CHEM 1474
Quiz #3
Spring 2013

1. (5 points) Determine whether solutions of each of the following compounds would be acidic, basic, or neutral. Further, identify which of the ions involved would cause the observed behavior. In the case of a neutral salt, both of the ions should be listed.

<table>
<thead>
<tr>
<th>Acidic, basic, or neutral?</th>
<th>Ion(s) responsible?</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. NH₄Cl</td>
<td>ACIDIC</td>
</tr>
<tr>
<td>b. Ba(NO₃)₂</td>
<td>NEUTRAL</td>
</tr>
<tr>
<td>c. NaClO₂</td>
<td>BASIC</td>
</tr>
<tr>
<td>d. FeCl₃</td>
<td>ACIDIC</td>
</tr>
<tr>
<td>e. KF</td>
<td>BASIC</td>
</tr>
</tbody>
</table>

2. (3 points) For binary acids, does the acid strength get smaller or larger as one moves from left to right across a period on the periodic table (example, CH₄, NH₃, H₂O, HF)? And, for the most important part, explain why we see this trend.

From left to right, the acid strength increases due to the increasing electronegativity of the non-hydrogen atom.

3. (5 points) Consider separate solutions of the same concentration of each of the following species.

NH₃      HCl      NH₄⁺      KOH      F⁻

Rank these solutions in order from the one with the lowest pH to the one with the highest pH. K_a and K_b values, if necessary, may be found at the bottom of the page.

\[
\begin{align*}
\text{HCl} &< \text{NH₄⁺} < \text{F⁻} < \text{NH₃} < \text{KOH} \\
\text{Most Acidic} &< \text{NH₄⁺} &< \text{F⁻} &< \text{NH₃} &< \text{KOH} \\
\text{Least Basic} &< \text{NH₄⁺} &< \text{F⁻} &< \text{NH₃} &< \text{KOH} \\
\end{align*}
\]

K_b for NH₃ is 1.8 x 10⁻⁵  \quad K_a for HF is 6.8 x 10⁺⁴  \quad K_a for HCN = 4.9 x 10⁻¹⁰
4. (2 points) We tend to like to use the assumption that $C_A - x$ is about equal to $C_A$ if $x$ is sufficiently small compared to $C_A$. That helps avoid the quadratic. Circle the set of conditions below under which this assumption would be most likely to fail.

a. large value of $K_a$ and large value of $C_A$

b. large value of $K_a$ and small value of $C_A$

c. small value of $K_a$ and large value of $C_A$

d. small value of $K_a$ and small value of $C_A$

5. (4 points) Consider a solution that is 0.0750 M solution in HIO. Its $K_a = 2.3 \times 10^{-11}$.

a. What is its pH? Show your work.

$$[H^+] = \sqrt{K_a C_A} = \sqrt{(2.3 \times 10^{-11})(0.0750)} = 1.31 \times 10^{-6} M$$

$$pH = -\log(1.31 \times 10^{-6}) = 5.88$$

b. What is its % ionization? Show your work.

$$\% \text{ Ionization} = \frac{1.31 \times 10^{-6} M}{0.075 M} \times 100 \% = 1.75 \times 10^{-3} \%$$

6. (4 points) What is the pH of a solution that is 0.125 M in KCN? Show your work.

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

$$[OH^-] = \sqrt{K_b C_B} = \sqrt{(2.94 \times 10^{-5})(0.125 \text{ M})} = 1.577 \times 10^{-3}$$

$$K_b = \frac{1 \times 10^{-14}}{4.9 \times 10^{-10}} = 2.04 \times 10^{-5}$$

$$pOH = -\log(1.577 \times 10^{-3}) = 2.80$$

$$pH = 11.20$$

$K_b$ for NH$_3$ is $1.8 \times 10^{-5}$  $K_a$ for HF is $6.8 \times 10^{-4}$  $K_a$ for HCN $= 4.9 \times 10^{-10}$