SOLUTIONS

1. Solution Concentration

If you take a glass of water add sugar and stir it, you will see how the sugar disappears, becoming a clear solution. You have made a solution, where the sugar, the **solute**, has dissolved in the water, the **solvent.** Obviously, the sugar is there even if we don't see it. And if you were to taste the water, you will notice a particular 'sweet' flavor. Therefore, the mass of the solution will be the mass of the solute plus the mass of the solvent.

Mass of the solution = mass of solute + mass of solvent

There are different types of solvents; water being the most common. When we talk of aqueous solutions that means, by definition, that the solvent used is water (*aqua* in Latin means water).

Solutions can be **diluted** or **concentrated** depending on the amounts of solute and solvent that make up a particular solution. However, saying that a solution is diluted or concentrated does not tell us much about the actual amounts (quantitative aspect) of solute and solvent.
The **concentration** of a solution is the relationship between the amount of solute and the amount of solvent. It is a measure of the quantity of solute in a given quantity of solvent or solution

There are several methods of expressing concentration. We are going to study four different ways to express the concentration of a solution: **mass percent, concentration by weight, Molarity and molality.**

Mass Percent (also called percent by weight)

$$\text{mass \%} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100$$

Concentration by Weight (also referred to as mass concentration)

$$\text{Concentration by weight} = \frac{\text{mass of solute (in g)}}{\text{volume of solution (in L)}}$$

Molarity

Molarity, represented with a capital **M**, is the number of moles of solute per solution volume (in L).

$$M = \frac{\text{moles}}{\text{Liters of solution}}$$

Molality

Molality, represented with a lower case **m**, is the number of moles of solute per kg of solvent.

$$m = \frac{\text{moles}}{\text{Kilogram of solvent}}$$

2. Solubility

If we keep adding sugar to our mixture, eventually we will saturate the solution to the point that the sugar will no longer dissolve in the water. At that point, we will start to see the solute settling at the bottom of the glass. We now have a **saturated solution.** At that particular temperature no more sugar can be dissolved in that amount of water. It has reached its maximum capacity of solubility. Each and every substance has a specific solubility at a given temperature.

> Therefore, **solubility** is the maximum amount of solute that will dissolve in a solvent at a given temperature.

Solubility can be measured in grams of solute per 100 g of solvent, at a given temperature. (g of solute/100g of water).

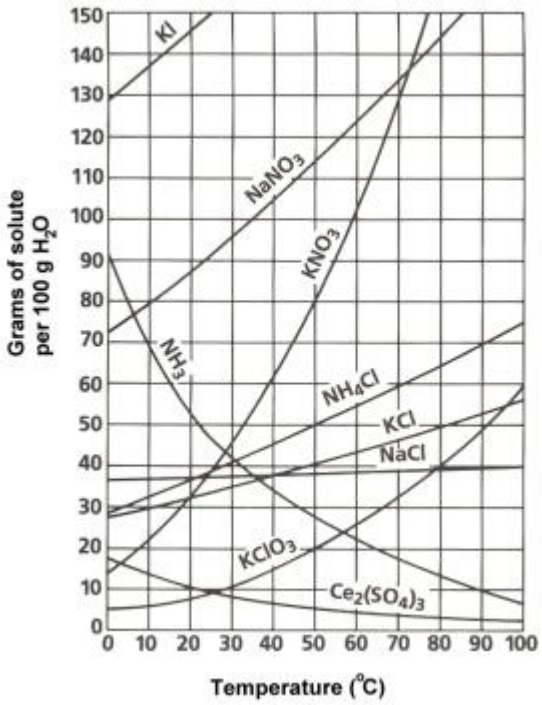
If we now take our saturated solution and heat it up, as we increase the temperature the sugar will begin to dissolve. So sugar is more soluble in hot water than in cold. In fact, this is usually the case with solids that dissolve. **If a solid is soluble in a liquid, usually its solubility increases as the temperature rises.**

2.1 Solubility Curves

There are charts and tables available that we can use to get an idea of how soluble a certain solute is in a certain solvent.

Solubility curves, like the one shown here, tell us what mass of solute will dissolve in 100g (or 100mL) of water over a range of temperatures.

You'll notice that for most substances, solubility increases as temperature increases. As discussed earlier in solutions involving liquids and solids typically more solute can be dissolved at higher temperatures. Can you find any exceptions on the chart?



Here's an example of reading the chart. Find the curve for $KClO_3$.

At 30°C approximately 10g of $KClO_3$ will dissolve in 100g of water. If the temperature is increased to 80°C, approximately 40g of the substance will dissolve in 100g (or 100mL) of water.

Here are some for you to try.

What mass of solute will dissolve in 100mL of water at the following temperatures? Also determine which of the three substances is most soluble in water at 15°C.

1. KNO_3at 70°C
2. NaCl at 100°C
3. NH_4Cl at 90°C