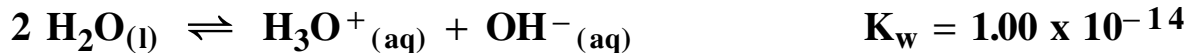
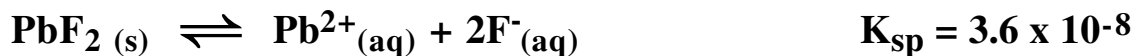


**Problem 1 (20 Points)**

Given that the following multiple equilibria take place in water:



Using the systematic approach to solving multiple equilibria, write the mass balance, charge balance and equilibria based algebraic expressions you would use to solve for the solubility of  $\text{PbF}_2$  in water. Also list the soluble chemical species (Unknowns) for which concentrations could be determined.

**Mass Balance Equation:**

**Charge Balance Equation:**

**Equilibria Based Algebraic Equations:**

**Unknowns**

**Problem 2 (20 Points) Note: This is a two part problem.**

**a) (10 points)** Find the pH of a solution prepared by dissolving **10.876 grams** of ammonia ( $\text{NH}_3$ , molecular weight=17.03) and **15.572 grams** of ammonium chloride ( $\text{NH}_4^+\text{Cl}^-$ , molecular weight=53.49) in **2.00** Liter of water. The  $\text{pK}_b$  of ammonia ( $\text{NH}_3$ ) is **4.756**.

pH=\_\_\_\_\_

**b) (10 points)** If **50.00 mL** of **1.00 M HCl** had been added to the solution in part (a), what would be the new pH of the solution?

pH=\_\_\_\_\_

**Problem 3 (20 Points) Note: this is a two part problem**

(a) What is the pH of a solution prepared by dissolving **6.6035 grams** of sodium acetate ( $\text{NaOOCCH}_3$  - **mw=82.03 g/mole**) in **2.000** Liters of water. The  $\text{pK}_a$  of acetic acid is **4.757**. (b) What is the **fraction** of association ( $\alpha$ ) of sodium acetate in this solution?

(a) pH=\_\_\_\_\_

(b)  $\alpha$  = \_\_\_\_\_

**Problem 4 (15 Points)**

The **bismuth oxycarbonate**  $(\text{BiO})_2\text{CO}_3$  (mw = 509.97 g/mole) in a veterinary drug tablet was analyzed by dissolving a 0.2005 gram sample in dilute  $\text{HNO}_3$  and precipitating the  $\text{Bi}^{3+}$  as  $\text{BiOCl}$  (mw = 260.43 g/mole) by addition of  $\text{Cl}^-$ . After drying at 100 degrees C, the  $\text{BiOCl}$  precipitate was found to weigh 0.0512 grams. Calculate the weight percent  $(\text{BiO})_2\text{CO}_3$  in the original sample.

weight %  $(\text{BiO})_2\text{CO}_3 = \text{_____} \%$

**Problem 5 (5 Points)**

What would be the approximate pH of a 1.00 L pure water solution to which  $1 \times 10^{-9}$  moles of  $\text{NaOH}$  was added?

pH  $\approx$  \_\_\_\_\_

**Problem 6 (20 Points)**

A **100.0 mg** sample of an ore that contained chromium was dissolved by acid and the **chromium (Cr)** was oxidized to chromate ion,  $\text{CrO}_4^{2-}$  (molecular weight = 115.9921 g/mole). **5.00 mL of 0.2000 M  $\text{Ag}^+$**  (as soluble  $\text{AgNO}_3$ ) was added to the solution to precipitate the  $\text{CrO}_4^{2-}$  as  $(\text{Ag}_2\text{CrO}_4)_{(s)}$ . The  $\text{Ag}_2\text{CrO}_4$  precipitate ( $\text{Ag}_2\text{CrO}_4$  has a molecular weight = 331.7285 g/mole) was removed by filtration and discarded. The **excess  $\text{Ag}^+$**  in the remaining solution required **14.50 mL of 0.0450 M KSCN** for titration. (a) How many **moles of Cr** were in the original ore sample? (b) What was the **weight % of Cr (atomic weight of Cr = 51.9961 g/mole)** in the ore sample?

(a) \_\_\_\_\_ moles Cr      (b) Wt. % Cr = \_\_\_\_\_ %