

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) $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$ (1) [3]
- (b) (i) alkanes or paraffins (1)
- (ii) $2\text{H}_2\text{O}_2 : \text{O}_2$ and $\text{C}_{15}\text{H}_{32} : 23\text{O}_2$ (1)
whence $\text{C}_{15}\text{H}_{32} : 46\text{H}_2\text{O}_2$ (1)
allow e.c.f. on (a)(ii) [3]
- (c) (i) $\text{C}_{15}\text{H}_{32} = 212$ (1)
 $n(\text{C}_{15}\text{H}_{32}) = \frac{212 \times 10^6}{212} = 1 \times 10^6 \text{ mol}$
allow e.c.f. on wrong M_r of $\text{C}_{15}\text{H}_{32}$ (1)
- (ii) $n(\text{H}_2\text{O}_2)$ required = $46 \times 10^6 \text{ mol}$ (1)
mass of $\text{H}_2\text{O}_2 = 34 \times 46 \times 10^6 \text{ g} = 1564 \text{ tonnes}$
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) $\text{H}-\text{C}-\text{H}$ 117 to 120° (1)
 $\text{C}=\text{C}=\text{O}$ 180° (1)
- (ii) molecule contains **both** ketone **and** alkene (1) [3]
- (b) (i) $\text{C}_2\text{H}_2\text{O} + 2\text{O}_2 \rightarrow 2\text{CO}_2 + \text{H}_2\text{O}$ (1)
- (ii) from eqn., $42 \text{ g C}_2\text{H}_2\text{O} \rightarrow 48 \text{ dm}^3 \text{ of CO}_2$ (1)
whence $3.5 \text{ g C}_2\text{H}_2\text{O} \rightarrow \frac{48 \times 3.5}{42} \text{ dm}^3 \text{ of CO}_2$ (1)
= $4.0 \text{ dm}^3 \text{ of CO}_2$ (1)
- or $n(\text{C}_2\text{H}_2\text{O}) = \frac{42}{3.5} = 0.0833$ (1)
 $n(\text{CO}_2) = 2 \times 0.083 = 0.0166$ (1)
vol. of $\text{CO}_2 = 0.0166 \times 24 = 4.0 \text{ dm}^3$ (1)
allow e.c.f. on wrong eqn. in (b)(i)
penalise significant figure error [4]

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- (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}
 $C_2H_2 + 2O_2 \rightarrow 2CO_2 + H_2O$ $-1028 \text{ kJ mol}^{-1}$
 $2C + H_2 + \frac{1}{2}O_2 \rightarrow C_2H_2 \Delta H = 2(-395) + (-286) - (-1028)$
 $= -48 \text{ kJ mol}^{-1}$
 correct cycle (1) use of 2 for C/CO₂ (1) answer (1) [6]

- (d) H₂O/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 (PCl₃) or a white solid (PCl₅) (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) MgCl₂ 6 to 7 (1)
 SiCl₄ 0 to 3 (1)
 MgCl₂ dissolves without reaction (1)
 SiCl₄ reacts with water/hydrolyses (1)
 $SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$ or
 $SiCl_4 + 4H_2O \rightarrow Si(OH)_4 + 4HCl$ or
 $SiCl_4 + 4H_2O \rightarrow SiO_2 \cdot 2H_2O + 4HCl$ (1) [5]

[Total: 15 max]

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4

organic reaction	type of reaction	reagent(s)
$\text{CH}_3\text{CHO} \rightarrow$ $\text{CH}_3\text{CH}(\text{OH})\text{CN}$	nucleophilic (1) addition (1)	HCN or HCN and CN^- (1)
$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3 \rightarrow$ $\text{CH}_3\text{CH}_2\text{CHBrCH}_3$	free radical (1) substitution (1)	Br_2 or Br_2 in an organic solvent not $\text{Br}_2(\text{aq})$ (1)
$\text{CH}_3\text{CH}(\text{OH})\text{CH}_3 \rightarrow$ $\text{CH}_3\text{CH}=\text{CH}_2$	elimination (1)	conc. H_2SO_4 (1)
$\text{CH}_3\text{CH}=\text{CH}_2 \rightarrow$ $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{OH}$	addition or oxidation (1)	$\text{KMnO}_4/\text{MnO}_4^-$ (1)

[10]

[Total: 10]

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

(b)

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