SOLUTIONS (K1)

Homogeneous mixtures formed by combining of any two substances are called solution. The less amount substance spreads homogeneously in the more amount substance also they form the solution. The less amount substance is called solute, and the more amount substance is called solvent.

We utilize the terms of concentrated or diluted to give an information about the ratios of the componennts. Concentrated solutions have high solute/solvent ratio, and diluted solutions have low solute/solvent ratio.

These terms are not enough to obtain the numerical result for understand the substances which are found in the solutions. For obtaining the numerical results, needed to utilize from the units of concentration. Weight percent, volume percent, weight percent in volume , molarity, molality, mole fraction, parts per million and parts per billion are most used concentration units.

A. WEIGHT PERCENT ($^{w/w}$%)

The expression of concentration in terms of the masses to specify the ratio of solute and solvent. It is obtained with the dividing of the solute mass to summation of the solute and solvent masses and multiplication of total ratio with 100. It is specified with **($^{w/w}$%),** and it is used frequently in solid-solid and solid-liquid solutions. For example, if the 5 gr of NaCl dissolves in the 50 gr of water the following solution is obtained;

$$(m_{solute}/(m_{solute}+m_{solvent}))x100={}^{w/w}\%$$

$$(5/(5+50))x100=9{,}09 \text{ also}$$

$$^{w/w}\% \; 9{,}09 \text{ NaCl solution}$$

B. VOLUME PERCENT ($^{V/V}$ %)

The expression of concentration in terms of the volumes to specify the ratio of solute and solvent. It is obtained with the dividing of the solute volume to summation of the solute and solvent and volumes multiplication of total ratio with 100. It is specified with **($^{V/V}$ %)**, and it is used generally in liquid-liquid solutions. For example, if the 20 ml of ethanol dissolves in the 90 ml of water the following solution is obtained;

$$(V_{solute}/(V_{solute}+V_{solvent}))x100={}^{V/V}\%$$

$$(20/(20+90))x100=18{,}2 \text{ also}$$

$$^{w/w}\% \; 18{,}2 \text{ Ethanol-Water solution}$$

C. WEIGHT PERCENT in VOLUME ($^{w/v}\%$)

It is obtained with the dividing of mass of solute to volume of solvent and multiplication of them with 100. Solid volume is neglected. It is specified with **($^{w/v}\%$)**. It is used frequently in solid-liquid solutions. For example, if the 12 gr of NaOH dissolves in 108 ml of water the following solution is obtained;

$$(m_{solute}/V_{solvent})x100={}^{w/v}\%$$

$$(12/108)x100=11,1 \text{ also}$$

$$^{w/v}\%\ 11,1 \text{ ethanol-water solution}$$

D. MOLARITY (M)

It is obtained with dissolving of the solute of 1 mole gr (M_A, n) in 1 L of solvent. It is specified with mole/L (M). For example, the molarity of the solution which is prepared by melting of 5,84 gram of NaCl in few amount of water and completing of it till the 250 ml.

Molarity (M) (mole/L) = Mole number of solute (n)/ Total volume of solution in terms of the liter (L)

$$M_A, \text{NaCl} = 58,45 \text{ g } n_{NaCl}=5,84/58,45 = 0,1 \text{ mole } V_{water} =250/1000=0,25 \text{ L}$$

$$M=n/V=0,1/0,25 = 0,4 \text{ M}$$

The another concentration units are called milimolar (mM) or micromolar (µM) which are included to molarity. If the mass of solute which is dissolved in 1l of solution equals to the milimole it is called milimolar, if it equals to micromole it is called micromolar solutions.

E. MOLALITY (M)

The mole number of dissolved solute in 1 kg of solvent, and it is specified with “m”. ıf the 1 mole of the solute dissolves in 2 kg of solvent, the solution will be 0,5 molal.

Molal (m) (mole/kg) = mole number of solute (n) / Total mass of solvent in terms of the kg (L)

F. MOLE FRACTION (X)

The ratio of the solute to sum of the solute and solvent and it is specified with X. For example, dissolving of 11,68 of NaCl in few amount of water and completing of it till the 180 ml.

$$MA,\ NaCl = 58{,}45\ g \qquad nNaCl = 11{,}68/58{,}45 = 0{,}2\ mole$$

$$MA,\ water = 18{,}02\ g \qquad nwater = 180/18{,}02 = 10\ mole$$

$$XNaCl = 0{,}2/(0{,}2+10) = 0{,}019$$

G. PARTS PER MILLION (PPM)

It is unit which is used for the few amount of solutes in much amount of solvents. 1 kg consists of the 1000000 mg. It means that 1 mg is one of the million of kg. If we will review this description, when the 1 mg of the solute dissolved in 1 kg of solvent (1 L for water), the obtained solution has 1 ppm value.

H. PARTS PER BILLION (PPB)

It is one of the ppm in one thousand. 1 ppm equals to the 1000 ppb. On the another hand, if the 1 µg of the solute dissolves in 1 kg of solvent (1 L for water), 1 ppb solutions is obtained. Every type of the solution can be prepared utilizing from these concentration units. While preparing the solutions, main stocks should be formed certainly. Main stocks mean that having most concentration value. The solutions that will prepared should be prepared by dilution processes from main stock. Preparing of the diluted solutions using with the main stock the following equation is used;

$$C1 \times V1 = C2 \times V2$$

C1 is concentration of main stock, C2 is concentration of desired diluted solution, V2 is final volume of diluted solution, V1 express the amount of volume to needed for preparation of diluted solution in C2 concentration. For example, for preparing of the 1 L 0,02 M solution of KCl solution and using with a 0,24 M main stock concentration;

$$C1 \times V1 = C2 \times V2$$

$$0{,}24 \times V1 = 0{,}02 \times 1$$

$$V1 = 0{,}083\ L$$

If the main stock is taken in 83 ml, and concentration is 0,24, and the taken this main stock is diluted to the 1 L, then KCl solution is obtained in 0,02 M.

Some chemical substances can be obtained in certain percent solutions. For these, HCl which is the best example can be given. HCl is in gas state in room conditions and they are sold in $^{w/w}$%32 - $^{w/w}$%37 solutions. While working with like HCl solution, the density of the solution should be known. Thus, the mass and mole number of HCl in certain volume can be calculated. For example, if we want to prepare HCl solution which has a density of 1,08 g/ml in %32 percent,1 Molar and 250 ml;

1. The mol number of HCl is calculated which is needed for 1 M 250 ml

   M=n/V and n=M.V n=1 x 0,25 x 36,5 = 0,25 mol HCl is needed.

2. The gram value of found HCl is determined

   N = m/MA   m=nxMA   m=0,25 x 36,5 = 9,125 g HCl is needed.

3. It is determined how many ml of 32% HCl solution is in the required volume of HCl

   d=1,08 g/ml and the solution is in %32 percentage, it means that the %32 percentage of mass consists of the HCl.
   In 1 ml solution, 1,08 x 0,32 = 0,346 g HCl is found.

4. If the 1 ml contains 0,346 g of HCl, 9,125 g of HCl is obtained from how many liter of solution

   9,125 / 0,346 = 26,38 ml

   If the solution is diluted from 26,38 ml volume, 1,08 g/ml density 32% to 250 ml, 1 M 250 ml HCl solution is obtained.