*Multiple Choice: (3 Points each) Place the letter associated with the correct answer in the blank to the left of each number.*

_____1.    What is the conjugate base of $H_2PO_4^-$ ?
   a.  $HPO_4^{2-}$
   b.  $PO_4^{3-}$
   c.  $H_3PO_4$
   d.  $H_3O^+$
   e.  $OH^-$

_____2.    Which of the following is NOT a conjugate acid-base pair?
   a.  $H_2O/OH^-$
   b.  $H_3O^+/H_2O$
   c.  $H_2SO_3/SO_3^{-2}$
   d.  $C_2H_3O_2^-/HC_2H_3O_2$
   e.  All of the above are conjugate acid-base pairs.

_____3.    Give the characteristics of a strong acid.
   a.  ionizes completely in aqueous solutions to form $H_3O^+$
   b.  ionizes completely in aqueous solutions to form $OH^-$
   c.  Partially ionizes in aqueous solutions to form $H_3O^+$
   d.  Does not form an electrolyte when in solution.
   e.  can be used to make a buffer when added to a base

_____4.    The stronger the acid, then which of the following is TRUE?
   a.  The stronger the conjugate acid.
   b.  The stronger the conjugate base.
   c.  The weaker the conjugate base.
   d.  The weaker the conjugate acid.
   e.  The strength of the acid has no affect on the conjugate base.

_____5.    Calculate the hydroxide ion concentration in an aqueous solution with a pH of 9.85 at 25°C.
   a.  $7.1 \times 10^{-5}$ M
   b.  $4.2 \times 10^{-10}$ M
   c.  $8.7 \times 10^{-10}$ M
   d.  $6.5 \times 10^{-5}$ M
   e.  $1.4 \times 10^{-10}$ M

_____6.     Which of the following solutions would make a good buffer system?
   a.  A solution that is 0.10 M $HC_2H_3O_2$ and 0.10 M $LiC_2H_3O_2$
   b.  A solution that is 0.10 M HF and 0.10 M $NaC_2H_3O_2$
   c.  A solution that is 0.10 M HCl and 0.10 M $NH_4^+$
   d.  A solution that is 0.10 M NaOH and 0.10 M KOH
   e.  None of the above are buffer systems.

_____7.     Calculate the pH of a solution that is 0.050M in benzoic acid $(HC_7H_5O_2)$ and 0.150 M $NaC_7H_5O_2$. For benzoic acid, the $K_a=6.5$ x $10^{-5}$.
   a.  4.19
   b.  4.66
   c.  3.71
   d.  9.36
   e.  none of the above

_____8.      If the pKa of $HCHO_2$ is 3.74 and the pH of an $HCHO_2/NaCHO_2$ solution is 3.11, which of the following is TRUE?
   a.  $[HCHO_2] < [NaCHO_2]$
   b.  $[HCHO_2] = [NaCHO_2]$
   c.  $[HCHO_2] << [NaCHO_2]$
   d.  $[HCHO_2] > [NaCHO_2]$
   e.  It is not possible to make a buffer of this pH from $HCHO_2$ and $NaCHO_2$.

_____9.      In a titration, a pH of 7 at the equivalence point indicates that:
   a.  you are titrating a strong acid with a strong base
   b.  you are titrating a strong acid with a weak base
   c.  you are titrating a weak acid with a strong base
   d.  you are titrating a weak acid with a weak base
   e.  you are titrating a weak base with a strong acid

_____10.     If an ionic compound is dissolved in an unsaturated solution, how does Q compare with $K_{sp}$.
   a.  $Q < K_{sp}$
   b.  $Q > K_{sp}$
   c.  $Q = K_{sp}$
   d.  Q is totally unrelated to $K_{sp}$, so there is no way to tell
   e.  Q is related to K, but doesn't tell you if a solution is saturated

*Problems: Show your work for the following problems.  This may include writing a reaction, a K expression, and even some math.*

1.  (5 Pts)  Write the reaction for pyridine ($C_5H_5N$), a Bronsted-Lowry base, with water. Include phases.

   a.  (3 Pts) Write the $K_b$ expression for this base

   b.  (4 Pts) If the $K_b$ for $C_9H_7O_4^-$ is $1.7 \times 10^{-9}$, what is the $K_a$ value for the conjugate acid of pyridine?

   c.  (6 Pts)  What is the pH of a 0.42M solution of pyridine?

2. (10 Pts) Calculate the concentration of $Hg^{2+}$ in a solution containing $HgBr_2$ ($K_{sp}$= 6.2 x 10$^{-20}$) at equilibrium in a 1.0 x 10$^{-3}$M solution of NaBr.

3. (10 Pts) A 1.00 L buffer solution is 0.250 M in HF and 0.250 M in NaF. Calculate the pH of the solution after the addition of 100.0 mL of 1.00 M HCl.
The $K_a$ for HF is 3.5 × 10$^{-4}$.

4. (10 Pts)  A 100.0 mL sample of 0.20 M HCl is titrated with 0.15 M KOH.  Determine the pH of the solution after the addition of 145 mL of KOH.

5. (12 Pts) A 100.0 mL sample of 0.10 M $NH_3$ is titrated with 0.15 M $HNO_3$.  Determine the pH of the solution after the addition of 80.0 mL of $HNO_3$.  The $K_b$ of $NH_3$ is $1.8 \times 10^{-5}$.

6. (12 Pts)  Determine the concentration of $CO_3^{2-}$ ions in a 0.18 M $H_2CO_3$ solution. Carbonic acid is a diprotic acid whose $K_{a1} = 4.3 \times 10^{-7}$ and $K_{a2} = 5.6 \times 10^{-11}$.