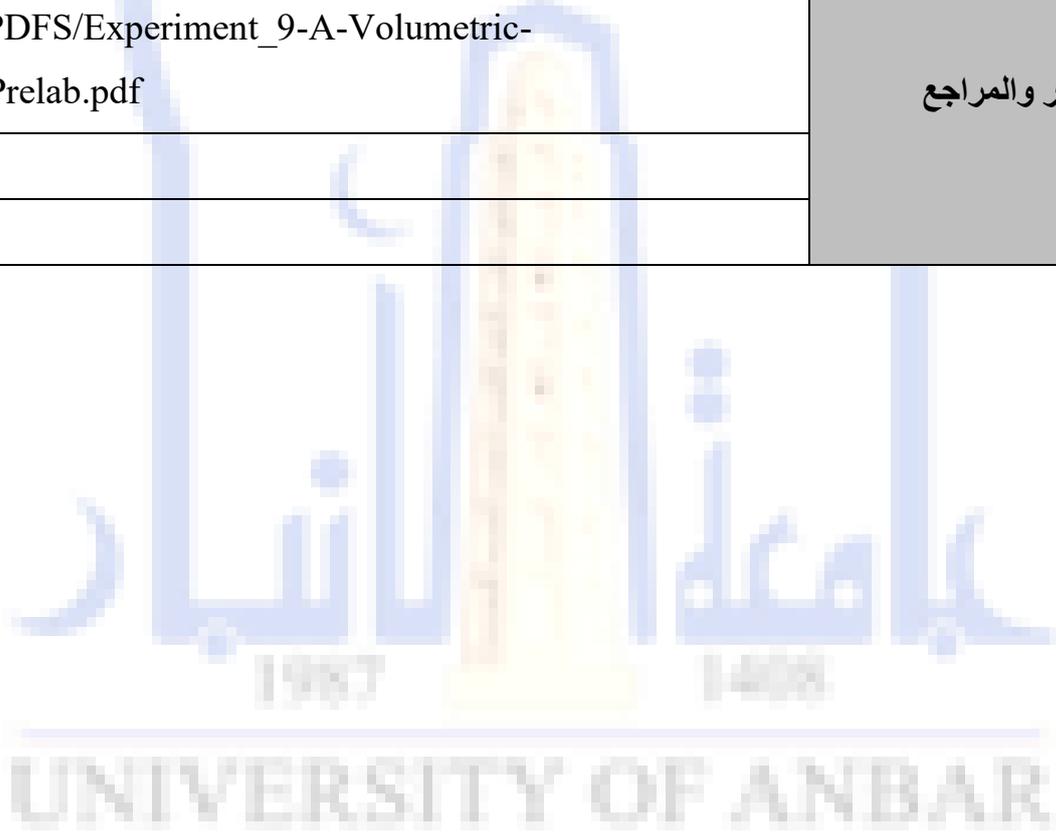


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م.م. محمد حاتم محمد عبدالرزاق	اسم التدريسي
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طرق تحضير المحاليل وحسابات المعايرة الحجمية	عنوان المحاضرة باللغة العربية
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## Methods of Preparation Solutions & Volumetric Titration Calculations

### Standard and standardized solutions

Standard solution is the solution of accurately known concentration, such as 0.1M Na<sub>2</sub>CO<sub>3</sub>, 0.1N Borax (Na<sub>2</sub>B<sub>4</sub>O<sub>7</sub>·10 H<sub>2</sub>O), 0.1M H<sub>2</sub>C<sub>2</sub>O<sub>4</sub> and to 0.1 N or 0.1 M NaCl solutions. These standard solutions are prepared from the primary standard materials by direct weighing. Standardized solution is a solution of approximate concentration which can be known exactly by standardization with standard solution such as preparation of approximately 0.1M or 0.1N HCl and calibrate it with standard solution of Na<sub>2</sub>CO<sub>3</sub>, or Borax. Standard solutions of Na<sub>2</sub>CO<sub>3</sub>, and Borax can be prepared from the pure Solid materials by weighing. When the standard solution is prepared and standardized, its properties become identical to the properties of standard solution.

### Characteristics of standard solution

1. Its concentration remains constant for months or years, or at least within the period of calibration.
2. It rapidly reacts with the analyte and the reaction is complete within the period of the experiment.
3. Its reaction with the analyte can be expressed as balanced equation in order to get the exact weight of the analyte.
4. A sudden change of the reaction should occur in order to identify the equivalence point of the reaction by suitable chemical indicator.

### Primary standard materials

It is a material or chemical of high purity and characterized by the following requirements,

1. Its purity should not less than 99.5%, otherwise a purification method should be available to confirm its purity.
2. It should be stable and not be hydrated or efflorescent.
3. It can be easily obtained and not expensive.
4. It is preferred to have high equivalent weight, for example; if we compare the equivalent weights of Na<sub>2</sub>CO<sub>3</sub> (53) and borax (191), we find that the equivalent weight of borax is four times larger than sodium carbonate. If we want to prepared 0.1N of both solutions, we should use: 1.325 g Na<sub>2</sub>CO<sub>3</sub> and 4.7759 borax.

If an error of 0.02 g is occurred in weighing, therefore the percentages of error equal;

$$\frac{0.02}{1.325} = 1.6\% \quad \text{and} \quad \frac{0.02}{4.7759} = 0.4\% \quad \text{respectively}$$

Therefore, the percentage of error with Na<sub>2</sub>CO<sub>3</sub> is four times than borax. As the weight is increased the percentage of error is decreased

5. The primary standard material is easily soluble in water or the applicable solvent. Examples: oxalic acid, sodium carbonate, borax, sodium chloride and zine sulphate hepta hydrate

## Methods of preparation of solutions

### From Solid materials.

The solid material may be primary standard material; therefore, the prepared solution is standard of the solid material is not primary standard, the prepared solution is not standard (has an approximate concentration).

Example - 1 Show by calculation how could you prepare 250 ml of 0.1N Na<sub>2</sub>CO<sub>3</sub> from the solid primary standard of Na<sub>2</sub>CO<sub>3</sub>,

The solution:

$$\text{Eq. wt of Na}_2\text{CO}_3 = \frac{2 \times 23 + 12 + 3 \times 16}{2} = 53$$

$$\text{wt of Na}_2\text{CO}_3 = \text{Eq. wt} \times N \times V.L$$

$$= 53 \times 0.1 \times 250/1000 = 1.325 \text{ g}$$

Therefore, 1.325 g of Na<sub>2</sub>CO<sub>3</sub> is exactly weighed by sensitive balance and dissolved in 250 ml of solution in 250 ml size volumetric flask to get 0.1 N of Na<sub>2</sub>CO<sub>3</sub> solution. This solution is standard solution which is prepared from high purity of solid Na<sub>2</sub>CO<sub>3</sub>.

Example - 2 Show by calculation how could you prepare 2 liters of 0.2 M NaOH solution from Solid NaOH.

The solution:

$$\text{Mw of NaOH} = 23 + 16 + 1 = 40 \text{ g/mol}$$

$$\text{wt. of NaOH} = \text{Mw} \times M \times V_L$$

$$= 40 \times 0.2 \times 2 = 16 \text{ g}$$

Therefore, 16 g of NaOH is weighed by usual balance and dissolved in 2 liters of solution to get 0.2 M. This solution is not standard since NaOH is not primary standard material because

- It absorbs water from atmosphere and dissolves it.
- It reacts with CO<sub>2</sub> from atmosphere and forms thin layer of Na<sub>2</sub>CO<sub>3</sub> Surrounding NaOH.

Thus, NaOH is not pure Therefore, this solution is standardized with standard solution of an acid such as standard Oxalic acid solution using suitable indicator.

### Preparation of dilute solution from concentrated solution.

The concentrated solutions are always acids or bases kept in bottles carrying some information's such as: percent (w/w), density of the solution, purity, or its specific gravity and the formula of the solute and its formula weight. From these information's, can calculate the concentration of solution which is an approximate because the information's on the bottle are approximate in formal, normal and molar concentrations we are dealing with weight of solute in liter of solution.

$$\text{The normality of Con. Solution} = \frac{1000 \times \text{density} \times \%}{\text{Eq.w}}$$

From this concentration, we can Calculate the value of concentrated solution that when is diluted to the wanted volume, it gives the required concentration. This concentration is also approximate since we use approximate figures.

No. of mill eq of solution before dilution = No. of mill eq of solution after dilution

$(N \times V)$  before =  $(N \times V)$  after

Example - 3 show by calculation how could you prepare 500 ml of 0.1N H<sub>2</sub>SO<sub>4</sub> from its concentrated solution has density of 1.84 g/ml and percentage of acid equals 98% (w/w)

The solution

$$\text{Eq. w of H}_2\text{SO}_4 = \frac{2 \times 1 + 32 + 4 \times 16}{2} = 49$$

$$\text{Normality of con. H}_2\text{SO}_4 \text{ solution} = \frac{1000 \times 1.84 \times 0.98}{49} = 36.8 \text{ eq/L Or meq/ml}$$

$$N_1 \times V_1 = N_2 \times V_2 \quad \rightarrow \quad 36.8 \times V_1 = 500 \times 0.1 \quad \rightarrow \quad V_1 = 1.4 \text{ ml}$$

Thus, 1.4 ml of conc. sulphuric acid is measured by graduated cylinder and transferred into a beaker containing 300 ml distilled water with stirring and cooling and then transferred to volumetric flask of 500 ml. The solution is diluted to the mark with distilled water and stirred vigorously to get homogeneous solution. The same steps are followed when formal and molar concentration are required with employing formula weigh and molecular weight.

Example – 4 Show by calculation how could you prepare 500 ml of 2M ammonia solution from concentrated solution has specific gravity all of 0.9 and percentage of ammonia = 27% The

solution:

$$\text{Mw of NH}_3 = 14 + 3 \times 1 = 17 \text{ g/mol}$$

$$\text{Molarity of cone NH}_3 \text{ solution} = \frac{1000 \times 0.9 \times 0.27}{17} = 14.5 \text{ mol/l}$$

$$M_1 \times V_1 = M_2 \times V_2 \quad \rightarrow \quad 14.5 \times V_1 = 2 \times 500 \quad \rightarrow \quad V_1 = 70 \text{ ml}$$

Therefore, 70 ml of cone NH<sub>3</sub> solution is measured by graduated cylinder and transferred to 500 ml volumetric flask and diluted to the mark with distilled water.

