

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

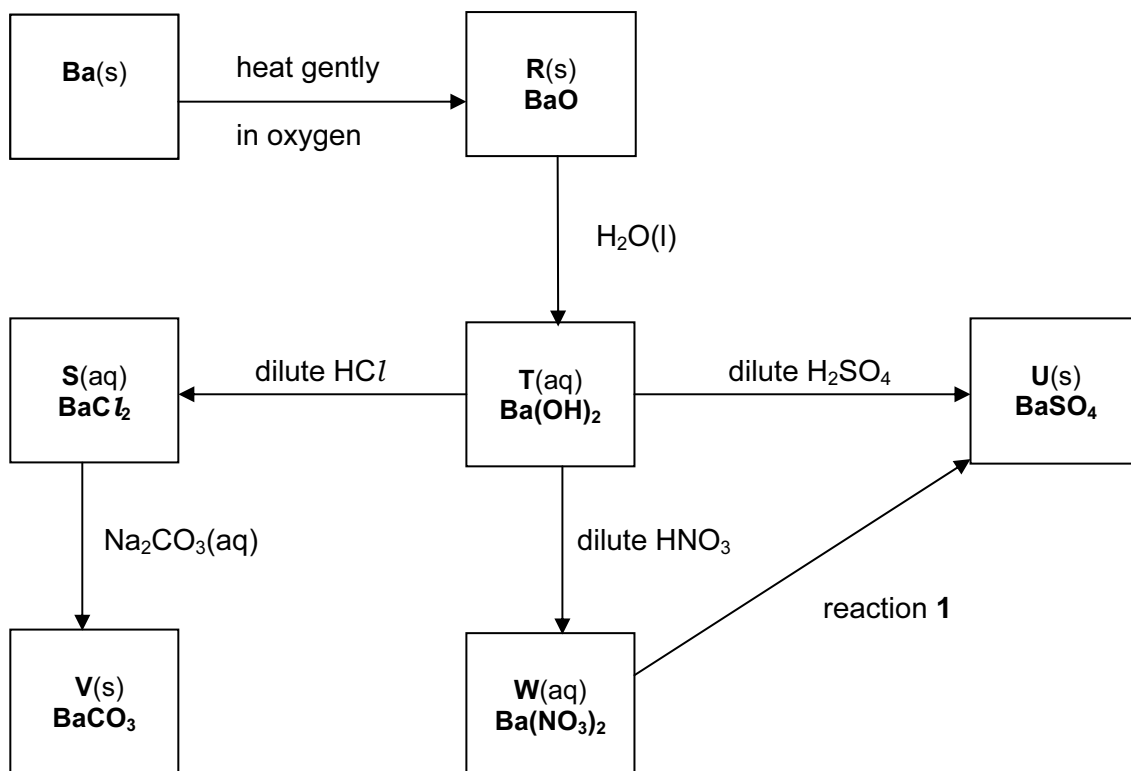
- 1 (a) $K_c = \frac{[\text{CH}_3\text{CH}_2\text{R}][\text{H}_2\text{O}]}{[\text{CH}_3\text{CH}_2\text{H}][\text{ROH}]}$ (1)
no units (1) [2]
- (b) (i) $n(\text{NaOH}) = \frac{22.5 \times 2.00}{1000} = 0.045$ (1)
- (ii) $n(\text{NaOH}) = n(\text{HCl}) = 0.005$ (1)
- (iii) $\text{CH}_3\text{CO}_2\text{H} + \text{NaOH} \rightarrow \text{CH}_3\text{CO}_2\text{Na} + \text{H}_2\text{O}$ (1)
- (iv) $n(\text{NaOH}) = 0.045 - 0.005 = 0.04$ (1) [4]
allow ecf on (i) and/or (ii)
- (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) $K_c = \frac{0.06 \times 0.06}{0.04 \times 0.04} = 2.25$ (1)
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 ⁻¹ | 1 H-F | <u>562</u> | /kJ mol ⁻¹ | 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)
- $\Delta H^\circ_{\text{reaction}} = - (2400 + E) + 2812 = - 73 \text{ kJ mol}^{-1}$ (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 CCl_2F_2
 C-Cl bond energy is 340 kJ mol^{-1} 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_2 /carbon dioxide (1) [3]
- (e) octahedral (1) [1]
- [Total: 12]

3



- (a) R BaO (1)
 S BaCl₂ (1)
 T Ba(OH)₂ (1)
 U BaSO₄ (1)
 V BaCO₃ (1)
 W Ba(NO₃)₂ (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)
- heat on V

$$\text{BaCO}_3 \rightarrow \text{BaO} + \text{CO}_2$$
 (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) Na₂SO₄(aq)/K₂SO₄(aq) or any soluble sulfate (1) [1]

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

$= 0.59 : 1.18$

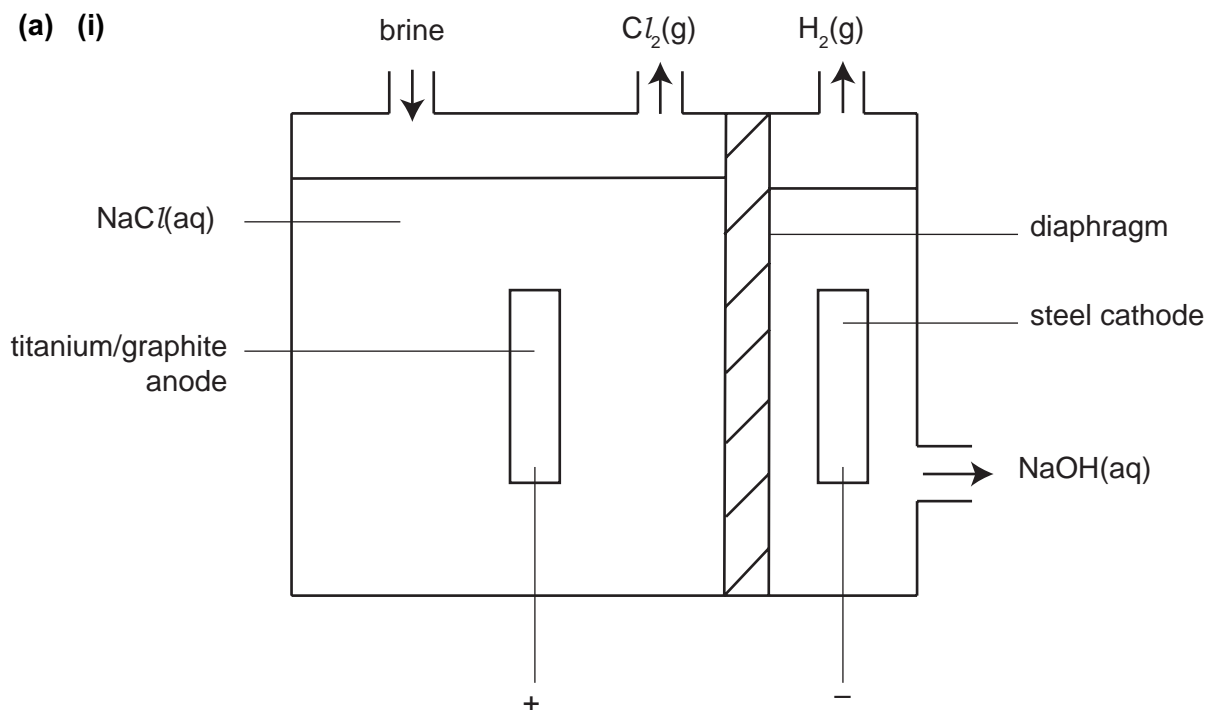
$= 1 : 2$

gives BaO_2 (1)



[Total: 15]

4 (a) (i)

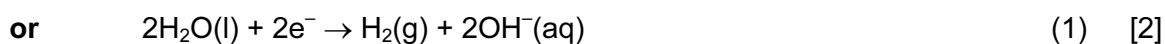
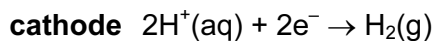


titanium/graphite anode identified correctly (1)

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 H₂SO₄ or dilute mineral acid or NaOH(aq) followed by dilute acid (1) [1]
- (c) $\begin{array}{c} \text{CH}_3(\text{CH}_2)_7 \\ \diagdown \\ \text{C} = \text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad (\text{CH}_2)_7\text{CO}_2\text{H} \end{array}$ (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) CH₃(CH₂)₇CHO (1)
OHC(CH₂)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. (1)
grey precipitate (1) [6]
- (f) (i) two (1)
- (ii) ester (1) [2]
- [Total: 14]