Part 3. The Ionization Constant of Acetic Acid
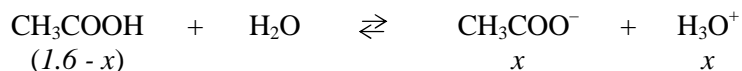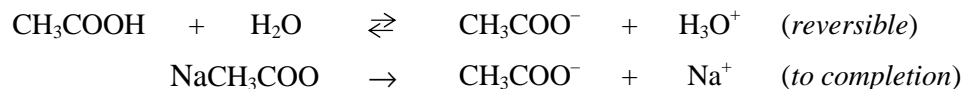
Solution: 10 ml of 1.6 M CH₃COOH

$$pH - measured$$
$$K_a - ?$$

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

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

$$CH_3COOH \quad + \quad H_2O \quad \rightleftharpoons \quad CH_3COO^- \quad + \quad H_3O^+$$
$$(1.6 - x) \qquad\qquad\qquad\qquad\qquad x \qquad\qquad x$$

3. $K_a = \dfrac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]} = \dfrac{x^2}{(1.6 - x)}$

Solution: 25 ml of 1.6 M NaCH₃COO + 10 ml of 1.6 M CH₃COOH

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

$$pH - measured$$
$$K_a - ?$$

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. $K_a = \dfrac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]}$

Part 4. Buffering Capacity

Solution: 30 ml of DI H₂O + 2 ml of 3.0 M HCl

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

$$pH - measured$$
$$pH \ (calculated) - ?$$

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 3.0 M NaOH

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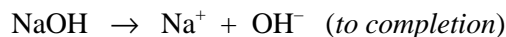
pH – measured

pH (calculated) – ?

Calculations: Use the same approach as shown above for the (H_2O + 3.0 M HCl) solution.

Remember, that $[H^+] \times [OH^-] = 10^{-14}$

Solution: 30 ml of 1.6 M $NaCH_3COO$ + 30 ml of 1.6 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. $pH = pK_a + \log \dfrac{[CH_3COO^-]}{[CH_3COOH]}$ Use $K_a = 1.76 \times 10^{-5}$

Solution: 30 ml of the buffer (prepared previously) + 2 ml of 3.0 M HCl

pH – measured

pH (calculated) – ?

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

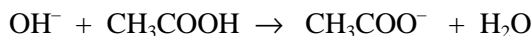2. Determine the number of moles of CH_3COO^- in solution: b

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. $pH = pK_a + \log \dfrac{\text{moles of } CH_3COO^-}{\text{moles of } CH_3COOH}$ Use $K_a = 1.76 \times 10^{-5}$

Solution: 30 ml of the buffer (prepared previously) + 2 ml of 3.0 M NaOH

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

Calculations: Use the same approach as shown above for the (buffer + 3.0 M HCl) solution.