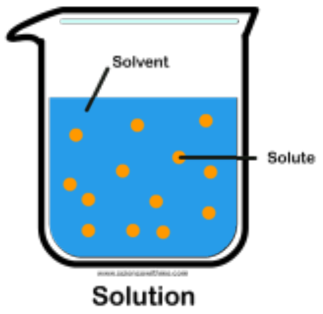
Preparation of Solutions

Solutions:

- Understanding how to prepare solutions and make dilutions is an essential skill for biochemists which is necessary knowledge needed for doing any experiment.

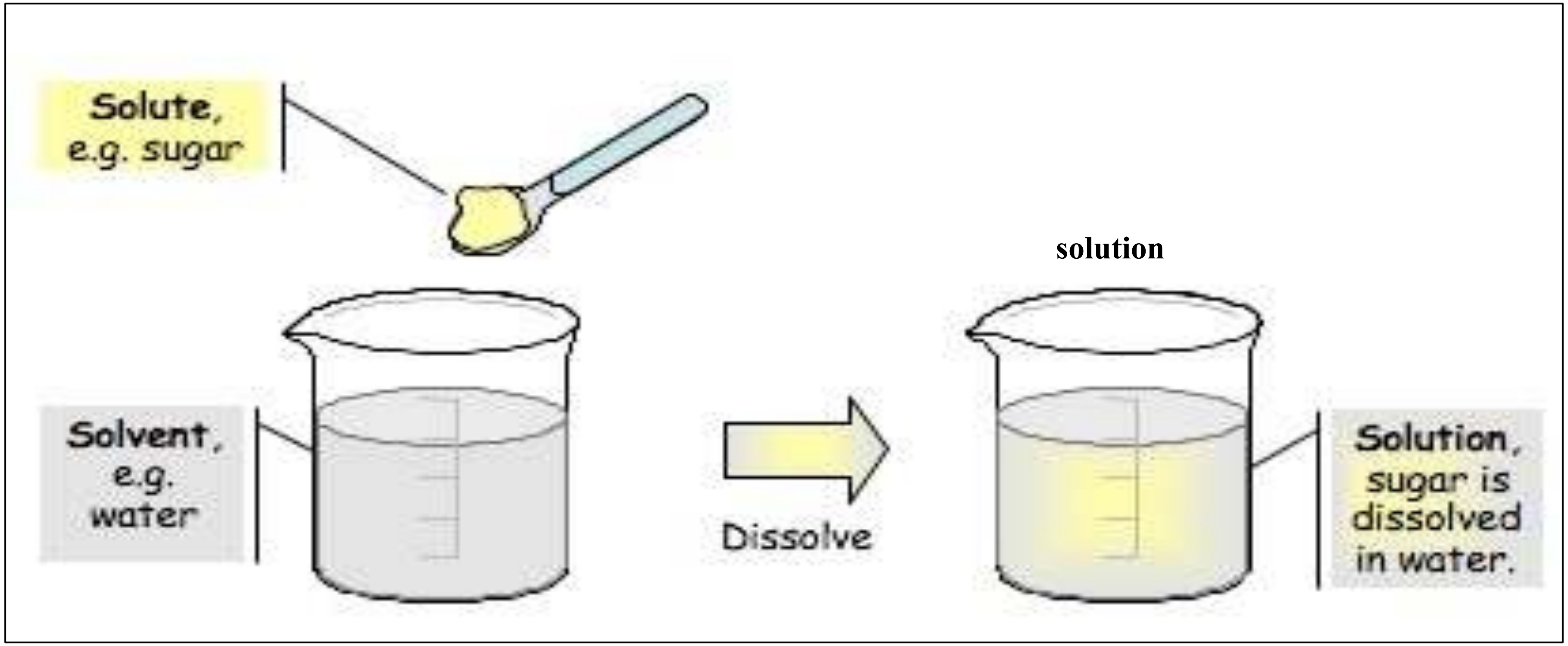
- **What is SOLUTIONS ?**

A simple solution is basically two substances that are evenly mixed together.



- One of them is called the **solute** and the other is the **solvent**.
- Solution can be composed from **one or more** solute dissolved in a solvent forming a homogenous mixture.

Solutions



Solute ➔ is the substance to be dissolved (sugar)

Solvent ➔ is the one doing the dissolving (water)

Preparation of solutions:

- **Solution concentration define as:** quantity of a substance dissolved in per unit quantity of another substance (the relative amounts of solute and solvent in a solution).

- **There are different ways to express concentration:**

  a. Molarity

  b. W/V %

  c. W/W %

1. Molarity:

- **Molarity define as:** the number of moles of solute in one liter of a solution.
- Molar= number of mole/volume in L

$$\textbf{Molarity} = \frac{\text{moles of solute (mole)}}{\text{volume of solution in (L)}}$$

Remember that:

$$\textbf{Mole} = \frac{\text{weight (g)}}{\text{molecular weight (g/mole)}}$$

Mole= Wt / M.W

$$\textbf{Molarity} = \frac{\text{weight (g)}}{\text{volume (L) x M.W}}$$

- **1 Molar** solution is a solution in which **1 mole** of solute is dissolved in a total volume of **1 liter (1000ml).** *(0.5 Molar (M) solution: that mean there are 0.5 mole dissolved in 1L ..etc)*
- Units of molarity are : M, molar or mole/L

Note: The MW of NaCl is 58.44 =(35.5+23)

a. Example

How to Prepare 2M of NaCl in 100 ml?

How many grams of NaCl I need to prepare 2 Molar of 100 ml NaCl solution?

- You are given:

Concentration= 2M, **solution volume**= 100ml, **M.W of NaCl** is 58.44 =(35.45+22.99)

- You can solve this problem in two ways:

2 mole of NaCl present in 1000 ml [or 1Liter] of solvent (dis.H_2O)

And we know that → No of mole = weight (g) / molecular weight.

[2 mole= **weight (g)** / 58.5] → **weight (g) =** 2 x 58.5 = 117 g.

➔ This weight needed if 1000 ml is required to be prepared. Since we need to prepare only 100 ml.

117 g ====> 1000 ml.
? g ====> 100 ml.
→ [(100 x 117)/1000] = **11.7 g**

11.7 g of NaCl dissolved in small volume of dis.H_2O, then complete the volume up to 100 ml.

Molarity= 2M

Solution volume= 100 ml ➔ convert to L = 100/1000 = 0.1L

Molecular weight (M.W)= 58.5 g/mole

Weight= ?

$$\boxed{\text{Molarity} = \frac{\text{weight (g)}}{\text{volume (L)} \times \text{M.W}}}$$

So:

Weight = Molarity x volume in L x M.W

Weight = 2 x 0.1 x 58.5 = 11.7g

11.7 g of NaCl dissolved in small volume of dis.H_2O, then complete the volume up to 100 ml.

Practically how to prepare 2M NaCl:

1. Place a beaker in a balance and zero the balance.
2. Weight 11.7 grams of NaCl, in the beaker and dissolve it in a little water (less than 100 ml).
3. Once the solid is dissolved the volume is transferred to 100 ml volumetric flask.
4. Brought up to a final volume 100 ml by water.

2. W/V % :

- W/V% ➔ Weight/Volume Percentage Concentration.
- **W/V% define as :** The number of grams of solute dissolved in **100 mL** of solution

(% = 100).

$$\boxed{W/V\% = \frac{\text{weight of solute in (g)}}{\text{volume of solution in (ml)}} \text{ X } 100}$$

- **For example:** 3 w/v% NaOH ➔Mean 3 grams of NaOH is dissolved in 100 ml of the solution.

b. Example

How to Prepare 50 ml of 4 w/v% NaOH?

How many grams of NaOH I need to prepare 50ml of 4%NaOH solution?

4% NaOH → Mean 4 grams of NaOH is dissolved in 100 ml of the solution.

SO →

4g ------> 100 ml

? --------> 50 ml

The Weight in grams of NaOH needed to prepare 4% NaOH is = (4 x 50)/100 = 2 g.

So,
2 grams of NaOH is dissolved in little water and the volume made up to 50 ml.

3. W/W %:

- W/W% → Weight/Weight Percentage Concentration.
- **W/W% define as:** the number of grams of solute dissolved in **100 gram** of solution. (% = 100).

$$\boxed{W/W\% = \frac{\text{weight of solute in (g)}}{\text{weight of solution in (g)}} \text{ X } 100}$$

- The concentrations of many commercial acids are giving in terms of w/w%.

→In order to calculate the volume of the stock solution required for a given preparation the **density (specific gravity)** of stock solution should be provided.

$$\boxed{\textbf{Weight (wt) = volume (ml) x SG x w/w\% (as decimal)}}$$

- → To calculate w/w% as decimal = (w/w)/100 , For example: w/w%= 13% → 13 / 100 = **0.13**

c. Example: How to Prepare 100ml with 0.4 M HCl solutions starting with the concentrated HCl solution you are provided with: (w/w% = 36% , S.G= 1.15)?

How many ml of concentrated HCl we need to make 0.4M of 100 ml HCl solution?

Weight= volume (ml) x SG x w/w% (as decimal) ➔

Important Note! : the volume in this formula is not the required volume in the question, it is the volume of the concentrated HCl that you must add to make the solution.

1. First we must calculate the weight by the following:

from molarity formula ➔ Mole=Molarity x volume in liter

= 0.4 x 0.1= **0.04 mole**

➔ Weight= mole x MW (Note: The MW of HCl = 36.4)

=0.04 x 36.5= 1.46 g

2. Second:

Weight (wt) = volume (ml) x SG x w/w% (as decimal) ➔ 1.46=volume x 1.15 x 0.36

➔ Volume= 3.53 ml

So, 3.53 ml of stock (i.e. concentrated HCl) solution is needed and the volume made up to 100 ml by the addition of water.

Practical Part

Objectives:

- To learn how to prepare solutions with different concentration expression

Method:

Preparation of solutions:

You are provided with solid NaOH, Prepare 50ml with 0.08M NaOH solution.

- <u>Calculation:</u>

………

………

- To prepare the 0.08M NaOH solution ……………..g of solid NaOH should be dissolved in a little volume of water then the volume made up to …………..ml ,by the addition of water.

Method:

You are provided with solid NaCl, Prepare 50ml with 1.5 w/v% solution of NaCl.

- Calculation:

………

………

- To prepare the 1.5 w/v% solution …………g of NaCl should be dissolved in little water and the volume made up to ………ml by the addition of water.

Method:

Prepare 100ml with 0.4 M HCl solutions starting with the concentrated HCl solution you are provided with: (w/w%= 36 , S.Gr =1.15).

- Calculation:

……………………………………………………………………………………………………

……………………………………………………………………………………………………

a. To prepare the 100ml of 0.4M HCl solution ……….ml of stock (i.e. concentrated HCl) solution is needed and the volume made up to ……..ml by the addition of water.
b. Measure and record the pH value of the acid you prepared……………………
c. Calculate the pH of the acid (pH= - log [H+]) ……………………………………………
d. Determine your accuracy? …………………………..

Homework

1. **A student needed to prepare 1L of a 1M NaCl solution, which of the following methods is more accurate in preparing the solution? Why?**

a. Weighing 58.5g of solid NaCl carefully, dissolving it in 300ml of water, then adding 700ml of water.

b. Weighing 58.5g of solid NaCl carefully, dissolving it in a small volume of water then making the final volume up to 1L by adding water.

2. **How would you prepare 50ml of a 6% NaCl solution?**