OCR
RECOGNISING ACHIEVEMENT

GCE

Chemistry

Advanced GCE **2816/01**

Unifying Concepts in Chemistry

Mark Scheme for June 2010

Oxford Cambridge and RSA Examinations

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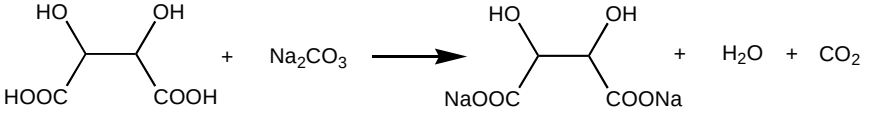
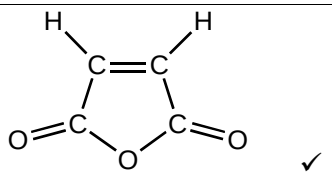
Qu.	Expected Answers	Marks
1 (a)	$K_c = \frac{[CH_3COOC_2H_5]\,[H_2O]}{[CH_3COOH]\,[C_2H_5OH]}$ ✓	1
(b)(i)	<table><tr><td>CH_3COOH</td><td>C_2H_5OH</td><td>$CH_3COOC_2H_5$</td><td>H_2O</td></tr><tr><td>8.0</td><td>14.5</td><td>0</td><td>0</td></tr><tr><td>1.5</td><td>8.0</td><td>6.5</td><td>6.5</td></tr></table> ✓ ✓	2
(ii)	$K_c = \frac{6.5 \times 6.5}{1.5 \times 8.0}$ ✓ = 3.5 ✓ (calc. value 3.520833333) **ALLOW** 2 significant figures upwards **DO NOT ALLOW** numerical answer if units given [or ECF based on answers to **(i)** and/or **(a)**]	2
(c)(i)	More $CH_3COOC_2H_5$ & H_2O **OR** less CH_3COOH & C_2H_5OH **OR** /equilibrium ⟶ right	1
(ii)	**AND** to oppose increase in ethanol **OR** to decrease the ethanol **OR** to oppose the change ✓ AW K_c stays same ✓	1
(d)	Stays that same **OR** catalyst does not shift equilibrium position ✓ forward and reverse reactions affected by same amount **OR** equilibrium is reached in less time **OR** catalyst not in K_c expression ✓	2
(e)	Equilibrium ⟶ left **OR** more reactants **OR** less products ✓ (forward) reaction is exothermic ✓	2
	Total:	11

Qu.	Expected Answers	Marks
2(a)(i)	Time for half a reactant to react ✓	**1**
2(a)(ii)	Evidence from graph, either drawn or stated with 2 half-lives ✓ Half-life 52 ± 2 s (50–54) ✓	**2**
2(a)(iii)	No effect ✓	**1**
2(b)(i)	Rate = $k[N_2O(g)]$ ✓	**1**
2(b)(ii)	Evidence of tangent on graph at 70 s ✓ rate = 0.00524 ✓ mol dm^{-3} s^{-1} (dependent on tangent) (**ALLOW** ± 0.0005: i.e. values in range 0.0047–0.0058 mol dm^{-3} s^{-1}) **ALLOW** ECF on tangent drawn	**2**
2(b)(iii)	k = 0.0131 ✓ s^{-1} ✓ (from 0.00524/0.4) **ALLOW** 2 significant figures up to calculator value **ALLOW** answer to **(ii)** / conc. used in get answer in (**ii**)	**2**
2(c)	Rate determining step **OR** rate equation has 1 molecule of N_2O ✓ (overall) equation shows 2 mol N_2O reacting ✓	**2**
2(d)(i)	moles N_2O = moles NH_4NO_3 = 100/80 = 1.25 mol **OR** 80 g NH_4NO_3 ⟶ 44 g N_2O ✓ mass N_2O = 1.25 x (28 + 16) = 55 g ✓	**2**
2(d)(ii)	nitrogen in NH_4^+: –3 ⟶ +1 / increases by 4 ✓ nitrogen in NO_3^-: +5 ⟶ +1 / decreases by 4 ✓	**2**
2(e)(i)	$4NH_3(g) + 5O_2(g) \longrightarrow 4NO(g) + 6H_2O(l)$ ✓	**1**
2(e)(ii)	molar masses NH_3 = 17; HNO_3 = 63 ✓ mass = 700 000 x 17/63 = 1.89 x 10^5 tonnes OR 1.89 x 10^{11} g ✓ calc. value 1.888888.... x 10^5 *ans: mark could be consequential on incorrect molar masses.* **ALLOW** 2 significant figures up to calculator value	**2**
	Total:	**18**

Qu.	Expected Answers	Marks
3(a)(i)	HCl is a strong acid and CH_3COOH a weak acid ✓	**1**
3(a)(ii)	$[H^+] = 10^{-3.23} = 5.89 \times 10^{-4}$ mol dm^{-3} ✓ $K_a = [H^+]^2 / [HA] = (5.89 \times 10^{-4})^2 / 0.0200 = 1.73 \times 10^{-5}$ ✓ mol dm^{-3} ✓ **ALLOW** 2 significant figures up to calculator value	**3**
3(a)(iii)	conc HCl = 0.00500 mol dm^{-3} ✓ pH = 2.31 ✓ (calc: 2.306029996)	**2**
3(b) (i)	$K_w = [H^+(aq)]\,[OH^-(aq)]$ ✓ state symbols not needed ✓	**1**
3(b)(ii)	$[H^+(aq) = \frac{K_w}{[OH^-(aq)]} = \frac{1.0 \times 10^{-14}}{0.015} = 6.7 \times 10^{-13}$ mol dm^{-3} ✓ pH = –log (6.7×10^{-13}) = 12.18 ✓ *pH ECF from $[H^+]$* **ALLOW** one decimal place up to calculator value	**2**
3(c)(i)	Shape: small rise, sharp rise small rise ✓ Sharp rise at approx 33.3 cm^3 ✓ Finish is nearer to 14 than start is to 0 ✓	**3**
3(c)(ii)	Thymol blue as pH range matches pH change during sharp rise ✓ **ALLOW** ECF from incorrect titration curve	**1**
3(d)	A solution that minimises pH changes/resists pH changes/opposes pH changes ✓ (**not** pH is kept constant/pH maintained/pH cancelled out) equilibrium: $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$ ✓ **ALLOW** HA from now on CH_3COOH reacts with added alkali / $CH_3COOH + OH^- \rightarrow H_2O + CH_3COO^-$ / added alkali reacts with H^+ / $H^+ + OH^- \rightarrow H_2O$✓ $\rightarrow CH_3COO^-$ / Equil $\rightarrow$ right (to counteract change) ✓ CH_3COO^- reacts with added acid or H^+ ✓ $\rightarrow CH_3COOH$ / Equil $\rightarrow$ left (to counteract change) ✓ pH increases as $[H^+]$ is less ✓ $[H^+] = K_a\,[CH_3COOH]/[CH_3COONa]$ **OR** equilibrium shifts left ✓ Quality of Written Communication mark is subsumed within discussion for last mark	**1** **1** **2** **2** **2**
	Total:	**21**

Qu.	Expected Answers	Marks
4(a) (i)	$C_4H_{10} + 3½O_2 \longrightarrow C_4H_2O_3 + 4H_2O$ ✓	1
4(a) (ii)	moles butane = 30 x 1 000/24 = 1 250 ✓ mass maleic anhydride = moles x M_r = 1 250 x 98 = 122,500 g / 122.5 kg ✓	2
4(b)	Empirical formula = $C_2H_3O_3$ ✓	1
4(c) (i)	 CO_2 and H_2O ✓ complete equation ✓	2
4(c) (ii)	Any chemical that reacts: e.g. metal more reactive than Pb / base / alkali carboxylic acid / alcohol / hydrogen halide ✓ Equation to match chemistry of chemical added; organic product ✓ balanced ✓	3
4(d)	 ✓ **ALLOW** any other cyclic version	1
	Total:	10

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