

**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.

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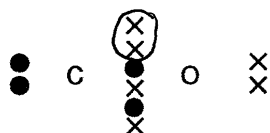


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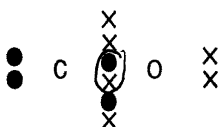
1 (a) fewer electrons in  $Cl_2$  than in  $Br_2$  (1)  
smaller van der Waals' forces in  $Cl_2$  **or** stronger van der Waals' forces in  $Br_2$  (1) [2]

(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]

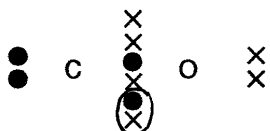
(c) (i) a co-ordinate bond (1)



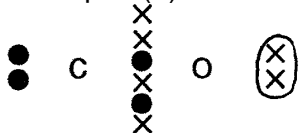
(ii) a covalent bond (1)



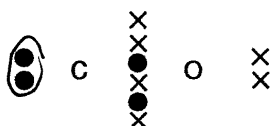
or



(iii) a lone pair (1)



or

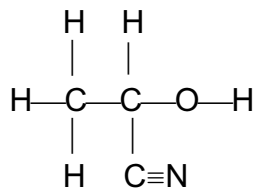


penalise any groups of 3 or 4 electrons that are circled [3]

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

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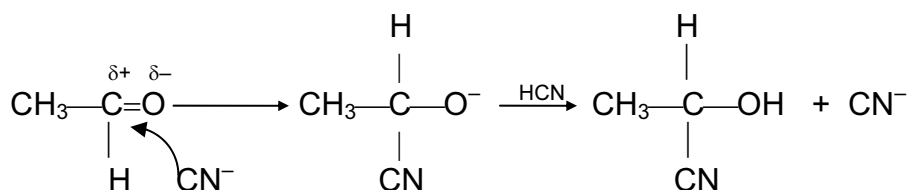
(e) (i)



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<sup>δ+</sup> by C of CN<sup>-</sup> (1)

correct intermediate (1)

CN<sup>-</sup> regenerated (1)

[5 max]

[Total: 13]

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- 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  $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$   
**or** reaction involves ions (1)  
opposite charges attract (1) [4]

[Total: max 12]

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3 (a) Accept only symbols.

- (i) S or S<sub>8</sub> (1)
- (ii) K or K<sup>+</sup> (1)
- (iii) Na – allow K or Li (1)
- (iv) Cl or Br or F (1)
- (v) Mg or Ca or Li  
allow Ni, Cu, or Zn (1)

[5]

(b) Accept only formulae.

- (i) F<sub>2</sub>O (1)
- (ii) SO<sub>2</sub> and SO<sub>3</sub>  
or P<sub>2</sub>O<sub>3</sub>/P<sub>4</sub>O<sub>6</sub> and P<sub>2</sub>O<sub>5</sub>/P<sub>4</sub>O<sub>10</sub>  
or any two from N<sub>2</sub>O<sub>3</sub>, NO<sub>2</sub>/N<sub>2</sub>O<sub>4</sub>, N<sub>2</sub>O<sub>5</sub>  
or any two from Cl<sub>2</sub>O, ClO<sub>2</sub>, ClO<sub>3</sub>, Cl<sub>2</sub>O<sub>7</sub> (1+1)

[3]

(c) (i) NaF, MgF<sub>2</sub>, AlF<sub>3</sub> – any two (1)

(ii) octahedral (1)

(iii) I atom is larger than Cl atom (1)

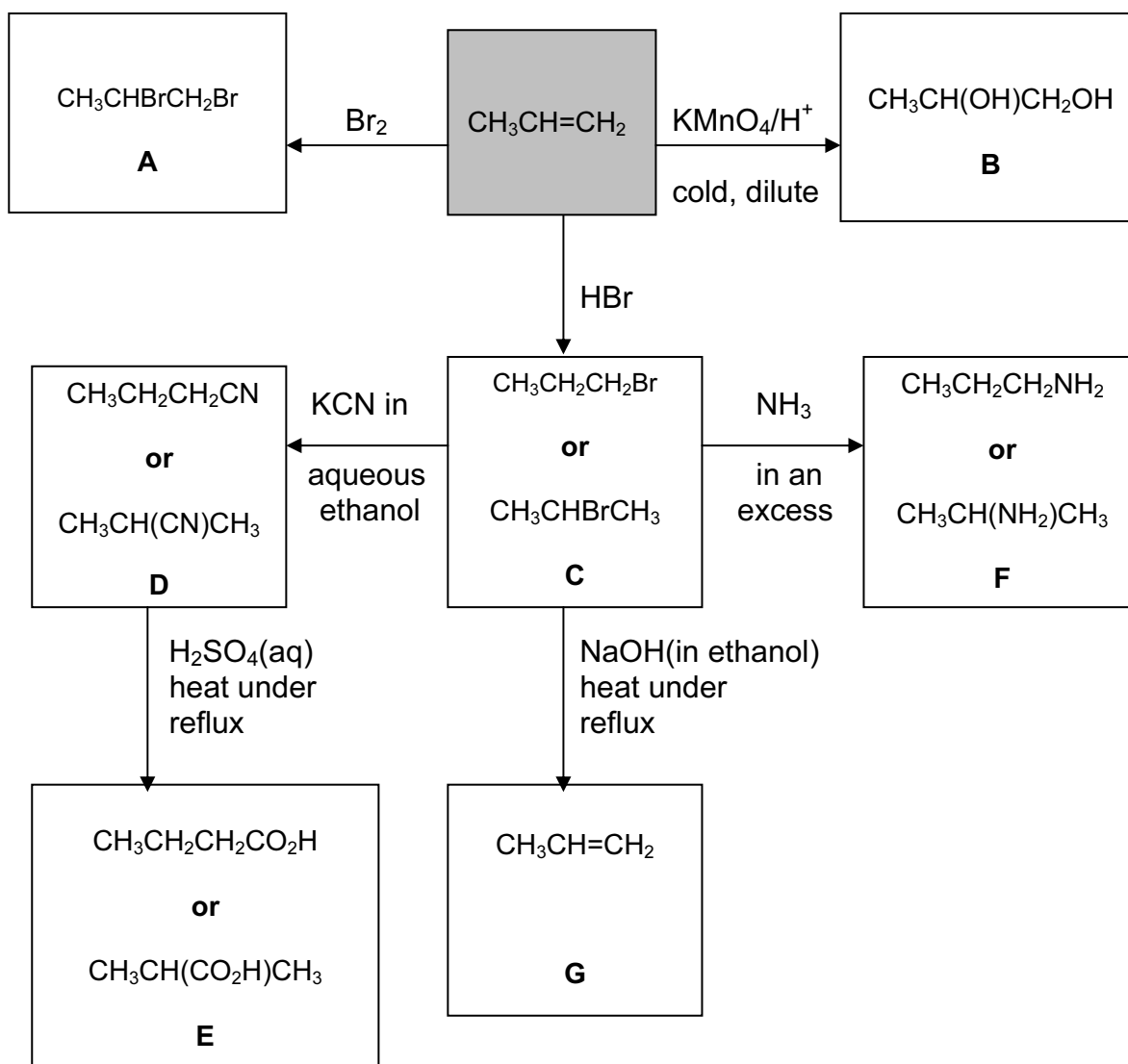
(iv) cannot pack 7 F atoms around Cl atom  
or can pack 7 F atoms around I atom (1)

[4]

[Total: 12]

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4 (a)



give 1 for each correct structure ( $7 \times 1$ )

[7]

(b) (i) ester (1)

(ii) heat under reflux (1)  
trace of conc.  $\text{H}_2\text{SO}_4$  or presence of  $\text{HCl}$  (g) (1)

[3]

[Total: 10]

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- 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)  $\text{NaO}_2\text{CCH}(\text{OH})\text{CH}(\text{OH})\text{CO}_2\text{Na}$  (1) [1]
- (c) no **because** there is no chiral carbon atom present (1) [1]
- (d) (i)  $\text{C} : \text{H} : \text{O} = \frac{35.8}{12} : \frac{4.5}{1} : \frac{59.7}{16}$  this mark is for correct use of  $A_r$  values (1)  
 $\text{C} : \text{H} : \text{O} = 2.98 : 4.5 : 3.73$   
 $\text{C} : \text{H} : \text{O} = 1 : 1.5 : 1.25$  this mark is for evidence of correct calculation (1)  
gives empirical formula of **W** is  $\text{C}_4\text{H}_6\text{O}_5$
- (ii)  $\text{C}_4\text{H}_6\text{O}_5 = 12 \times 4 + 1 \times 6 + 16 \times 5 = 134$   
molecular formula of **W** is  $\text{C}_4\text{H}_6\text{O}_5$  (1) [3]

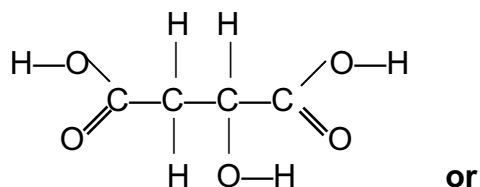
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(e) (i)  $n(\text{OH}^-) = \frac{29.4 \times 100}{1000} = 0.0294$  (1)  
 $n(\mathbf{W}) = \frac{1.97}{134} = 0.0147$  (1)  
 no. of  $-\text{CO}_2\text{H}$  groups present  
 in one molecule of  $\mathbf{W} = \frac{0.0294}{0.0147} = 2$  (1)

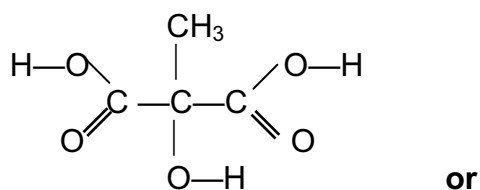
or  $n(\text{OH}^-) = \frac{29.4 \times 1.00}{1000} = 0.0294$  (1)  
 $1.97 \text{ g } \mathbf{W} \equiv 0.0294 \text{ mol NaOH}$   
 $134 \text{ g } \mathbf{W} \equiv \frac{0.0294 \times 134}{1.97} = 1.999 \approx 2 \text{ mol NaOH}$  (1)  
 no. of  $-\text{CO}_2\text{H}$  groups present in 1 molecule of  $\mathbf{W} = 2$  (1)

[3]

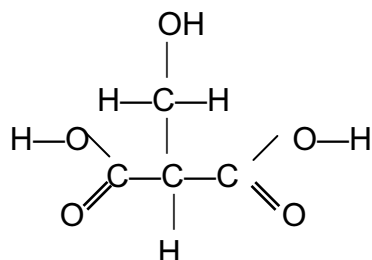
(ii)



or



or



one correct structure (1)  
 correctly displayed (1)  
 allow any correct ether

[2]

[Total: 13]