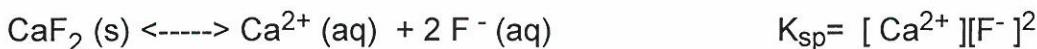


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Chemistry 12
Solubility Lesson #6
THE SOLUBILITY PRODUCT

The specialized "equilibrium expression" for a saturated solution is called the "K_{sp}" or the Solubility Product constant:

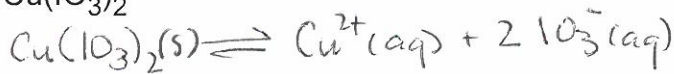
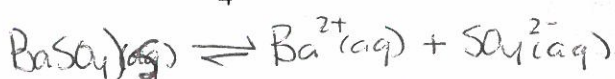


WE WILL USE THE "K_{sp} TABLE" pg 5 of your Data Booklet IF WE ARE ASKED TO CALCULATE OR COMPARE RELATIVE SOLUBILITIES OF SUBSTANCES.

Example 1: Write out the K_{sp} expressions for the following saturated solutions:

a. BaSO₄

b. Cu(IO₃)₂



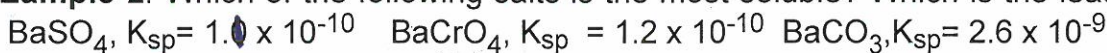
$$K_{sp} = [\text{Ba}^{2+}] [\text{SO}_4^{2-}] = 1.1 \times 10^{-10}$$

$$K_{sp} = [\text{Cu}^{2+}] [\text{IO}_3^-]^2 = 6.9 \times 10^{-8}$$

BECAUSE THE K_{sp} DEPENDS ON THE CONCENTRATIONS OF THE IONS IN SOLUTION, THE LARGER THE K_{sp} VALUE THE MORE SOLUBLE THE SALT. THE SMALLER THE K_{sp} VALUE THE LESS SOLUBLE THE SALT.

∴ BaSO₄ is ~~less~~ more soluble than Cu(IO₃)₂

Example 2. Which of the following salts is the most soluble? Which is the least?



Most (largest #) = BaCO₃, k_{sp} = 2.6 × 10⁻⁹

Least (smallest #) = BaSO₄, k_{sp} = 1.0 × 10⁻¹⁰

SOLVING K_{sp} PROBLEMS:

THERE ARE TWO TYPES OF K_{sp} PROBLEMS THAT YOU WILL ENCOUNTER

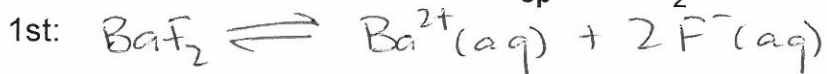
Type 1: The saturated solution ion concentrations are given, or they have to be calculated from a given mass → then calculate the k_{sp}

Type 2: The K_{sp} value is given (or see k_{sp} table) and you are asked to find the individual []'s.

Regardless of the type of problem you will start each problem by:

- 1st: write out the equilibrium ~~expression~~ ^{equation} for the saturated solution. (solid on reactant side always)
- 2nd: write out the K_{sp} expression

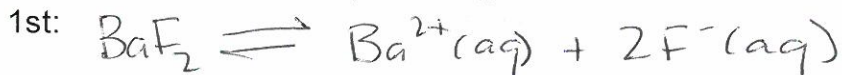
Example 3: A Solution with a precipitate of BaF_2 contains $4.59 \times 10^{-2} M Ba^{2+}$ and $2.00 \times 10^{-3} M F^-$. What is the K_{sp} for BaF_2 ?



2nd: $K_{sp} = [Ba^{2+}][F^-]^2$

3rd: $K_{sp} = [4.59 \times 10^{-2}][2.00 \times 10^{-3}]^2$
 $= [1.84 \times 10^{-7}]$

Example 4: A saturated solution contains 7.16×10^{-3} mol of BaF_2 in 2.00 L of solution. What is the K_{sp} for BaF_2 ?



2nd: $K_{sp} = [Ba^{2+}][F^-]^2$

3rd: Using $[7.16 \times 10^{-3} \text{ mol} / 2.00 \text{ L} = 3.58 \times 10^{-3} M BaF_2]$
determine $[Ba^{2+}] = 3.58 \times 10^{-3} M$
 $[F^-] = 3.58 \times 10^{-3} M \times 2 = 7.16 \times 10^{-3} M$

4th: plug values into K_{sp} .

$$K_{sp} = [3.58 \times 10^{-3}][7.16 \times 10^{-3}]^2$$
$$= [1.84 \times 10^{-7}]$$

Example 5: What is the $[Mg^{2+}]$ in a saturated solution of $Mg(OH)_2$?



2nd: $K_{sp} = [Mg^{2+}][OH^-]^2 = 5.6 \times 10^{-12}$ (value from table)

3rd: look up K_{sp} value from table. $K_{sp} = 5.6 \times 10^{-12}$

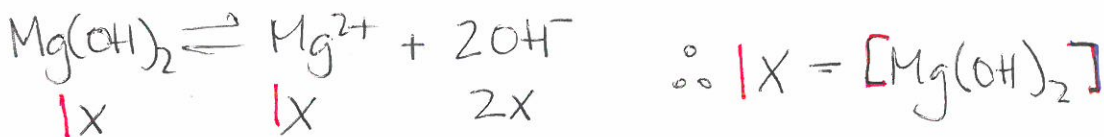
let "x" represent $[Mg(OH)_2]$ $\therefore 1x = [Mg^{2+}]$ and $2x = [OH^-]$

4th: plug into K_{sp} + solve for "x"
 $5.6 \times 10^{-12} = [1x][2x]^2 = 1x \cdot 4x^2 = 4x^3$
 $\frac{5.6 \times 10^{-12}}{4} = \frac{4x^3}{4} \Rightarrow \sqrt[3]{1.4 \times 10^{-12}} = \sqrt[3]{x^3}$
 $x = 1.1 \times 10^{-4}$
 $\therefore [Mg^{2+}] = 1.1 \times 10^{-4} M$

Example 6. What mass of $Mg(OH)_2$ will dissolve in 250 mL of water?

Carry out Steps 1-4 as in example #5

THEN: Convert the $[Mg^{2+}]$ to mass of $Mg(OH)_2$ using STOICHIOMETRY!!!



$\frac{1.1 \times 10^{-4} \text{ mol } Mg(OH)_2}{1x} \times \frac{58.3 \text{ g } Mg(OH)_2}{1 \text{ mol } Mg(OH)_2} \times 0.250 L =$

$1.6 \times 10^{-3} \text{ g } Mg(OH)_2$

SEATWORK/HOMEWORK: Exercises 40-55 pgs 91-95

PLO's: I1-I4

Mg = 24.3
 2 O = 32.0
 H = 2.0
 58.3g