

Chem 321

Module 14: Calculation of the Buffer pH Using Activities

Buffer solution: mix 4.0 mL of 1.0 M $\text{NaC}_2\text{H}_3\text{O}_2$
 6.5 mL of 3.0 M $\text{HC}_2\text{H}_3\text{O}_2$
 89.5 mL de-ionized water

Solution

The concentration of each diluted solute is first determined.

$$[\text{NaC}_2\text{H}_3\text{O}_2] = 1.0 \text{ M} (0.0040 \text{ L}) / (0.100 \text{ L}) = 0.040_0 \text{ M}$$

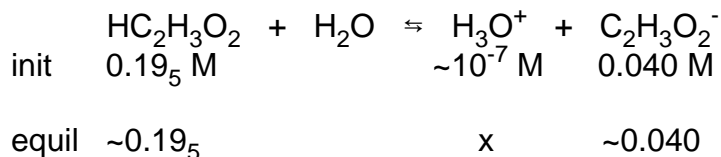
$$[\text{HC}_2\text{H}_3\text{O}_2] = 3.0 \text{ M} (0.0065 \text{ L}) / (0.100 \text{ L}) = 0.19_5 \text{ M}$$

Since the only important source of ions is the $\text{NaC}_2\text{H}_3\text{O}_2$ this is a +1/-1 electrolyte, the ionic strength $\mu = 0.040 \text{ M}$.

for $\mu = 0.40 \text{ M}$,

$$\gamma_{\text{C}_2\text{H}_3\text{O}_2^-} = 0.902 - \frac{0.040 - 0.010}{0.040} (0.902 - 0.82) = 0.84_0$$

$$\gamma_{\text{HC}_2\text{H}_3\text{O}_2} \approx 1 \text{ (since } \text{HC}_2\text{H}_3\text{O}_2 \text{ is uncharged)}$$



$$K_a = 1.75 \times 10^{-5} = \frac{a_{\text{H}_3\text{O}^+} a_{\text{C}_2\text{H}_3\text{O}_2^-}}{a_{\text{HC}_2\text{H}_3\text{O}_2}} = \frac{a_{\text{H}_3\text{O}^+} [\text{C}_2\text{H}_3\text{O}_2^-] \gamma_{\text{C}_2\text{H}_3\text{O}_2^-}}{[\text{HC}_2\text{H}_3\text{O}_2] \gamma_{\text{HC}_2\text{H}_3\text{O}_2}} = \frac{a_{\text{H}_3\text{O}^+} (0.040_0) (0.84_0)}{(0.19_5) (1.0)}$$

$$a_{\text{H}_3\text{O}^+} = 1.0_2 \times 10^{-4} \Rightarrow \text{pH} = -\log(a_{\text{H}_3\text{O}^+}) = \mathbf{3.99}$$