More Review Problems (Chapters 16-17)

1. Morpholine, $O(CH_2CH_2)_2NH$ (87.12 g/mole), call it R_2NH for short, is a weak base with $pK_b = 5.508$. A 2.505-g sample of morpholine was dissolved in enough water to make 250.0 mL of solution. A 50.00-mL portion of this solution was then titrated with 0.150 M HCl.
   (a) What volume of HCl is required to reach the end-point?
   (b) Determine the pH of the solution:
      - before any HCl is added
      - after 25.00 mL of HCl is added
      - at the equivalence point

2. A 0.625-gram sample of an unknown weak acid (call it HA for short) is dissolved in enough water to make 25.0 mL of solution. This weak acid solution is then titrated with 0.100 M NaOH and 45.0 mL of the NaOH solution is required to reach the equivalence point. The pH of the solution at the equivalence point is found to be 8.25.
   (a) Determine the molecular mass of the unknown acid.
   (b) Determine the pKa value of the unknown acid.

3. For $Fe(OH)_3$, $K_{sp} = 1.6 \times 10^{-39}$. For $Fe(CN)_6^{3-}$, $K_f = 1.0 \times 10^{31}$. Determine molar solubility of $Fe(OH)_3$ in:
   (a) water (***Hint***: It's even LESS soluble than you may think!)
   (b) 1.0 M NaCN.

4. The pK_a of cyanic acid, HOCN, is 3.46. Calculate the volume (in mL) of 2.00 M NaOH that must be added to 500 mL of 0.300 M HOCN in order to yield a buffer solution with a pH equal to 4.00.

5. Consider an aqueous solution that is 0.20 M NH_4CN.

   (a) First, write balanced ionic equations for the ***three*** important equilibrium reactions that are occurring in this solution. Second, use numerical values of the appropriate equilibrium constants to predict whether this solution should be acidic, basic, or neutral. Briefly explain your reasoning (in 30 words or less!)

   (b) Determine the pH of this 0.20 M NH_4CN solution.
   (***Think*** carefully! The pH is lower than you might first expect!)