

Chemistry 192
Problem Set 6
Spring, 2017

1. The solubility product of $\text{Al}(\text{OH})_3$ is 1.1×10^{-15} . Calculate the concentrations of aluminum ions, hydroxide ions and hydronium ions in a saturated aqueous solution of aluminum hydroxide.
Answer: $[\text{Al}^{3+}] = 8.0 \times 10^{-5} \text{ M}$, $[\text{OH}^-] = 2.4 \times 10^{-4} \text{ M}$, $[\text{H}_3\text{O}^+] = 4.2 \times 10^{-11} \text{ M}$
2. The solubility product of Ag_2S is 1.6×10^{-49} . Calculate the molar solubility of silver sulfide in water.
Answer: $3.4 \times 10^{-17} \text{ M}$
3. The solubility of Ag_3AsO_4 in water is $8.5 \times 10^{-4} \text{ g mL}^{-1}$. Calculate the solubility product of silver arsenate.
Answer: $K_{sp} = 3.1 \times 10^{-19}$.
4. The solubility product of Ag_2CO_3 is $K_{sp} = 5.0 \times 10^{-12}$. Calculate the molar solubility of silver carbonate in a) water and b) a 0.20 M aqueous AgNO_3 solution (silver nitrate is 100% ionized).
Answer: $1.1 \times 10^{-4} \text{ M}$ and $1.3 \times 10^{-10} \text{ M}$
5. The solubility product of AgCl is $K_{sp} = 1.1 \times 10^{-10}$. Calculate the weight of silver nitrate that must be added to 10. mL of a 0.10 M sodium chloride solution to initiate the silver chloride precipitation reaction.
Answer: $1.9 \times 10^{-9} \text{ g}$.
6. The solubility product of Ag_2SO_4 is 7.0×10^{-5} . A laboratory student mixes 10. mL of a 0.010 M silver nitrate solution with 10. mL of a 0.020 M sodium sulfate (Na_2SO_4) solution. Calculate a suitable reaction quotient to determine if silver sulfate precipitate should form when the two solutions are mixed.
Answer: $Q = 2.5 \times 10^{-7}$
7. The solubility product of $\text{Cu}(\text{OH})_2$ is 1.0×10^{-16} . Calculate
 - (a) the pH of a saturated solution of copper (II) hydroxide in water;
Answer: pH=8.77

(b) the molar solubility of copper (II) hydroxide in a solution having pH=1.00;

(c) the molar solubility of copper (II) hydroxide in a solution having pH=13.00.

Answer: 1.0×10^{-14} M

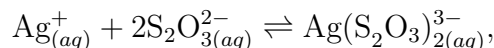
8. Problem 54, page 814 textbook.

Answer: 9.2×10^{-18} M

9. Problem 56, page 814 textbook.

Answer: $Q = 4.5 \times 10^{-21}$

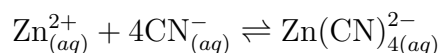
10. Aqueous silver ions form a coordination complex with thiosulfate anions according to the reaction



where the formation equilibrium constant for the complex is $K_f = 1.7 \times 10^{13}$. Given the solubility product of silver iodide, AgI, is $K_{sp} = 8.5 \times 10^{-17}$, calculate the molar solubility of silver iodide in a solution that is 0.100 M in thiosulfate.

Answer: 3.4×10^{-2} M

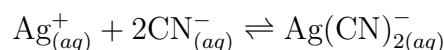
11. Zinc ions form a complex in cyanide solutions according to the reaction



with a formation constant $K_f = 1.0 \times 10^{18}$. It is found that the solubility of solid zinc selenide (ZnSe) in a 0.100 M cyanide solution is 6.0×10^{-5} M. Calculate the solubility of zinc selenide in water.

Answer: 6.0×10^{-12} M

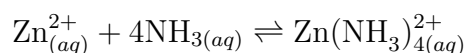
12. The silver cyanide coordination complex, $\text{Ag}(\text{CN})_2^-$ forms by the reaction



with associated equilibrium constant $K_f = 5.6 \times 10^{18}$. Given the solubility product of silver iodide (AgI) is $K_{sp} = 8.5 \times 10^{-17}$, calculate the solubility of silver iodide in a solution having $[\text{CN}^-] = 0.500$ M.

Answer: 0.24 M.

13. Zinc ions form a coordination complex in aqueous ammonia



having formation equilibrium constant $K_f = 4.1 \times 10^8$. Zinc sulfide (ZnS) is only sparingly soluble in water with solubility product constant $K_{sp} = 2.0 \times 10^{-25}$. Calculate the molar solubility of zinc sulfide in a 0.10 M aqueous ammonia solution. **Answer:** 9.1×10^{-11} M

14. Silver ions (Ag^+) react with thiocyanate ions (SCN^-) in aqueous solution to form the coordination complex $\text{Ag}(\text{SCN})_4^{3-}$ with associated formation constant $K_f = 1.2 \times 10^{10}$. Consider a solution that is made by adding 0.050 moles of silver ions to 0.250 L of a 2.50 M thiocyanate solution. Calculate the concentration of free silver ions (Ag^+) when equilibrium is reached.

Answer: 2.0×10^{-12} M.

15. The formation equilibrium constant for the cobalt ammonia complex $[\text{Co}(\text{NH}_3)_6]^{3+}$ is $K_f = 4.5 \times 10^{33}$. Calculate the molar concentration of free $\text{Co}_{(aq)}^{3+}$ in a solution made by mixing 0.100 L of 0.0500 M Co^{3+} to 0.500 L of 0.250 M aqueous ammonia. Approximations work for this problem.

Answer: 1.2×10^{-31} M

16. The solubility product constant for zinc oxalate (ZnC_2O_4) is 2.7×10^{-8} and the formation constant for the zinc cyanide coordination complex $[\text{Zn}(\text{CN})_4]^{2-}$ is 1.0×10^{18} . Consider a mixture that is formed by combining 0.25 L of a 1.0×10^{-4} M CN^- solution and 0.35 L of a 6.0×10^{-6} M Zn^{2+} solution. After the solutions are mixed 0.50 moles of oxalate ions are added to the solution. Assuming the added oxalate does not change the total volume of the solution, determine if a zinc oxalate precipitate will form. Approximations work for this problem.

Answer: Yes