*AP Chemistry*

*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 (Q) 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 75.0 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 = 125.0 mL; M1V2 = M2V2)
* Calculate new concentrations of ions in mixture that will form a precipitate
* Substitute into Ksp expression; compare Qsp to Ksp
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. Assume that the volumes are additive.
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. Assume that the volumes are additive.
3. Predict whether calcium carbonate will precipitate when 0.50 L of 0.0010 M Ca(NO3)2 is mixed with 0.25 L of 0.00080 M Na2CO3 to form 0.75 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 solid lead nitrate can dissolve in 1.00 L of a 0.1 M solution of sodium chloride? Assume that addition of solid lead nitrate does not affect the total solution volume. (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.)

5. At 25ºC the solubility product constant, Ksp, for strontium sulfate, SrSO4, is 7.6 x 10-7. The solubility product constant for strontium fluoride, SrF2, is 7.9 x 10-10.

 (a)     What is the molar solubility of SrSO4 in pure water at 25ºC?

 (b)     What is the molar solubility of SrF2 in pure water at 25ºC?

(c)     An aqueous solution of Sr(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 25ºC. (You may assume that the added Sr(NO3)2 solution does not materially affect the total volume of the system.)

          i.     Which salt precipitates first?

          ii.     What is the concentration of strontium ion, Sr2+, in the solution when the first precipitate begins to form?

 (d)     As more Sr(NO3)2 is added to the mixture in (c) a second precipitate begins to form. At that stage, what percent of the anion of the first precipitate remains in solution?

Answers:

1. (No precipitation)
2. (ppt will form)
3. (ppt will form)
4. (0.0017 mol can be dissolved)
5. (a) molar solubility = [Sr2+] = 8.7 x 10-4 M

(b) molar solubility = [Sr2+] = 5.8 x 10-4 M

(c) i. SrF2 precipitates first since at [Sr2+] > 2.0 x 10-6 M this will precipitate.
  ii. SrF2 starts to precipitate when [Sr2+] > 2.0 x 10-6 M

 (d)  When the SrSO4 starts to precipitate only 50% of the original concentration of F- remains.



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