Assessment Schedule – 2020

Chemistry: Demonstrate understanding of chemical reactivity (91166)

Evidence Statement

Q	Evidence	Achievement	Merit	Excellence
ONE (a)(i) (ii)	$NaHCO_3 \rightarrow Na^+ + HCO_3^-$ Acid: $HCO_3^- + H_2O \rightleftharpoons CO_3^{2-} + H_3O^+$ Base: $HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$	• One equation correct.		
(b)(i) (ii)	$[H_3O^+] = 10^{-11.8} = 1.58 \times 10^{-12}$ mol L^{-1} $[OH^-] = \dfrac{1 \times 10^{-14}}{1.58 \times 10^{-12}} = 6.31 \times 10^{-3}$ mol L^{-1} (or 0.00631 mol L^{-1}) $[H_3O^+] = \sqrt{0.114 \times 10^{-14}} = 3.38 \times 10^{-8}$ mol L^{-1} $pH = -\log[H_3O^+] = 7.47$	• Calculates hydronium ions in (i). • Calculates hydronium ions (ii). OR Recognises $[H_3O^+] = [OH^-]$.	• Calculates hydroxide ion concentration in (i). • Calculates pH in (ii).	• All calculations correct with units.
(c)	The higher the pH, the more hydroxide ions present and the fewer hydronium ions, because the product of hydronium and hydroxide ions is 1×10^{-14}, and pH is the negative log of the hydronium ion concentration. The more hydroxide ions, the greater the dissociation or ionisation in water due to more ions being present. NaOH is a strong base, so fully dissociates releasing many OH^- ions giving a very high $[OH^-]$, a very low $[H_3O^+]$ and in turn a high pH. $NaOH \rightarrow Na^+ + OH^-$ NH_3 is a weak base, so only partially ionises, releasing fewer hydroxide ions than NaOH; giving a high $[OH^-]$,a low $[H_3O^+]$, in turn a high (10.6) pH, but still lower NaOH. $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$ CH_3COONa dissolves into ions and in turn the released weak base CH_3COO^- partially dissociates, releasing even fewer hydroxide ions than ammonia, so an increased $[OH^-]$,a lowered $[H_3O^+]$, in turn a pH above 7 (8.88), but lower than ammonia. $CH_3COONa \rightarrow CH_3COO^- + Na^+$ $CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$	• Recognises that pH is a measurement of $[H3O^+]$ ions. OR States that higher $[OH^-]$ the higher the pH. • Recognises degree of dissociation for two solutions.	• Links differences in pH in terms of concentrations of OH– (or [H3O+]) ions for two solutions. • Links dissociation of TWO solutions to two correct equations.	• Relates the pH to relative dissociation and either OH^- or H_3O^+ ion concentration with relevant equations for each solution.

NØ	N1	N2	A3	A4	M5	M6	E7	E8

No response; no relevant evidence.	1a	2a	3a	4a	2m	3m	2e (1 error)	2e

Q	Evidence	Achievement	Merit	Excellence
TWO (a)	The warmer the solution, the more complete the reaction / the greater the colour change after 45 seconds. An increased temperature means an increase in the rate of the reaction because the kinetic energy of the particles has increased. The particles are moving faster, increasing the frequency of collisions. More of these collisions will have enough energy to be successful collisions, which means their energy is greater than the activation energy. Overall, this leads to a greater frequency of effective collisions, so the rate of reaction is increased, and the solution turns colourless more quickly.	• Recognises increased kinetic energy of particles. OR Recognises faster moving particles collide more often / with more energy. • Recognises that the picture indicates faster reaction rate with greater temperature.	• Link increased frequency of effective/successful collisions to EITHER: the rate change observed in the context OR Increased temperature resulting in more kinetic energy of particles OR Increased temperature resulting in more collisions exceeding activation energy.	• Links temperature to more kinetic energy of particles which gives to more collisions exceeding activation energy and in turn to a greater frequency of effective collisions. This is then used to justify rate change in the observations.
(b)(i) (ii)	0.129 mol L^{-1} 1.80 0.00115 mol L^{-1} or 1.15×10^{-3} mol L^{-1} Solution A will have the highest rate of reaction. This is because the lowest pH (solution A) has the highest concentration of H_3O^+, therefore there are more acid particles in the same volume, so there will be more frequent collisions leading to more effective collisions per second.	• TWO correct calculations. • Identifies Solution A.	• All calculations correct with solution A identified and linked to concentration. • Links a higher concentration of H_3O^+ to more frequent collisions and reaction rate.	• Explains the relative concentration of H_3O^+ linked to solution A, and reaction rate by referring to frequency of effective collisions.
(c)	$HCl + H_2O \rightarrow H_3O^+ + Cl^-$ HCl is a strong acid, so it ionises completely in solution to produce a lot of ions. Conductivity depends on the number of mobile charged particles, in this instance ions, to conduct. Ethanoic is a weak acid, so partially ionises in solution, therefore not producing many ions. So ethanoic acid is a poor conductor with HCl is a good conductor. $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$	• Recognises that conductivity depends on the number of ions (or free moving charged particles). OR Identifies HCl as the better conductor • ONE equation correct.	• Links the number of ions produced in each acid to the ability to conduct.	• Uses two correct equations and the extent of ionisation to illustrate the ability of each acid to conduct electricity.

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

Q	Evidence	Achievement	Merit	Excellence
THREE (a)(i)	$K_c = \frac{[CF_4][CO_2]}{[COF_2]^2}$	• K_c expression correct.	• Correct calculation and explanation of value of K_c.	
(ii)	$K_c = \frac{0.8 \times 0.8}{0.40^2} = 400$	• Correct process for calculation.		
(iii)	The value of K is significantly over 1, so there are far more products than reactants, which means the equilibrium favours the products.	• Recognises K_c increased means more products (or products favoured)		
(iv)	The reaction is exothermic. If the temperature is decreased, the reaction moves in the exothermic direction to produce more heat energy. For this reaction, it will favour the forward reaction. This leads to fewer reactants / increased products so the value of K_c will increase.	• Identifies that a temperature decrease moves the equilibrium in the exothermic direction. OR Identifies the forward reaction as exothermic / releases heat.	• Links the forward reaction as exothermic (or gives out heat) and that temperature decreased favours the exothermic reaction and therefore the forward direction is favoured.	• Explains that as the forward reaction is exothermic and that temperature decreased favours the exothermic reaction (or gives out heat) and therefore the forward direction is favoured giving more product and hence a larger K_c.
(b)(i)	Adding thiocyanate ions to the equilibrium means there is an increase in the concentration of a reactant. The system will react to reduce this change so the forward reaction will be favoured to use up the added SCN^- ions producing more red $[FeSCN]^{2+}$. This means the dark red colour will intensify.	• Identifies correct shift in equilibrium with a reason for ONE of these reactions.	• For two parts: links the change to the system to the system minimising / resisting change and gives the correct direction favoured.	• Justifies each colour change using equilibria principles for all THREE reactions.
(ii)	The added fluoride ions reacts with the Fe^{3+} ions, and this decreases the concentration of the Fe^{3+} in this equilibrium. The system will react by favouring the backward reaction to replace the lost orange Fe^{3+} ions, while using up red $[FeSCN]^{2+}$. This means the dark red colour will lighten and it will become more orange.	• Identifies TWO correct colour changes.	• For two parts: links the production or loss of Fe^{3+} or $[FeSCN]^{2+}$ to colour change.	
(iii)	The forward reaction produces heat so when the mixture is put into hot water, the reaction moves in the endothermic direction to absorb the added heat energy. This will favour the backward reaction using up red $[FeSCN]^{2+}$ and producing orange Fe^{3+}, which means the dark red colour will lighten and the mixture will be more orange.			

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

Cut Scores

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