Review Problems for Exam 3: Draft as of 4/6/05

This review sheet contains problems to help you prepare for the third hour exam. This is an initial version that will evolve as we get closer to the exam.

1) Use the following four aqueous species to write an acid-base reaction with $K>1$. (An acid-base reaction is one that involves the exchange of a proton. Your reaction will involve all four species.)

$$\text{NO}_2^-(aq), \text{F}^-(aq), \text{HF}(aq), \text{HNO}_2(aq)$$

2) For each of the following reactions circle either $K>1$ or $K<1$

   a) $\text{NH}_3 + \text{H}_3\text{O}^+ \rightarrow \text{NH}_4^+ + \text{H}_2\text{O}$ $K>1$ $K<1$
   b) $\text{NH}_3 + \text{H}_2\text{O} \rightarrow \text{NH}_4^+ + \text{OH}^-$ $K>1$ $K<1$
   c) $\text{NH}_4^+ + \text{OH}^- \rightarrow \text{NH}_3 + \text{H}_2\text{O}$ $K>1$ $K<1$

3) Nitrous acid, $\text{HNO}_2$, is a weak acid with a $pK_a$ of 3.34:

$$\text{HNO}_2 (aq) \leftrightarrow \text{H}^+ (aq) + \text{NO}_2^-(aq)$$

   a) What is the pH of a 0.15M solution of $\text{HNO}_2$?
   b) What is the pH of a 0.15M solution of $\text{NaNO}_2$?
   c) What is the pH of the solution resulting from mixing 50ml of 1.20M $\text{NaNO}_2$ with 50ml of 0.40M HCl (HCl is a strong acid)?
   d) You make 100ml of a buffer solution that is 0.5M in $\text{HNO}_2$ and 0.5M in $\text{NaNO}_2$.
      What is the pH of this buffer solution?
      What is the pH of the buffer solution after addition of 10ml of 1M HCl?
      What is the pH of the buffer solution after addition of 10ml of 1M NaOH?
   e) You want to make a buffer solution with a pH=3.6, and $[\text{HNO}_2]+[\text{NO}_2^-]=1\text{M}$. What concentrations of $[\text{HNO}_2]$ and $[\text{NO}_2^-]$ do you want?

4) Consider the following three solutions:

   Solution A: $0.1\text{M NaC}_6\text{H}_5\text{COO}$
   Solution B: $0.1\text{M NaNO}_2$
   Solution C: $0.1\text{M NaCN}$

Which of the solutions (A, B, or C) has the higher pH? (You don’t need to do explicit calculations.)

5) Hypobromous acid, $\text{HBrO}$, is a weak acid that ionizes according to the reaction,

$$\text{HBrO} (aq) \leftrightarrow \text{H}^+ (aq) + \text{BrO}(aq) \quad K=2.5\times10^{-9}$$

Consider the titration of 50ml of a 1.0M solution of $\text{HBrO}$ with 1.0M NaOH

   a) Calculate the pH of the solution before any NaOH is added.
   b) Calculate the pH after 25 ml of the NaOH has been added.
   c) Calculate the pH after 50 ml of the NaOH has been added.
   d) Calculate the pH after 100ml of NaOH have been added.

6) Given bottles containing 1M $\text{NH}_3$ and 1M HCl, how would you make a buffer solution with pH=9.25?

7) The molar solubility, $s$, of $\text{Mn(OH)}_2$ in water, in term of its $K_{sp}$ is:

   a) $s = (K_{sp})^{1/2}$
   b) $s = (K_{sp})^{1/3}$
   c) $s = (K_{sp}/4)^{1/3}$
   e) $s = (K_{sp}/27)^{1/4}$

8) Calculate the solubility (in moles/liter) of $\text{AgCl}$ in a solution that is 1.0M in $\text{NH}_3$.

9) Silver ion is added to a solution that contains 0.01M Cl$^-$ and 0.01M I$^-$. Which salt precipitates first, $\text{AgCl}$ or $\text{AgI}$? What is the value of $[\text{Ag}^+]$ when the first salt starts to precipitate? What is the concentration of the anion of the first precipitate, when the second precipitate starts to form?

   ($K_{sp}(\text{AgCl}) = 1.6\times10^{-10}$, $K_{sp}(\text{AgI}) = 1.5\times10^{-16}$)
10) You are making a bowl of soup by mixing 100ml of condensed soup with 300ml of tap water. The condensed soup contains iodine ion with a concentration $[I^-] = 0.014M$. Unfortunately, your tap water has lead ion in it with $[Pb^{2+}] = 2.5 \times 10^{-4}M$. When you mix the 100ml of condensed soup with 300ml of tap water, will solid PbI$_2$ form?

11) The solubility of PbBr$_2$ in 0.20M KBr is $2.2 \times 10^{-4}M$. What is its solubility in 0.20M Pb(NO$_3$)$_2$?

12) What is the equilibrium constant for the following reaction:

$$\text{Ag}_2\text{CrO}_4(s) + 4 \text{NH}_3(aq) \leftrightarrow 2 \text{Ag(NH}_3)_2^+(aq) + \text{CrO}_4^{2-}(aq)$$
Review Problems for Exam 3: Redox problems

1) For the above voltaic (galvanic) cell, which of following is true (check one): (note that cell may not be drawn correctly (anode may not be on the left)

a) The Au is the cathode and the Sn is the anode _____________

b) The Au is the anode and the Sn is the cathode _____________

c) What is the potential on the voltmeter for the voltaic (galvanic) cell shown above?

d) The cell is connected such that the following reaction occurs:

\[ 2 \text{Au}^{3+} + 3 \text{Sn}(s) \rightarrow 3\text{Sn}^{2+} + 2 \text{Au} \ (s) \]

If a current of 2.5 amps flows for 1 minute, how many grams of Au (s) are created (deposit on the Au electrode).

2) For which reaction is \( K > 1 \) (check one):

a) \( 2\text{Fe}^{3+} + \text{Ni}(s) \rightarrow \text{Ni}^{2+} + 2\text{Fe}^{2+} \) _____________

b) \( \text{Ni}^{2+} + 2\text{Fe}^{2+} \rightarrow 2\text{Fe}^{3+} + \text{Ni}(s) \) _____________

Half-cell potential data

\begin{align*}
\text{Au}^{3+} + 3e^- & \rightarrow \text{Au} \ (s) \quad E^o= 1.42V \\
\text{Sn}^{2+} + 2e^- & \rightarrow \text{Sn} \ (s) \quad E^o= -0.1364V \\
\text{Fe}^{3+} + 1e^- & \rightarrow \text{Fe}^{2+} \quad E^o= 0.770V \\
\text{Ni}^{2+} + 2e^- & \rightarrow \text{Ni} \ (s) \quad E^o= -0.23V \\
\end{align*}

F (faraday constant) = 9.64834 x 10^4 Coulomb/mole e^-

Atomic mass of Au is 196.97 g/mol