Part 3. The Ionization Constant of Acetic Acid

Solution: 10 ml of 1.2 M CH_3COOH

Measured: pH
To be determined: K_a

Calculations: 1. $[H_3O^+] = 10^{-pH} = x$

2. Determine $[CH_3COO^-]$ and $[CH_3COOH]$ from the following:

CH_3COOH	+	H_2O	$\rightleftarrows$	CH_3COO^-	+	H_3O^+	
1.2				*0*		*0*	*initial*
–x				*x*		*x*	*change*
(1.2 – x)				*x*		*x*	*equilibrium*

3. $K_a = \dfrac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]} = \dfrac{x^2}{(1.2 - x)}$

Solution: 30 ml of 1.2 M $NaCH_3COO$ + 10 ml of 1.2 M CH_3COOH

$CH_3COOH + H_2O \rightleftarrows CH_3COO^- + H_3O^+$ (*reversible*)

$NaCH_3COO \rightarrow CH_3COO^- + Na^+$ (*to completion*)

Measured: pH
To be determined: K_a

Assume that the equilibrium molarities of CH_3COOH and CH_3COO^- are the same as their initial molarities. However, keep in mind that the initial molarities decrease after the two solutions are mixed together (they dilute each other)

Calculations: 1. $[H_3O^+] = 10^{-pH}$

2. Determine $[CH_3COO^-]$ in a new volume of 40 ml (*dilution problem*)
3. Determine $[CH_3COOH]$ in a new volume of 40 ml (*dilution problem*)
4. $K_a = \dfrac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]}$

Part 4. Buffering Capacity

Solution: 40 ml of DI H_2O + 4 ml of 2.0 M HCl

$HCl + H_2O \rightarrow H_3O^+ + Cl^-$ (*to completion*)

To be determined: pH (calculated)

Calculations: 1. Determine [HCl] in a new volume of 44 ml (*dilution problem*)

2. $[H_3O^+] = [HCl]$

3. $pH_{calc} = -\log [H_3O^+]$

Solution: 40 ml of DI H_2O + 4 ml of 2.0 M NaOH

$$NaOH \rightarrow Na^+ + OH^- \quad (\textit{to completion})$$

To be determined: pH (calculated)

Calculations: Use the same approach as shown above for the (H_2O + 2.0 M HCl) solution.
Remember that $[H_3O^+]\times[OH^-] = 10^{-14}$

Solution: 40 ml of 1.2 M $NaCH_3COO$ + 40 ml of 1.2 M CH_3COOH = 80 ml of the buffer

To be determined: pH (calculated)

Calculations: 1. Determine $[CH_3COO^-]$ in a new volume of 80 ml (*dilution problem*)

2. Determine $[CH_3COOH]$ in a new volume of 80 ml (*dilution problem*)

3. $pH = pK_a + \log\dfrac{[CH_3COO^-]}{[CH_3COOH]}$ Use $K_a = 1.76\times10^{-5}$

Solution: 40 ml of the buffer (prepared previously) + 4 ml of 2.0 M HCl

To be determined: pH (calculated)

Calculations: 1. Determine the initial number of moles of CH_3COOH in solution: *a*

2. Determine the initial number of moles of CH_3COO^- in solution: *b*

3. Determine the number of moles of HCl added: *x*

4.

H_3O^+ +	CH_3COO^- →	CH_3COOH + H_2O	
x	*b*	*a*	*initial*
–x	*–x*	*x*	*change*
0	*(b – x)*	*(a + x)*	*equilibrium*

5. $pH = pK_a + \log\dfrac{\text{moles of } CH_3COO^-}{\text{moles of } CH_3COOH} = pK_a + \log\dfrac{(b-x)}{(a+x)}$ Use $K_a = 1.76\times10^{-5}$

Solution: 40 ml of the buffer (prepared previously) + 4 ml of 2.0 M NaOH

$$OH^- + CH_3COOH \rightarrow CH_3COO^- + H_2O$$

Calculations: Use the same approach as shown above for the (buffer + 2.0 M HCl) solution.