NAME: **HONORS CHEMISTRY**

SECTION: Solubility Product Constants

The **solubility product** is just the equilibrium constant for the dissolving of a slightly soluble solid. Here are some examples:

AgCl(s) ⇌ Ag+(aq) + Cl- (aq) Ksp = [Ag+][Cl-]

MgF2(s) ⇌ Mg2+(aq) + 2 F-(aq) Ksp = [Mg2+][F-]2

Since the reactant is always a solid, there is no denominator on solubility equilibrium expressions. Assume that the denominator is always “1”.

There are two basic types of Ksp problems:

1. Give the solubility (also known as the concentration of a saturated solution), find the Ksp.
2. Given the Ksp, find the molarity or the concentration of a saturated solution (also known as the solubility) of the solid in question.

General Problem-Solving Strategy

**List what you know.**

Write out the balanced ionization expression.

List known values. Identify the unknown(s).

**Set up the problem.**

Write the Ksp expression.

Write out the ICE table (initial/change/equilibrium)

**Estimate and calculate.**

Substitute and evaluate. Use sig figs.

*Watch out—these problems all use different ways of*

*saying the same thing*!

1. The solubility of Agl is 1.34 x 10-5 M. Find the Ksp of AgI.

Model Calculation:

AgI(s) ⇌ Ag+(aq) + I-(aq)

I -- 0 0

C -- +x +x

E -- 1.34 x 10-5 1.34 x 10-5

Ksp = [Ag+][I-] = (1.34 x 10-5)2 = 1.80 x 10-10

1. The concentration of a saturated solution of barium carbonate, BaCO3, is 7.00 x 10-5 M. Calculate the Ksp of barium carbonate.
2. Find the Ksp of magnesium hydroxide, Mg(OH)2, if a saturated solution is 2.51 x 10-4M.
3. What is the Ksp of lead(II) iodate, Pb(IO3)2, if a saturated solution has a concentration of 4.13 x 10-5 M?
4. The Ksp of strontium oxalate, SrC2O4, is 1.58x 10-7. Find the concentration of a saturated solution of strontium oxalate.

Model Calculation: SrC2O4(s) ⇌ Sr2+(aq) + C2O42-(aq)

I -- 0 0

C -- +x +x

E -- x x

Ksp = [Sr2+][C2O42-]

1.58 x 10-7 = x2

x = 3.97 x 10-4 ∴ [Sr2+] = [C2O42-] = 3.97 x 10-4 M

1. If the Ksp of barium chromate is 2.00 x 10-10, what is the solubility of BaCrO4?
2. What will be the concentration of copper ions in a saturated solution of copper (II) carbonate, CuCO3? (The Ksp of copper carbonate is 8.7 x 10-9).
3. What is the molarity of a saturated solution of lead (II) iodide, PbI2? The Ksp of lead (II) iodide is 7.08 x 10-9. (Note: Be careful! Write the balanced equation first, then express the unknown concentrations of the ions in terms of each other.)

NAME: **HONORS CHEMISTRY**

Answers

2. 4.90 x 10-9

3. 6.33 x 10-11

4. 2.82 x 10-13

6. 1.41 x 10-5 M

7. 9.3 x 10-5 M

8. 1.21 x 10-3 M

SECTION: Ksp Problems, level 2

A useful application of Ksp data is to determine if precipitation will occur when a salt and a solution or when two solutions are mixed. Precipitation takes place only when the ion product exceeds the Ksp.

Ion product < Ksp no precipitate will form

Ion product = Ksp no precipitate will form

Ion product > Ksp precipitate will form

Remember that if the final solution is formed by mixing two solutions, it is necessary to consider dilution. Each solute is diluted when the other solution is added.

**Example:**

Will precipitation occur when 50.0 mL of a 3.00 x 10-2 M Pb(NO3)2 solution is added to 50.0 mL of 2.00 x 10-3 M KCl? The Ksp of PbCl2 is 1.62 x 10-5.

* Write a Ksp expression based on the Ksp value given
* Assume volumes are additive (total volume = 100.0 mL)
* Calculate new concentrations of ions in mixture
* Substitute into Ksp expression
* Compare Q to K

1. 25.0 mL of 6.00 x 10-6 M Sr(NO3)2 is mixed with 25.0 mL of 4.00 x 10-7 H3PO4. Will precipitation occur? The Ksp of Sr3(PO4)2 is 4.07 x 10-28.
2. Determine if a precipitate of silver chromate, Ag2CrO4, will form when 100.0 mL of .100 M AgNO3 are added to 100.0 mL of .350 M K2CrO4. The Ksp of Ag2CrO4 is 9.00 x 10-12.
3. Predict whether calcium carbonate will precipitate when 0.5 L of 0.001 M Ca(NO3)2 is mixed with 0.5 L of 0.0008 M Na2CO3 to form 1.0 L of solution. The Ksp of CaCO3 is 4.5 x 10-9 M.
4. The solubility product constant for lead (II) chloride is 1.7 x 10-5. How many moles of lead nitrate can dissolve in 1.00 L of a 0.1 M solution of sodium chloride? (Hint: One of the ions found in PbCl2, the chloride ion, is already present in the solution. That can be taken to be its equilibrium concentration.)

Answers:

1. (No precipitation)
2. (ppt will form)
3. (ppt will form)
4. (0.0017 mol can be dissolved)