UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

MARK SCHEME for the October/November 2008 question paper

9701 CHEMISTRY

9701/02 Paper 2 (Theory 1), maximum raw mark 60

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1 **(a)** **(i)** substance that speeds up a chemical reaction (1)
by lowering E_a
or by providing an alternative reaction pathway
or without being used up in the process (1)

(ii) $2H_2O_2 \rightarrow 2H_2O + O_2$ (1) [3]

(b) **(i)** alkanes **or** paraffins (1)

(ii) $2H_2O_2 : O_2$ and $C_{15}H_{32} : 23O_2$ (1)
whence $C_{15}H_{32} : 46H_2O_2$ (1)
allow e.c.f. on **(a)(ii)** [3]

(c) **(i)** $C_{15}H_{32} = 212$ (1)

$$n(C_{15}H_{32}) = \frac{212 \times 10^6}{212} = 1 \times 10^6 \text{ mol}$$

allow e.c.f. on wrong M_r of $C_{15}H_{32}$ (1)

(ii) $n(H_2O_2)$ required $= 46 \times 10^6$ mol (1)
mass of $H_2O_2 = 34 \times 46 \times 10^6$ g $=$ 1564 tonnes
final answer must be in tonnes (1)
allow e.c.f. on **(b)(ii)** and **(c)(i)** [4]

(d) they would dissolve (1) [1]

[Total: 11]

2 **(a)** **(i)** H–C–H 117 to 120° (1)
C=C=O 180° (1)

(ii) molecule contains **both** ketone **and** alkene (1) [3]

(b) **(i)** $C_2H_2O + 2O_2 \rightarrow 2CO_2 + H_2O$ (1)

(ii) from eqn., 42 g $C_2H_2O \rightarrow 48$ dm^3 of CO_2 (1)
whence 3.5 g $C_2H_2O \rightarrow \frac{48 \times 3.5}{42}$ dm^3 of CO_2 (1)
$= 4.0$ dm^3 of CO_2 (1)

or $n(C_2H_2O) = \frac{42}{3.5} = 0.0833$ (1)
$n(CO_2) = 2 \times 0.083 = 0.0166$ (1)
vol. of $CO_2 = 0.0166 \times 24 = 4.0$ dm^3 (1)
allow e.c.f. on wrong eqn. in **(b)(i)**
penalise significant figure error [4]

(c) **(i)** enthalpy change when
1 mol of a compound is formed (1)
from its elements (1)
in their standard states under standard conditions (1)

(ii) $C + O_2 \rightarrow CO_2$ -395 kJ mol^{-1}
$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ -286 kJ mol^{-1}
$C_2H_2O + 2O_2 \rightarrow 2CO_2 + H_2O$ -1028 kJ mol^{-1}
$2C + H_2 + \frac{1}{2}O_2 \rightarrow C_2H_2O$ $\Delta H = 2(-395) + (-286) - (-1028)$
$= -48$ kJ mol^{-1}
correct cycle (1) use of 2 for C/CO_2 (1) answer (1) [6]

(d) H_2O/water/steam (1) [1]

[Total: 14]

3 **(a)** anode $Cl^-(aq) \rightarrow \frac{1}{2}Cl_2(g) + e^-$ (1)
cathode $H^+(aq) + e^- \rightarrow \frac{1}{2}H_2(g)$
or $2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$ (1)
correct state symbols (1) [2]

(b) because the iron in steel will react with chlorine (1) [1]

(c) **(i)** sodium hydroxide/NaOH (1)
$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$
or $2H^+ + 2e^- \rightarrow H_2$ (1)
leaving OH^- in solution as NaOH (1) [3]

(d) **Na** burns with a yellow flame/forms a white solid (1)
$2Na + Cl_2 \rightarrow 2NaCl$ (1)
P burns with a white flame/forms a colourless liquid (PCl_3) **or** a white solid (PCl_5) (1)
$P + 1\frac{1}{2}Cl_2 \rightarrow PCl_3$ **or** $P_4 + 6Cl_2 \rightarrow 4PCl_3$
or $P + 2\frac{1}{2}Cl_2 \rightarrow PCl_5$ **or** $P_4 + 10Cl_2 \rightarrow 4PCl_5$ (1) [4]

(e) $MgCl_2$ 6 to 7 (1)
$SiCl_4$ 0 to 3 (1)
$MgCl_2$ dissolves without reaction (1)
$SiCl_4$ reacts with water/hydrolyses (1)
$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$ **or**
$SiCl_4 + 4H_2O \rightarrow Si(OH)_4 + 4HCl$ **or**
$SiCl_4 + 4H_2O \rightarrow SiO_2.2H_2O + 4HCl$ (1) [5]

[Total: 15 max]

4

organic reaction	type of reaction	reagent(s)
$CH_3CHO \rightarrow$	nucleophilic (1)	HCN
$CH_3CH(OH)CN$	addition (1)	**or** HCN and CN^- (1)
$CH_3CH_2CH_2CH_3 \rightarrow$	free radical (1)	Br_2
$CH_3CH_2CHBrCH_3$	substitution (1)	**or** Br_2 in an organic solvent **not** $Br_2(aq)$ (1)
$CH_3CH(OH)CH_3 \rightarrow$	elimination (1)	conc. H_2SO_4 (1)
$CH_3CH=CH_2$		
$CH_3CH=CH_2 \rightarrow$	addition	$KMnO_4/MnO_4^-$ (1)
$CH_3CH(OH)CH_2OH$	**or** oxidation (1)	

[10]

[Total: 10]

5 **(a)** $C_4H_8O_2$ (1) [1]

(b)

$HCO_2CH(CH_3)_2$ **W**	$HCO_2CH_2CH_2CH_3$ **X**	$CH_3CO_2CH_2CH_3$ **or** $CH_3CO_2C_2H_5$ **Y**	$CH_3CH_2CO_2CH_3$ **or** $C_2H_5CO_2CH_3$ **Z**

each correct structure is worth (1) [4]

(c) **(i)** presence of >C=O group/carbonyl group (1)

(ii) –CHO group/aldehyde group is absent
or ketone is present (1)

(iii) alcohol **C** is $(CH_3)_2CHOH$
allow e.c.f. on **(c)(i)** and **(ii)** (1)

(iv) correct identification of candidate's ester
(**W** in this case)

allow e.c.f. on **(c)(iii)** (1) [4]

(d) none
no chiral centres are present in any of the four esters
allow e.c.f. on candidate's compounds in **(a)** (1) [1]

[Total: 10]