

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.

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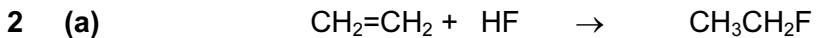
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International Examinations

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- 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
to maintain value of K_c or
to restore system to equilibrium (1) [2]

[Total: 12]

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bonds broken /kJ mol ⁻¹	4 C-H	1640	bonds made /kJ mol ⁻¹	5 C-H	2050
	1 C=C	610		1 C-C	350
	1 H-F	562		1 C-F	<u>E</u>

$$2812 \qquad \qquad \qquad (2400 + E)$$

breaking reactant bonds requires
 $4 \times 410 + 610 + 562 = 2812 \text{ kJ mol}^{-1}$

(1)

making product bonds gives

$$5 \times 410 + 350 + E = (2400 + E) \text{ kJ mol}^{-1} \quad (1)$$

$$\Delta H^\circ_{\text{reaction}} = - (2400 + E) + 2812 = - 73 \text{ kJ mol}^{-1} \quad (1)$$

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

$$E = 2885 - 2400 = 485 \text{ kJ mol}^{-1} \quad (1)$$

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

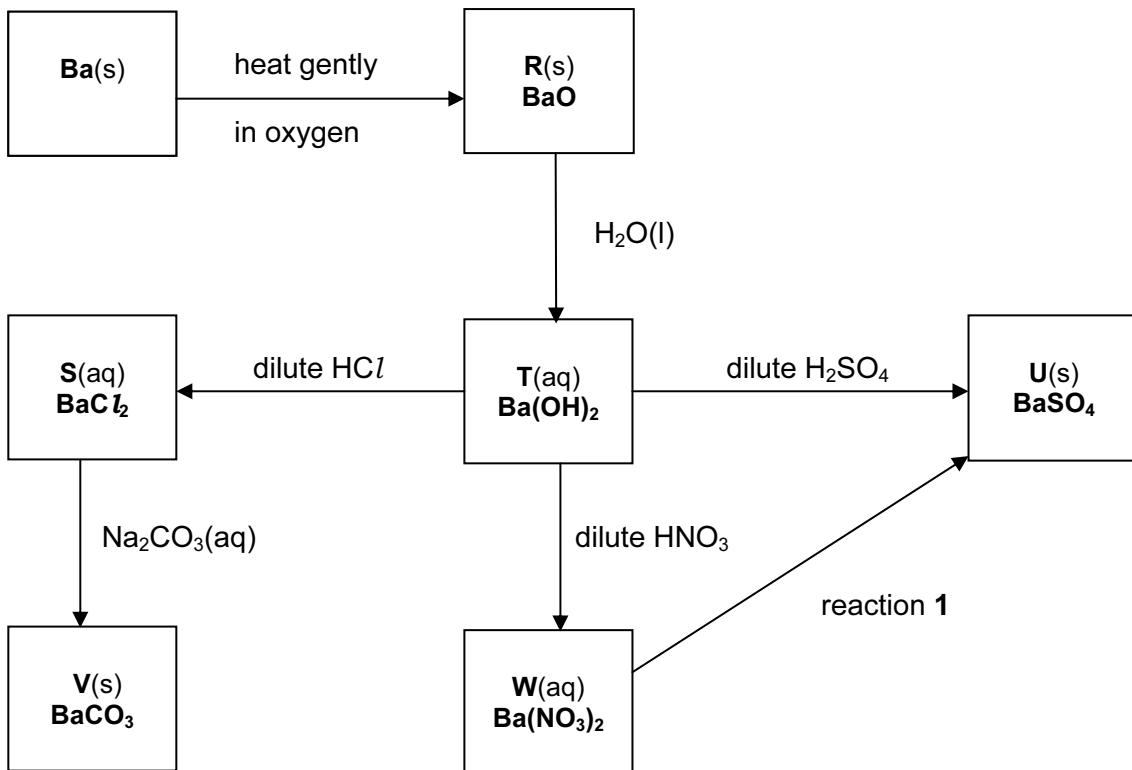
(1) [3]

- (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**
 $\text{Ba(OH)}_2 + 2\text{HNO}_3 \rightarrow \text{Ba}(\text{NO}_3)_2 + 2\text{H}_2\text{O}$ (1)



- (ii) **T** to **V**
 CO_2 (1)
 $\text{Ba(OH)}_2 + \text{CO}_2 \rightarrow \text{BaCO}_3 + \text{H}_2\text{O}$ (1) [4]

- (c) $\text{Na}_2\text{SO}_4(\text{aq})/\text{K}_2\text{SO}_4(\text{aq})$ or any soluble sulfate (1) [1]

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

$$= 0.59 : 1.18$$

$$= 1 : 2$$

gives BaO_2

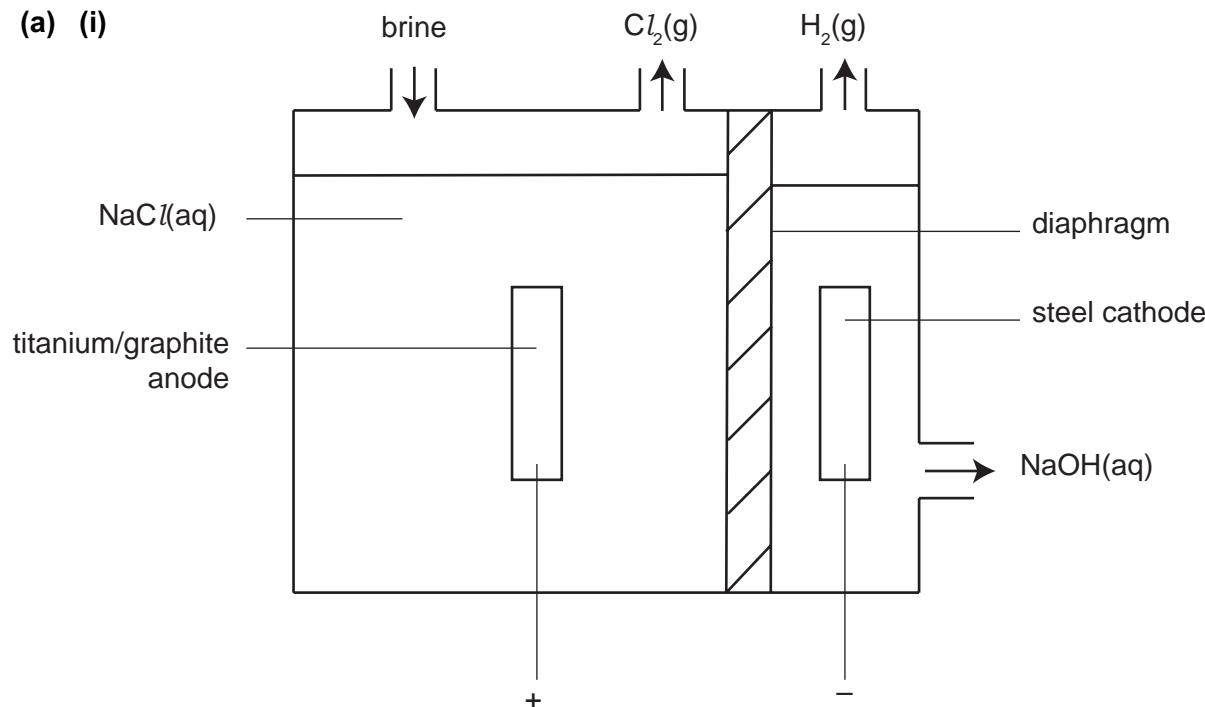
(1)

(ii) BaSO_4 (1)



[Total: 15]

4 (a) (i)

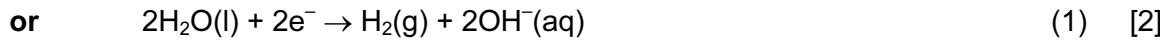
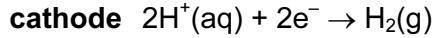


titanium/graphite anode identified correctly (1)

steel cathode identified correctly (1)

diaphragm identified correctly (1)

all three outlets correctly shown (1) [4]



(iii) sodium hydroxide (1) [1]

[Total: 7]

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5 (a) $\text{CH}_2\text{OCO}(\text{CH}_2)_{16}\text{CH}_3$



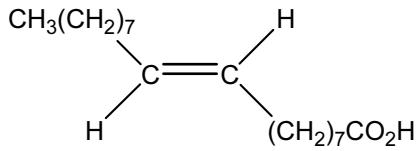
all three alcohol groups must be esterified

(1) [1]

(b) dilute HCl or dilute H_2SO_4 or dilute mineral acid
or $\text{NaOH}(\text{aq})$ followed by dilute acid

(1) [1]

(c)



(1) [1]

(d) (i) fatty acid that contains more than one $\text{C}=\text{C}$ bond

(1)

(ii) hydrogen
nickel/Raney nickel/platinum/palladium

(1)

(1) [3]

(e) (i) $\text{CH}_3(\text{CH}_2)_7\text{CHO}$

(1)



(1)

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

(1)

(1)

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

(1)

(1) [6]

(f) (i) two

(1)

(ii) ester

(1) [2]

[Total: 14]