

## Qualitative Chemistry

### **Solubility:**

$$S = \frac{\text{Moles of Solute}}{\text{Volume of Solvent}} \quad ; \text{Unit: mole/L or M}$$

$$S = \frac{100 \times \text{Mass of solute in grams}}{\text{Mass of solvent in gram}}$$

### **Effect of Pressure in Solubility (Henry's Law):**

If applied pressure in a Gaseous Solute solution is  $P$

$$S \propto P$$

$$S = K_H \times P$$

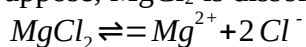
$\frac{S_1}{P_1} = \frac{S_2}{P_2} = \frac{S_3}{P_3} = \dots\dots\dots$
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$K_H$  = Henry's Proportional Constant  
=  $S/P$

Unit of  $K_H$  in SI standard is:  $\text{M atm}^{-1}$

### **Solubility Product ( $K_{sp}$ and $K_{ip}$ ):**

Suppose,  $\text{MgCl}_2$  is dissolved in water. Hence the ionic equation as follow-



$$K_{sp} = [\text{Mg}^{2+}] + [\text{Cl}^-]^2$$

**\*\*Note:** In IUPAC standard the Solubility of a solution with a specific solute and solvent is measured in mole/Liter which essentially means the Molarity of the solution. So  $K_{sp}$  is the Ionic Product of the product ion. For example: in the example above shows how to find  $K_{sp}$  of a Solution. Which needs the molarity of  $\text{Mg}^{2+}$  and  $\text{Cl}^-$ . But because solubility is the molarity of the solution so we can say  $[\text{Mg}^{2+}] = [\text{Cl}^-] = \text{Solubility or } S$

$K_{sp}$  in the above reaction is,  $K_{sp} = S \times S^2 = S^3$

**\*\*In order to use this equation the given Solubility must be converted to mole/L or M. For example if the Given solubility is :  $5 \times 10^{-4} \text{ g/L}$  we have to convert g/L to mole/L. In order to convert g/L to mole/L we have to divide the g/L by the Molar mass of solute**

**\*\*\*\*** The equation of  $K_{ip}$  and  $K_{sp}$  is the same . Difference between  $K_{ip}$  and  $K_{sp}$  is  $K_{sp}$  is the constant Ionic product for a solution in saturated state. It means we can identify  $K_{sp}$  only for saturated solutions. And its value is constant in a specific solution and at a specific Temperature. But  $K_{ip}$  is essentially the ionic product of solute .  $K_{ip}$  can be changed if the Concentration of the solution is changed . Also  $K_{ip}$  can be calculated at any solution (saturated , unsaturated or over-saturated).

### **Relation between $K_{sp}$ and $K_{ip}$ :**

if,  $K_{ip} = K_{sp}$  : The solution is saturated

if,  $K_{ip} > K_{sp}$  : The solution is over-saturated .

if,  $K_{ip} < K_{sp}$  : The solution is unsaturated .

