Qualitative Chemistry

Solubility:

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

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

Effect of Pressure in Solubility (Henry's Law):
If applied pressure in a Gaseous Solute solution is *P*

$$S \propto P$$
$$S = K_H \times P$$

$$\frac{S_1}{P_1} = \frac{S_2}{P_2} = \frac{S_3}{P_3} = \ldots\ldots\ldots\ldots$$

K_H = Henry's Proportional Constant
= S/P
Unit of K_H in SI standard is: M atm^{-1}

Solubility Product (K_{sp} and K_{ip}):
Suppose, $MgCl_2$ is dissolved in water. Hence the ionic equation as follow-

$$MgCl_2 \rightleftharpoons Mg^{2+} + 2\,Cl^-$$
$$K_{sp} = [Mg^{2+}] + [Cl^-]^2$$

***Note: In IUPAC standard the Solubility of a solution with a specific solute and solvent is measured I 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 Ksp of a Solution. Which needs the molarity of Mg^{2+} and Cl^- . But because solubility is the molarity of the solution so we can say $[Mg^{2+}] = [Cl^-]$ = 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 : $5x10^{-4}$ g/L we have to covert 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 it's 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 .