**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Subsidiary Level and GCE Advanced Level**

# MARK SCHEME for the May/June 2011 question paper

# for the guidance of teachers

## 9701 CHEMISTRY

**9701/22** 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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**1** **(a)** $K_c = \dfrac{[CH_3CH_2R][H_20]}{[CH_3CH_2H][ROH]}$ (1)

no units (1) [2]

**(b)** **(i)** $n(NaOH) = \dfrac{22.5 \times 2.00}{1000} = 0.045$ (1)

**(ii)** $n(NaOH) = n(HCl) = 0.005$ (1)

**(iii)** $CH_3CO_2H + NaOH \rightarrow CH_3CO_2Na + H_2O$ (1)

**(iv)** $n(NaOH) = 0.045 - 0.005 = 0.04$
allow ecf on **(i)** and/or **(ii)** (1) [4]

**(c)** **(i)** $n(NaOH)$ **and** $n(CH_3CO_2H) = 0.04$ (1)
$n(CH_3CO_2R)$ **and** $n(H_2O) = 0.06$ (1)

**(ii)** $K_c = \dfrac{0.06 \times 0.06}{0.04 \times 0.04} = 2.25$

allow ecf on wrong values in **(b)(i)**
allow ecf on wrong expression in **(a)** (1) [3]

**(d)** $E_a$ for reaction with ester is high **or**
$E_a$ for reaction with acid is low
**or**
reaction with ester is slow **or**
reaction with acid is fast (1) [1]

**(e)** equilibrium moves to RHS/more ester would be formed (1)
to maintain value of $K_c$ **or**
to restore system to equilibrium (1) [2]

**[Total: 12]**

**2 (a)** $CH_2=CH_2 + HF \rightarrow CH_3CH_2F$

| | | | | | |
|---|---|---|---|---|---|
| bonds | 4 C-H | 1640 | bonds | 5 C-H | 2050 |
| broken | 1 C=C | 610 | made | 1 C-C | 350 |
| /kJ mol$^{-1}$ | 1 H-F | 562 | /kJ mol$^{-1}$ | 1 C-F | *E* |
| | | 2812 | | | (2400 + *E*) |

breaking reactant bonds requires
4 x 410 + 610 + 562 = 2812 kJ mol$^{-1}$ (1)

making product bonds gives

5 x 410 + 350 + *E* = (2400 + *E*) kJ mol$^{-1}$ (1)

$\Delta H^{\ominus}_{reaction}$ = - (2400 + *E*) + 2812 = – 73 kJ mol$^{-1}$ (1)

(2400 + *E*) = 2812 + 73 = 2885 kJ mol$^{-1}$

*E* = 2885 - 2400 = 485 kJ mol$^{-1}$ (1)

allow ecf on wrong bond energy values and/or incorrect arithmetic [4]

**(b)** any **two** from
non-toxic
unreactive
volatile
non-flammable
easily liquefied (1 + 1) [2]

**(c)** in $CCl_2F_2$
C-C*l* bond energy is 340 kJ mol$^{-}$1 and is weaker than C-F or C-H bonds (1)
C-C*l* bond is broken by uvl **or**
C*l* free radicals are formed (1) [2]

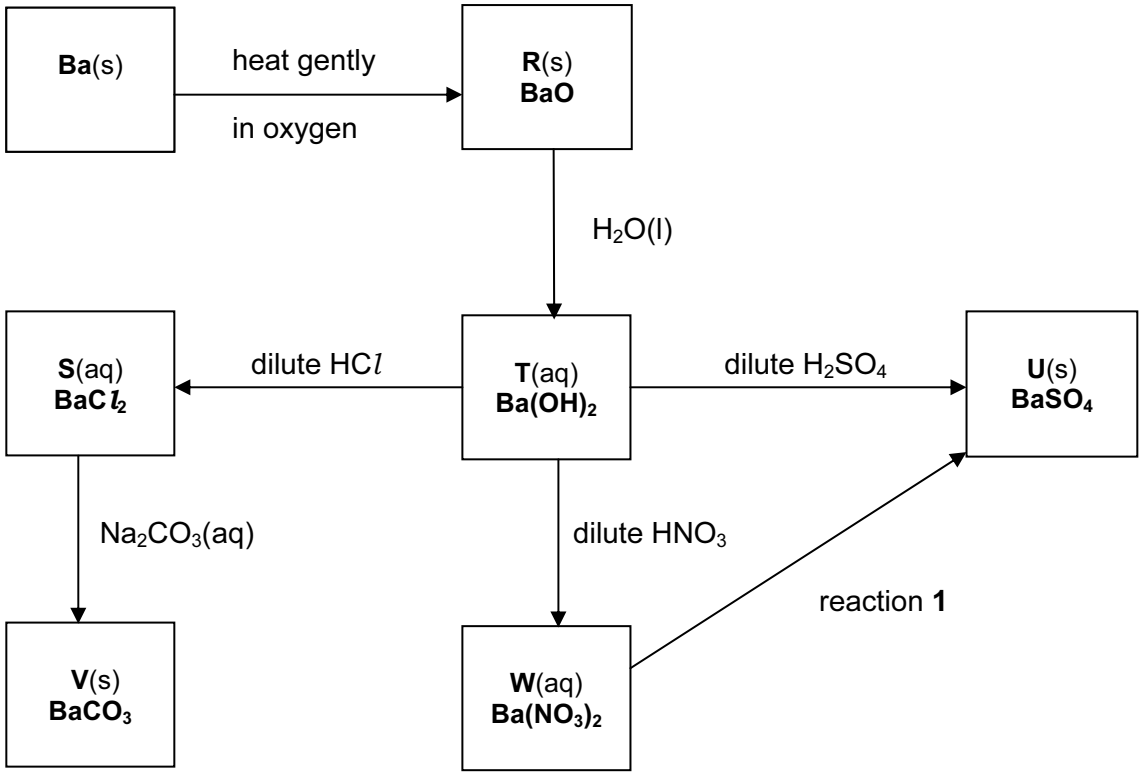
**(d) (i)** the trapping of reflected heat from the Earth in the lower atmosphere producing global warming

**(ii)** $CO_2$/carbon dioxide (1) [3]

**(e)** octahedral (1) [1]

**[Total: 12]**

**3**




**(a)** **R** BaO (1)
**S** $BaCl_2$ (1)
**T** $Ba(OH)_2$ (1)
**U** $BaSO_4$ (1)
**V** $BaCO_3$ (1)
**W** $Ba(NO_3)_2$ (1) [6]

**(b)** **(i)** **T** to **W**
$Ba(OH)_2 + 2HNO_3 \rightarrow Ba(NO_3)_2 + 2H_2O$ (1)

heat on **V**
$BaCO_3 \rightarrow BaO + CO_2$ (1)

**(ii)** **T** to **V**
$CO_2$ (1)
$Ba(OH)_2 + CO_2 \rightarrow BaCO_3 + H_2O$ (1) [4]

**(c)** $Na_2SO_4(aq)/K_2SO_4(aq)$ or any soluble sulfate (1) [1]

**(d) (i)** Ba:O = $\frac{81.1}{137} : \frac{18.9}{16}$ (1)

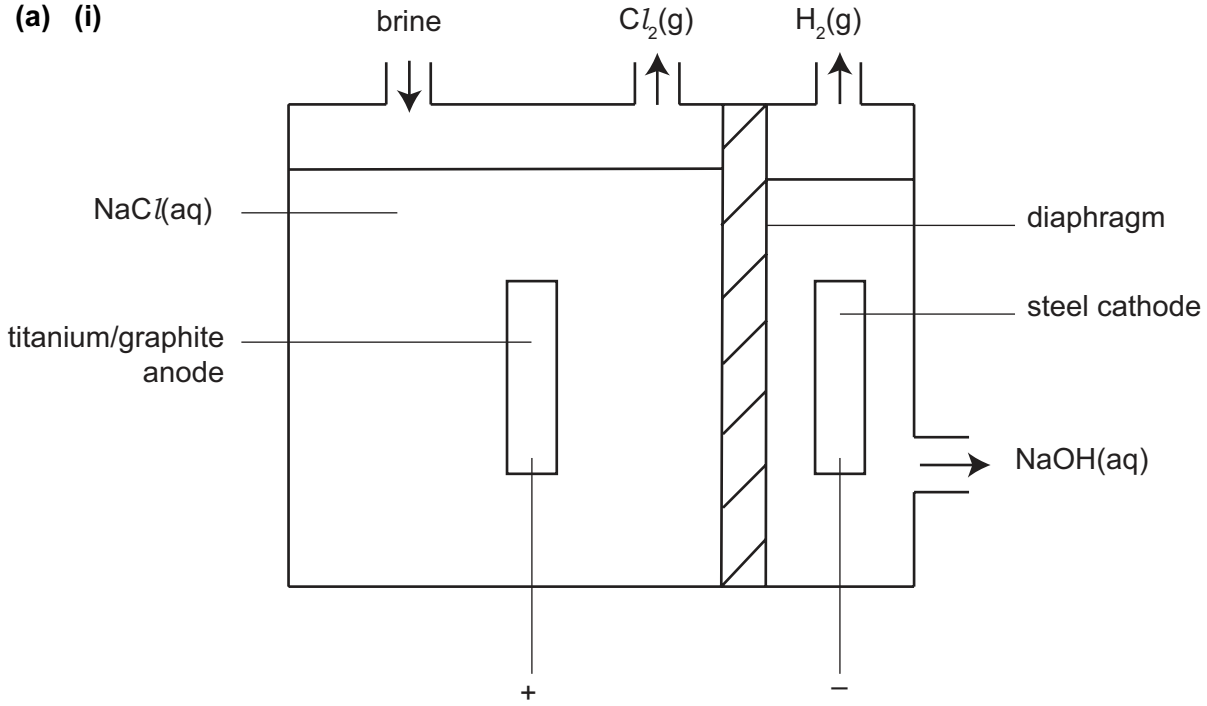
= 0.59 : 1.18
= 1 : 2
gives $BaO_2$ (1)

**(ii)** $BaSO_4$ (1)

**(iii)** $BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$ (1) [4]

**[Total: 15]**

**4 (a) (i)**




titanium/graphite anode identified correctly (1)
steel cathode identified correctly (1)
diaphragm identified correctly (1)
all three outlets correctly shown (1) [4]

**(ii)** **anode** $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ (1)

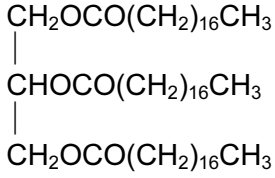
**cathode** $2H^+(aq) + 2e^- \rightarrow H_2(g)$

**or** $2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ (1) [2]

**(iii)** sodium hydroxide (1) [1]

**[Total: 7]**

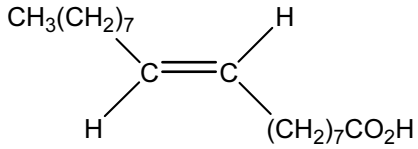
**5** **(a)**



all three alcohol groups must be esterified (1) [1]

**(b)** dilute HC*l* **or** dilute $H_2SO_4$ **or** dilute mineral acid
**or** NaOH(aq) **followed by** dilute acid (1) [1]

**(c)**



(1) [1]

**(d)** **(i)** fatty acid that contains more than one C=C bond (1)

**(ii)** hydrogen (1)
nickel/Raney nickel/platinum/palladium (1) [3]

**(e)** **(i)** $CH_3(CH_2)_7CHO$ (1)
$OHC(CH_2)_7CX$ (1)

**(ii)** 2,4-dinitrophenylhydrazine (1)
yellow/orange/red precipitate (1)

**(iii)** Tollens' reagent **or** Fehling's/Benedict's solution (1)
silver mirror/ **or** brick red ppt.
grey precipitate (1) [6]

**(f)** **(i)** two (1)

**(ii)** ester (1) [2]

**[Total: 14]**