Example :

Aqueous solution of $NiCl_2$ with a concentration of 500 ppm, what is the molarity and normality of this solution? At.wt of : Ni=58.69 , Cl=35.5

Diluting solutions:

Example:

You are given a solution of 14.8 M NH_3 , How many milliliters of this solution do you require to give 100ml of 1M NH_3 when dilute ?

In this kinds of examples and if you need to get a diluted solution, follow the dilution equation:

$Mi \times Vi = Mf \times Vf$

$14.8 \times Vi = 1 \times 100$

$Vi = 6.76$ ml

Home work

Question: 45.57 mL of a solution is diluted to 63.40 mL. The diluted solution is found to have a concentration of 0.433 N. What was the concentration of the original solution?

Question: Calculate the weight of Calcium hydroxide present in 250 ml of two normal solution?

Question: If 40 grams of NaOH with an equivalent weight of 40 is dissolved in one liter of a solution, does the normality of the solution is one , give the calculation ?

Question: Calculate the molarity of 0.650 N HCl.

Question : What will be the normality of 3 molar solution of calcium hydroxide?

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Volumetric analysis

An important method for determining the amount of particular substance which is based on measuring the volume of reactant solution.

Suppose substance ((A)) react in solution with substance ((B)). If you know the volume and concentration of ((B)) that just react with substance ((A)) in a sample, you could determine the amount of ((A)).

*The reagent of exactly known composition (volume and concentration) in a titration is called a ((**Standard solution**)).

Commonly, the concentration of standard solution is arrived at in either of two ways:

1- From preparatory data obtained when a carefully weighed quantity of the pure reagent is diluted to an exactly known volume.

2- Form data obtained by titration of a weighed quantity of a pure compound with the reagent.

The first is named primary standard solution; the second is named secondary standard solution.

A primary standard substance should satisfy the following requirements:

1- It must be of the highest purity.
2- It should be stable, not be attacked by constituents of the atmosphere.
3- The compound should not be hygroscopic, otherwise drying and weighing would be difficult
4- It should be available and not too expensive.
5- It should have a high equivalent weight.

Titration:

It is a process for determining the amount of the substance by adding to it a carefully measured volume of standard solution until the reaction between them is just complete. The point at which this occurs is called the equivalence point or the theoretical end point.

Equivalence point: is the point where the amount of titrating solution added is chemically equivalent to the amount of substance being titrated:

Number of milliequivalent of titrant=Number of milliequivalent of titrated

$$\text{Volume} \times \text{normality} = \text{volume} \times \text{normality}$$

The completion of the titration should be detectable by the addition of a reagent, known as an indicator.

Indicator: is a substance that undergoes color change when a reaction approaches completion.

After the reaction between the substance and the standard solution is practically complete, the indicator should give a clear visual change in the liquid being titrated. The point at which this occurs is called the end point of titration.

End point: is the point where the indicator changes color. In the ideal titration the visible end point will coincide with the equivalence point. In practice, however, a very small difference usually occurs, this represents the titration error.

Titration error: is the volume difference between the end point and equivalence point, (it must be very small).

Example:

Titration of HCl with NaOH solution.

Transfer an accurate volume of HCl solution to conical flask and add a few drops of phenolphthalein indicator. Phenolphthalein indicator is colorless in HCl solution but turns pink at the completion of the reaction of the reaction of

NaOH with HCl.

Sodium hydroxide is contained in a buret.

Buret: is a glass tube graduated to measure the volume of liquid delivered from the stopcock.

The solution in the buret is added to HCl in the flask until the indicator just change from colorless to pink. (This is the end point). At this point the reaction is complete and the volume of NaOH that react with HCl is read from the buret. This volume then used to obtain the concentration of HCl in the original solution.

Reactions used in volumetric analysis:

To be suitable for a volumetric analysis, a chemical reaction should meet certain requirements:

1- The reaction must be simple which can be expressed by a chemical equation; this requirement implies the absence of side reactions between the reagent and the unknown or other constituents of the solution.
2- The reaction should be rapid, and the substance to be determined should react completely with the reagent in equivalent proportions.
3- There must be available a method for detecting the equivalence point in the reaction, that is a satisfactory end point is required.
4- An indicator should be available which should sharply define the end point of the reaction.

Reaction Types:

Volumetric methods may be divided conveniently into four categories based upon reaction type, these include:

1- Acid-base reactions or (neutralization):

This titration reaction involves the determination of the volume of solution of an acid (or base) of known concentration termed the "standard solution" (titrant) required to be added to a base (or acid) of unknown concentration. When the total number of milliequivalents of reactant added are unknown (ml × N = milliequivalents) we will then have a numerically exact and equal measure of the quantity of the substance that it has neutralized.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

A number of indicators are used in this titration such as:

	Methyl orange	Phenolphthalein	Methyl red
pH range	**3.1-4.4**	**8-9.6**	**4.2-6.2**
Acid color	red	colorless	Red
Base color	yellow	pink	Yellow

Approximate pH range for color change

3- Precipitation reactons:

Based on the formation of a slightly soluble precipitate.

For example: $Ag^{+} + Cl^{-} \longrightarrow AgCl_{(s)}$

A chemical indicator produces in solution readily observable change – usually of color or of turbidity- that serves to signal a state of chemical equivalence between the participants of a titration.

4- Oxidation –reduction reactions:

Potassium permanganate in the most widely used in this reaction. It is powerful oxidant. The intense color of permanganate ion is sufficient to signal the end point titrations:

$$MnO_4^{-} + 5\,Fe^{++} + 8\,H^{+} \longrightarrow 5\,Fe^{+++} + Mn^{++} + 4H_2O$$

4-Complex formation reactions:

Twenty five (25) metals that can be determined by direct titration with organic material as a titrant is that it combines with metal ions in a 1:1 ratio