STOCK SOLUTION AND DILUTION

Analytical Chemistry – BIO 206
First Semester
4th Week
22/12/2023

➢**Outlines:**

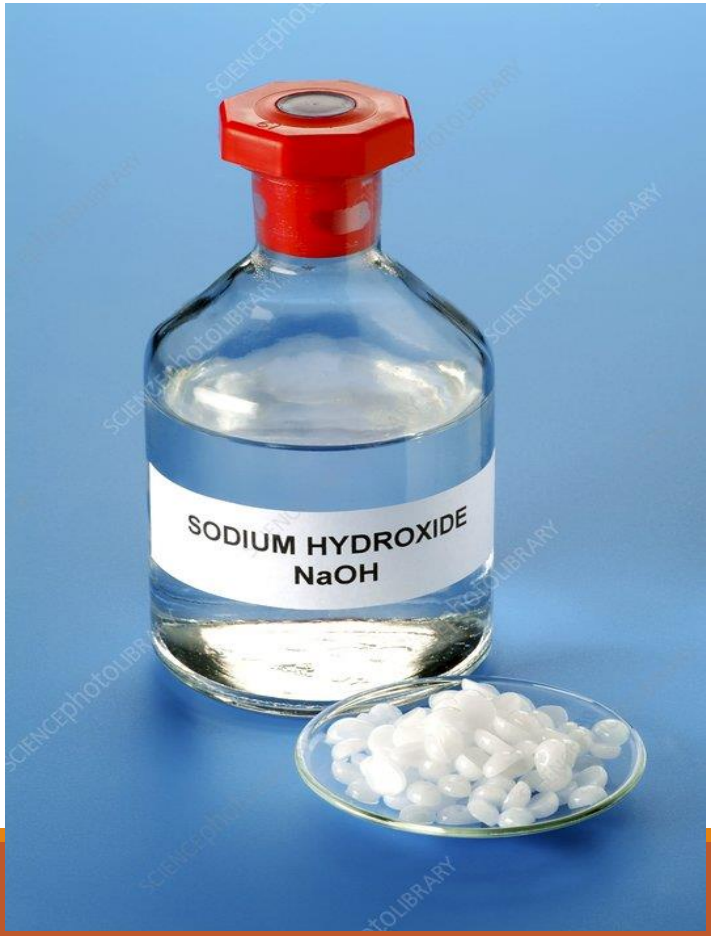
1. Standard solution.
2. Preparation of solution.
3. Preparation of solution by dilution.

Standard solution

- Solutions can be prepared in two ways:

1. Solids add to liquid.
2. Liquid adds to liquid.

➢ **<u>Stock solution:</u>** is a solution, which is usually concentrated and it is available for using in the laboratories.



➢ Preparation of stock solutions:

A ***stock solution*** is prepared by ***weighing*** out an appropriate portion of a ***pure solid*** or by measuring out an appropriate ***volume*** of a ***pure liquid*** and diluting to a known volume.

* There are many expressions for concentration:

➢ Molarity:

To prepare a ***stock solution*** for a ***solid*** sample the following equation can be used:

Wt. = M x L x molar mass (molecular weight)

Example: Prepare 100 ml of 2.0 M NaCl?

- First, we must calculate number of moles so we can calculate the weight in grams.
- Molarity = Number of moles / Volume in Liters
- Number of moles = Molarity x volume
- = 2 x 0.1 = 0.2 moles
- Now, we need to calculate grams of NaCl:
- Weight = mole x molecular weight
- = 0.2 x (23 + 35.5) = 11.7 grams
- We dissolve **11.7** grams of NaCl and make up the volume to **100** ml.

Practically:

1. Place a beaker in a balance and zero the balance.

2. Weight **11.7** grams of NaCl , in the beaker and dissolve in a very small volume of water ,once the solid is dissolved, the volume is transferred to **100** ml volumetric flask.

3. Wash the beaker **at least 2** times with small amount of distilled water and transfer it to the volumetric flask, to make sure all the solute is dissolved and there is no left overs.

4. Bring up to a final volume **100** ml.

Example: How many grams of NaCl would you need to prepare 200.0 mL of a 5.0 M solution?

Solution:

- First, we must calculate number of moles so we can calculate the weight in grams.
- Molarity = Number of moles / Volume in Liters
- Number of moles = Molarity x volume

  = 5.0 x 0.2 = 1.0 moles
- Now, we need to calculate grams of NaCl:

- Weight = mole x molecular weight of (NaCl)
- = 1 x 58.5 = 58.5 grams

- We dissolve **58.5** grams of NaCl and make up the volume to **200** mL.

Example: Describe how you would prepare the following solution:

- 500 mL of 0.20 M NaOH using solid NaOH.

Solution:

➢ w/v %:

It is the number of grams of solute dissolved in 100 mL of solution.

- For example, 3% of NaOH, means 3 grams of NaOH is dissolved in 100 ml of the solution.

- Example: Prepare 50 ml of 4% NaOH

4g ⟶ 100 ml

X ⟶ 50 ml

Weight = 2 g.

➢ To prepare the solution, 2 grams of NaOH is dissolved in little water and the volume made up to 50 ml

Example: Prepare 0.5 L of 5.0 % **(w/v)** KOH?

Solution:

5.0 g ⇨ 100 mL

X ⇨ 500 mL

Weight = 25 g.

- To prepare the solution, 25 grams of KOH is dissolved in little water and the volume made up to 500 mL

Example: Prepare 0.9 L of 20 % **(w/v)** KOH?

Solution:

Example: How can you prepare 250 ml of 35 % **(w/v)** KCl?

Solution:

➢ v/v %:

It is the number of mL of solute dissolved in 100 mL of solution.

- For example, 5% of isopropyl alcohol, means 5 mL of isopropyl alcohol in 100 ml of the solution.

- Example: Prepare 60 ml of 10%(v/v) NaOH

10mL → 100 ml

X → 60 ml

Weight = 6 mL.

➢ To prepare the solution, 6 mL of NaOH is added in little water and the volume made up to 60 ml.

Example: Prepare **2.0 L** of 4% **(v/v)** acetic acid using concentrated glacial acetic acid?

Solution:

4 mL → 100 mL

X → 2000 mL

Volume = 80 mL.

- To prepare the solution, 80 mL of acetic acid is added to little water and the volume made up to 2000 mL.

Example: Prepare **0.55 L** of 8.0% **(v/v)** acetic acid using concentrated glacial acetic acid?

Solution:

Preparation of Solutions by Dilution:

Solutions with ***small concentrations*** are often prepared by ***diluting*** a more ***concentrated*** stock solution. A known volume of the stock solution is transferred to a new container and brought to a new volume.

Or Dilution: is the process of decreasing the concentration of a solution, usually by adding more water (solvent).

- **Types of dilution:**

1. **Simple dilution:** is mixing a unit volume of liquid of interest with an appropriate volume of a liquid solvent to get a desired concentration. The diluted materials must mix

well in order to get the true dilution.

- **Dilution factor:** is the total number of unit volumes in which your materials will be dissolved.

For example, 1:5 dilution (expressed as “1 to 5”dilution) which it means mixing of 1 unit diluent (the material to be diluted) + 4 unit volume of the solvent (so, 1 + 4 = 5 dilution factor).

Example: what is dilution factor in 1:9 dilution?

2. Preparing dilutions by using the [C_1 X $V_1 = C_2$ X V_2] formula:

$$\text{Moles of solute}_{\text{before dilution}} = \text{moles of solute}_{\text{after dilution}}$$

$$n_{\text{before}} = n_{\text{after}}$$

$$\mathbf{C_1 * V_1 = C_2 * V_2}$$

Or

$$\mathbf{M_1 * V_1 = M_2 * V_2}$$

* Where:

V_1= Volume of starting solution needed to make the diluted solution.

C_1= Concentration of starting solution.

V_2= Final volume of diluted solution.

C_2= Final concentration of diluted solution.

Example: How to make 5.0 L of 1.50 M KCl solution from 12.0 M stock solution?

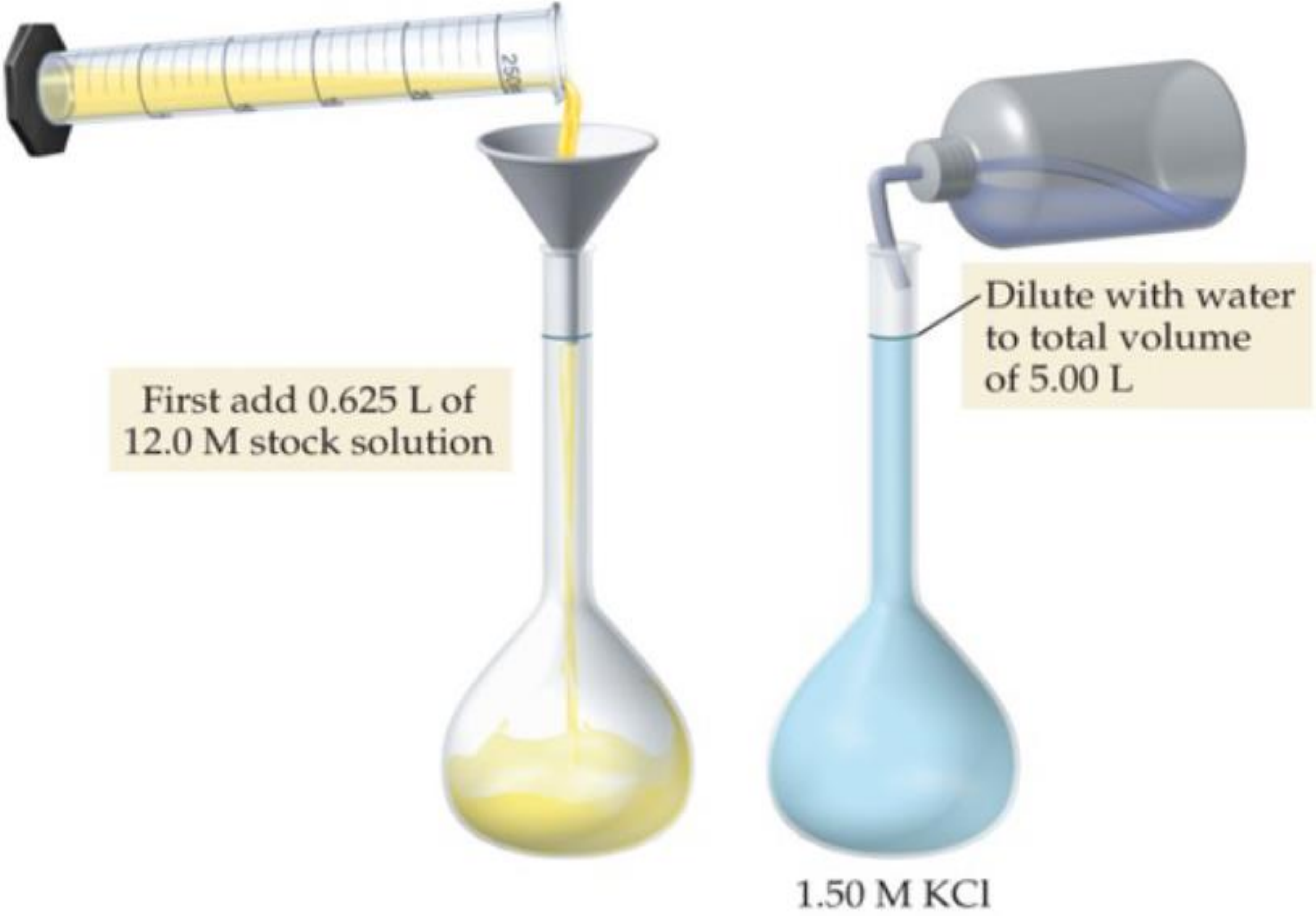
Solution:

$$C_1 \text{ x } V_1 = C_2 \text{ x } V_2$$

$$12.0 \text{ M x } V_1 = 1.50 \text{ M x } 5.0 \text{ L}$$

$$V_1 = 0.625 \text{ L}$$

- 0.625 L of the starting solution is taken and final volume made up to 5.0 L by the addition of water.


First add 0.625 L of
12.0 M stock solution
Dilute with water
to total volume
of 5.00 L
1.50 M KCl

Example: Prepare 50 ml of a $2.5x10^{-3}$M from prepared 0.4M HCl?

Solution:

$$C_1 \text{ x } V_1 = C_2 \text{ x } V_2$$

$$0.4 \text{ x } V_1 = 2.5x10^{-3} \text{ x } 50$$

$$V_1 = 0.337 \text{ mL}$$

- 0.337 ml of the starting solution is taken and final volume made up to 50 ml by the addition of water.

Example: How many milliliters of a 5.0 M stock solution of NaCl are needed to prepare 100 ml of a 0.4 M solution?

Solution:

$$C_1 \times V_1 = C_2 \times V_2$$

$$(5.0\ M) \times V_1\ (mL) = (0.4\ M) \times (100\ mL)$$

$$V_1 = 8\ ml$$

- 8.0 mL of the starting solution is taken and final volume made up to 100 mL by the addition of water.

Example: Determine the amount of (2.0 M) stock solution in order to prepare diluted solution of 0.04 M in 1.0 L?

Solution:

3. Serial Dilutions:

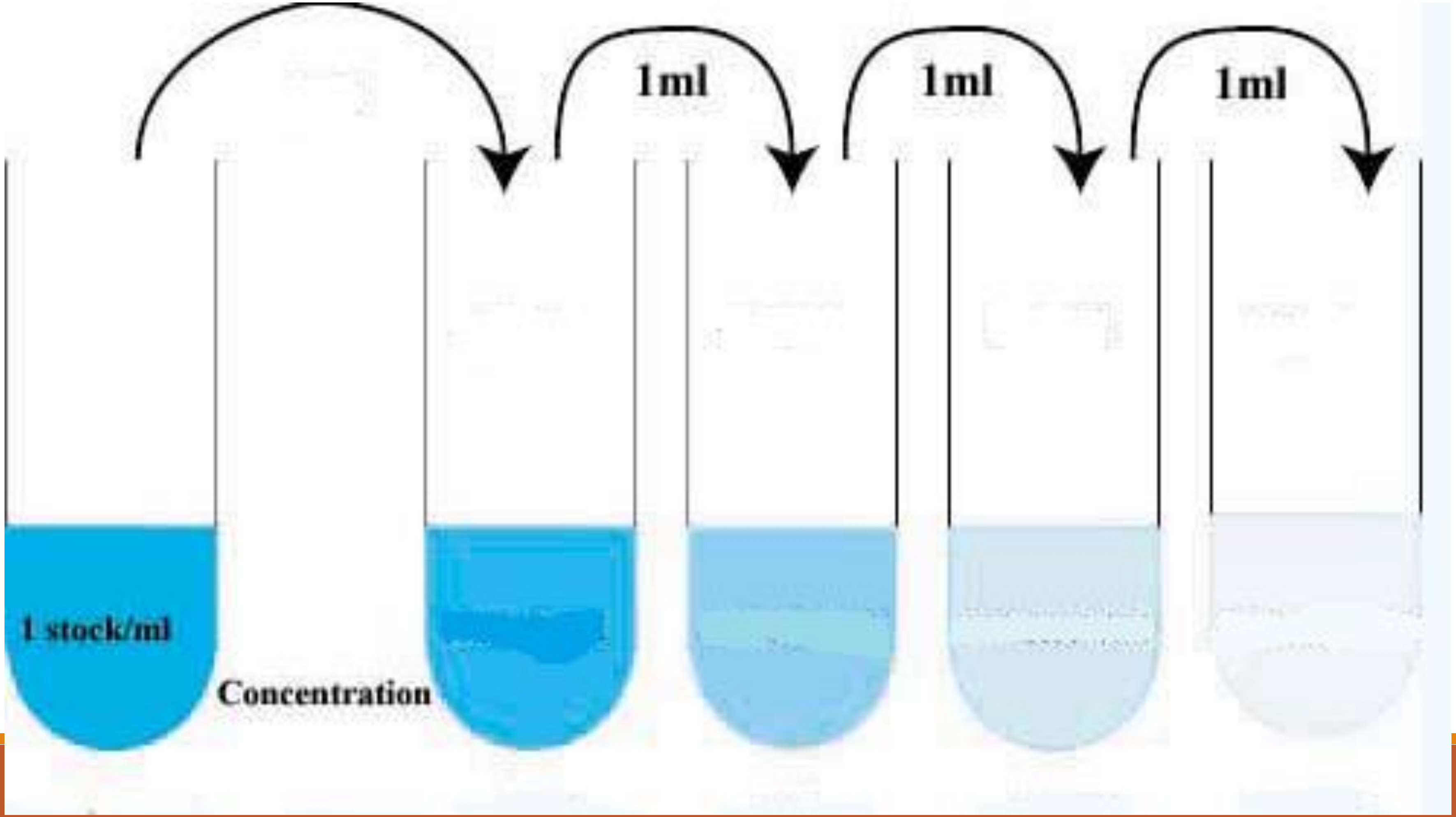
It is a step wise dilution of a solution, where the dilution factor is constant at each step. The source of dilution material for each step comes from the diluted material of the previous step.

- **Example:**

Starting with a 2.0 M stock solution of hydrochloric acid, prepare four standard solutions by serial dilution of the following Molarity respectively 1 M, 0.5 M, 0.25 M, 0.125 M.

Dilution factor (D.F) = 2/1 = 2 D.F. is (1:2)

To prepare standard solution 1; 1 ml of the stock 2.0M solution is needed and volume made up to 2 ml with distilled water (never forget to mix properly). To prepare standard solutions 2-4, 1 ml of the previously diluted solution is taken and volume is made up to a final volume of 2 ml by the addition of distilled water .



H.W.:

1. What is the mass of KCl needed to form 670 mL of 2.6 M solution?
2. How can you prepare 68 ml of 1.8 % **(w/v)** NaOH?
3. Prepare **0.560 L** of 1.5% **(v/v)** ethanol?
4. Water is added to 0.350 mL of 1.65 M cleaning solution, until the final volume reaches 1500 mL. what is the molar concentration of the final, diluted solution?

Reference:

1. Fundamentals of analytical chemistry by Skoog, 9th edition.
2. Modern analytical chemistry by David Harvey.
3. Vogel's textbook of quantitative analysis, 5th edition.