**K_a and K_b Calculations Worksheet**

When a strong acid or base is placed in water, they completely ionize. This means that approximately 100% of the acid or base forms products (or the arrow in the chemical equation points one direction). In the case of a weak acid or base, the substance only partially ionizes. This means equilibrium is established in an aqueous solution of a weak acid or base. Using your understanding of acid/base chemistry, complete the following problems.

1. Write chemical equations which represent the dissociation of each of these acids or bases in aqueous solution. Use a single arrow in the case of a strong acid or base, and a double arrow to represent the equilibrium condition that exists in the solution of a weak acid or base.

   a. HCl
   b. NaOH
   c. H₂SO₄
   d. KOH
   e. HC₂H₃O₂
   f. HCN
   g. Cu(OH)₂
   h. NH₄OH

2. Calculate the [H⁺] and [OH⁻] of a 1.0 x 10⁻³ M solution of HCl, a strong acid.

3. Calculate the [OH⁻] and the [H⁺] of a 0.0020 M solution of NaOH, a strong base.
4. Benzoic acid, $\text{HC}_6\text{H}_5\text{CO}_2$, is an organic acid whose sodium salt, $\text{NaC}_6\text{H}_5\text{CO}_2$, has long been used as a safe food additive to protect beverages and many foods against harmful yeasts and bacteria. The acid is monoprotic. Write the equation for its $K_a$.

5. The $[\text{H}^+]$ of a 0.10 M solution of cyanic acid (HCNO) is found to be 0.0010 M. Calculate the $K_a$ for cyanic acid.

$$\text{HCNO} \leftrightarrow \text{H}^+ + \text{CNO}^-$$

6. If 1.22 grams of benzoic acid, $\text{HC}_6\text{H}_5\text{CO}_2$, is dissolved in 1.0 L of water, the $[\text{H}^+]$ is found to be $8.0 \times 10^{-4}$ M. Calculate the $K_a$ for benzoic acid.

$$\text{HC}_6\text{H}_5\text{CO}_2 \leftrightarrow \text{H}^+ + \text{C}_6\text{H}_5\text{CO}_2^-$$

7. A 0.0050 M solution of butyric acid, $\text{HC}_4\text{H}_7$, has a pH =4.0, calculate $K_a$.

$$\text{HC}_4\text{H}_7\text{O} \leftrightarrow \text{H}^+ + \text{C}_4\text{H}_7\text{O}_2^-$$

8. Determine the $[\text{OH}^-]$ and the $[\text{H}^+]$ of a 0.20 M solution of formic acid. The $K_a = 1.8 \times 10^{-4}$

$$\text{HCOOH} \leftrightarrow \text{H}^+ + \text{HCOO}^-$$
9. HCN has an initial molarity of 0.50 M, with a $K_a$ value of $3.7 \times 10^{-8}$. Calculate its pH at equilibrium. (Hint: This is an ICE problem.)

10. Ethylamine (C$_2$H$_5$NH$_3$) is a weak Bonsted-Lowry base. If it has an initial molarity of 0.024 M and a $K_b$ of $5.6 \times 10^{-4}$, calculate its pH at equilibrium. (Hint: This is an ICE Problem.)

11. A chemist adds 0.75 moles of NH$_3$ to enough water to make 0.50 liters of solution. $K_b$ of ammonia is $1.8 \times 10^{-5}$. Determine the pH of this solution at equilibrium. (Hint: This is an ICE problem.)

12. Hydrazine, N$_2$H$_4$, has been used as a rocket fuel. Like ammonia, it is a Bronsted base. A 0.15 M solution has a pH of 10.70. What is the $K_b$ for hydrazine?