AP CHEMISTRY

TOPIC 7: ACIDS & BASES, MORE EXAMPLES

Day 83:

CLEARLY SHOW THE METHOD USED AND THE STEPS INVOLVED IN ARRIVING AT YOUR ANSWERS.

$$HC_6H_{11}O_{2\,(aq)} \rightleftharpoons H^{+}{}_{(aq)} + C_6H_{11}O_2{}^{-1}{}_{(aq)}$$

1. Hexanoic acid, $HC_6H_{11}O_{2\,(aq)}$, is a monoprotic acid that dissociates in an aqueous solution, as represented by the equation above. The equilibrium concentration for the hexanate ions, $C_6H_{11}O_2{}^{-1}{}_{(aq)}$, is equal to 0.00332 *M*. Hexanoic acid's initial concentration is 0.750 *M* $HC_6H_{11}O_{2\,(aq)}$ at 298 K. For parts (a) through (d) below, assume the temperature remains at 298 K.

   (a) Write the expression for the acid-dissociation constant, K_a, for hexanoic acid and calculate its value.

$$K_a = \frac{\left[\ H^{+1}\ \right]\left[\ C_6H_{11}O_2{}^{-1}\ \right]}{\left[\ HC_6H_{11}O_2\ \right]} = \frac{(0.00332)^2}{(0.75-0.00332)} = 1.48\times10^{-5}$$

   (b) Calculate the pH of the above solution at equilibrium.

$$[\ H^{+1}\ ] = 0.00332, \quad \textbf{\textit{pH = - log (0.0032) = 2.48}}$$

   (c) Calculate the pH of a solution formed by dissolving 21.7 grams of solid cesium hexanate, $CsC_6H_{11}O_2$, in 250 mL of 0.75 *M* $HC_6H_{11}O_{2\,(aq)}$. Assume that volume change is negligible. (This time we will write the ICE chart in a way that expresses the addition of the solid, and cause the reaction to shift to the left)

$$CsC_6H_{11}O_2 \rightarrow Cs^{+1} + C_6H_{11}O_2{}^{-1} \text{ (strong electrolyte = 100 \% dissociation)}$$

$$\frac{21.7\ g}{}\times\frac{1\ mol\ CsC_6H_{11}O_2}{247.9969\ g} = 0.0875\ mol \ ; \ \frac{0.0875\ mol}{0.250\ L} = 0.35\ M = \left[Cs^{+1}\right] = \left[C_6H_{11}O_2{}^{-1}\right]$$

	$[\ C_6H_{11}O_2{}^{-1}\ ]$	+	HOH	$\rightleftharpoons$	$[\ HC_6H_{11}O_2\ ]$	+	$[\ OH^{-1}\ ]$
I	0.35 *M*		-		0.75		~ 0
C	- *x*		-		+ *x*		+ *x*
E	0.35 - *x*		-		0.75 + *x*		$[\ OH^{-1}\ ]$

$$K_b = \frac{K_w}{K_a} = \frac{1.00\times10^{-14}}{1.48\times10^{-5}} = 6.76\times10^{-10}$$

$$K_b = \frac{\left[\ HC_6H_{11}O_2\ \right]\left[\ OH^{-1}\right]}{\left[\ C_6H_{11}O_2{}^{-1}\right]} = \frac{(0.750\ +\ x)\left[\ OH^{-1}\right]}{(0.35\ -\ x)} = \frac{(0.750)\left[\ OH^{-1}\right]}{(0.35)} = 1.48\times10^{-5}$$

$$\left[\ OH^{-1}\right] = \frac{(6.76\times10^{-10})(0.35)}{(0.750)} = 3.15\times10^{-10}$$

$$\textbf{\textit{pH = 14 – pOH, pH = 14 (- log (3.15 x 10 }}^{\textbf{\textit{-10}}}\textbf{\textit{)) = 4.50}}$$