UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the May/June 2007 question paper

9701 CHEMISTRY

9701/02 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.

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1 (a) (i) between 117° and 120° [1]

(ii) 

14 electrons must be shown
single N-N bond [1]
lone pair on each N atom [1]

(iii) between 107° and 109° [1] **[4]**

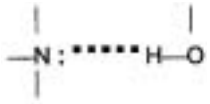
(b) ethene – van der Waals' forces [1]
hydrazine – hydrogen bonds [1]

hydrogen bonds are stronger
or van der Waals' forces are weaker [1] **[3]**

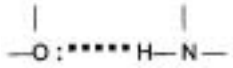
(c) correct dipole on O—H and N—H bonds [1]

labelled hydrogen bond shown
between an O atom of H_2O and a H atom of N_2H_4
or between an N atom of N_2H_4 and a H atom of H_2O [1]

lone pair on O atom *or* on N atom *in the H bond*

i.e. 

or



[1] **[3]**

(d) (i) $CH_2 = CH_2 + HCl \rightarrow CH_3CH_2Cl$ [1]

(ii) electrophilic addition [1]

(iii) there is no further unsaturation
or CH_3CH_2Cl molecule is saturated
or no possibility of addition
or no free radicals are present [1] **[3]**

(e) (i) acid – base/neutralization [1]

(ii) N atom has a lone pair of electrons
or N atom can behave as a base
or N atom can form dative bond [1]

(iii) each N atom has a lone pair
or each nitrogen atom can behave as a base
or each nitrogen atom can form a dative bond [1] **[3]**

[Total: 16]

2 **(a)** rate of forward reaction equals
rate of backward reaction
or equilibrium concentrations remain constant
while reaction is occurring [1] **[1]**

(b) $K_C = \dfrac{[CH_3CO_2C_2H_5][H_2O]}{[CH_3CO_2H][C_2H_5OH]}$ [1] **[1]**

(c) $CH_3CO_2H + C_2H_5OH \rightleftharpoons CH_3CO_2C_2H_5 + H_2O$

initial moles	0.5	0.5	0.1	0.1
equil. moles	$(0.5 - x)$	$(0.5 - x)$	$(0.1 + x)$	$(0.1 + x)$
equil. concn./ mol dm^{-3}	$\frac{(0.5-x)}{V}$	$\frac{(0.5-x)}{V}$	$\frac{(0.1+x)}{V}$	$\frac{(0.1+x)}{V}$

[1]

$$K_c = \frac{(0.1+x)^2}{(0.5-x)^2} = 4$$ [1]

gives $x = 0.3$ [1]

$n(CH_3CO_2H) = n(C_2H_5OH) = 0.2$ **and**

$n(CH_3CO_2C_2H_5) = n(H_2O) = 0.4$ [1]

allow ecf on wrong equil. moles subject to $x < 0.5$ **[4]**

(d)

alcohol / reagent(s) and conditions	$CH_3CH_2CH_2CH_2OH$	$CH_3CH_2CH(OH)CH_3$	$(CH_3)_3COH$
red phosphorus and iodine heat under reflux	X	$CH_3CH_2\underset{\displaystyle I}{\underset{\vert}{C}}HCH_3$ [1]	X
concentrated H_2SO_4 heat	X	X	$CH_3\!-\!\underset{\displaystyle CH_3}{\underset{\vert}{C}}\!=\!CH_2$ [1]
$Cr_2O_7^{2-}/H^+$ heat under reflux	$CH_3CH_2CH_2CO_2H$ [1]	$CH_3CH_2COCH_3$ [1]	no reaction [1]

[5]

[Total: 11]

3 (a)

	1s	2s	2p	3s	3p	3d	4s	4p	4d	
Ca	2	2	6	2	6	0	2	0	0	[1]
Sr^{2+}	2	2	6	2	6	10	2	6		[1]

[2]

(b) (i) more shells of electrons [1]

(ii) outermost shell has been removed [1]

(iii) outermost electrons are further from nucleus/there are more shells [1]
increased shielding [1] **[4]**

(c) (i) very slow reaction [1]
formation of bubbles of gas [1]

$Mg + H_2O \rightarrow MgO + H_2$
allow $Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$ [1]

(ii) faster reaction than with Mg [1]

white suspension formed
or evolution of gas
or calcium dissolves/disappears [1]

$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$ [1]

allow 1 mark in **(i)** *or* **(ii)** if gas is described as colourless [1] **[7]**

(d) (i) gas evolved [1]
gas is brown [1]

(ii) $2Sr(NO_3)_2 \rightarrow 2SrO + 4NO_2 + O_2$
correct products [1]
balanced equation [1] **[4]**

[Total: 17 max. 16]

4 **(a)** **(i)** white ppt. [1]
AgCl [1]

(ii) white/steamy/misty fumes [1]
HCl [1]

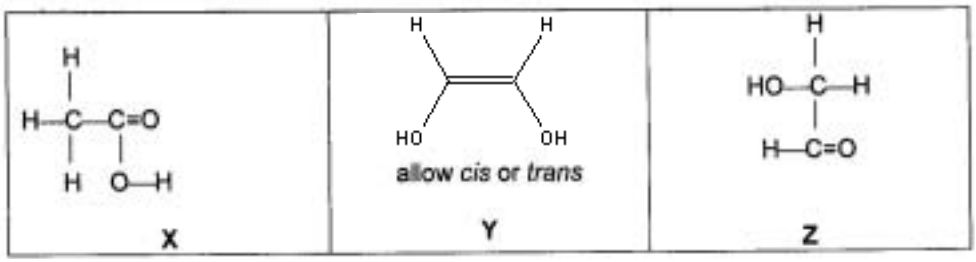
(iii) colourless gas evolved *or* Na dissolves [1]
H_2 *or* CH_3ONa [1] **[6]**

(b) $C : H : O = \frac{40}{2} : \frac{6.7}{1} : \frac{53.3}{16}$ [1]

= 3.33 : 6.7 : 3.33 [1]

= 1 : 2 : 1 **[2]**

(c)



[1] [1] [1] **[3]**

(d) **(i)** with solid $NaHCO_3$
candidate's carboxylic acid [**X** above] [1]
gas/CO_2 evolved [1]

(ii) with Tollens' reagent
candidate's aldehyde [**Z** above] [1]
Ag mirror/Ag ppt. [1] **[4]**

(e) two correct structures [of **Y** above] [1]
correctly labelled *cis* and *trans* [1] **[2]**

[Total: 17]