Assessment Schedule – 2016

Chemistry: Demonstrate understanding of equilibrium principles in aqueous systems (91392)

Evidence Statement

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
ONE (a)	$K_s = [Ag^+]^2[CO_3^{2-}]$	• Correct K_s expression.		
(b)	Let s = solubility $[Ag^+] = 2s$ $[CO_3^{2-}] = s$ $K_s = 4s^3$ $s = 1.27 \times 10^{-4}$ mol L^{-1} $n = c \times v$ = 6.33×10^{-6} mol $m = n \times M$ = 1.75×10^{-3} g OR $g\ L^{-1} = c \times M$ = 0.0349 g L^{-1} so mass in 50 mL = $\frac{0.0349 \times 50}{1000} = 1.75 \times 10^{-3}$ g	• One step correct.	• Correct process for two steps.	• Mass in 50 mL correctly calculated, including correct units and significant figures.
(c)	$Ag_2CO_3(s) \rightleftharpoons 2Ag^+(aq) + CO_3^{2-}(aq)$ $Ag^+(aq) + 2NH_3(aq) \rightarrow [Ag(NH_3)_2](aq)$ The equilibrium responds by favouring the forward reaction and thus more dissolves.	• One correct equation. • Recognises that a complex ion is formed.	• Explanation linked to the effect on equilibrium.	• Correct explanation, giving both correct equations.
(d)	$AgNO_3$ dilution: $\frac{20}{55} \times 0.105 = 0.0382$ Na_2CO_3 dilution: $\frac{35}{55} \times 0.221 = 0.141$ Q / $I.P.$ = $[0.03818]^2[0.1406] = 2.06 \times 10^{-4}$ As Q / $I.P.$ > K_s, a precipitate will form.	• Correct value for Q calculated with incorrect dilution. OR ONE dilution calculated correctly.	• Correct value for Q calculated, based on correct dilutions, but no conclusion given.	• Correct value for Q calculated, based on correct dilutions, with the correct conclusion.

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	Achievement with Merit	Achievement with Excellence
TWO (a)	$CH_3CH_2NH_2 + H_2O \rightleftharpoons CH_3CH_2NH_3^+ + OH^-$	• Correct equation with equilibrium arrow.		
(b)	$[H_3O^+] = \sqrt{(K_a \times K_w \div [CH_3CH_2NH_2])}$ $[H_3O^+] = \sqrt{(2.51\times10^{-11} \times 1.00\times10^{-14} \div 0.109)}$ $[H_3O^+] = 1.52\times10^{-12}$ molL^{-1} pH = -log $[H_3O^+]$ = 11.8	• ONE step correct.	• Correct answer, with minor error, e.g. sig. fig. or rounding error.	• Correct answer, including significant figures.
(c)	$Cl^- > CH_3CH_2NH_3^+ > H_3O^+ > CH_3CH_2NH_2 > OH^-$ OR $Cl^- > CH_3CH_2NH_3^+ > H_3O^+ = CH_3CH_2NH_2 > OH^-$ $CH_3CH_2NH_3Cl \rightarrow CH_3CH_2NH_3^+ + Cl^-$ $CH_3CH_2NH_3Cl$ completely dissociates. (*The chloride ion does not react further with water and so will be in the greatest concentration.*) The ethanamine ion will react further with water, but only partially, leaving it the next in the series. $CH_3CH_2NH_3^+ + H_2O \rightleftharpoons CH_3CH_2NH_2 + H_3O^+$ For every mole of $CH_3CH_2NH_3^+$ that reacts with water, 1 mole of $CH_3CH_2NH_2$ and H_3O^+ are formed. (However, H_3O^+ is slightly more concentrated than $CH_3CH_2NH_2$, as there is a small contribution from water). OH^- is present in the lowest concentration as this comes from the dissociation of water only.	• FOUR species in the correct order. • ONE correct equation. OR ONE correct justification.	• All species in their correct order. AND TWO correct equations / justifications.	• All species in their correct order. AND TWO correct equations. AND Correct justifications.

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

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
THREE (a)	*(Ammonium chloride)* is acidic OR $NH_4^+ + H_2O \rightleftharpoons H_3O^+ + NH_3$ So therefore $[H_3O^+] > [OH^-]$	• H_3O^+ is produced. OR It is acidic.	• BOTH concepts correct.	
(b)	$[NH_4^+] = 0.320 \times 20 / 30 = 0.213$ molL^{-1} *($K_a = 10^{-9.24} = 5.75 \times 10^{-10}$)* $[H_3O^+] = \sqrt{(5.75 \times 10^{-10} \times 0.213)}$ $= 1.11 \times 10^{-5}$ molL^{-1} $pH = -\log[H_3O^+]$ pH = 4.96	• One step correct.	• TWO steps correct.	• All correct.
(c)	Since B is half way to the equivalence point, $[NH_4^+] = [NH_3]$. $K_a = \frac{[NH_3][H_3O^+]}{[NH_4^+]}$ OR $pK_a = pH + \log [acid] \div [c.base]$ *so $K_a = [H_3O^+]$* therefore $pK_a = pH$.	• EITHER K_a expression rearranged OR $[NH_4^+] = [NH_3]$ at B OR $pH = pK_a$	• $[NH_4^+] = [NH_3]$ AND $pH = pK_a$	• Complete explanation.
(d)	*The solution at the equivalence point is NH_4Cl.* NH_4^+ solution is acidic since, $NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$	• NH_4^+ is acidic. OR Correct equation.	• NH_4^+ is acidic AND equation in either symbols or words.	

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

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 13	14 – 19	20 – 24