Worksheet 5

1. A sample containing 26.38 mL of 0.1439 M HBr is titrated with a solution of NaOH having a molarity of 0.1219 M. Compute the pH of the titration solution added, when the titration is 1.00 mL short of the equivalence point, when the titration is at the equivalence point, and when the titration is 1.00 mL past the equivalence point.

2. Ammonia is a weak base with a K_b of 1.8×10^{-5}. A 140.0 mL sample of a 0.175 M solution of aqueous ammonia is titrated with 0.106 M solution of the strong acid HCl. Write the reaction and compute the pH of the titration solution before any acid is added, when titration solution is at the half-equivalence point, and when the titration is 1.00 mL past the equivalence point.

3. Oxalic acid ionizes in two stages in aqueous solution:

$H_2C_2O_4$ (*aq*) + H_2O (*l*) ⇋ H_3O^+ (*aq*) + $HC_2O_4^-$ (*aq*) $\qquad K_{a1} = 5.9 \times 10^{-2}$

$HC_2O_4^-$ (*aq*) + H_2O (*l*) ⇋ H_3O^+ (*aq*) $C_2O_4^{2-}$ (*aq*) $\qquad K_{a2} = 6.4 \times 10^{-5}$

Calculate the equilibrium concentrations of $C_2O_4^{2-}$, $HC_2O_4^-$, $H_2C_2O_4$, and OH^- in a 0.10 M solution of sodium oxalate ($Na_2C_2O_4$).

4. The pH of a drop of acid rain is 4.00. Compute the concentrations of H_2CO_3 (*aq*), HCO_3^- (*aq*), and CO_3^{2-} (*aq*) in the acid raindrop if the total concentration of dissolved carbonates is 3.6×10^{-5} M. You will need to figure out the two stage reaction and their respective K_a at 25°C.

5. A 1.00 g sample of magnesium sulfate is dissolved in water, and the water is then evaporated away until the residue is bone dry. If the temperature of the water is kept between 48°C and 69°C, the solid that remains weighs 1.898 g. If the experiment is repeated with the temperature held between 69°C and 100°C, however, the solid has a mass of 1.150 g. Determine how many waters of crystallization per $MgSO_4$ there are in each of these two solids.

6. Thallium thiocyanate (TISCN) is only soluble in water. Its K_a at 25°C is 1.8×10^{-4}. Estimate the solubility of thallium thiocyanate in units of grams per 100.0 mL of water.

7. At 25°C, 400 mL of water can dissolve 0.00896 g of lead iodate, $Pb(IO_3)_2$. Calculate K_{sp} for lead iodate.

8. A solution is prepared by dissolving 0.090 g of PbI_2 in 1.00 L of hot water and cooling the solution to 25°C. Will solid precipitate result from this process, according to the solubility product expression? Explain.

9. When 40.0 mL of 0.0800 M $Sr(NO_3)_2$ and 80.0 mL of 0.0500 M KF are mixed, a precipitate of strontium fluoride (SrF_2) is formed. The solubility product of strontium fluoride in water at 25°C is 2.8×10^{-9}. Calculate the [Sr^{2+}] and [F^-] remaining in solution at equilibrium.

10. Compare the molar solubility of $Mg(OH)_2$ in pure water with that in a solution buffered at pH 9.00.

Worksheet 5

11. Calculate the [Cd^{2+}] in a solution that is in equilibrium with CdS (*s*) and in which [H_3O^+] = 1.0×10^{-3} M and [H_2S] = 0.10 M.

12. The two salts $BaCl_2$ and Ag_2SO_4 are both far more soluble in water than either $BaSO_4$ (K_{sp} = 1.1×10^{-10}) or AgCl (K_{sp} = 1.6×10^{-10}) at 25°C. Suppose 50.0 mL of 0.040 M $BaCl_2$ (*aq*) is added to 50.0 mL of 0.020 M Ag_2So_4 (*aq*). Calculate the concentrations of SO_4^{2-} (*aq*), Cl^- (*aq*), Ba^{2+} (*aq*), and Ag^+ (*aq*) that remain in solution at equilibrium.

13. The volume of a certain saturated solution is greater than the sum of the volumes of the water and salt from which it is made. Predict the effect of increased pressure on the solubility of this salt.