Chemistry 146 Lecture Problems
Sodium Nitrite Equlibrium

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

$M := mole \cdot liter^{-1}$ $K_w := 1.0 \cdot 10^{-14} \cdot M^2$ $K_a := 4.5 \cdot 10^{-4} \cdot M$ $i := 0, 1 .. 1$

$$K_b := \frac{K_w}{K_a} \qquad K_b = 2.222 \cdot 10^{-11} \cdot M$$

The concentration of the salt is):

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

$$MW_{salt} := (((22.990) + (14.007)) + (2 \cdot 15.999)) \cdot gm \cdot mole^{-1}$$

$$mole_{salt} := \frac{mass_{salt}}{MW_{salt}} \qquad mole_{salt} = 0.014\ mol$$

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

$$C_{salt} := \frac{mole_{salt}}{volume_{salt}} \qquad C_{salt} = 0.058 \cdot M$$

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:

$$X := \sqrt{K_b \cdot C_{salt}}$$

$$X = 1.135 \cdot 10^{-6} \cdot M$$

Equlibrium Concentrations:

$C_{HA} := X$ $\quad C_{HA} = 1.135 \cdot 10^{-6} \cdot M$

$C_{OH} := X$ $\quad C_{OH} = 1.135 \cdot 10^{-6} \cdot M$

$C_A := C_{salt} - X$ $\quad C_A = 0.058 \cdot M$

$pOH := -\log\left(C_{OH} \cdot M^{-1}\right)$ $\quad pOH = 5.945$

$pH := 14 - pOH$ $\quad pH = 8.055$

Solving for X without assumptions:

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

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

$$X = \begin{bmatrix} 1.135 \cdot 10^{-6} \\ -1.1351 \cdot 10^{-6} \end{bmatrix} \cdot M$$

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

$C_{HA} := X$ $\quad C_{HA} = \begin{bmatrix} 1.135 \cdot 10^{-6} \\ -1.135 \cdot 10^{-6} \end{bmatrix} \cdot M$

$C_{OH} := X$ $\quad C_{OH} = \begin{bmatrix} 1.135 \cdot 10^{-6} \\ -1.135 \cdot 10^{-6} \end{bmatrix} \cdot M$

$C_A := C_{salt} - X$ $\quad C_A = \begin{bmatrix} 0.058 \\ 0.058 \end{bmatrix} \cdot M$

$pOH_i := -\log\left(C_{OH_i} \cdot M^{-1}\right)$ $\quad pOH = \begin{bmatrix} 5.945 \\ 5.945 - 1.364i \end{bmatrix}$

$pH := 14 - pOH$ $\quad pH = \begin{bmatrix} 8.055 \\ 8.055 + 1.364i \end{bmatrix}$