

Assessment Schedule – 2014

Chemistry: Demonstrate understanding of chemical reactivity (91166)

Evidence Statement

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence				
ONE (a)(i)	NH_4^+ , OH^-	<ul style="list-style-type: none"> Both products given (must have charges). 	<ul style="list-style-type: none"> NH_3 is the base and accepts a proton to form the conjugate acid NH_4^+ AND H_2O is the acid and donates a proton to form the conjugate base OH^-. 					
(ii)	Protons are being transferred from the acid, H_2O to the base, NH_3 . When the NH_3 gains a proton, it forms its conjugate acid, NH_4^+ . When H_2O loses its proton, it forms its conjugate base, OH^- .	<ul style="list-style-type: none"> Two of acid, base, conjugate base, conjugate acid. (eg. NH_3 base). H_2O donates protons or NH_3 accepts protons. 						
(b)(i)	$[\text{H}_3\text{O}^+] = 1.58 \times 10^{-13} \text{ mol L}^{-1}$ $[\text{OH}^-] = \frac{1 \times 10^{-14}}{1.58 \times 10^{-13}}$ $= 0.0633 \text{ mol L}^{-1}$	<ul style="list-style-type: none"> $[\text{H}_3\text{O}^+]$ correct. $[\text{OH}^-]$ calculation process correct based on incorrect $[\text{H}_3\text{O}^+]$. 	<ul style="list-style-type: none"> $[\text{OH}^-]$ correctly calculated. 	<ul style="list-style-type: none"> THREE calculations correct with correct units. 				
(ii)	pH = 10.4		<ul style="list-style-type: none"> pH correctly calculated. 					
(c)	<p>Strong base = E; red litmus paper turns blue and blue litmus remains blue indicates base; good conductivity indicates large number of charged particles to conduct current – strong base completely dissociates and produces high $[\text{OH}^-]$.</p> <p>Neutral salt = C; no colour change in either litmus, indicating neutral solution; good conductivity indicates large number of charged particles to conduct current – salt will dissolve to give ions in solution or solution has ions.</p>	<ul style="list-style-type: none"> ONE of E or C correctly identified with some justification. 	<ul style="list-style-type: none"> BOTH E and C correctly identified with good explanations of litmus and conductivity for both solutions. 	<ul style="list-style-type: none"> Identifies BOTH solutions with justification relating to litmus and conductivity. 				
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	2a	3a	4a	6a	3m	4m	2e with minor error / omission.	2e

Two	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
(a)(i)	$K_c = \frac{[\text{H}_2]^3 [\text{CO}]}{[\text{CH}_4][\text{H}_2\text{O}]}$	<ul style="list-style-type: none"> • K_c expression correct. 	<ul style="list-style-type: none"> • No, with the correct calculation.* 	<ul style="list-style-type: none"> • No, with the correct reason and calculation.
(ii)	No $K_c = 3.6$ which is < 4.7 ; therefore the reaction is not at equilibrium since if the reaction was at equilibrium, the K_c would be 4.7 at 1127°C.			
(b)	<p>CuO catalyst: Amount of methanol stays the same. A catalyst, such as CuO, will speed up the rate of both the forward and the reverse reactions. The proportions of all of the reactants and products remain the same.</p> <p>H₂ removed: Amount of methanol will decrease. As hydrogen gas is removed, the system will oppose the change and the position of the equilibrium will shift in the reverse direction as more hydrogen is formed. This means the amount of methanol will decrease.</p>	<ul style="list-style-type: none"> • CH₃OH or reaction stays the same since the catalyst speeds up the reaction OR proportion of reactants & products stays the same. • CH₃OH or reaction decreases, since shift is in the reverse direction OR reaction to form more hydrogen. 	<ul style="list-style-type: none"> • CH₃OH stays the same since the catalyst speeds both reactions and equilibrium is established faster or the proportion (amount) of reactants & products stays the same. • CH₃OH decreases since the shift is in the reverse direction in order to form more hydrogen or replace lost reactants. 	
(c)	<p>Increasing pressure resulted in the colour fading. This was due to the position of the equilibrium shifting in the forward direction to counteract this change. The system shifts in the direction of the least number of moles of gas since this will decrease the pressure. This forms more N₂O₄ (g), which is colourless, so the colour fades.</p> <p>When the pressure is decreased again the system adjusts to increase the pressure, hence shifts in the direction of a greater number of moles, i.e. in the reverse direction, forming more NO₂, resulting in a darker colour due to the brown colour of this gas.</p> <p>When the reaction container is placed in hot water, the system will adjust so that some of the heat is used up; therefore it will shift in the endothermic direction. In this case, the colour darkened, indicating that this favoured the reverse reaction which must be the endothermic direction. When the container was cooled, the colour faded indicating that the forward reaction, forming colourless N₂O₄, must be exothermic.</p>	<ul style="list-style-type: none"> • One correct statement regarding pressure change. • One correct statement regarding temperature change. 	<ul style="list-style-type: none"> • Changes when the pressure is altered explained in terms of equilibrium principles. Change when the temperature is altered is explained in terms of equilibrium principles AND correctly identifies the forward reaction as exothermic. 	<ul style="list-style-type: none"> • Shows a thorough understanding of equilibrium principles relating to changes of pressure and temperature.

*Can be considered for Achievement.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	1a	2a	3a	4a	3m	4m	2e with minor error	2e

Three	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
(a)	<p>A Reaction rate starts off high (steep slope) since there is a high concentration of reactants or many Zn particles at the start, so the frequency of collisions is highest, therefore the reaction rate is highest.</p> <p>B As zinc and sulfuric acid react to form zinc sulfate & hydrogen gas, the number of Zn particles decrease as it is used up. As the concentration of this reactant drops, the frequency of collisions will be less since there are fewer particles per unit volume to collide with the zinc. Thus the rate of reaction starts to slow down and the gradient of the graph becomes shallower.</p> <p>C Once all of the zinc reactant has been used up (sulfuric acid is in excess), then the reaction will stop since there is no more zinc to collide with the sulfuric acid and produce zinc sulfate & hydrogen gas. Thus there will be no more hydrogen gas formed; the maximum volume of hydrogen gas has been obtained and so the line remains horizontal.</p>	<ul style="list-style-type: none"> • Reaction rate high or many collisions at start as large number of particles • Reaction rate slows or concentration of reactants drops. • Reaction stopped or reactant(s) used up. 	<ul style="list-style-type: none"> • Concentration of reactants highest, so reaction rate is highest, as many collisions • Concentration decreasing so reaction rate decreases, fewer collisions <i>(Note: both bullet points above must link to rate or unit time.)</i> • All Zn used up, so no more collisions possible to result in reaction. 	
(b)	<p>Increases the rate of reaction. The catalyst, copper, provides an alternative pathway for the reaction between zinc and sulfuric acid, which involves lower activation energy. Therefore more particles will collide with sufficient energy to overcome the activation energy and result in successful collisions, so the rate of reaction will increase.</p>	<ul style="list-style-type: none"> • Catalysts lower (activation) energy or provide alternative pathway or are not used up. 	<ul style="list-style-type: none"> • Alternative pathway involving lower activation energy therefore increased rate of reaction. • More collisions are effective therefore increased reaction rate. 	<ul style="list-style-type: none"> • Fully explains the nature of catalysts on rate of reaction.

(c)(i)	$\text{HA} + \text{H}_2\text{O} \rightarrow \text{A}^- + \text{H}_3\text{O}^+$ $[\text{H}_3\text{O}^+] = 0.100 \text{ mol L}^{-1}$	<ul style="list-style-type: none"> One correct equation with correct arrow. ONE correct calculation. 	<ul style="list-style-type: none"> Both equations correct. OR Both calculations correct. Explanations of both acids with respect to dissociation. 	<ul style="list-style-type: none"> Compares the strength of each acid, supported by correct calculations and equations, and a prediction of observations with reasons. Must mention observed gas production. 				
	$\text{HB} + \text{H}_2\text{O} \rightleftharpoons \text{B}^- + \text{H}_3\text{O}^+$ $[\text{H}_3\text{O}^+] = 0.00631 \text{ mol L}^{-1}$							
(ii)	<p>HA is a strong acid since it fully dissociates, as shown by concentration of hydronium ions in HA solution – same as original concentration of HA (both 0.100 mol L^{-1}).</p> <p>HB is a weak acid since it only partially dissociates; as shown by the concentration of hydronium ions in HB solution – concentration is only $0.00631 \text{ mol L}^{-1}$.</p>	<ul style="list-style-type: none"> HA is strong acid since it fully dissociates OR produces more hydronium ions. OR HB is a weak acid since it partially dissociates OR produces few hydronium ions. 	<ul style="list-style-type: none"> Either observation given with explanation relating to hydrogen ion concentration and rate of reaction. 					
	<p>HA Expect reaction to be more vigorous; rapidly produces gas / bubbles (CO_2) – since the concentration of hydrogen ions is high, there will be more frequent collisions resulting in a faster rate of reaction.</p> <p>HB Expect a slower reaction, taking longer to produce the same volume of gas – since the concentration of hydrogen ions is low, there will be less frequent collisions resulting in a slower rate of reaction.</p>							
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	2a	3a	4a	6a	4m	6m	2e with minor error / omission.	2e

Cut Scores

	Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
Score range	0 – 6	7 – 13	14 – 18	19 – 24