Chemistry 146 Lecture Problems
Sodium Acetate Equlibrium

$M := mole \cdot liter^{-1}$ $K_a := 1.8 \cdot 10^{-5} \cdot M$ $K_w := 1.0 \cdot 10^{-14} \cdot M^2$

Calculate the H3O, OH, acid, base pH and pOH when 1.00 g sodium acetate is added to 250 mL water.

$$K_b := \frac{K_w}{K_a} \qquad K_b = 5.556 \cdot 10^{-10} \cdot M$$

The concentration of the salt is):

$mass_{salt} := 1.00 \cdot gm$

$MW_{salt} := (((22.990) + (2 \cdot 12.001) + (4 \cdot 1.0079)) + (2 \cdot 15.999)) \cdot gm \cdot mole^{-1}$

$$mole_{salt} := \frac{mass_{salt}}{MW_{salt}} \qquad mole_{salt} = 0.012\ mol$$

$volume_{salt} := 250 \cdot mL$

$$C_{salt} := \frac{mole_{salt}}{volume_{salt}}$$

$C_{salt} = 0.048 \cdot M$

The equlibrium solution for A- + H2O <-> OH- + HA

Initial Concentraion C_{salt}

Equlibrium Concentration $C_{salt} - X$ X X

Equlibrium expression:

$$K_b = \frac{X^2}{C_{salt} - X}$$

Assuming X is smaller than [acid], this reduces to:

$$K_b = \frac{X^2}{C_{salt}}$$

Solving for X:

$$X := \sqrt{K_b \cdot C_{salt}} \qquad X = 5.1737 \cdot 10^{-6} \cdot M$$

Equlibrium Concentrations:

$C_{HA} := X$ $\quad C_{HA} = 5.174 \cdot 10^{-6} \cdot M$

$C_{OH} := X$ $\quad C_{OH} = 5.174 \cdot 10^{-6} \cdot M$

$C_A := C_{salt} - X$ $\quad C_A = 0.048 \cdot M$

$pOH := -\log\left(C_{OH} \cdot M^{-1}\right)$ $\quad pOH = 5.286$

$pH := 14 - pOH$ $\quad pH = 8.714$

Solving for X without assumptions:

$$K_b = \frac{X^2}{C_{salt} - X}$$

$$X := \begin{bmatrix} \frac{-1}{2} \cdot K_b + \frac{1}{2} \cdot \sqrt{K_b^{\,2} + 4 \cdot K_b \cdot C_{salt}} \\ \frac{-1}{2} \cdot K_b - \frac{1}{2} \cdot \sqrt{K_b^{\,2} + 4 \cdot K_b \cdot C_{salt}} \end{bmatrix}$$

$$X = \begin{bmatrix} 5.1734 \cdot 10^{-6} \\ -5.1739 \cdot 10^{-6} \end{bmatrix} \cdot M$$

Equlibrium Concentrations (Calculated for both roots, select the reasonable answer [top or bottom in ( )]:

$C_{HA} := X$ $\quad C_{HA} = \begin{bmatrix} 5.173 \cdot 10^{-6} \\ -5.174 \cdot 10^{-6} \end{bmatrix} \cdot M$

$C_{OH} := X$ $\quad C_{OH} = \begin{bmatrix} 5.173 \cdot 10^{-6} \\ -5.174 \cdot 10^{-6} \end{bmatrix} \cdot M$

$C_A := C_{salt} - X$ $\quad C_A = \begin{bmatrix} 0.048 \\ 0.048 \end{bmatrix} \cdot M$

$pOH_i := -\log\left(C_{OH_i} \cdot M^{-1}\right)$ $\quad pOH = 5.286$

$pH := 14 - pOH$ $\quad pH = 8.714$