

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

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.

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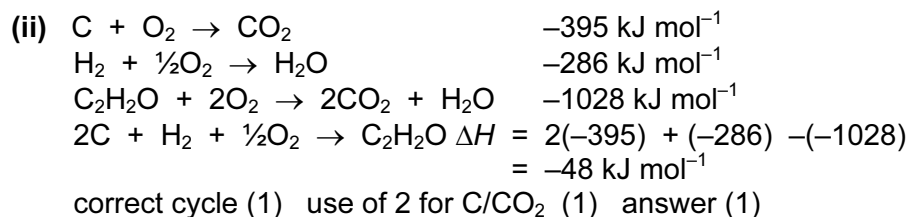
- 1 (a) (i) substance that speeds up a chemical reaction (1)
by lowering E_a
or by providing an alternative reaction pathway
or without being used up in the process (1)
- (ii) $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$ (1) [3]
- (b) (i) alkanes or paraffins (1)
- (ii) $2\text{H}_2\text{O}_2 : \text{O}_2$ 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)



(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]