

## CONCEPT: SOLUBILITY PRODUCT CONSTANT: $K_{sp}$

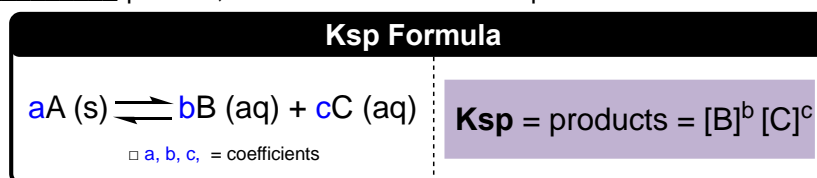
- **Solubility Product Constant ( $K_{sp}$ )** measures \_\_\_\_\_ of solid ionic compounds in a solvent at equilibrium.
  - *Solubility* is the maximum amount of solid \_\_\_\_\_ in a solvent, usually represented as M (molar solubility).
- Magnitude of  $K_{sp}$  value determines \_\_\_\_\_ of solubility
  - \_\_\_\_  $K_{sp}$ : \_\_\_\_\_ soluble the solid;      \_\_\_\_  $K_{sp}$ : \_\_\_\_\_ soluble the solid
  - This comparison can only be used between compounds that break up into the \_\_\_\_\_ number of ions.

**EXAMPLE:** Given the following ionic compounds, which will have the highest  $[\text{OH}^-]$  concentration? Hint: which is most soluble in water?

- a)  $\text{Fe}(\text{OH})_2$   $K_{sp} = 4.87 \times 10^{-17}$       b)  $\text{Pb}(\text{OH})_2$   $K_{sp} = 1.43 \times 10^{-20}$   
c)  $\text{Mg}(\text{OH})_2$   $K_{sp} = 2.06 \times 10^{-13}$       d)  $\text{Sn}(\text{OH})_2$   $K_{sp} = 5.45 \times 10^{-27}$

## $K_{sp}$ Calculations

- Solubility is an \_\_\_\_\_ process; hence calculations will require an ICE chart.



**EXAMPLE:**  $\text{PbF}_2$  is a white solid and has diverse applications in pharmaceuticals, metallurgy, and technology. If the concentration of lead (II) fluoride is 4.2 M with a  $K_{sp} = 3.6 \times 10^{-8}$ , calculate the molar solubility of this solid at 25°C.

ICE Chart ( $K_{sp}$ )				
	$\text{PbF}_2(s)$	$\rightleftharpoons$	$\text{Pb}^{+2}(aq)$	$+ \quad 2 \text{F}^-(aq)$
I	_____			
C	_____			
E	_____			

**STEP 1:** Set up an ICE Chart with solid as the only reactant; cross out the \_\_\_\_\_ side.

**STEP 2:** Using **INITIAL ROW**, set products equal to zero.

**STEP 3:** We lose reactants to make products.

- Using the **CHANGE ROW**, place a \_\_\_\_\_ for the products

**STEP 4:** Using the **EQUILIBRIUM ROW**, set up the equilibrium constant expression with \_\_\_\_\_ and solve for \_\_\_\_\_.

- variable \_\_\_\_\_ in the ICE chart represents molar \_\_\_\_\_ of a solid

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**PRACTICE:** Solubility of  $\text{Sn}(\text{OH})_2$  was found to be  $1.11 \times 10^{-9} \text{ M}$ ; calculate  $K_{sp}$  of this compound.

**PRACTICE:** If a saturated solution of  $\text{Ag}_2\text{CO}_3$  contains  $2.56 \times 10^{-4} \text{ M}$  of  $\text{Ag}^+$  ions, determine its solubility product constant.

**PRACTICE:** What is the solubility of  $\text{CN}^-$  ions in a solution of  $5.5 \text{ M Hg}_2(\text{CN})_2$ , with a  $K_{sp}$  of  $5.0 \times 10^{-40}$ ?