

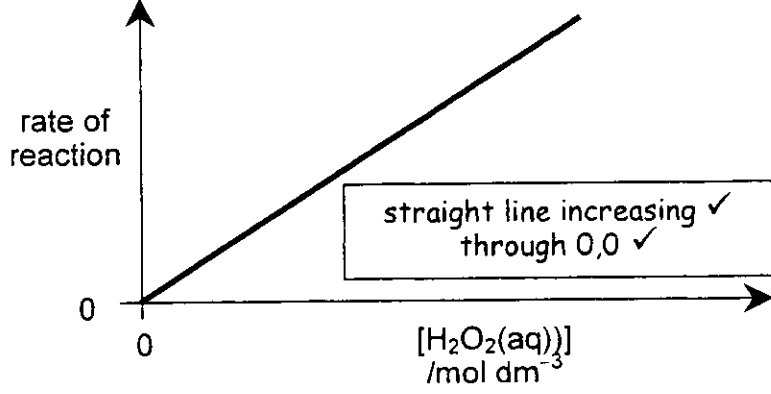


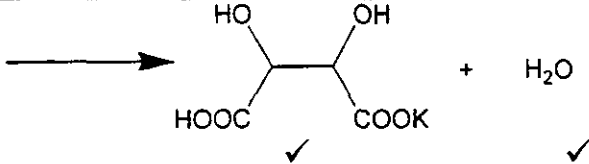


A2 CHEMISTRY
UNIFYING CONCEPTS
Mark Scheme 2816/1
January 2004

Question	Expected Answers	Marks												
1 (a)	$K_c = \frac{[\text{CH}_3\text{COOC}_2\text{H}_5][\text{H}_2\text{O}]}{[\text{CH}_3\text{COOH}][\text{C}_2\text{H}_5\text{OH}]}$ ✓✓ award 1 mark if upside down	[2]												
(b) (i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding: 2px;">CH₃COOH</td> <td style="padding: 2px;">C₂H₅OH</td> <td style="padding: 2px;">CH₃COOC₂H₅</td> <td style="padding: 2px;">H₂O</td> </tr> <tr> <td style="padding: 2px;">6.0</td> <td style="padding: 2px;">12.5</td> <td style="padding: 2px;">0</td> <td style="padding: 2px;">0</td> </tr> <tr> <td style="padding: 2px;">1</td> <td style="padding: 2px;">7.5</td> <td style="padding: 2px;">5</td> <td style="padding: 2px;">5</td> </tr> </table> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;">  </div> <div style="text-align: center;">  </div> </div>	CH ₃ COOH	C ₂ H ₅ OH	CH ₃ COOC ₂ H ₅	H ₂ O	6.0	12.5	0	0	1	7.5	5	5	[2]
CH ₃ COOH	C ₂ H ₅ OH	CH ₃ COOC ₂ H ₅	H ₂ O											
6.0	12.5	0	0											
1	7.5	5	5											
(b) (ii)	$K_c = \frac{5 \times 5}{1 \times 7.5} = 3.3$ ✓ no units ✓ (or ecf based on answers to (i) and/or (a))	[2]												
(c)	leave experiment longer ✓ monitor compositions and repeat until constant value ✓	[2]												
(d) (i)	more CH ₃ COOC ₂ H ₅ & H ₂ O / less CH ₃ COOH & C ₂ H ₅ OH ✓ equilibrium → right ✓ AW	[2]												
(d) (ii)	K _c stays same ✓	[1]												
(e)	stays the same/ catalyst does not shift equilibrium position ✓ forward & reverse reactions altered by same amount/ equilibrium achieved in less time ✓	[2]												
(f) (i)	equilibrium → left ✓ more reactants / less products ✓	[2]												
(f) (ii)	forward reaction is exothermic ✓	[1]												
		Total: 16												

Question	Expected Answers	Marks
2 (a)	$\text{H}_2\text{O}_2 + 2\text{I}^- + 2\text{H}^+ \longrightarrow \text{I}_2 + 2\text{H}_2\text{O}$ equation includes H_2O , I^- , H^+ as reactants and I_2 as product ✓ equation balanced ✓	[2]
(b) (i)	Exp 2 has twice $[\text{I}^-]$ as Exp 1 and rate has quadrupled ✓, so order = 2 with respect to I^- ✓ Exp 3 has twice $[\text{H}^+]$ as 2 and rate is unchanged ✓, so order = 0 with respect to H^+ ✓AW	[4]
(ii)	$\text{rate} = k [\text{H}_2\text{O}_2] [\text{I}^-]^2$ ✓✓ 1 mark for: $\text{rate} = k \times \text{concs}$ (ecf from (i))	[2]
(iii)	$k = \text{rate} / [\text{H}_2\text{O}_2] [\text{I}^-]^2$ ✓ (ecf from (ii)) From one of expts, e.g. Exp 1: $k = 1.15 \times 10^{-6} / (0.01)(0.01)^2$ $= 1.15 \text{ dm}^6 \text{ mol}^{-2} \text{ s}^{-1}$ ✓ (ecf from (ii))	[3]
(c)		[2]
(d) (i)	$2\text{H}_2\text{O}_2 \longrightarrow 2\text{H}_2\text{O} + \text{O}_2$ ✓	[1]
(ii)	$1 \text{ dm}^3 \text{ H}_2\text{O}_2 \longrightarrow 20 \text{ dm}^3 \text{ O}_2$ ✓ amount of $\text{O}_2 = 20/24 \text{ mol}$ ✓ concentration of $\text{H}_2\text{O}_2 = 2 \times 20/24 = 1.67 \text{ mol dm}^{-3}$ ✓	[3]
		Total: 17

Question	Expected Answers	Marks
3 (a) (i)	a proton donor ✓	[1]
(ii)	partially dissociates ✓	[1]
(iii)	pH = $-\log[H^+]$	[1]
(iv)	A solution that minimises changes/resists change in pH after addition of acid/alkali ✓ NOT 'maintains constant pH' or 'cancel out'	[1]
(b)	<p>H₂CO₃ reacts with added alkali / added alkali reacts with H⁺ / H⁺ + OH⁻ → H₂O ✓</p> <p>The base or HCO₃⁻ reacts with added acid ✓</p> <p>H₂CO₃ + OH⁻ → HCO₃⁻ + H₂O ✓</p> <p>HCO₃⁻ + H⁺ → H₂CO₃ ✓AW</p> <p>QoWC: equilibrium position moves to counteract change / explanation in terms of le Chatelier's principle ✓</p>	[4] [1]
(c)	$K_a = \frac{[H^+][HCO_3^-(aq)]}{[H_2CO_3(aq)]} \checkmark$ $[H^+] = 10^{-pH} \checkmark = 10^{-7.4} = 3.98 \times 10^{-8} \checkmark$ $\frac{[HCO_3^-(aq)]}{[H_2CO_3(aq)]} = \frac{K_a}{[H^+]} = \frac{4.17 \times 10^{-7}}{3.98 \times 10^{-8}} = 10.5 \checkmark$	[4]
		Total: 13

Question	Expected Answers	Marks
4 (a) (i)	crude oil ✓ (ii) $C_4H_{10} + 3\frac{1}{2}O_2 \longrightarrow C_4H_2O_3 + 4H_2O$ C_4H_{10} , O_2 & $C_4H_2O_3$ ✓ all correct and balanced ✓ (iii) moles butane = $30 \times 1\,000 / 24 = 1\,250$ ✓ M_r maleic anhydride = 98 ✓ mass maleic anhydride = moles $\times M_r$ $= 1\,250 / 1000 \times 98$ kg 122.5 kg ✓	[1] [2] [3]
(b)	molecular formula = $C_4H_6O_6$ ✓ empirical formula = $C_2H_3O_3$ ✓ (award both marks if only empirical formula is shown)	[2]
(c) (i)		[2]
(ii)	any chemical that reacts: e.g. metal more reactive than Pb / carbonate / carboxylic acid / alcohol / hydrogen halide ✓ observation to match chemical added ✓ equation to match chemistry of chemical added; products ✓ balanced ✓	[4]
		Total: 14

