Assessment Schedule – 2012

Chemistry: Demonstrate understanding of chemical reactivity (91166)

Assessment Criteria

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding involves describing, identifying, naming, drawing, calculating, or giving an account of chemical reactivity. This requires the use of chemistry vocabulary, symbols and conventions.	*Demonstrate in-depth understanding* involves explaining chemical reactivity. This requires explanations that use chemistry vocabulary, symbols and conventions.	*Demonstrate comprehensive understanding* involves elaborating, justifying, relating, evaluating, comparing and contrasting, or analysing chemical reactivity. This requires the consistent use of chemistry vocabulary, symbols and conventions.

One	Expected coverage	Achievement	Merit	Excellence
(a)	• Decrease concentration of a reactant. • Decrease temperature.	• One correct.		
(b)	**Experiment 2 and 1** Concentration of a reactant has decreased, which decreased the rate of reaction. This means there are fewer reactant particles per unit volume so the collision rate decreases.	• Factor and reaction rate decreases. • Fewer reactant particles per unit volume OR collision rate decreases.	• Factor and reaction rate decreases. AND EITHER Fewer reactant particles per unit volume. OR Collision rate decreases.	• Full analysis: Factor and reaction rate decreases and fewer reactant particles per unit volume AND collision rate decreases.
	Experiment 3 and 1 Temperature is increased, so the rate of reaction increases. This means: The particles have more average kinetic energy and are moving faster. There will be an increase in the frequency of collisions between particles. Particles also collide more effectively as the particles have more energy to overcome the activation energy for the reaction.	• Factor and reaction rate increase. • Particles moving faster OR more kinetic energy. • Collisions more effective OR easier to overcome activation energy.	• Factor and reaction rate increases. AND EITHER The particles have more kinetic energy and are moving faster. There will be an increase in the frequency of collisions between particles. OR Particles collide more effectively as the particles have more energy to overcome the activation energy for the reaction.	• Full analysis: Factor and reaction rate increases and the particles have more kinetic energy and are moving faster. There will be an increase in the frequency of collisions between particles AND particles also collide more effectively as the particles have more energy to overcome the activation energy for the reaction.

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

Two	Expected coverage	Achievement	Merit	Excellence
(a)	$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]}$	• K_c expression correct.		
(b)(i) (ii)	PCl_5 The value of K_c is less than 1 / small. This means that the concentration of reactant (PCl_5) is greater than the concentration of products (PCl_3/Cl_2).	• K_c is small or less than 1.	• Value of K_c linked to proportions of reactants and products.	
(iii)	$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]}$ $[PCl_5] = \frac{[PCl_3][Cl_2]}{K_c}$ $[PCl_5] = \frac{0.352 \times 0.352}{0.612}$ $= 0.202 \text{ mol L}^{-1}$	• One step of calculation correct.	• Calculation carried out correctly (units and sig figs not required).	
(c)	When $PCl_3(g)$ is removed: Amount of Cl_2 increases. As $PCl_3(g)$ is removed / concentration decreased, the equilibrium will shift to oppose the change, i.e. increase the concentration of $PCl_3(g)$. This will favour the forward reaction, producing more Cl_2.	• One correct statement.	• $PCl_3(g)$ is removed: explained in terms of equilibrium principles.	• $PCl_3(g)$ is removed: explained in terms of equilibrium principles and related to the reaction.
	When the pressure is decreased: Amount of Cl_2 increases. Decrease in pressure causes the equilibrium to shift to increase the number of gaseous particles, i.e. shifts equilibrium to the side with the greatest number of moles. Since there are two moles of gaseous products and one mole of gaseous reactant, equilibrium will shift to right. This will favour the forward reaction, producing more Cl_2.	• One correct statement.	• The pressure is decreased: explained in terms of equilibrium principles.	• The pressure is decreased: explained in terms of equilibrium principles and related to the reaction.
(d)	At increased temperature the value of K_c increases. This means that equilibrium shifts in favour of products i.e. the forward direction. An increase in temperature causes the equilibrium to shift to favour the reaction that absorbs heat / energy, i.e. the endothermic direction. Hence, the forward reaction is endothermic.	• One correct statement.	• Link made between K_c and temperature change, and one other relevant statement.	• Full justification.

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

Three	Expected coverage	Achievement	Merit	Excellence
(a)(i)	CO_3^{2-}, OH^-, HCN	• TWO correct.		
(ii)	$HPO_4^{2-} + H_2O \rightleftharpoons PO_4^{3-} + H_3O^+$ $HPO_4^{2-} + H_2O \rightleftharpoons H_2PO_4^- + OH^-$	• ONE correct.	• BOTH correct.	
(b)(i)	$K_w = [H_3O^+]\,[OH^-]$ $[H_3O^+] = \dfrac{K_w}{[OH^-]}$ $= 1 \times 10^{-14} / 9.56 \times 10^{-5}$ $= 1.05 \times 10^{-10}$ mol L^{-1}	• ONE step of calculation correct.		
(ii)	Basic since $[H_3O^+] < [OH^-]$ OR vice versa OR Basic since pH = $-\log(1.05 \times 10^{-10}) = 9.98$ OR pH > 7	• Correct statement.		
(c)(i)	$pH = -\log_{10}[H_3O^+]$ $= -\log 0.133$ $= 0.876$	• pH correct.		
(ii)	$[H_3O^+] = 10^{-pH}$ $= 10^{-12.8}$ $= 1.58 \times 10^{-13}$ mol L^{-1} $[OH^-] = 1 \times 10^{-14} / 1.58 \times 10^{-13}$ $= 0.0631$ mol L^{-1}	• ONE step of calculation correct.	• BOTH steps of calculation correct (units and sig. fig. not required).	
(d)	$NH_4Cl(aq)$ is solution **A**: good conductor of electricity – it fully dissociates in solution into ammonium and chloride ions, which conduct electricity. $NH_4Cl \rightarrow NH_4^+ + Cl^-$ Its pH is that of a weak acid, as the ammonium ion is a weak acid and partially dissociates in water, producing hydronium ions: $NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$	• ONE correct statement. OR • ONE correct equation.	• ONE correct explanation with correct equation. OR • TWO correct explanations.	• Correct justifications for both pH and conductivity fully linked to equations for TWO of the three substances.
	$NH_3(aq)$ is solution **B**: its pH is that of a weak base as NH_3 is a weak base and it partially dissociates in water, producing hydroxide ions: $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ Poor conductor of electricity as it is only partially dissociated into ions in water.	• ONE correct statement OR • ONE correct equation.	• ONE correct explanation with correct. OR • TWO correct explanations.	
	HCl(aq) is solution **C**: low pH is that of a strong acid, HCl fully dissociates in water, producing hydronium ions: $HCl + H_2O \rightarrow H_3O^+ + Cl^-$ Good conductor of electricity as it fully dissociates into ions in solution which conduct electricity.	• ONE correct statement. OR • ONE correct equation.	• ONE correct explanation with correct equation. OR • TWO correct explanations.	

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	1a	3a	4a	5a	3m	4m	e with minor error / omission / additional irrelevant information	e

Judgement Statement

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