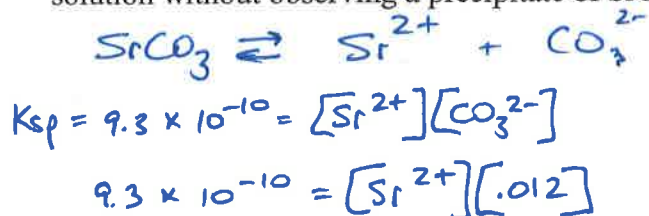


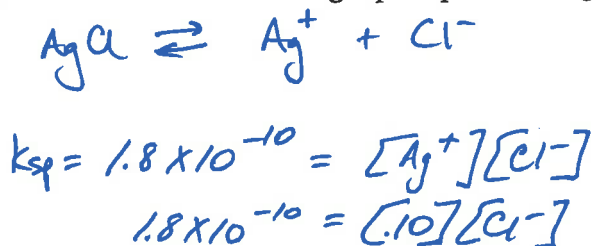
Ksp Problems Worksheet #3 (2011)
Threshold Saturation Ion Concentration before ppt formation begins

1. What is the maximum concentration of strontium ion (Sr^{2+}) that can be present in a 0.012 M K_2CO_3 solution without observing a precipitate of SrCO_3 ?



$[\text{Sr}^{2+}] = 7.8 \times 10^{-8} \text{ M}$ for a sat'd solution. Anything higher will cause a ppt to form.

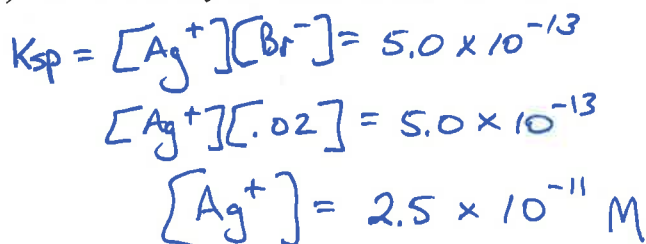
2. What is the maximum concentration of chloride ion (Cl^-) that can be present in a 0.10 M AgNO_3 solution without observing a precipitate of AgCl ?



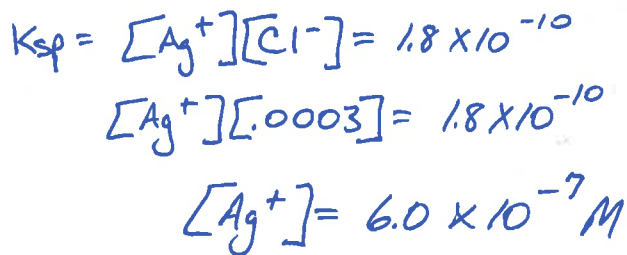
$[\text{Cl}^-] = 1.8 \times 10^{-9} \text{ M}$ for a sat'd solution. Anything higher will cause a ppt of AgCl to form.

3. Solid AgNO_3 is added to a solution containing 0.0003 M KCl and 0.02 M NaBr .

- (a) What molarity of dissolved Ag^{1+} is required to start the precipitation of the AgBr ?



- (b) What molarity of dissolved Ag^{1+} is required to start the precipitation of the AgCl ?



- (c) Which compound, AgBr or AgCl , will precipitate first upon slow addition of AgNO_3 ? Explain your reasoning.

AgBr will ppt first because it ppts when $[\text{Ag}^+] > 2.5 \times 10^{-11} \text{ M}$
the AgCl will start to ppt after $[\text{Ag}^+] > 6.0 \times 10^{-7} \text{ M}$

4. If solid NaCl is added slowly to a beaker containing 0.120 M AgNO₃ and 0.150 M Pb(NO₃)₂, which will precipitate first, AgCl(s) or PbCl₂(s)? Show calculations to support your answer.



$$K_{sp} = [Ag^+][Cl^-] = 1.8 \times 10^{-10}$$

$$[.120][Cl^-] = 1.8 \times 10^{-10}$$

$$[Cl^-] = 1.5 \times 10^{-9} M$$

PbCl₂ $K_{sp} = [Pb^{2+}][Cl^-]^2 = 1.7 \times 10^{-5}$

$$[.150][Cl^-]^2 = 1.7 \times 10^{-5}$$

$$[Cl^-]^2 = 1.1 \times 10^{-4}$$

$$[Cl^-] = .011 M$$

The AgCl will start to ppt when $[Cl^-] > 1.5 \times 10^{-9} M$ which would come much before $[Cl^-] > .011 M$ that would be needed for PbCl₂ to ppt.

5. An aqueous solution of Ca(NO₃)₂ is added slowly to 1.0 Liter of a well-stirred solution containing 0.020 mole F⁻ and 0.10 mole SO₄²⁻ at 25°C. (You may assume that the added Ca(NO₃)₂ solution does not affect the total volume of the system.)

- (a) Which salt precipitates first? Explain your reasoning.



$$K_{sp} = [Ca^{2+}][F^-]^2 = 3.9 \times 10^{-11}$$

$$[Ca^{2+}] \left[\frac{.020}{1.0} \right]^2 = 3.9 \times 10^{-11}$$

$$[Ca^{2+}] > 9.8 \times 10^{-8} M$$

when CaF₂ starts to ppt



$$K_{sp} = [Ca^{2+}][SO_4^{2-}] = 2.4 \times 10^{-5}$$

$$[Ca^{2+}] \left[\frac{.10}{1.0} \right] = 2.4 \times 10^{-5}$$

$$[Ca^{2+}] > 2.4 \times 10^{-4} M$$

when CaSO₄ starts to ppt

- (b) What is the concentration of Ca²⁺ in the solution when the first precipitate begins to form?

I would expect the CaF₂ to ppt first because CaF₂ will ppt once the $[Ca^{2+}]$ exceeds $9.8 \times 10^{-8} M$ whereas the CaSO₄ will only ppt once $[Ca^{2+}]$ exceeds $2.4 \times 10^{-4} M$.