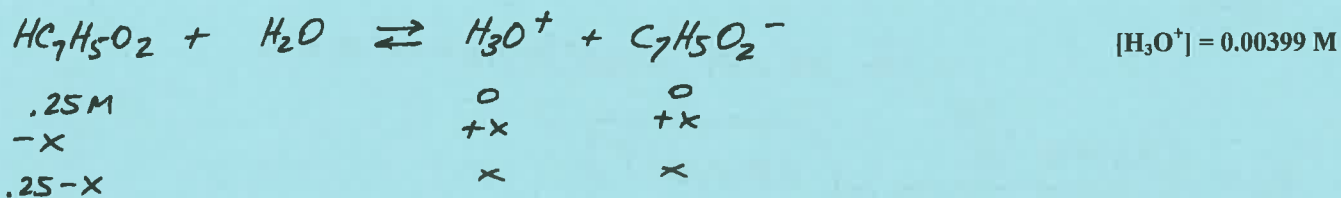


Acids & Bases: Worksheet #2
Weak Acid Problems (2009)

1. What is the $[H^+]$ of a 0.25 M solution of benzoic acid, $HC_7H_5O_2$? $K_a = 6.46 \times 10^{-5}$

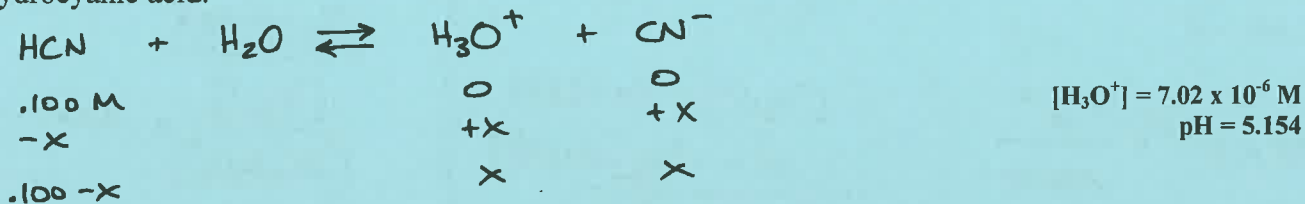


$$6.46 \times 10^{-5} = \frac{x^2}{.25 - x}$$

$$x = .00399$$

$$[H_3O^+] = .00399 \text{ M}$$

2. Hydrocyanic acid, HCN , has a K_a of 4.93×10^{-10} . Calculate the pH and $[H^+]$ of a 0.100 M solution of hydrocyanic acid.



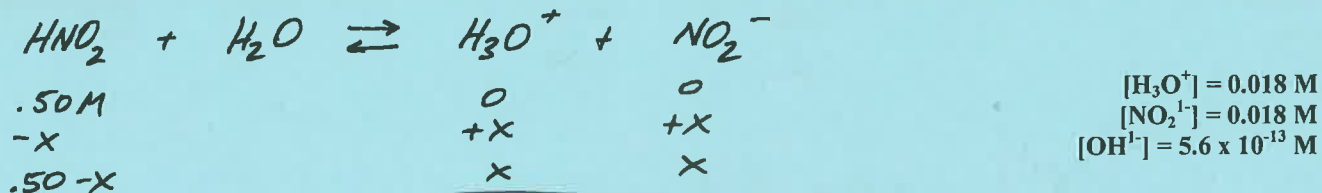
$$4.93 \times 10^{-10} = \frac{x^2}{[.100 - x]}$$

$$x = 7.02 \times 10^{-6}$$

$$[H_3O^+] = 7.02 \times 10^{-6} \text{ M}$$

$$pH = -\log[7.02 \times 10^{-6}] = 5.154$$

3. Nitrous acid, HNO_2 , has a K_a of 7.1×10^{-4} . What are the $[H^+]$, $[NO_2^-]$, $[OH^-]$ in 0.50 M HNO_2 ?



$$7.1 \times 10^{-4} = \frac{x^2}{.50 - x}$$

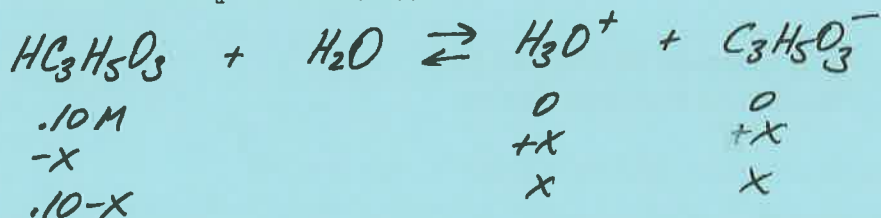
$$x = .018$$

$$[H_3O^+] = [NO_2^-] = .018 \text{ M}$$

Recall $[H^+][OH^-] = 1 \times 10^{-14}$
 $[.018][OH^-] = 1 \times 10^{-14}$

$$[OH^-] = 5.6 \times 10^{-13} \text{ M}$$

4. Lactic acid ($\text{HC}_3\text{H}_5\text{O}_3$) is a monoprotic acid. A 0.10 M solution of lactic acid has a pH of 2.44. Calculate the K_a for lactic acid.

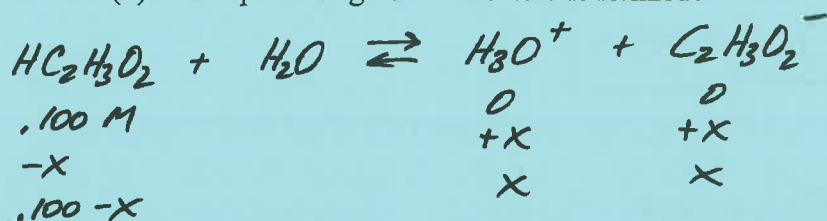


$$K_a = 1.3 \times 10^{-4}$$

from pH 2.44 $[\text{H}_3\text{O}^+] = 3.6 \times 10^{-3} \text{ M} = x$

$$K_a = \frac{[3.6 \times 10^{-3}]^2}{[.10 - 3.6 \times 10^{-3}]} = 1.3 \times 10^{-4}$$

5. Acetic acid, $\text{HC}_2\text{H}_3\text{O}_2$, has a $K_a = 1.78 \times 10^{-5}$.
 (a) Determine the pH of a 0.100 M solution.
 (b) What percentage of acetic acid is ionized?



$$[\text{H}_3\text{O}^+] = 0.00133 \text{ M}$$

$$\text{pH} = 2.876$$

$$1.33\% \text{ ionized}$$

$$1.78 \times 10^{-5} = \frac{x^2}{.100-x}$$

$$x = .00133$$

$$[\text{H}_3\text{O}^+] = .00133 \text{ M}$$

$$\text{pH} = -\log(.00133)$$

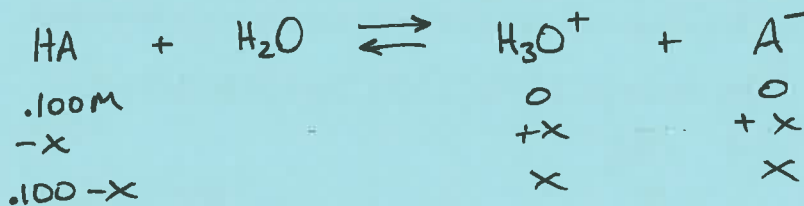
$$\text{pH} = 2.876$$

% ionized

$$\frac{[\text{H}_3\text{O}^+]}{[\text{HC}_2\text{H}_3\text{O}_2]} \times 100 =$$

$$\frac{.00133}{.100} \times 100 = 1.33\%$$

6. A 0.100 M solution of a certain monoprotic acid (HA) is 11.0% ionized. Using this information, calculate the equilibrium concentrations of $[\text{A}^-]$, $[\text{H}^+]$, $[\text{HA}]$, and the K_a for this acid.



$$[\text{H}_3\text{O}^+] = 0.011 \text{ M}$$

$$[\text{A}^-] = 0.011 \text{ M}$$

$$[\text{HA}] = 0.089 \text{ M}$$

$$K_a = 1.36 \times 10^{-3}$$

$$\% \text{ ionized} = \frac{[\text{H}_3\text{O}^+]}{[.100]} \times 100 = 11.0$$

$$[\text{H}_3\text{O}^+] = .011 \text{ M}$$

$$[\text{A}^-] = .011 \text{ M}$$

$$[\text{HA}] = .100 - .011 = .089 \text{ M}$$

$$K_a = \frac{x^2}{.100-x}$$

$$K_a = \frac{[.011]^2}{[.100 - .011]} = 1.36 \times 10^{-3}$$