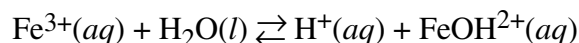


**Problem Set 5 (For February 10)****Recommended Text Problems:** 8.46, 8.53, 8.69, 8.71, 8.76, 8.103

**Note:** This problem set focuses on Chapter 8 material (acid-base and solubility equilibria). Problem Set 6 will be available Thursday, Feb. 10 (along with the solutions to these problems). There will be an x-hour lecture on Feb. 10, but there will be no class or office hour on Friday, Carnival Holiday. We have an exam Tuesday, Feb. 22, and a practice exam will be available soon.

1. A saturated solution of carbon dioxide in water produces carbonic acid,  $\text{H}_2\text{CO}_3$ , at a concentration of 0.034 M. Calculate the pH of this solution as well as the concentrations of all the species in the carbonic acid dissociation chain,  $\text{H}_2\text{CO}_3$ ,  $\text{HCO}_3^-$ , and  $\text{CO}_3^{2-}$ . The relevant acid dissociation constants are in Table 7.4 in the text. Suppose the pH of this solution is raised to 10.0. What are the concentrations of  $\text{H}_2\text{CO}_3$ ,  $\text{HCO}_3^-$ , and  $\text{CO}_3^{2-}$  now?
2. 20.0 mL of 0.10 M  $\text{Hg}(\text{NO}_3)_2$  solution and 30.0 mL of 0.20 M NaI solution are mixed. Assuming that no reaction takes place, calculate the concentration of each of the ions present in the solution. Actually, a yellow-orange precipitate of mercury(II) iodide ( $K_{\text{sp}} = 3 \times 10^{-26}$ ) forms. Calculate the concentrations of  $\text{Hg}^{2+}$  and  $\text{I}^-$  once equilibrium has been established. (There is actually more to this story: see Problem 8.89, but ignore the chemistry described in that problem as you work this one!)
3. Here's a challenging problem on simultaneous solubility equilibria. The oxalate ion,  $\text{C}_2\text{O}_4^{2-}$ , forms many insoluble compounds with metal ions. For example, copper oxalate,  $\text{CuC}_2\text{O}_4$ , has  $K_{\text{sp}} = 3 \times 10^{-8}$ , and barium oxalate,  $\text{BaC}_2\text{O}_4$ , has  $K_{\text{sp}} = 2 \times 10^{-8}$ . In a solution saturated with both compounds at the same time, what are  $[\text{Cu}^{2+}]$ ,  $[\text{Ba}^{2+}]$ , and  $[\text{C}_2\text{O}_4^{2-}]$ ? Take care to note that  $\text{C}_2\text{O}_4^{2-}$  comes from two sources, and check your answers by verifying that  $[\text{Cu}^{2+}][\text{C}_2\text{O}_4^{2-}] = 3 \times 10^{-8}$  and  $[\text{Ba}^{2+}][\text{C}_2\text{O}_4^{2-}] = 2 \times 10^{-8}$ .
4. The solubility product for  $\text{Zn}(\text{OH})_2$  is  $4.5 \times 10^{-17}$ . Calculate the solubility (in  $\text{g L}^{-1}$  units) of  $\text{Zn}(\text{OH})_2$  in a solution buffered at  $\text{pH} = 6.00$ . Assume the buffer capacity is large enough to maintain the pH at 6.00 as the  $\text{Zn}(\text{OH})_2$  dissolves.
5. Solutions of the very soluble salt  $\text{Fe}(\text{NO}_3)_3$ , iron(III) nitrate, in pure water are acidic. If one dissolves 0.100 mol of this salt in 1.00 L of water, the solution has a pH of 1.6. This surprising result is explained by the reaction



Calculate the equilibrium constant for this reaction. *Note:* you will find that our usual simplifying assumption that the amount of material that has reacted is a small fraction of the initial amount is not very good here. An exact treatment is called for. What is the ratio  $[\text{FeOH}^{2+}]/[\text{Fe}^{3+}]$ ?