Acid-Base Definitions

1. In the reaction, identify the Bronsted-Lowry acid, the Bronsted-Lowry base, the conjugate acid, and the conjugate base.

\[ C_5H_5N (aq) + H_2O (l) \rightleftharpoons C_5H_5NH^+ (aq) + OH^- (aq) \]

Acid-Base Strength

2. Which acid has the largest $K_a$: HClO$_2$ (aq), HBrO$_2$ (aq), HIO$_2$ (aq)?

(a) HClO$_2$ (aq)
(b) HBrO$_2$ (aq)
(c) HIO$_2$ (aq)
(d) All three acids have the same $K_a$.

3. Based on their molecular structure, pick the stronger acid/base from each pair.

(a) HF or HCl

(b) H$_2$O or HF

(c) S$^2-$ or Se$^{2-}$

pH/pOH/Concentration Calculations

4. For the strong acid solution, determine $[H_3O^+]$, $[OH^-]$, and pH:

A solution that is 0.052 M in HBr and 0.020 M in HNO$_3$
5. A 0.185 M solution of weak acid (HA) has a pH of 2.95. Calculate the acid ionization constant (K_a) for the acid.

**Percent Ionization**

6. Calculate the percent ionization of 1.45 M aqueous acetic acid solution (K_a = 1.8 x 10^{-5}).

**Acid Mixtures and Salts**
7. Calculate the pH of a solution that contains 1.00 M HCN \( (K_a = 6.2 \times 10^{-10}) \) and 5.00 M \( HNO_2 \) \( (K_a = 4.0 \times 10^{-4}) \). Also calculate the concentration of cyanide ion \( (CN^-) \) in this solution at equilibrium.

8. Determine the \([OH^-]\), \([H^+]\), and the pH of each of the following solutions.
   a. 1.0 M KCl
   b. 1.0 M \( KC_2H_3O_2 \)

9. Predict whether the following solutions will be acidic, basic, or nearly neutral:
a. NH$_4$I  
b. NaNO$_2$  
c. FeCl$_3$  
d. NH$_4$F.

**Polyprotic Acids**

10. Calculate the pH of a 5.0-M $H_3PO_4$ solution and the equilibrium concentrations of the species $H_3PO_4$, $H_2PO_4^-$, $HPO_4^-$, $PO_4^{3-}$. 
Acid Base Reactions
11. Calculate the pH of a solution in which 10.0 mL of 0.100 M NaOH is added to 25.0 mL of 0.100 M HCl.

Buffers and Common Ion Effect
12. Instructions for making up a buffer say to mix 60. mL (0.060 L) of 0.100 M NH₃ with 40. mL (0.040 L) of 0.100 M NH₄Cl. What is the pH of this buffer?
13. Calculate the pH of a solution containing 0.75 M lactic acid ($K_a = 1.4 \times 10^{-4}$) and 0.25 M sodium lactate. Lactic acid ($\text{HC}_3\text{H}_5\text{O}_3$) is a common constituent of biological systems. For example, it is found in milk and is present in human muscle tissue during exertion.

**Titrations**

14. Consider the titration of a 35.0 mL sample of 0.175 M HBr with 0.200 M KOH. Determine the following.

   a. pH at the equivalence point

   b. pH after adding 5.0 mL of base beyond the equivalence point.

15. Consider the titration of a 25.0 mL sample of 0.175 M CH$_3$NH$_2$ with 0.150 M HBr. Determine the following.

   a. the volume of added acid to reach the equivalence point

   b. the pH at one-half of the equivalence point
16. A 0.552 g sample of ascorbic acid (vitamin C) is dissolved in water to a total volume of 20.0 mL and titrated with 0.1103 M KOH. The equivalence point occurs at 28.42 mL. The pH of the solution at 10.0 mL of added base was 3.72. From this data, determine the molar mass and $K_a$ for vitamin C.

**Molar Solubility and Precipitation**

17. Predict whether a precipitate forms if you mix 75.0 mL of an NaOH solution with pOH = 2.58 with 125.0 mL of a 0.018 M MgCl$_2$ solution. Identify the precipitate, if any.
18. The magnesium and calcium ions present in seawater ([Mg$^{2+}$] = 0.025 M and [Ca$^{2+}$] = 0.011 M) can be separated by selective precipitation with KOH. What minimum [OH$^-$] is needed to trigger the precipitation of Mg$^{2+}$ ion? Once enough [OH$^-$] is added, what is the concentration of Mg$^{2+}$ when Ca$^{2+}$ begins to precipitate?

19. A solution is made 1.1 x 10$^{-3}$ M in Zn(NO$_3$)$_2$ and 0.150 M in NH$_3$. After the solution reaches equilibrium, what concentration of Zn$^{2+}$ (aq) remains?