

Work Sheet 8+

CH302 Spring 2008

1.

A solution is made with NaI and NaCl such that it is 0.01 M in both I⁻ and Cl⁻. To 1 L of this solution 0.01 moles Ag(NO₃) are added (you can ignore any volume change). The NaI, NaCl, and Ag(NO₃) are completely soluble (as is NaNO₃ but you already knew that). The K_{SP} for AgI is 8.3 x 10⁻¹⁷ and for AgCl is 1.8 x 10⁻¹⁰.

After the solution has reached equilibrium what are the concentrations of the following?

Will anything precipitate?

Initial concentration of [Ag⁺] is 0.01 M, [I⁻] = 0.01 M, [Cl⁻] = 0.01 M

$$Q_{sp} = [Ag^+][I^-] = (.01)(.01) = 10^{-4} \quad \text{AgI could precipitate}$$

$$Q_{sp} = [Ag^+][Cl^-] = (.01)(.01) = 10^{-4} \quad \text{AgCl could precipitate}$$

However AgI is much less soluble than AgCl. Assume the AgI precipitates completely to equilibrium

Then you have a saturated solution of AgI

Concentration of Ag⁺ will be

$$K_{sp} = [Ag^+][I^-] \quad [Ag^+] = \sqrt{K_{sp}} = \sqrt{8.3 \times 10^{-17}} = 9.11 \times 10^{-9}$$

Given this concentration will the AgCl precipitate?

$$Q_{sp} = [Ag^+][Cl^-] = (9.11 \times 10^{-9})(.01) = 9.11 \times 10^{-11}$$

$$Q_{sp} < K_{sp} \quad \text{so no AgCl will precipitate}$$

$$[Ag^+] \quad 9.11 \times 10^{-9} \text{ M}$$

$$[I^-] \quad 9.11 \times 10^{-9} \text{ M}$$

$$[Cl^-] \quad 0.01 \text{ M}$$

Are there any solid precipitates? If so how many grams of each.

Only AgI will precipitate. Essentially all the silver will precipitate as AgI. That is 0.01 moles. (0.01 mol)(234.8 g mol⁻¹) = 2.35 g

2. The K_{sp} of $PbCl_2$ is 1.7×10^{-5} . How many grams of $PbCl_2$ will dissolve in 100 mL of a 0.1 M NaCl solution?

	Pb^{2+}	Cl^-
I	0	.1
C	+x	+2x
E	+x	.1+2x

$$K_{sp} = [Pb^{2+}][Cl^-]^2 = (x)(.1 + 2x)^2 \sim (x)(.1)^2$$

$$[Pb^{2+}] = K_{sp}/[Cl^-]^2 = (1.7 \times 10^{-5})/(.1)^2 = 1.7 \times 10^{-3}$$

that will be $(1.7 \times 10^{-3} \text{ M})(.1 \text{ L}) = 1.7 \times 10^{-4}$ moles $PbCl_2$

$$(1.7 \times 10^{-4} \text{ moles})(278.1 \text{ g mol}^{-1}) = 0.047 \text{ g}$$

3. Will CaF_2 be more soluble in acid or base?

F^- is the conjugate base of the weak acid HF. In acid, F^- will form HF allowing more CaF_2 to dissolve.

4. Consider the following reactions



You a saturated solution of AgCN, what will the effect of each of the following (nothing, more AgCN dissolves, some AgCN precipitates)

What is the concentration of

A. Adding HNO_3

Increasing H^+ will cause more HCN to form lowering the CN^- concentration. More AgCN will dissolve. (also the Cl^- concentration will increase. If it get high enough AgCl will precipitate causing more AgCN to dissolve)

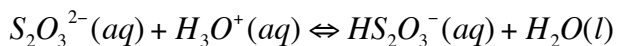
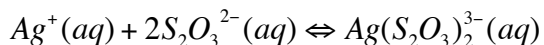
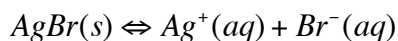
B. Adding KCN

Adding CN^- will cause some AgCN to precipitate

C. Adding KNO_3

Adding K^+ and NO_3^- will do nothing

5. A blast from the past



What is the effect of each of these on the solubility of $\text{AgBr}(s)$

1. Adding the soluble salt KBr

This will decrease the solubility of the AgBr as the concentration of Br^- will increase

2. Adding the soluble salt $\text{Na}_2\text{S}_2\text{O}_3$

This increase the solubility of the AgBr . The $\text{S}_2\text{O}_3^{2-}$ will react with the silver to form $\text{Ag}(\text{S}_2\text{O}_3)_2^{3-}$. This will decrease the Ag^+ concentration leading to more AgBr dissolving.

3. Adding HCl

Adding HCl will casue the $\text{S}_2\text{O}_3^{2-}$ to form HS_2O_3^- . This will decrease in $\text{S}_2\text{O}_3^{2-}$. This will cause $\text{Ag}(\text{S}_2\text{O}_3)_2^{3-}$ to dissolve forming more Ag^+ . This will decrease the solubility of the AgBr

4. Adding solid AgBr

This will have no effect.