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.

Mark schemes must be read in conjunction with the question papers and the report on the examination.

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

(b) **2** $C_{14}H_{30}$ + **43** $O_2 \rightarrow$ **28** CO_2 + **30** H_2O **or**

$C_{14}H_{30} + {}^{\mathbf{43}}/_{\mathbf{2}}O_2 \rightarrow \mathbf{14}\ CO_2 + \mathbf{15}\ H_2O$ (1) [1]

(c) **(i)** **mass of $C_{14}H_{30}$ burnt**

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

(ii) **mass of CO_2 produced**

M_r of $C_{14}H_{30}$ = (14 x 12 + 30 x 1) = 198 (1)

2 x 198 t of $C_{14}H_{30} \rightarrow$ 28 x 44 t of CO_2

88.5 t of $C_{14}H_{30} \rightarrow \frac{28 \times 44 \times 88.5}{2 \times 198}$ (1)

= 275.3 t of CO_2 (1)

allow 275.4 t if candidate has used 88.506
allow ecf on wrong value for M_r of $C_{14}H_{30}$ [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 Pa = 5.7×10^5 (1)

allow ecf on **(d)** [2]

[Total: 10]

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)** $C_2H_5SH + \mathbf{{}^9/_2}\,O_2 \rightarrow \mathbf{2}CO_2 + SO_2 + \mathbf{3}H_2O$ **or**
$\mathbf{2}C_2H_5SH + \mathbf{9}O_2 \rightarrow \mathbf{4}CO_2 + \mathbf{2}SO_2 + \mathbf{6}H_2O$
correct products (1)
correct equation which is balanced (1)

(ii) **for CO_2**
enhanced greenhouse effect (1)
global warming (1)

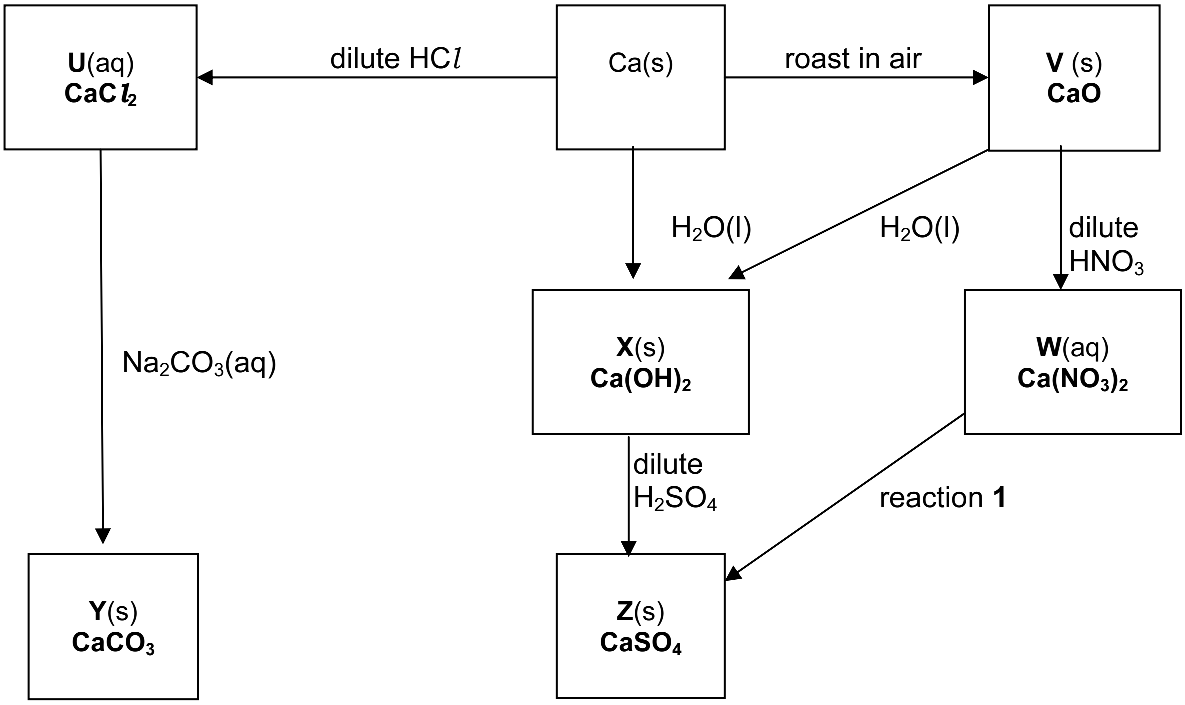
for SO_2
formation of acid rain (1)
damage to stonework of buildings/
dissolving of aluminium ions into rivers/
damage to watercourses or forests/
aquatic life destroyed/
corrosion of metals (1) [6]

(d) help detect leaks of gas (1) [1]

(e) temperature of 450°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	$Ca(NO_3)_2$	(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**
$Ca + 2HCl \rightarrow CaCl_2 + H_2$ (1)

V to **W**
$CaO + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2O$ (1)

U to **Y**
$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$ (1)

(ii) $2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$ (1) [4]

(d) $Na_2SO_4(aq)/K_2SO_4(aq)$ **or** formula of any **soluble** sulfate (1) [1]

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

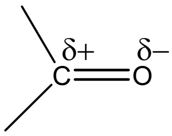
(ii) strongly exothermic/vigorous reaction **or**
steam formed/steamy fumes **or**
surface crumbles (1)
do not allow white ppt. [2]

[Total: 13]

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

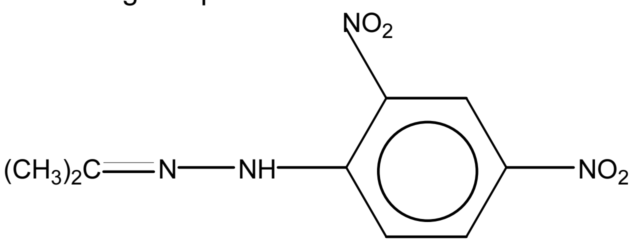
(ii) NaCN and H_2SO_4 **or**
HCN plus CN^-
do not allow HCN on its own (1)

(iii) correct δ+ **and** δ-, i.e.



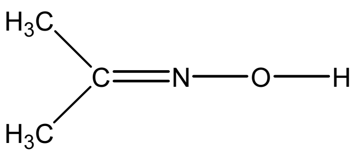
(1) [3]

(b) **(i)** correct organic product



C=N bond must be clearly shown (1)
H_2O formed/ equation balanced (1) [2]

(ii)



(1) [1]

[Total: 6]

5 **(a)** $CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$ (1) [1]

(b) **(i)** step 1 electrophilic (1)
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 CH_3CO_2H (as minimum) (1)

(ii) step 3 is addition (1)
step 4 is oxidation/redox (1) [4]

(d) **(i)** **combustion**
$C_2H_2(g) + {}^{\mathbf{5}}\!/_{\mathbf{2}}O_2(g) \rightarrow \mathbf{2}CO_2(g) + H_2O(l)$ **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
$2C(s) + H_2(g) \rightarrow C_2H_2(g)$
no mark for state symbols here (1)

(ii) let **Z** be ΔH°_f of C_2H_2

	C_2H_2 +	${}^5/_2O_2 \rightarrow$	$2CO_2$ +	H_2O
ΔH°_f	**Z**	0	2(-394)	-286

$\Delta H^{\circ}_c = -1300 = 2(-394) + (-286) - \mathbf{Z}$ (1)

whence $\mathbf{Z} = 2(-394) + (-286) - (-1300)$

$= \mathbf{+}226\ kJ\ mol^{-1}$
value (1)
sign (1)
allow ecf on wrong equation [6]

[Total: 16]