Worksheet 5: Acids and Bases

1. a) Define acid and base using the Arrhenius definition.

   b) Define acid and base using the Bronsted-Lowry definition.

2. Write the equation for the reaction that’s associated with dissolving each of the following acids or bases in water. Make sure you indicate whether this should be considered an equilibrium or not.

   a) Sulfuric acid (H$_2$SO$_4$)

   b) Perchloric acid (HClO$_4$)

   c) Potassium hydroxide

   d) Ammonia

   e) Nitrous acid (HNO$_2$)

3. Find the conjugate acid/base pairs in the following:
   a. HNO$_2$ + H$_2$O $\rightleftharpoons$ H$_3$O$^+$ + NO$_2^-$

   b. NH$_3$ + H$_2$O $\rightleftharpoons$ NH$_4^+$ + OH$^-$

   c. H$_2$PO$_4^-$ + CO$_3^{2-}$ $\rightleftharpoons$ HCO$_3^-$ + HPO$_4^{2-}$

4. In the following equation, identify all of the species indicated:

   HCO$_3^-$ (aq) + H$_2$S (aq) $\rightleftharpoons$ H$_2$CO$_3$ (aq) + HS$^-$ (aq)

   Acid? _______________  Conjugate Base? _______________

   Base? _______________  Conjugate Acid? _______________

5. The following is a list of weak acids and their $K_a$ values:

   HOCl  hypochlorous acid  $3.5 \times 10^{-8}$
   H$_2$S  hydrogen sulfide  $1.1 \times 10^{-7}$
   HCN  hydrocyanic acid  $4.0 \times 10^{-10}$
   HNO$_2$  nitrous acid  $4.5 \times 10^{-4}$

   a. Which acid given above is the strongest? Explain your choice.

   b. Write the $K_a$ expression for the strongest acid.

   c. Which acid has the strongest conjugate base? Explain your choice.
6. The concentration of OH⁻ ions in a sample of seawater is 5.0 x 10⁻⁶ M. Calculate the concentration of H₃O⁺ ions and classify the solution as neutral, acidic, or basic.

7. The concentration of H₃O⁺ ions in a sample of lemon juice is 2.5 x 10⁻³ M. Calculate the concentration of OH⁻ ions, and classify the solution as neutral, acidic or basic.

8. For each of the following, determine [H₃O⁺], [OH⁻], and whether or not the solution is acidic, basic, or neutral.
   
   a. A 0.015 M solution of HCl (aq).

   b. A sample of Ca(OH)₂ with a concentration of 0.16 g Ca(OH)₂/100.0 mL solution