Part 3. The Ionization Constant of Acetic Acid

Solution: 10 ml of 1.5 M CH_3COOH

pH – measured
K_a – ?

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

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

$$\underset{(1.5 - x)}{CH_3COOH} + H_2O \rightleftarrows \underset{x}{CH_3COO^-} + \underset{x}{H_3O^+}$$

3. $$K_a = \frac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]} = \frac{x^2}{(1.5 - x)}$$

Solution: 25 ml of 1.5 M $NaCH_3COO$ + 10 ml of 1.5 M CH_3COOH

$$CH_3COOH + H_2O \rightleftarrows CH_3COO^- + H_3O^+ \quad (\textit{reversible})$$
$$NaCH_3COO \rightarrow CH_3COO^- + Na^+ \quad (\textit{to completion})$$

pH – measured
K_a – ?

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

2. Determine $[CH_3COO^-]$ in a new volume of 35 ml
3. Determine $[CH_3COOH]$ in a new volume of 35 ml
4. $$K_a = \frac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]}$$

Part 4. Buffering Capacity

Solution: 30 ml of DI H_2O + 2 ml of 2.0 M HCl

$$HCl \rightarrow H^+ + Cl^- \quad (\textit{to completion})$$

pH – measured
pH (calculated) – ?

Calculations: 1. Determine [HCl] in a new volume of 32 ml

2. $[H^+] = [HCl]$
3. $pH_{calc} = -\log [H^+]$

Solution: 30 ml of DI H_2O + 2 ml of 2.0 M NaOH

$NaOH \rightarrow Na^+ + OH^-$ (*to completion*)

pH – measured
pH (calculated) – ?

Calculations: Use the same approach as above. Remember, that $[H^+]\times[OH^-] = 10^{-14}$

Solution: 30 ml of 1.5 M $NaCH_3COO$ + 30 ml of 1.5 M CH_3COOH = 60 ml of the buffer

pH – measured

pH (calculated) – ?

Calculations:
1. Determine $[CH_3COO^-]$ in a new volume of 60 ml
2. Determine $[CH_3COOH]$ in a new volume of 60 ml
3. $pH = pK_a + \log\frac{[CH_3COO^-]}{[CH_3COOH]}$ Use $K_a = 1.76\times10^{-5}$

Solution: 30 ml of the buffer (prepared previously) + 2 ml of 2.0 M HCl

pH – measured

pH (calculated) – ?

Calculations:
1. Determine the number of moles of CH_3COOH in solution: *a*
2. Determine the number of moles of CH_3COO^- in solution: *b*
3. Determine the number of moles of HCl added: *x*
4. $H^+ + CH_3COO^- \rightarrow CH_3COOH$

x	*b*	*a*	*start*
–x	*–x*	*x*	*change*
0	*(b – x)*	*(a + x)*	*after*

5. $pH = pK_a + \log\frac{\text{moles of } CH_3COO^-}{\text{moles of } CH_3COOH}$ Use $K_a = 1.76\times10^{-5}$

Solution: 30 ml of the buffer (prepared previously) + 2 ml of 2.0 M NaOH

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

Calculations: Use the same approach as above.