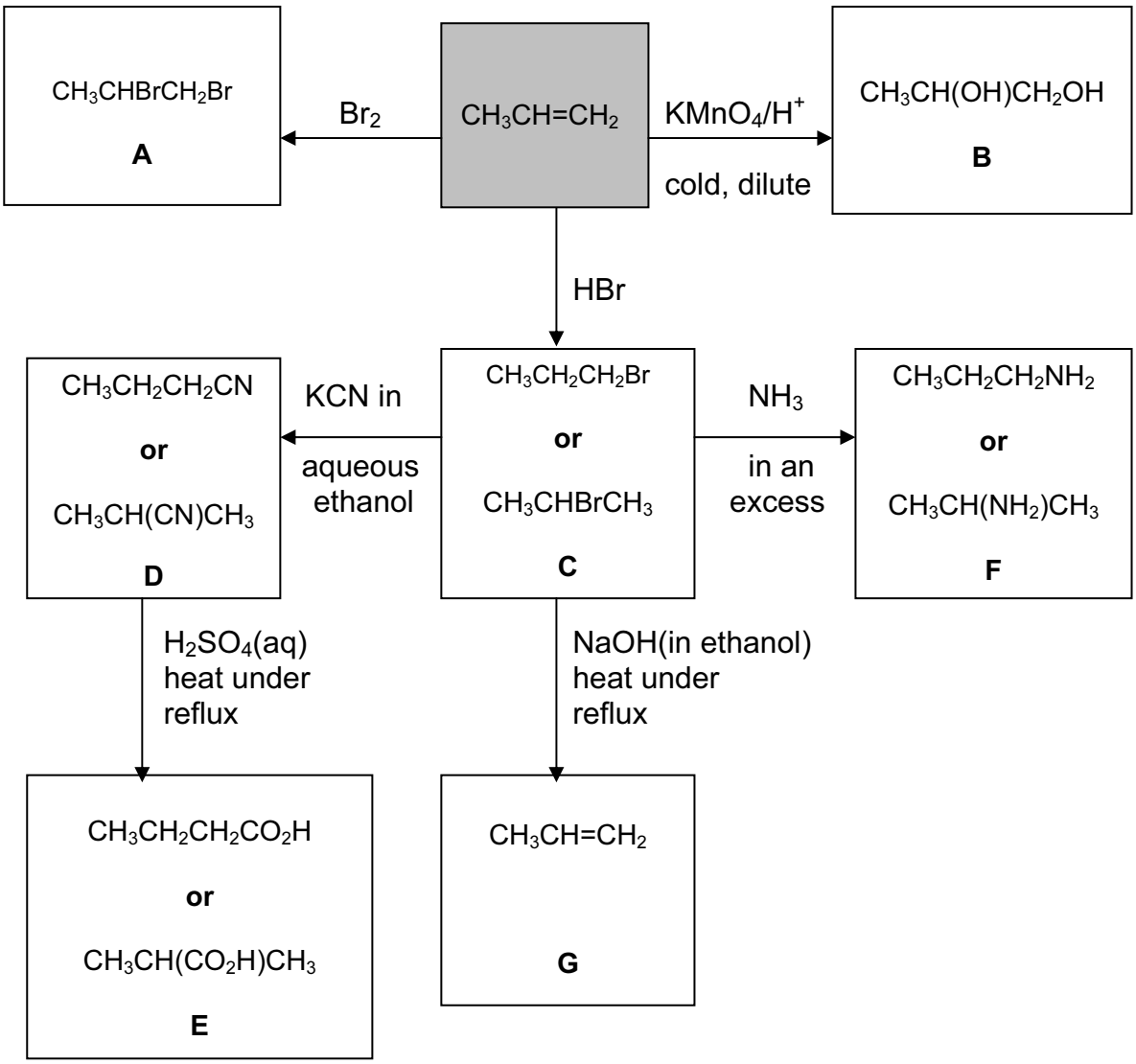
(ii) octahedral (1)

(iii) I atom is larger than C*l* atom (1)

(iv) cannot pack 7 F atoms around C*l* atom
or can pack 7 F atoms around I atom (1) [4]

[Total: 12]

4 (a)



give 1 for each correct structure (7 × 1) [7]

(b) (i) ester (1)

(ii) heat under reflux (1)
trace of conc. H_2SO_4 **or** presence of HC*l* (g) (1) [3]

[Total: 10]

5 **(a)** **(i)** same molecular formula
but different structural formula/structure (1)

(ii) asymmetric C atom/chiral centre present (1)
>C=C< bond present (1) [3]

(b) $NaO_2CCH(OH)CH(OH)CO_2Na$ (1) [1]

(c) no **because** there is no chiral carbon atom present (1) [1]

(d) **(i)** C : H : O = $\frac{35.8}{12} : \frac{4.5}{1} : \frac{59.7}{16}$ this mark is for correct use of A_r values (1)
C : H : O = 2.98 : 4.5 : 3.73
C : H : O = 1 : 1.5 : 1.25 this mark is for evidence of correct calculation (1)
gives empirical formula of **W** is $C_4H_6O_5$

(ii) $C_4H_6O_5 = 12 \times 4 + 1 \times 6 + 16 \times 5 = 134$
molecular formula of **W** is $C_4H_6O_5$ (1) [3]

(e) (i) $n(OH^-) = \dfrac{29.4 \times 100}{1000} = 0.0294$ (1)

$n(\mathbf{W}) = \dfrac{1.97}{134} = 0.0147$ (1)

no. of $-CO_2H$ groups present

in one molecule of **W** $= \dfrac{0.0294}{0.0147} = 2$ (1)

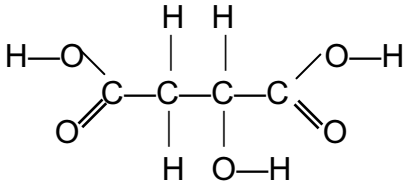
or $n(OH^-) = \dfrac{29.4 \times 1.00}{1000} = 0.0294$ (1)

1.97 g **W** $\equiv$ 0.0294 mol NaOH

134 g **W** $\equiv \dfrac{0.0294 \times 134}{1.97} = 1.999 \approx 2$ mol NaOH (1)

no. of $-CO_2H$ groups present in 1 molecule of **W** = 2 (1) [3]

(ii)



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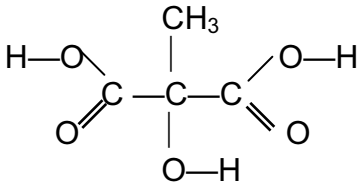

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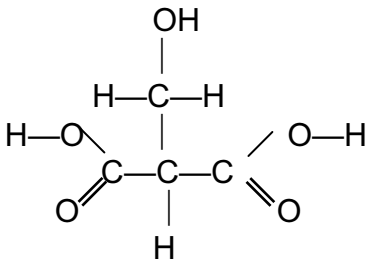

one correct structure (1)
correctly displayed (1)
allow any **correct** ether [2]

[Total: 13]