Unit 9 – Chapter 15: Acid-Base Equilibrium & Buffers **Name _____**

Assignment #9: Chapter Review Problems **Period _____**

1) A certain indicator HIn has a pK_a of 3.00 and a color change becomes visible when 7.00% of the indicator has been converted to In^-. At what pH is this color change visible?

2) Which of the indicators in Figure 15.8 could be used for the titrations of 0.200 *M* acetic acid (K_a = 1.8 X 10^{-5}) with 0.100 *M* KOH and 0.200 *M* $HClO_3$ with 0.100 *M* KOH?

3) Which of the indicators in Figure 15.8 could be used for the titrations of 0.100 *M* $Ba(OH)_2$ with 0.400 *M* HCl and 0.100 *M* H_2NNH_2 with 0.200 *M* HNO_3?

4) Which of the indicators in Figure 15.8 could be used for the titrations of 0.100 *M* lactic acid ($HC_3H_5O_3$, pK_a = 3.86) with 0.100 NaOH *M* and 0.100 *M* NH_3 (K_b = 1.8 X 10^{-5}) with 0.100 *M* HCl?

5) Which of the indicators in Figure 15.8 could be used for the titrations of 0.100 *M* propanoic acid ($HC_3H_5O_2$, K_a = 1.3 X 10^{-5}) with 0.100 *M* NaOH and 0.100 *M* pyridine (K_b = 1.7 X 10^{-9}) with 0.100 *M* HCl?

6) Estimate the pH of a solution in which bromocresol green is blue and thymol blue is yellow. (See Figure 15.8)

7) A solution has a pH of 7.0. What would be the color of the solution if each of the following indicators were added? (See Figure 15.8)
   a. thymol blue b. bromothymol blue c. methyl red d. crystal violet

8) Write balanced equations for the dissolution reactions and the corresponding solubility product expressions for each of the following solids.
   a. $AgC_2H_3O_2$ b. $Al(OH)_3$ c. $Ca_3(PO_4)_2$

9) Write balanced equations for the dissolution reactions and the corresponding solubility product expressions for each of the following solids.
   a. Ag_2CO_3 b. $Ce(IO_3)_3$ c. BaF_2

10) Use the following data to calculate the K_{sp} value for each solid.
   a. The solubility of CaC_2O_4 is 6.1 X 10^{-3} g/L.
   b. The solubility of BiI_3 is 1.32 X 10^{-5} mol/L.

11) Use the following data to calculate the K_{sp} value for each solid.
   a. The solubility of $Pb_3(PO_4)_2$ is 6.2 X 10^{-12} mol/L.
   b. The solubility of Li_2CO_3 is 7.4 X 10^{-2} mol/L.

12) The concentration of Pb^{2+} in a solution saturated with $PbBr_{2(s)}$ is 2.14 X 10^{-2} *M*. Calculate K_{sp} for $PbBr_2$.

13) The concentration of Ag^+ in a solution saturated with $Ag_2C_2O_{4(s)}$ is 2.2 X 10^{-4} *M*. Calculate K_{sp} for $Ag_2C_2O_4$.

14) Calculate the solubility of each of the following compounds in moles per liter. Ignore any acid-base properties.

a. Ag_3PO_4, K_{sp} = 1.8 X 10^{-18}
b. $CaCO_3$, K_{sp} = 8.7 X 10^{-9}
c. Hg_2Cl_2, K_{sp} = 1.1 X 10^{-18} (Hg_2^{2+} is the cation in the solution)

15) Calculate the solubility of each of the following compounds in moles per liter. Ignore any acid-base properties.

a. PbI_2, K_{sp} = 1.4 X 10^{-8}
b. $CdCO_3$, K_{sp} = 5.2 X 10^{-12}
c. $Sr_3(PO_4)_2$, K_{sp} = 1 X 10^{-31}

16) The solubility of the ionic compound M_2X_3, having a molar mass of 288 g/mol, is 3.60 X 10^{-7} g/L. Calculate the K_{sp} of the compound.

17) A solution contains 0.018 mol each of I^-, Br^-, and Cl^-. When the solution is mixed with 200.0 mL of 0.24 *M* $AgNO_3$, what mass of $AgCl_{(s)}$ precipitates out, and what is the $[Ag^+]$? Assume no volume change.

AgI, K_{sp} = 1.5 X 10^{-16}
AgBr, K_{sp} = 5.0 X 10^{-13}
AgCl, K_{sp} = 1.6 X 10^{-10}

18) Calculate the molar solubility of $Co(OH)_3$, K_{sp} = 2.5 X 10^{-43}.

19) Calculate the molar solubility of $Cd(OH)_2$, K_{sp} = 5.9 X 10^{-11}.

20) For each of the following pairs of solids, determine which solid has the smallest molar solubility.

a. $CaF_{2(s)}$, K_{sp} = 4.0 X 10^{-11}, or $BaF_{2(s)}$, K_{sp} = 2.4 X 10^{-5}
b. $Ca_3(PO_4)_{2(s)}$, K_{sp} = 1.3 X 10^{-32}, or $FePO_{4(s)}$, K_{sp} = 1.0 X 10^{-22}

21) For each of the following pairs of solids, determine which solid has the smallest molar solubility.

a. $FeC_2O_{4(s)}$, K_{sp} = 2.1 X 10^{-7}, or $Cu(IO_4)_{2(s)}$, K_{sp} = 1.4 X 10^{-7}
b. $Ag_2CO_{3(s)}$, K_{sp} = 8.1 X 10^{-12}, or $Mn(OH)_{2(s)}$, K_{sp} = 2 X 10^{-13}

22) Calculate the solubility (in moles per liter) of $Fe(OH)_3$ (K_{sp} = 4 X 10^{-38}) in each of the following.

a. water
b. a solution buffered at pH = 5.0
c. a solution buffered at pH = 11.0

23) The K_{sp} for silver sulfate (Ag_2SO_4) is 1.2 X 10^{-5}. Calculate the solubility of silver sulfate in each of the following.
    a. water
    b. 0.10 *M* $AgNO_3$
    c. 0.20 *M* K_2SO_4

24) Calculate the solubility of solid $Ca_3(PO_4)_2$ (K_{sp} = 1.3 X 10^{-32}) in a 0.20 *M* Na_3PO_4 solution.

25) The solubility of $Ce(IO_3)_3$ in a 0.20 *M* KIO_3 solution is 4.4 X 10^{-8} mol/L. Calculate K_{sp} for $Ce(IO_3)_3$.

26) What mass of ZnS (K_{sp} = 2.5 X 10^{-22}) will dissolve in 300.0 mL of 0.050 *M* $Zn(NO_3)_2$? Ignore the basic properties of S^{2-}.