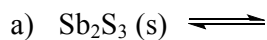
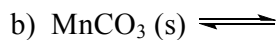


Writing out K_{sp} expressions: A K_{sp} expression is just a specific type of equilibrium expression. K_{sp} expressions are only used for relatively insoluble solids in water. Every saturated solution must satisfy its K_{sp} expression because every saturated solution is at equilibrium. (*Ion concentrations are constant because rate of dissolving = rate of crystallization.*)

- 1) Write the balanced chemical equations for the following solids dissolving in water. Then, write the K_{sp} expression for each. *Remember: Pure solids are never written in equilibrium expressions. Don't forget exponents.*



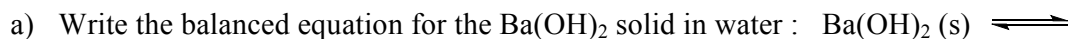
$K_{sp} =$



$K_{sp} =$

First Type of K_{sp} Calculation: Determining a K_{sp} value from concentrations.

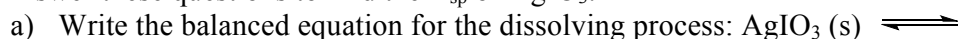
- 2) A sample of $\text{Ba}(\text{OH})_2(\text{s})$ is added to pure water and allowed to come to equilibrium. A saturated solution forms. The concentration of $\text{Ba}^{2+}(\text{aq})$ in this saturated solution is 0.108 M. What is K_{sp} of $\text{Ba}(\text{OH})_2$?



b) Since $[\text{Ba}^{2+}] = 0.108 \text{ M}$. What must be the concentration of the OH^- ions? (*Use balanced eq.*) _____

c) Write the K_{sp} expression (no numbers.) Then, plug in $[\text{Ba}^{2+}]$ and $[\text{OH}^-]$ values and solve for the K_{sp} .

- 3) A sample of $\text{AgIO}_3(\text{s})$ is dissolved in water and a saturated solution is formed. The $[\text{IO}_3^-] = 1.7 \times 10^{-4} \text{ M}$. Answer these questions to find the K_{sp} of AgIO_3 .



b) What is $[\text{Ag}^+]$? _____

c) Write the K_{sp} expression (no numbers.) Then, plug in $[\text{Ag}^+]$ and $[\text{IO}_3^-]$ values and solve for the K_{sp} .

Second type of K_{sp} calculations: Solving for an unknown ion concentration in a saturated solution.

- 4) Determine the equilibrium concentrations of Pb^{2+} and SO_4^{2-} in a saturated solution of PbSO_4 .

Given: K_{sp} of $\text{PbSO}_4 = 1.3 \times 10^{-8}$ To do so, follow these steps:



b) Suppose $[\text{Pb}^{2+}] = x$. Then, $[\text{SO}_4^{2-}] =$ _____

c) Write K_{sp} expression and then plug in K_{sp} value and concentration values in terms of "x's". Solve for x.

d) Thus, $[\text{Pb}^{2+}] =$ _____ and $[\text{SO}_4^{2-}] =$ _____

5) Follow these steps to find the equilibrium concentrations of Ni^{2+} and OH^- in a saturated solution of $\text{Ni}(\text{OH})_2$?

Given: K_{sp} of $\text{Ni}(\text{OH})_2 = 1.6 \times 10^{-16}$

- Write balanced equation for $\text{Ni}(\text{OH})_2$ solid in water : $\text{Ni}(\text{OH})_2 (\text{s}) \rightleftharpoons$
- Suppose $[\text{Ni}^{2+}] = x$. Then, $[\text{OH}^-] =$ _____
- Write K_{sp} expression and then plug in K_{sp} value and concentration values in terms of "x's". Solve for x.

d) Thus, $[\text{Ni}^{2+}] =$ _____ and $[\text{OH}^-] =$ _____

Third type of K_{sp} calculation: Determining if precipitate will form. Solve for Q. (You're not at equil.)

6) A solution is prepared by dissolving 9.2×10^{-4} moles of $\text{PbCl}_2 (\text{s})$ into 100. mL of hot water. Should a precipitate form if the solution is cooled to 25°C ? (Assume it is cooled too quickly for a supersaturated solution to form). Given: K_{sp} of PbCl_2 at $25^\circ\text{C} = 1.6 \times 10^{-5}$ To answer this question, follow these steps:

- Write the balanced equation for $\text{PbCl}_2 (\text{s})$ in water: $\text{PbCl}_2 (\text{s}) \rightleftharpoons$
- Write the Q expression-- no numbers. (same as K_{sp} expression -- you are just not at equilibrium)

c) Determine the concentrations of the ions in the hot solution.

d) Plug in concentrations and solve for Q.

- Q is (**greater than, less than**) the K_{sp} .
- Thus, there are (**more, fewer**) ions dissolved in the hot solution than at the saturation point at 25°C .
- Thus, if the solution is cooled to 25°C would solid precipitate? _____ (Assume one would disturb the solution if it were supersaturated.) Thus, the resulting solution at 25°C is (**unsaturated, saturated**).

7) Suppose 7.5×10^{-13} moles of $\text{Bi}(\text{NO}_3)_3$ solid and 1.3×10^{-13} moles of Na_2S solid are added to 500 mL of water at 25°C . Does Bi_2S_3 solid precipitate? (K_{sp} of $\text{Bi}_2\text{S}_3 = 1.1 \times 10^{-73}$) To answer, follow these steps:

a) What is the initial concentration of Bi^{3+} ions in the 500 mL solution? (assume no reaction yet)

b) initial $[\text{NO}_3^-]$ _____ initial $[\text{Na}^+]$ _____ initial $[\text{S}^{2-}]$ _____

c) Write the balanced equation for Bi_2S_3 solid in water: $\text{Bi}_2\text{S}_3 (\text{s}) \rightleftharpoons$

d) Write the Q expression-- no numbers. (same as K_{sp} expression -- you are just not at equilibrium)

e) Plug in the initial concentrations of the ions involved and solve for Q.

f) Q is (**greater than, less than**) the K_{sp} . Thus, there are (**more, fewer**) ions than at saturation pt.

g) Would a precipitate form? _____ The resulting solution is (**unsaturated, saturated**)

Answers: 2) 5.04×10^{-3} ; 3b) 1.7×10^{-4} M; 3c) 2.9×10^{-8} ; 4c) 1.1×10^{-4} M; 4d) both 1.1×10^{-4} M; 5c) 3.4×10^{-6} M; 5d) 3.4×10^{-6} M; 6c) 9.2×10^{-3} M; 6d) 1.8×10^{-2} M; 7a) 3.0×10^{-6} ; 7b) 4.5×10^{-12} M; 7c) 5.2×10^{-12} M; 7d) 2.6×10^{-10} M; 7e) 4.0×10^{-62}