

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

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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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 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]

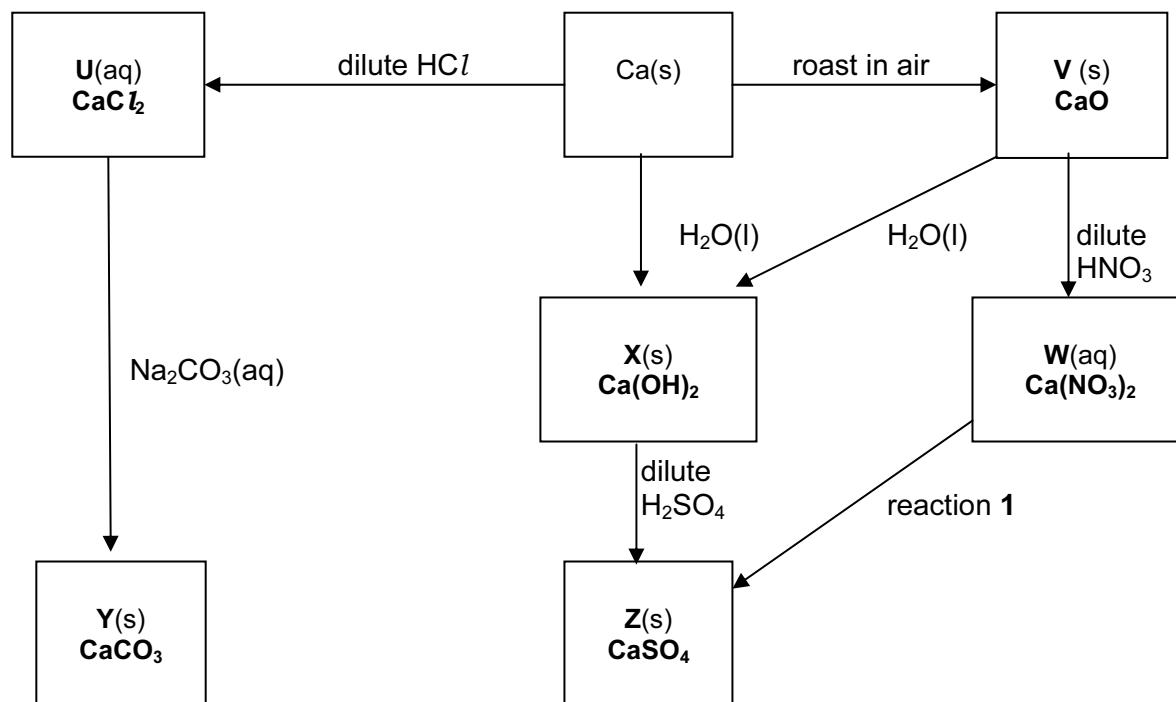
[Total: 10]

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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)
- | | | |
|----------|----------------------------|---------|
| U | CaCl_2 | (1) |
| V | CaO | (1) |
| W | $\text{Ca}(\text{NO}_3)_2$ | (1) |
| X | $\text{Ca}(\text{OH})_2$ | (1) |
| Y | 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)

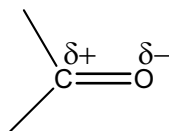
(ii) strongly exothermic/vigorous reaction **or**
steam formed/steamy fumes **or**
surface crumbles (1)
do not allow white ppt. [2]

[Total: 13]

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

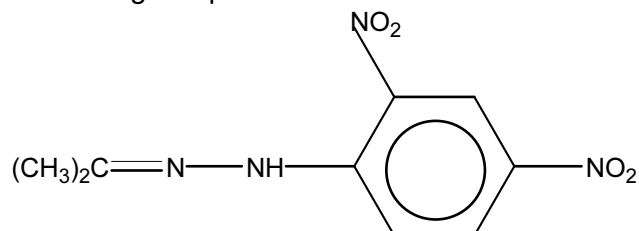
(ii) NaCN and H₂SO₄ **or**
HCN plus CN⁻ (1)
do not allow HCN on its own

(iii) correct δ+ **and** δ-, i.e.



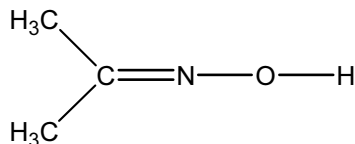
(1) [3]

(b) (i) correct organic product



C=N bond must be clearly shown (1)
H₂O 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 NaOH/KOH/OH^- (1)
 conditions in alcohol/ethanol (1)
 only allow conditions mark if reagent is correct [5]
- (c) (i) **Q** is CH_3CHO (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 C_2H_2
 H_2O 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 ΔH_f° of C_2H_2
- $$\text{C}_2\text{H}_2 + \frac{5}{2}\text{O}_2 \rightarrow 2\text{CO}_2 + \text{H}_2\text{O}$$
- | | | | | |
|--------------------|----------|---|---------|------|
| ΔH_f° | Z | 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]