## Topic 8.3 Worksheet

1. In terms of ionization, what is the difference between a strong acid and a weak acid? Use particle pictures in your explanation.

2. Write the reaction for the following weak acids reacting with water. Then give the $K_a$ expression.
   a. $CH_3CH_2COOH$*(aq)*

   b. HF*(aq)*

   c. $HSO_3^-$*(aq)*

3. Different weak acids have different $K_a$ values.
   a. Does the percent ionization of a weak acid increase, decrease, or remain the same as $K_a$ increases? Justify your answer.

   b. If the solutions are equimolar, does the pH of a weak acid increase, decrease, or remain the same as $K_a$ increases? Justify your answer.

4. Give the range of the following $K_a$ and $K_b$ values when converted to $pK_a$ or $pK_b$ without using a calculator. Then rank them based on pH assuming they are all 0.100 M and gives or accepts one proton. A high pH should be ranked 5 and a low pH should be ranked 1.

| $K_a$ | Low $pK_a$ value | High $pK_a$ value | Relative pH Rank |
|---|---|---|---|
| $1.2 \times 10^{-4}$ | | | |
| $4.22 \times 10^{-2}$ | | | |
| $5.00 \times 10^{-6}$ | | | |
| $6.22 \times 10^{-7}$ | | | |
| $7.8 \times 10^{-6}$ | | | |

| $K_b$ | Low $pK_b$ value | High $pK_b$ value | Relative pH Rank |
|---|---|---|---|
| $3.8 \times 10^{-7}$ | | | |
| $2.2 \times 10^{-5}$ | | | |
| $7.9 \times 10^{-8}$ | | | |
| $4.11 \times 10^{-3}$ | | | |
| $6.7 \times 10^{-4}$ | | | |

5. Using a calculator, determine either the $K_a$ of the $pK_a$ for the following acids.

| Acid | $K_a$ | $pK_a$ |
|---|---|---|
| A | $3.2 \times 10^{-4}$ | |
| B | | 3.80 |
| C | $5.0 \times 10^{-5}$ | |
| D | | 5.21 |
| E | $9.8 \times 10^{-7}$ | |

6. If each of the acids in #5 were monoprotic and 0.1 M, which would have the lowest pH? Explain your reasoning.

7. Without using a calculator, determine the $K_a$ for the following weak monoprotic acids. Then check your work with a calculator.
   a. A 0.10 M solution that has a pH of 4.0.

   b. A 0.0010 M solution that has a pH of 6.0.

   c. A 0.050 M solution that has a pH of 5.0.

$$HCN(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + CN^-(aq)$$

8. HCN partially ionizes as shown above. For each of the situations, determine if the pH would increase, decrease, or remain the same. In each case, justify your answer by referring to K and Q. (Assume no change in volume.)
    a. After the equilibrium has been established, a sample of solid NaCN is added to the solution.

    b. After the system has reached equilibrium, a sample containing $Pb^{2+}$ is added to the solution forming $Pb(CN)_2(s)$.

9. Without using a calculator, determine the $K_b$ for the following weak bases. Then check your work with a calculator.
    a. A 0.10 M solution that has a pH of 11.000

    b. A 0.0010 M solution that has a pH of 10.00

    c. A 0.050 M solution that has a pH of 8.00

10. When will the pH of a strong acid be equal to the pH of a weak acid?

11. Determine the $K_a$ of a 0.15 M weak, monoprotic acid that has a pH of 2.20 .

12. The pH of a 1.15 M weak base is 12.65. Determine the $K_b$ value.

13. The ionization constant ($K_a$) of acid A is $1.8 \times 10^{-5}$ and acid B is $4.5 \times 10^{-9}$.
    a. Which is a stronger acid?

    b. Which has a stronger conjugate base?

14. The acids shown in the particle diagrams below all have the same molarity. Arrange the acids from weakest to strongest. Justify your answer.