

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**

**9701/21**

Paper 2 (AS Structured Questions), maximum raw mark 60

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1 (a) alkanes/paraffins  
not hydrocarbon (1) [1]

(b)  $2 \text{C}_{14}\text{H}_{30} + 43 \text{O}_2 \rightarrow 28 \text{CO}_2 + 30 \text{H}_2\text{O}$  or

$\text{C}_{14}\text{H}_{30} + 43/2 \text{O}_2 \rightarrow 14 \text{CO}_2 + 15 \text{H}_2\text{O}$  (1) [1]

(c) (i) mass of  $\text{C}_{14}\text{H}_{30}$  burnt

$\frac{8195 \times 10.8}{1000} = 88.506 = 88.5 \text{ t}$  (1)

(ii) mass of  $\text{CO}_2$  produced

$M_r$  of  $\text{C}_{14}\text{H}_{30} = (14 \times 12 + 30 \times 1) = 198$  (1)

$2 \times 198 \text{ t of C}_{14}\text{H}_{30} \rightarrow 28 \times 44 \text{ t of CO}_2$

$88.5 \text{ t of C}_{14}\text{H}_{30} \rightarrow \frac{28 \times 44 \times 88.5}{2 \times 198}$  (1)

$= 275.3 \text{ t of CO}_2$  (1)

allow 275.4 t if candidate has used 88.506  
allow ecf on wrong value for  $M_r$  of  $\text{C}_{14}\text{H}_{30}$  [4]

(d)  $n = \frac{PV}{RT} = \frac{6 \times 10^5 \times 710 \times 10^{-6}}{8.31 \times 293}$  (1)

$= 0.175$  (1) [2]

(e)  $P = \frac{nRT}{V} = \frac{0.175 \times 8.31 \times 278}{710 \times 10^{-6}}$  (1)

$= 569410.5634 \text{ Pa} = 5.7 \times 10^5$  (1)

allow ecf on (d) [2]

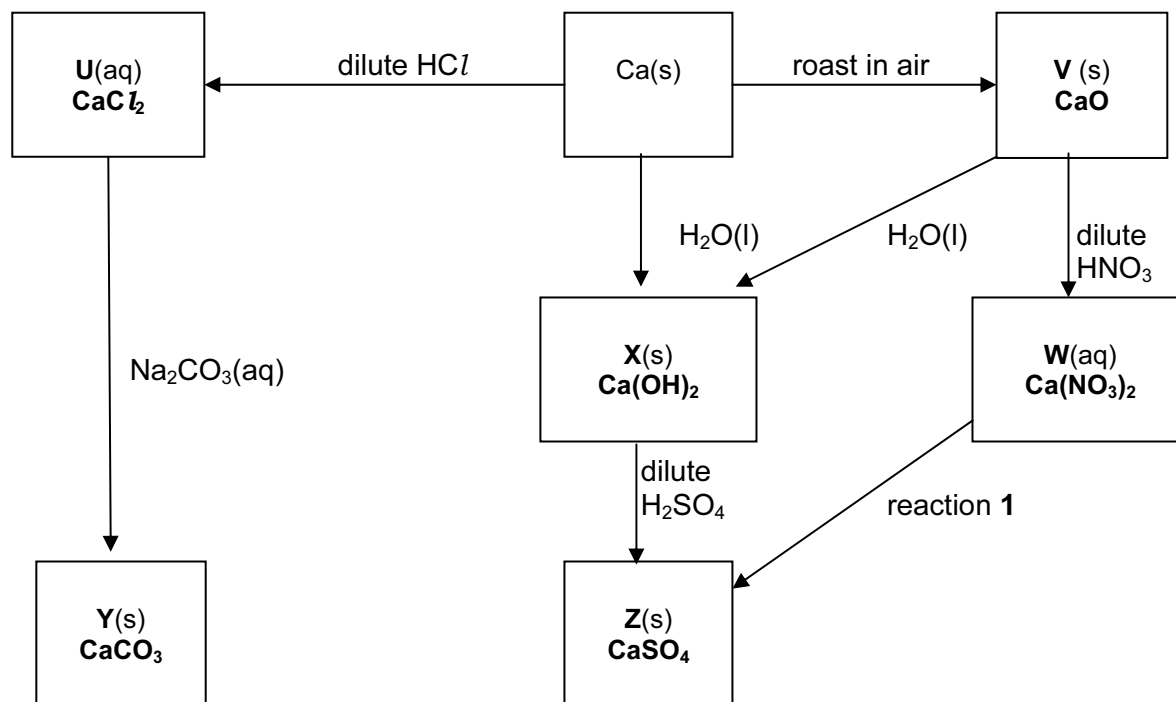
[Total: 10]

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- 2 (a) (i) break large hydrocarbons into smaller hydrocarbons **or**  
break down large hydrocarbons (1)
- smaller hydrocarbons are more useful **or**  
smaller hydrocarbons are more in demand (1)
- (ii) using high temperatures/thermal cracking **or**  
using catalysts/catalytic cracking (1)
- (iii)  $C_{14}H_{30} \rightarrow C_7H_{16} + C_7H_{14}$  **or**  
 $C_{14}H_{30} \rightarrow C_7H_{16} + C_2H_4 + C_5H_{10}$  **or**  
 $C_{14}H_{30} \rightarrow C_7H_{16} + C_3H_6 + C_4H_8$  **or**  
 $C_{14}H_{30} \rightarrow C_7H_{16} + 2C_2H_4 + C_3H_6$  (1)
- do not allow any equation with  $H_2$  [4]
- (b) ethanol has hydrogen bonding, ethanethiol does not (1) [1]
- (c) (i)  $C_2H_5SH + \frac{9}{2} O_2 \rightarrow 2CO_2 + SO_2 + 3H_2O$  **or**  
 $2C_2H_5SH + 9O_2 \rightarrow 4CO_2 + 2SO_2 + 6H_2O$   
correct products (1)  
correct equation which is balanced (1)
- (ii) **for  $CO_2$**   
enhanced greenhouse effect (1)  
global warming (1)
- for  $SO_2$**   
formation of acid rain (1)  
damage to stonework of buildings/  
dissolving of aluminium ions into rivers/  
damage to watercourses or forests/  
aquatic life destroyed/  
corrosion of metals (1) [6]
- (d) help detect leaks of gas (1) [1]
- (e) temperature of  $450^\circ C$  (1)  
pressure of 1 – 2 atm (1)  
 $V_2O_5$ /vanadium(V) oxide/vanadium pentoxide catalyst (1) [3]

[Total: 15]

3



- (a)
- |          |                            |         |
|----------|----------------------------|---------|
| <b>U</b> | $\text{CaCl}_2$            | (1)     |
| <b>V</b> | $\text{CaO}$               | (1)     |
| <b>W</b> | $\text{Ca}(\text{NO}_3)_2$ | (1)     |
| <b>X</b> | $\text{Ca}(\text{OH})_2$   | (1)     |
| <b>Y</b> | $\text{CaCO}_3$            | (1) [5] |
- (b) heat strongly in a test-tube or a boiling tube  
do not allow 'heat gently' or 'reflux' (1) [1]
- (c) (i) **Ca to U**  
 $\text{Ca} + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2$  (1)
- V to W**  
 $\text{CaO} + 2\text{HNO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + \text{H}_2\text{O}$  (1)
- U to Y**  
 $\text{CaCl}_2 + \text{Na}_2\text{CO}_3 \rightarrow \text{CaCO}_3 + 2\text{NaCl}$  (1)
- (ii)  $2\text{Ca}(\text{NO}_3)_2 \rightarrow 2\text{CaO} + 4\text{NO}_2 + \text{O}_2$  (1) [4]
- (d)  $\text{Na}_2\text{SO}_4(\text{aq})/\text{K}_2\text{SO}_4(\text{aq})$  or formula of any **soluble** sulfate (1) [1]

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(e) (i) Ca to X  
 colourless gas formed/fizzing/effervescence/bubbles **or**  
 Ca dissolves **or**  
 white precipitate/suspension formed (1)

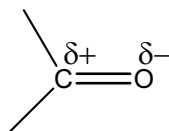
(ii) strongly exothermic/vigorous reaction **or**  
 steam formed/steamy fumes **or**  
 surface crumbles (1)  
 do not allow white ppt. [2]

[Total: 13]

4 (a) (i) nucleophilic addition (1)  
**both** words are necessary

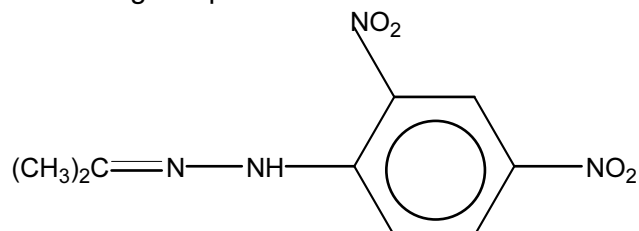
(ii) NaCN and H<sub>2</sub>SO<sub>4</sub> **or**  
 HCN plus CN<sup>-</sup> (1)  
 do not allow HCN on its own

(iii) correct δ+ **and** δ-, i.e.



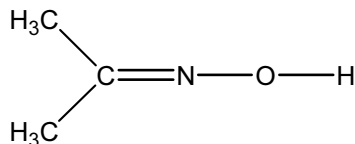
(1) [3]

(b) (i) correct organic product



C=N bond must be clearly shown (1)  
 H<sub>2</sub>O formed/ equation balanced (1) [2]

(ii)



(1) [1]

[Total: 6]

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- 5 (a)  $\text{CaC}_2 + 2\text{H}_2\text{O} \rightarrow \text{Ca}(\text{OH})_2 + \text{C}_2\text{H}_2$  (1) [1]
- (b) (i) step 1 electrophilic addition (1)  
 step 2 elimination **or** dehydrohalogenation (1)
- (ii) reagent  $\text{NaOH/KOH/OH}^-$  (1)  
 conditions in alcohol/ethanol (1)  
 only allow conditions mark if reagent is correct [5]
- (c) (i) **Q** is  $\text{CH}_3\text{CHO}$  ( as minimum) (1)  
**R** is  $\text{CH}_3\text{CO}_2\text{H}$  (as minimum) (1)
- (ii) step 3 is addition (1)  
 step 4 is oxidation/redox (1) [4]
- (d) (i) **combustion**  
 $\text{C}_2\text{H}_2(\text{g}) + \frac{5}{2}\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$  **or**  
 equation must be for the combustion of one mole of  $\text{C}_2\text{H}_2$   
 $\text{H}_2\text{O}$  must be shown as liquid (1)  
 correct state symbols in this equation (1)
- formation**  
 $2\text{C}(\text{s}) + \text{H}_2(\text{g}) \rightarrow \text{C}_2\text{H}_2(\text{g})$   
 no mark for state symbols here (1)
- (ii) let **Z** be  $\Delta H_f^\circ$  of  $\text{C}_2\text{H}_2$
- $$\text{C}_2\text{H}_2 + \frac{5}{2}\text{O}_2 \rightarrow 2\text{CO}_2 + \text{H}_2\text{O}$$
- |                    |          |   |         |      |
|--------------------|----------|---|---------|------|
| $\Delta H_f^\circ$ | <b>Z</b> | 0 | 2(-394) | -286 |
|--------------------|----------|---|---------|------|
- $$\Delta H_c^\circ = -1300 = 2(-394) + (-286) - \mathbf{Z}$$
- whence  $\mathbf{Z} = 2(-394) + (-286) - (-1300)$   
 $= +226 \text{ kJ mol}^{-1}$
- value (1)  
 sign (1)  
 allow ecf on wrong equation [6]

[Total: 16]