Assessment Schedule – 2005

Chemistry: Describe thermochemical and equilibrium principles (90310)

Evidence Statement

Q	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
1(a) 1(b) 1(c) 1(d)	exothermic exothermic endothermic exothermic	Three correct.		
2(a)(i)	$K_c = \dfrac{\left[Ag(NH_3)_2^+\right]}{\left[Ag^+\right]\left[NH_3\right]^2}$	Both K_c expressions correct.		
(ii)	$Ag(NH_3)_2^+(aq)$ circled			
	K_c is very <u>large</u> (10^7), so concentration of product is high compared to that of reactants (as the product concentration is on top of the ratio).	$Ag(NH_3)_2^+(aq)$ and $NO_2(g)$ both circled.	Magnitude of K_c is referred to and how this links to concentrations.	
2(b)(i)	$K_c = \dfrac{\left[NO\right]^2\left[O_2\right]}{\left[NO_2\right]^2}$			
(ii)	$NO_2(g)$ circled			
	K_c is very <u>small</u> (10^{-5}), so concentration of product is low compared to that of reactants (or concentration of reactant is higher) (as the product concentration is the top of the ratio, or reactant concentration is on the bottom of the ratio.)			

Q	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
3(a)	$\text{mol NaOH} = \frac{29.6\text{ g}}{40.0\text{ g mol}^{-1}} = 0.740\text{ mol}$ 0.740 mol reacts to produce 43.5 kJ 1 mol reacts to produce $\frac{43.5}{0.740} = 58.8$ kJ $\Delta_r H = -58.8$ kJ mol^{-1}	Numerical value correct.	Energy value, sign and units of $\Delta_r H$ all correct.	
3(b)	$\text{n(NaOH)} = \frac{150\text{ kJ}}{58.8\text{ kJ mol}^{-1}} = 2.55\text{ mol}$ m(NaOH) =2.55 mol × 40.0 g mol^{-1} = 102 g	n(NaOH) correct **OR** Numerical value of mass correct	Mass NaOH correct. (unit required)	
4(a)	$K_c = \frac{[NO_2]^4[O_2]}{[N_2O_5]^2}$	K_c expression correct.		
4(b)(i)	Lighter brown / brown colour becomes less intense. When the mixture is heated the endothermic reaction / absorption of heat is favoured. This is reverse reaction. So amount of brown NO_2 gas is decreased / N_2O_5 increased so that the observed colour gets lighter	Observation correct for **one** change. **Note:** "Goes clear" not acceptable **OR** One change clearly explained although observation not linked correctly.	Observations both correct and limited explanations. **OR** One observation correct with full explanation.	Observations both correct and full explanations given. Colour change linked to actual species.
(ii)	Lighter brown / brown colour becomes less intense. As the pressure is increased the formation of fewer moles of gas is favoured. This favours the reverse reaction since there are 5 moles of product gas compared with 2 moles of reactant gas. Thus the amount of brown NO_2 gas is decreased / N_2O_5 increased, so that the observed colour gets lighter.			

Q	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
5(a)	MnO_2 is catalyst for the reaction. The catalyst provides an alternative pathway of lower activation energy for the reaction. Thus molecules which previously did not have enough energy to react now reach the lowered activation energy upon collision. The successful collision rate is therefore increased, so that the reaction rate is increased. As the manganese dioxide (catalyst) is not used up in the reaction only a very small amount is required.	Manganese dioxide is recognised as a catalyst.	Limited explanation as to how the catalyst increases the reaction rate. ie MnO_2 is catalyst. **AND** two of the following ideas - alternative pathway - lower activation energy - successful collisions more frequent	Full explanation of the role of manganese dioxide as a catalyst.
5(b)	The low temperature means the molecules have less kinetic energy. Therefore, when the molecules collide there is less chance of reaching the activation energy for the reaction and therefore the reaction rate is decreased. Also, there will be a decrease in the frequency of collisions of molecules. Therefore, there are fewer successful collisions in the same time, so that the reaction rate is decreased and the rate of decomposition is decreased.	States that reaction rate is decreased. **OR** Kinetic energy of molecules is decreased and there are fewer successful collisions / less frequent collisions	States that reaction rate is decreased **AND** lower kinetic energy of molecules so collisions less frequent **OR** lower kinetic energy of molecules so collisions less likely to be successful **OR** lower kinetic energy of molecules so collisions less likely to reach required activation energy **OR** statement contrasting decreased rate at <u>lower temperature</u> with full explanation of why rate is higher at higher temperature.	Full explanation involving activation energy.
6(a)	acid HA Reaction rate of acid depends on concentration of hydrogen / hydronium ions – the higher the faster the reaction. Acid HA has the lowest pH therefore highest hydrogen / hydronium ion concentration.	Acid HA circled.	HA has the highest H^+ / H_3O^+ ion concentration.	

<table>
<tr><th>Q</th><th>Evidence</th><th>Evidence contributing to Achievement</th><th>Evidence contributing to Achievement with Merit</th><th>Evidence contributing to Achievement with Excellence</th></tr>
<tr><td>6(b)</td><td>acid HB
Acid strength is indicated by the ability to donate H^+ ions – the weakest acid is the poorest H^+ donor. Acid HA has fully donated H^+ ions since a pH of 1.00 indicates $[H^+]$ of 0.100 mol L^{-1}, which is the concentration of the acid. Similarly acid HC has fully donated H^+ ions since a pH of 3.00 indicates $[H^+]$ of 0.00100 mol L^{-1}, which is the concentration of the acid. These are both strong acids. Acid HB has only donated some of the H^+ ions since a pH of 2.50 is $[H^+]$ of about 3×10^{-3} mol L^{-1} and the acid concentration is 0.100 mol L^{-1}, thus it is only partly dissociated and therefore the weakest acid.</td><td>Acid HB circled (or answer clearly indicates this is the selected acid).</td><td>Acid HB circled.
Limited explanation.

eg
higher pH than HA
eg
lower % dissociation than both HA and HC.</td><td>Acid HB circled.
Full explanation that refers to all three acids, and links degree of dissociation to strength and thus $[H^+]$ / $[H_3O^+]$ ions.</td></tr>
<tr><td>7</td><td><table><tr><th>Soln</th><th>$[H_3O^+]$</th><th>$[OH^-]$</th><th>pH</th></tr><tr><td>1</td><td></td><td>2.86×10^{-13}</td><td>1.46</td></tr><tr><td>2</td><td>1.58×10^{-11}</td><td>6.31×10^{-4}</td><td></td></tr><tr><td>3</td><td>1.77×10^{-9}</td><td></td><td>8.75</td></tr></table></td><td>2 answers correct
1 sig. fig. not acceptable</td><td>4 answers correct</td><td>6 answers correct
(Answers may have 2–4 sig figs.)</td></tr>
<tr><td>8</td><td>Sodium ethanoate solution contains both $Na^+(aq)$ and $CH_3COO^-(aq)$ ions.
Ethanoate ions react with water to accept H^+ since ethanoic acid is a weak acid. / ethanoate ions are weakly basic.
$CH_3COO^-(aq) + H_2O \longrightarrow CH_3COOH(aq) + OH^-(aq)$
So $[OH^-]$ has increased
The increase in $[OH^-]$ means there is a decrease in $[H_3O^+]$ (or $[H^+]$), which makes the solution basic so the pH is greater than 7.</td><td>Explanation recognises an increase in $[OH^-]$.</td><td>Equation products not fully correct, but OH^- ions shown as product

OR

Explanation recognises increase in $[OH^-]$ due to reaction of $NaCH_3COO$ / CH_3COO^- ions with water</td><td>Correct equation
AND

so $[OH^-]$ has increased
OR
Increase in $[OH^-]$ means a decrease in $[H_3O^+]$ / $[H^+]$,
OR
so $[OH^-] > [H_3O^+]$

thus pH greater than 7.</td></tr>
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Judgement Statement

Achievement	Achievement with Merit	Achievement with Excellence
SEVEN opportunities answered at Achievement level or higher. 7 × A	EIGHT opportunities answered with FIVE at Merit level or higher, and THREE others at Achievement level or higher. 5 × M *plus* 3 × A	NINE opportunities answered with THREE at Excellence level, THREE at Merit level or higher and THREE others at Achievement level or higher. 3 × E *plus* 3 × M *plus* 3 × A