

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 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)

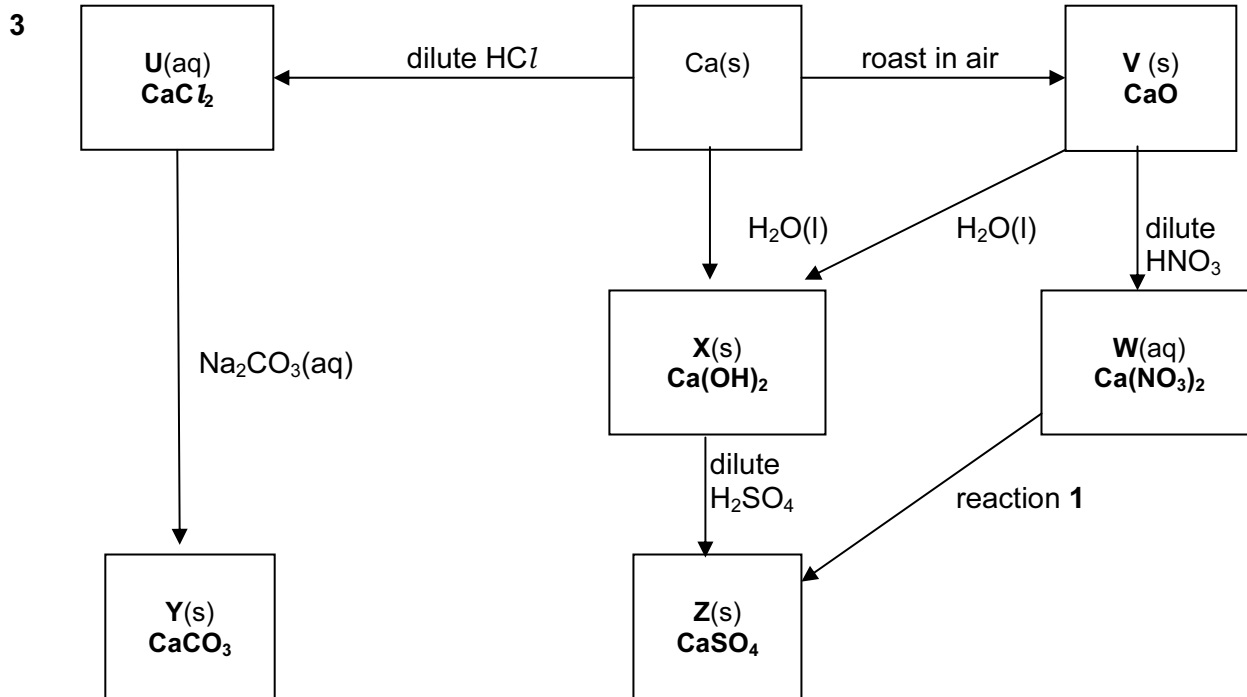
allow ecf on (d) [2]

[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 CO₂**
enhanced greenhouse effect (1)
global warming (1)
- for SO₂**
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°C (1)
pressure of 1 – 2 atm (1)
V₂O₅/vanadium(V) oxide/vanadium pentoxide catalyst (1) [3]

[Total: 15]



- (a)
- | | | |
|----------|-----------------------------------|---------|
| U | CaCl ₂ | (1) |
| V | CaO | (1) |
| W | Ca(NO ₃) ₂ | (1) |
| X | Ca(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**
Ca + 2HCl → CaCl₂ + H₂ (1)
- V to W**
CaO + 2HNO₃ → Ca(NO₃)₂ + H₂O (1)
- U to Y**
CaCl₂ + Na₂CO₃ → CaCO₃ + 2NaCl (1)
- (ii) 2Ca(NO₃)₂ → 2CaO + 4NO₂ + O₂ (1) [4]
- (d) Na₂SO₄(aq)/K₂SO₄(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)

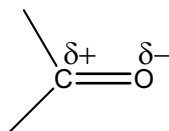
(ii) strongly exothermic/vigorous reaction **or**
 steam formed/steamy fumes **or**
 surface crumbles (1)
 do not allow white ppt. [2]

[Total: 13]

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

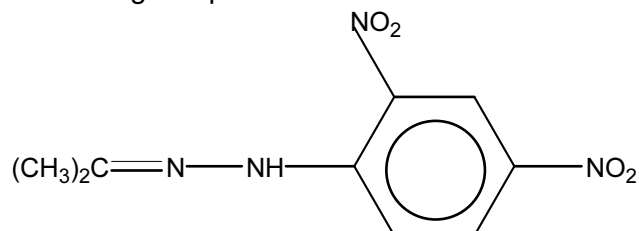
(ii) NaCN and H₂SO₄ **or**
 HCN plus CN⁻ (1)
 do not allow HCN on its own

(iii) correct δ+ **and** δ-, i.e.



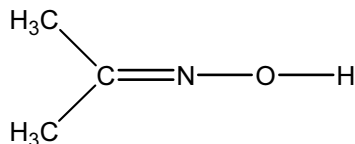
(1) [3]

(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^\ominus 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^\ominus | Z | 0 | 2(-394) | -286 |
|----------------------|---|---|---------|------|
- $$\Delta H_c^\ominus = -1300 = 2(-394) + (-286) - Z$$
- whence $Z = 2(-394) + (-286) - (-1300)$
 $= +226 \text{ kJ mol}^{-1}$
 value (1)
 sign (1)
 allow ecf on wrong equation [6]

[Total: 16]