1. **Solubility of Liquids In Liquids**

Water is known as a universal solvent as it dissolves almost every solute except for a few. Certain factors can influence the solubility of a substance.

Solubility is the new bond formation between the solute molecules and solvent molecules. In terms of quantity, solubility is the maximum concentration of solute that dissolves in a known concentration of solvent at a given temperature. Based on the concentration of solute dissolves in a solvent, solutes are categorized into highly soluble, sparingly soluble or insoluble. If a concentration of 0.1 g or more of a solute can be dissolved in a 100ml solvent, it is said to be soluble. While a concentration below 0.1 g is dissolved in the solvent it is said to be sparingly soluble. Thus, it is said that solubility is a quantitative expression and expressed by the unit gram/ liter (g/L).

Based on solubility, different types of solution can be obtained. A saturated solution is a solution where a given amount of solute is completely soluble in a solvent at a given temperature. On the other hand, a supersaturated solution is those where solute starts salting out or precipitate after a particular concentration is dissolved at the same temperature.

**Factors Affecting Solubility:**

The solubility of a substance depends on the physical and chemical properties of that substance. In addition to this, there are a few conditions which can manipulate it. Temperature, pressure and the type of bond and forces between the particles are few among them.

* Temperature:

By changing the temperature we can increase the soluble property of a solute. Generally, water dissolves solutes at 20° C or 100° C. Sparingly soluble solid or liquid substances can be dissolved completely by increasing the temperature. But in the case of gaseous substance, temperature inversely influences solubility i.e. as the temperature increases gases expand and escapes from their solvent.

* Forces and Bonds:

Like dissolves in like. The type of intermolecular forces and bonds vary among each molecule. The chances of solubility between two unlike substances are more challengeable than the like substances. For example, water is a polar solvent where a polar solute like ethanol is easily soluble.

* Pressure:

Gaseous substances are much influenced than solids and liquids by pressure. When the partial pressure of gas increases, the chance of its solubility is also increased. A soda bottle is an example of where CO2 is bottled under high pressure.

1. **Solubility of Solids In Liquids**

It has been observed that solid solubility depends on the nature of the solute as well as the solvent. We often see that substances like sugar, common salt (NaCl), etc readily dissolve in water while substances like naphthalene do not dissolve in water. From the various observations and experimental results, it has been seen that only polar solutes tend to dissolve in the polar solvent and non-polar solvents dissolve only non-polar solutes. Hence, the nature of the solvent can be seen as one of the prominent factors affecting solubility. The above observation led to the statement that like dissolves like, that is polar solvents will dissolve polar solutes and non-polar solvents dissolve non-polar solutes.

Now let us understand the process by which a solid dissolves in a solvent. Once a solid solute is added to a solvent, the solute particles dissolve in the solvent and this process is known as dissolution. Solute particles in the solution collide with each other and some of these particles get separated out of the solution, this process is called crystallization.

A state of dynamic equilibrium is established between these two processes and at this point, the number of solute molecules entering the solution becomes equal to the number of particles leaving the solution. As a result, the concentration of the solute in the solution will remain constant at a given temperature and pressure.

A solution in which no more solute can dissolve in the solvent at a given temperature and pressure is said to be a saturated solution as the solution contains the maximum amount of solute. The concentration of solute in such a solution is called its solubility at that temperature and pressure.  If more solute can be added to a solution then it is called an unsaturated solution.

**Factors Affecting Solubility:**

* Effect of Temperature:

Apart from the nature of solute and solvent, temperature also affects solid solubility considerably. If the dissolution process is endothermic then the solubility should increase with an increase in temperature in accordance with Le Chateliers Principle. If the dissolution process is exothermic the solid solubility should decrease.

* Effect of Pressure:

Solid solubility hardly gets affected by changes in pressure. This is due to the fact that solids and liquids are highly incompressible and practically do not get affected by changes in pressure.

1. **Solubility of Gases In Liquids**

Gas solubility in liquids deals with the concept of gas dissolving in a solvent. Let us first define solubility. For any substance, solubility is the maximum amount of solute that can be dissolved in a given solvent at a particular temperature. Now our concern is gas solubility in liquids. The gas solubility in liquids is greatly affected by temperature and pressure as well as the nature of the solute and the solvent.

There are many gases that readily dissolve in water, while there are gases that do not dissolve in water under normal conditions. Oxygen is only sparingly soluble in water while HCl or ammonia readily dissolves in water.

**Factors Affecting Solubility:**

* Effect of Pressure:

It has been found that the gas solubility in liquids increases with increase in pressure. To have a better understanding of the effect of pressure on gas solubility let us consider a system of a gas solution in a solvent in a closed container in a state of dynamic equilibrium. Now the solution is in equilibrium and hence the rate of gaseous molecules entering the solution is equal to the rate of gaseous molecules leaving the solution.

Now suppose we increase the pressure of the system by compressing the gas molecules present in the solution. As a result of an increase in pressure, the gases molecules will now be concentrated in a smaller volume. This will result in an increase in the number of gas molecules per unit volume available above the solution. Since the number of gas molecules presents above the solution has increased, the rate with which the gas molecules will be entering the solution will also increase. The end result is an increase in the number of gas molecules in the solution until a new equilibrium point is attained. Thus the solubility of gases increases with an increase in the pressure of a gas above the solution.

* Solubility of gases in liquids –

Henry’s Law gives a quantitative relation between pressure and gas solubility in a liquid. It states that:

The solubility of a gas in a liquid is directly proportional to the partial pressure of the gas present above the surface of liquid or solution.

The most general way of using Henry’s Law is that the partial pressure of a gas above a solution is proportional to the mole fraction of the gas in the solution.

P = KHx

Where, p = partial pressure of the gas

x = mole fraction of the gas in solution

KH = Henry’s law constant

kH is given as

kH=partial pressure of gas in atm / concentration in liquid (molL–1)

* Effect of Temperature:

Gas solubility in liquids is found to decrease with increase in temperature. The gas molecules in a liquid are dissolved by the process of dissolution. During this process, heat is evolved. According to Le Chatelier’s Principle which states that when the equilibrium of a system is disturbed, the system readjusts itself in such a way that the effect that has caused the change in equilibrium is countered. So, as we know that dissolution is an exothermic process, the solubility should decrease with an increase in temperature to validate Le Chatelier’s Principle.