

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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Page 2	Mark Scheme: Teachers' version	Syllabus	Paper
	GCE AS/A LEVEL – May/June 2011	9701	22

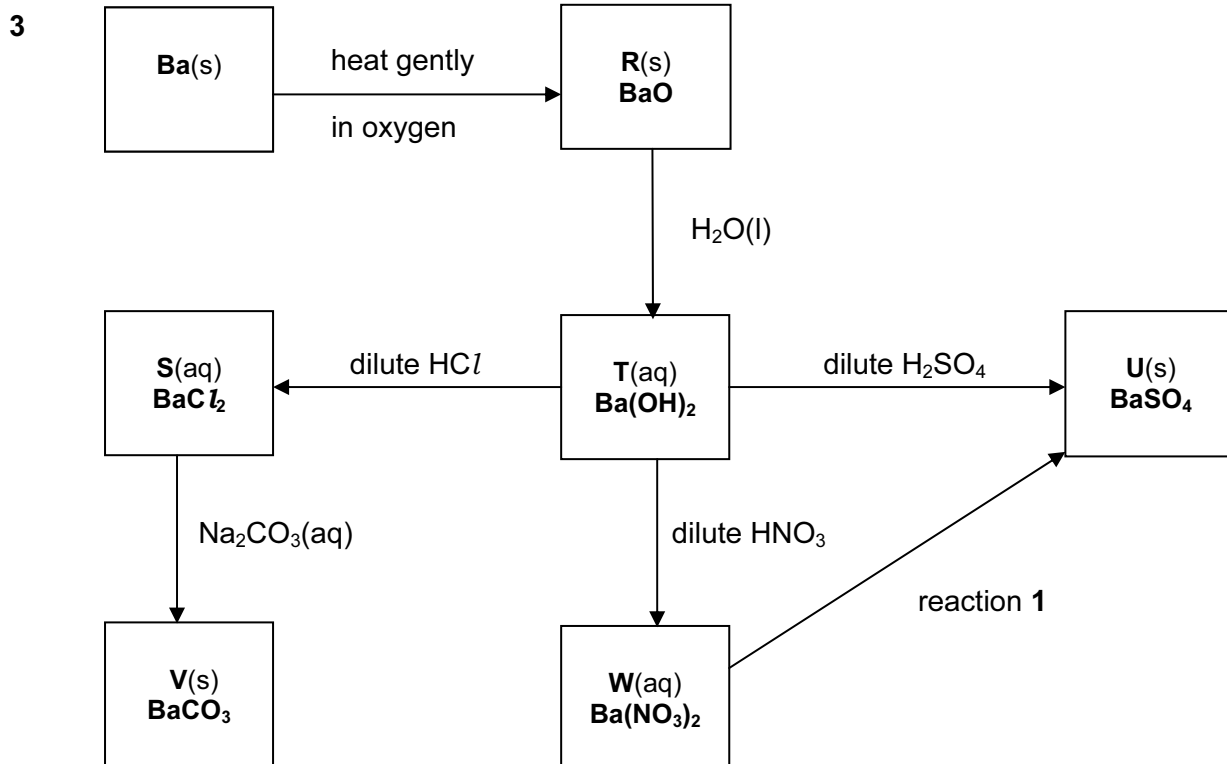
- 1 (a)  $K_c = \frac{[\text{CH}_3\text{CH}_2\text{R}][\text{H}_2\text{O}]}{[\text{CH}_3\text{CH}_2\text{H}][\text{ROH}]}$  (1)  
no units (1) [2]
- (b) (i)  $n(\text{NaOH}) = \frac{22.5 \times 2.00}{1000} = 0.045$  (1)
- (ii)  $n(\text{NaOH}) = n(\text{HCl}) = 0.005$  (1)
- (iii)  $\text{CH}_3\text{CO}_2\text{H} + \text{NaOH} \rightarrow \text{CH}_3\text{CO}_2\text{Na} + \text{H}_2\text{O}$  (1)
- (iv)  $n(\text{NaOH}) = 0.045 - 0.005 = 0.04$   
allow ecf on (i) and/or (ii) (1) [4]
- (c) (i)  $n(\text{NaOH})$  and  $n(\text{CH}_3\text{CO}_2\text{H}) = 0.04$  (1)  
 $n(\text{CH}_3\text{CO}_2\text{R})$  and  $n(\text{H}_2\text{O}) = 0.06$  (1)
- (ii)  $K_c = \frac{0.06 \times 0.06}{0.04 \times 0.04} = 2.25$   
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]

Page 3	Mark Scheme: Teachers' version	Syllabus	Paper
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- 2 (a)  $\text{CH}_2=\text{CH}_2 + \text{HF} \rightarrow \text{CH}_3\text{CH}_2\text{F}$
- |                       |       |            |                       |       |            |
|-----------------------|-------|------------|-----------------------|-------|------------|
| bonds broken          | 4 C-H | 1640       | bonds made            | 5 C-H | 2050       |
|                       | 1 C=C | 610        |                       | 1 C-C | 350        |
| /kJ mol <sup>-1</sup> | 1 H-F | <u>562</u> | /kJ mol <sup>-1</sup> | 1 C-F | <u>E</u>   |
|                       |       | 2812       |                       |       | (2400 + E) |
- breaking reactant bonds requires  
 $4 \times 410 + 610 + 562 = 2812 \text{ kJ mol}^{-1}$  (1)
- making product bonds gives  
 $5 \times 410 + 350 + E = (2400 + E) \text{ kJ mol}^{-1}$  (1)
- $\Delta H^\ominus_{\text{reaction}} = - (2400 + E) + 2812 = - 73 \text{ kJ mol}^{-1}$  (1)
- $(2400 + E) = 2812 + 73 = 2885 \text{ kJ mol}^{-1}$
- $E = 2885 - 2400 = 485 \text{ kJ mol}^{-1}$  (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  $\text{CCl}_2\text{F}_2$   
 C-Cl bond energy is 340 kJ mol<sup>-1</sup> and is weaker than C-F or C-H bonds (1)  
 C-Cl bond is broken by uv light **or**  
 Cl 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<sub>2</sub>/carbon dioxide (1) [3]
- (e) octahedral (1) [1]
- [Total: 12]

Page 4	Mark Scheme: Teachers' version	Syllabus	Paper
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- (a) R BaO (1)  
 S BaCl<sub>2</sub> (1)  
 T Ba(OH)<sub>2</sub> (1)  
 U BaSO<sub>4</sub> (1)  
 V BaCO<sub>3</sub> (1)  
 W Ba(NO<sub>3</sub>)<sub>2</sub> (1) [6]

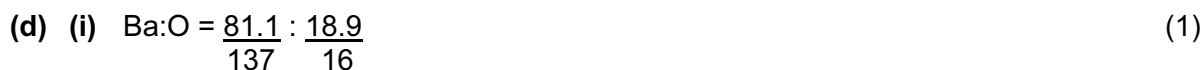
- (b) (i) T to W  
 $\text{Ba(OH)}_2 + 2\text{HNO}_3 \rightarrow \text{Ba(NO}_3)_2 + 2\text{H}_2\text{O}$  (1)



- (ii) T to V  
 $\text{CO}_2$  (1)  
 $\text{Ba(OH)}_2 + \text{CO}_2 \rightarrow \text{BaCO}_3 + \text{H}_2\text{O}$  (1) [4]

- (c) Na<sub>2</sub>SO<sub>4</sub>(aq)/K<sub>2</sub>SO<sub>4</sub>(aq) or any soluble sulfate (1) [1]

Page 5	Mark Scheme: Teachers' version	Syllabus	Paper
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$$= 0.59 : 1.18$$

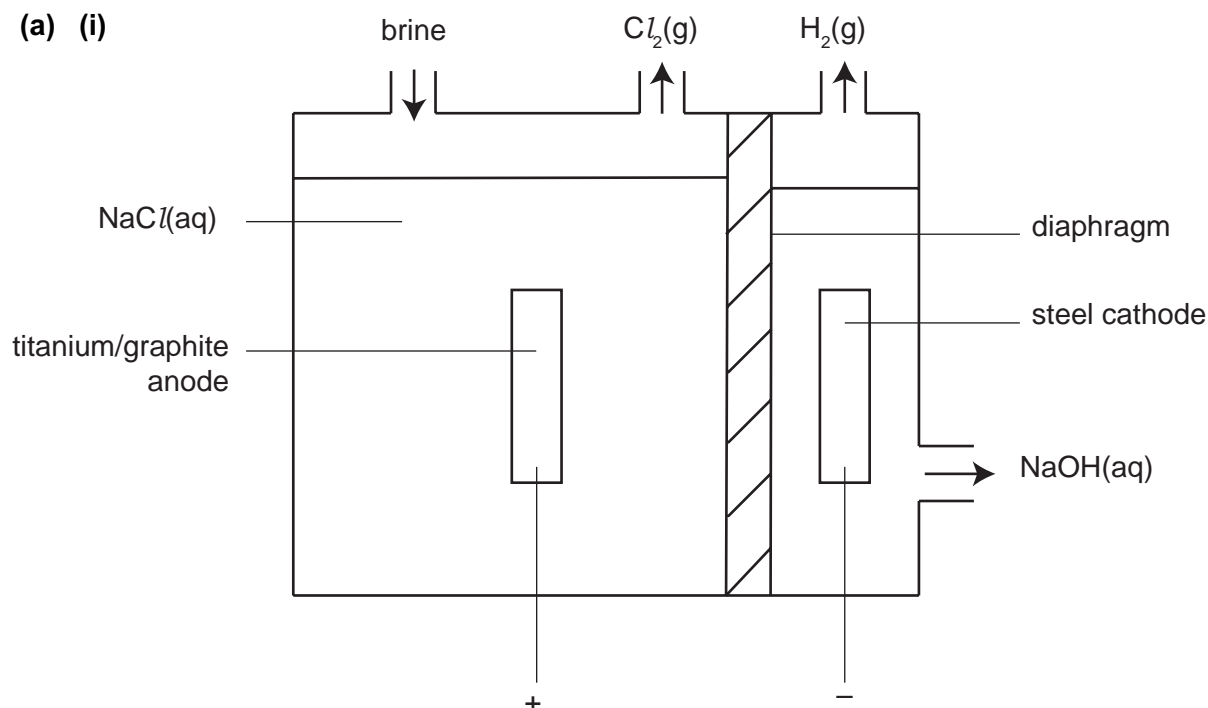
$$= 1 : 2$$

gives  $\text{BaO}_2$  (1)



[Total: 15]

4 (a) (i)

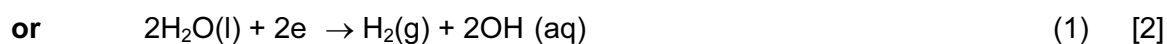
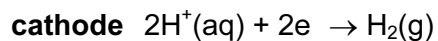


titanium/graphite anode identified correctly (1)

steel cathode identified correctly (1)

diaphragm identified correctly (1)

all three outlets correctly shown (1) [4]



(iii) sodium hydroxide (1) [1]

[Total: 7]

Page 6	Mark Scheme: Teachers' version	Syllabus	Paper
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- 5 (a)  $\begin{array}{c} \text{CH}_2\text{OCO}(\text{CH}_2)_{16}\text{CH}_3 \\ | \\ \text{CHOCO}(\text{CH}_2)_{16}\text{CH}_3 \\ | \\ \text{CH}_2\text{OCO}(\text{CH}_2)_{16}\text{CH}_3 \end{array}$
- all three alcohol groups must be esterified (1) [1]
- (b) dilute HCl **or** dilute H<sub>2</sub>SO<sub>4</sub> **or** dilute mineral acid **or** NaOH(aq) **followed by** dilute acid (1) [1]
- (c)
- $$\begin{array}{c} \text{CH}_3(\text{CH}_2)_7 \quad \quad \quad \text{H} \\ \quad \quad \quad \diagdown \quad \quad \quad \diagup \\ \quad \quad \quad \text{C} = \text{C} \\ \quad \quad \quad \diagup \quad \quad \quad \diagdown \\ \text{H} \quad \quad \quad \quad \quad \quad (\text{CH}_2)_7\text{CO}_2\text{H} \end{array}$$
- (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<sub>3</sub>(CH<sub>2</sub>)<sub>7</sub>CHO (1)  
OHC(CH<sub>2</sub>)<sub>7</sub>CX (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. (1)  
grey precipitate (1) [6]
- (f) (i) two (1)
- (ii) ester (1) [2]

**[Total: 14]**