VII) Quantitative Solubility

A saturated solution is at equilibrium because the rate of dissolving equals the rate of precipitation

Example: $BaSO_{4(s)} \Leftrightarrow Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)}$

Since equilibrium exists, we can work with an equilibrium constant (K_{eq}). The equilibrium constant for a saturated solution is called a K_{sp}.

Write the K_{sp} equation for $BaSO_4$: $K_{sp} = [Ba^{2+}][SO_4^{2-}]$

$BaSO_4$ is a solid (not included)

The 'sp' from K_{sp} stands for solubility product.

The word 'product' is mathematical. A product is the result of a multiplication.

K_{sp} equations only contain multiplication (no division) because since the solid is always written on the left of the saturated solution equation, there will never be a denominator for the K_{sp} equation.

$BaSO_{4(s)} \Leftrightarrow Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)}$

Solid on left; not Included in K_{sp} equation

Write the saturated solution equations (solid on left) and the respective K_{sp} equations for $Ca(OH)_2$ and Ag_3PO_4.

① $Ca(OH)_{2(s)} \rightleftharpoons Ca^{2+}_{(aq)} + 2OH^-_{(aq)}$ $K_{sp} = [Ca^{2+}][OH^-]^2$

② $Ag_3PO_{4(s)} \rightleftharpoons 3Ag^+_{(aq)} + PO_4^{3-}{}_{(aq)}$ $K_{sp} = [Ag^+]^3[PO_4^{3-}]$

Do **soluble** salts have large or small K_{sp} constants? Why? What about **low solubility** salts?

Soluble salts have large ion concentrations, and since Ksp is multiplying [ions], soluble salts have a LARGE Ksp value.

Low solubility salts have very low ion concentrations, therefore have a very small Ksp value.

Notice that the K_{sp} table in the data booklet (p.5) only lists K_{sp} constants for **low solubility** salts. Notice they are all small values (much less than 1), as they should be.