

PHARMACEUTICAL CHEMISTRY.

CHAPTER-2

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Pharmaceutical Analysis.

Pharmaceutical analysis is the branch of medical chemistry that includes the series of experiment or procedures for purification, identification, determination, and quantitation, characterization, of any chemical compounds or components.

An analyte is chemically reacted with a standard solution of a reagent of precisely known concentration or with a concentration that can be precisely determined. The amount of a standard solution required to completely reacts with all the sample is used to estimate the purity of the sample.

- Due to their applications, we determine the mixture components of any solution and separate their individual components and also determine their physical and chemical properties.
- It is the quantitative and qualitative analysis procedure which ensure the purity, quality, and safety of pharmaceutical products.
- Pharmaceutical analysis and quality control both are play a vital role in the pharmaceutical manufacturing for insuring the drug stability, drug compatibility, adverse drug reactions, toxic effects etc. Due to their involvement we increase the drug standards, safety, potency, and efficacy.

Methods involve in the pharmaceutical analysis—

- Chemical /Titrimetric methods.
- Biological methods.
- Physical and physicochemical methods.
- Pharmaceutical methods.

Apparatus used in analysis—

- Gas Detector Tubes.
- Nessler Cylinders.
- Sieves.
- Thermometers.
- Ultraviolet Ray Lamps.
- Volumetric Glassware.
- Weights and Balances.

General terms and formula used in pharmaceutical analysis.

- Concentration— the concentration of a chemical substance expresses the amount of a substance present in a mixture. It is mainly represent in the molar concentration in pharmaceutical.

$$\text{Concentration} = \text{Moles of solute/volume in litre.}$$

Solution— Solutions are homogeneous mixture of two or more than two components. Generally the component that is present in the large amount is known as the solvent or other; one or more components presents in the solution other than solvent are called solutes. Solvent determines the physical state in which solution is exists.

$$\text{Solution} = \text{solute} + \text{solvent.}$$

- Mass percentage (w/w)—

$$\text{Mass \% of a component} = \frac{\text{Mass of the component in the solution}}{\text{Total mass of the solution}} \times 100$$

- Volume percentage (v/v)—

$$\text{Volume \% of a component} = \frac{\text{volume of the component}}{\text{Total volume of solution}} \times 100$$

- Mass by volume percentage (m/v) — Mass of solute dissolved in 100ml of the solution. $m/v = \frac{\text{mass of solute}}{\text{Volume of solution}} \times 100$

- Molarity— Molarity = $\frac{\text{moles of solute}}{\text{Volume of solution in litre}} \times 100$

- Molality— Molality = $\frac{\text{moles of solute}}{\text{Mass of solvent in kg}} \times 100$

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- Normality— Normality = $\frac{\text{gram equivalent of solute}}{\text{liters of solution}} \times 100$
- Parts per million— When a solute is present in trace quantities, it is convenient to express concentration in parts per million (ppm).

$$\text{PPM} = \frac{\text{number of parts of the component}}{\text{Total number of parts of all components of the solution}} * 100$$

- Mole fraction— $\frac{\text{number of moles of the component}}{\text{Total number of moles of all components.}}$

CHEMICAL/ Titrimetric METHODS.

In the chemical analysis we discuss about the chemical reaction of the chemical components and discuss the chemical property. It includes many methods.

- Volumetric analysis.
- Gravimetric analysis.
- Gasometric analysis.

VOLUMETRIC ANALYSIS.

Volumetric analysis is the method of quantitative chemical analysis in which the amounts of the substances is determined by measuring the volume that it occupies in different- different proportions.

We analyze the strength, of the chemical which are involved in the chemical reaction and calculate the proportions.

Trimetric methods are still widely used in the pharmaceutical analysis than geometric analysis because of their robustness, cheapness, and capability for high precision. Volumetric methods are classified into different types depending upon the types of reactions involved in the reactions which are as follows.

1. **Neutralization titration.**
2. **Non- aqueous titration.**
3. **Redox titration.**
4. **Complex metric titration.**
5. **Precipitation titration.**

Neutralization Titration

It is also known as acid base titration in aqueous phase. In this method strong acid/base are used as titrate or analyte and other reagent or titrant are used as standard solution to define the concentration of analyte.

Titration— Titration is the phenomena to determine the unknown concentration of an identified solution or analyte. In this method, a reagent or titrant is prepared as a standard solution, then a known concentration and volume of the prepared titrant reacts with the analyte to determine the concentration.

Acid base theory.

ACID.

Arrhenius concept—According to this concept, those substances which produce free hydrogen ion (H^+) in an aqueous solution are called acids.

Example- HCl , HNO_3 , H_2SO_4 , CH_3COOH etc.

Bronsted-Lowry concept —According to this concept, those substances which have tendency to donate the proton (H^+) by any methods in any solvent are called acids.

Lewis concept—According to this concept, those substances which have tendency to gain lone pair or electron pair are called acids.

Example – $AlCl_3$, SF_6 , SO_3 etc.

BASE/ALKALI.

Arrhenius concept—According to this concept, those substances which produce free hydroxide ion (OH^-) in an aqueous solution are called bases.

Example-NaOH, KOH, $\text{Ca}(\text{OH})_2$ etc.

Bronsted-Lowry concept—According to this concept, those substances which have tendency to accept the proton (H^+) by any methods in any solvent are called bases.

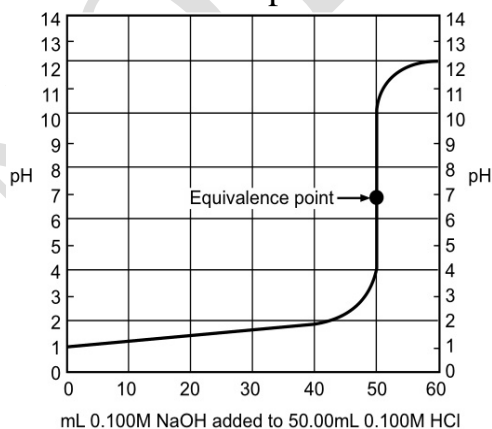
Example – SO_4^{2-} , Cl^- , O^{2-}

Lewis concept—According to this concept, those substances which have tendency to donate lone pair or electron pair are called bases.

Types of Neutralization titration

A. Strong acid/Strong base titrations—In this titration strong acid and strong base are reacted with each other by using a suitable indicators. Acid and base components are rapidly breakdown in its ions (cation and anion) and react with each other and form the salt and water.

➤ Titration curve is plotted on the basis of reaction between HCl and NaOH—



- Initially, the curve show low PH due to the presence of strong acid which slowly rises as the base is added slowly and reaches to sharp rise after the

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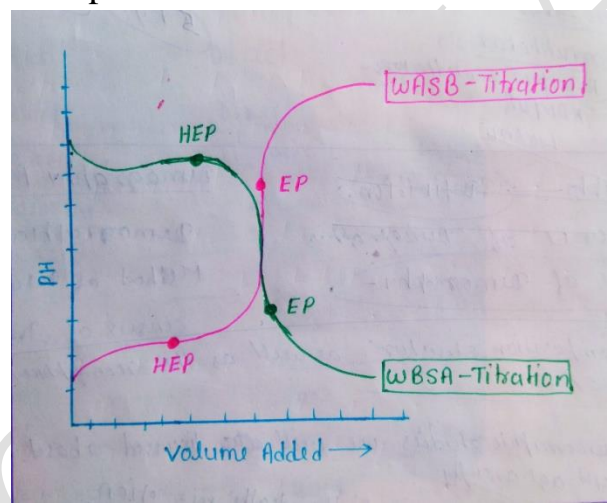
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end point or neutralization point to higher PH due to presence excess of alkali.

- The neutralization point occurs at PH-7 at which point all acid molecules have completely consume or reacts with the base molecule.

NOTE— All the strong acid and strong base curve will have the same shape.

B. Weak acid/strong base and weak base /strong acid titrations— In this titration method weak acid is titrated with the strong base or weak base is titrated with the strong acid by using the suitable indicators to detect the end point. During the procedure weak acid or weak base are dissociates slowly in its components and strong acid or strong base are dissociates rapidly in its components so this type of titration is differ from previous titration method.



➤ Titration curve plotted for both the titration is—

- Initially the PH rises normally and when it reaches a zone where reactions proceeds, the curve will not raise much. This point is said to be half neutralization point.
- At this point, there is no much change in PH even though lot of strong base is added and the half of the weak acid is reacted with the base to form acid conjugate base which means there will be mix of conjugate base and solution, it is a buffer solution.

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- Thus the H^+ ion concentration will be equal to the K_a value of the weak acid [$PH = PK_a$].
- After this zone, there will be a sharp rise in PH through its equivalence point due to the excess strong alkali above PH-7.
- This is because, all the weak acid molecule react with the base to form the conjugate base and only the base is remaining which rise the PH and therefore the curve follows the pattern as strong acid and strong base titration.

C. Weak acid-weak base titration— In this titration method weak acid and weak base titrate with each other by using the suitable indicators (mixed indicators).

- The chief feature of the curve is that change of PH near equivalence point and during whole neutralization is very gradual. Hence, the end point cannot be detected by ordinary indicator. For detection of this titration mixed indicators are used.

- **BACK TITRATION**— In case of insoluble substances which are volatile, reactions require additional heat, and substances for which reaction proceeds rapidly only in the presence of excess of reagents, direct titration will not be possible. These substances are determined by the back titration method.
- The determination involves addition of excess but known quantity of the standard solution to the weighed sample of analyte and after the complete the reaction, excess of solution is back titrated with standard solution.

- ✓ **Some important neutralization titration and their methods and titrant given below—**

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| Standard chemical | Type of titration | Titrant |
|--------------------|-------------------|--------------------------------|
| Aspirin | Back | H ₂ SO ₄ |
| Ammonium chloride | Back | NaOH |
| Methyl salicylate | Back | HCl |
| Ephedrine | Back | NaOH |
| Furosemide | Back | NaOH |
| Pyrazinamide | Back | NaOH |
| Sodium hydroxide | Direct | H ₂ SO ₄ |
| Theopentone sodium | Direct | H ₂ SO ₄ |
| Calamine | Direct | NaOH |
| Oxyphenbutazone | Direct | NaOH |
| Salicylic acid | Direct | NaOH |
| Boric acid | Direct | NaOH |
| Hydrochloric acid | Direct | NaOH |
| Nicotinic acid | Direct | NaOH |
| Saccharin | Direct | NaOH |

Neutralization Indicators.

Indicators— Chemical indicators are those substances which give a visible or distinguishable sign, usually by a color change, state change, and odor change etc of the presence or absence of a threshold concentration of a chemical species, such as an acid or an alkali in a solution.

Neutralization indicators—Those substances used in acid base titration that are helpful in detection of end point at the end of reaction by producing different color at the end point at various value of PH. So after the neutralization point, they produce color change as per the PH of the titrant or titrate, and thus denote the end point.

Examples of indicators—Table given below

| Indicators | PH range | Acid | Base |
|--------------------------|------------------|-----------------|---------------|
| Thymol blue | 1.2 - 2.8 | Red | Yellow |
| Methyl red | 4.2 – 6.3 | Red | Yellow |
| Methyl orange | 3.1 – 4.4 | Red | Orange |
| Bromocresol green | 3.8 – 5.4 | Yellow | Blue |
| Bromocresol blue | 3.0 – 4.6 | Yellow | Blue |
| Phenol red | 6.8 – 8.4 | Yellow | Red |
| Phenolphthalein | 8.3 - 11 | No color | Red |

Non-aqueous Titration.

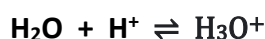
Non aqueous titration is the most common titration procedure used in pharmacopoeial assays and serves a double purpose, as it is suitable for the titration of weak acids and weak bases and provides a solvent in which organic compounds are soluble

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Common volumetric solvent— water is the most common solvent used in the volumetric titration because due to amphoteric nature, common availability, low cost, solubilizing capability etc. When an acid or base is to be used, they have to be dissolved in water to achieve the desired concentration. However, the pharmaceutical compounds or drugs which are used in various formulations are weak acidic and basic substances. These compounds have major limitation that they are poor soluble in water and have low reacting properties.

If the acid and base is relatively weak then it will not compete effectively with water for electron/proton. In other word, it will not be titrated.



Solvents used in the Non- aqueous Titration.

- Generally organic solvents are used in the non- aqueous titration.
- The non-aqueous solvents can be classified based on its proton donor acceptor properties. The solvent exert an influence on the acid- base properties of the solute they are of four types.
 - 1) Protogenic solvents.
 - 2) Protophilic solvents.
 - 3) Aprotic solvents.
 - 4) Amphiprotic solvents.

Protogenic Solvents— these solvents have a more acidic character and tend to have a levelling effect on the bases they come in contact with. These solvents have relatively high dielectric constant.

They are ionized and the ionic products of liberated ions are usually greater than that of water. Example- formic acid, acetic acid, sulphuric acid etc.

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Protophilic solvents— these are basic in nature and reacts with acid to form the solvated proton. It shows the greater tendency to the accepting the proton and have high dielectric constant.

They are ionized and the ionic product is less than ionic products of the water.

Example- dimethyl formaldehyde, pyridine, ammonia etc.

Aprotic solvents— these solvents are generally chemically neutral and hydrocarbons or chlorinated hydrocarbons. These solvents not contain any protons or hydrogen containing bonds refers as the O-H or N-H bonds.

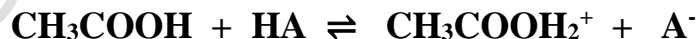
These solvents possess low dielectric constant and they are generally not ionized to give ion. Example- Benzene, acetone, chloroform etc.

Amphiprotic solvents— these solvents possess both acidic and basic properties and high dielectric constant.

They are partially ionized and the ionic products of liberated ions is less than that of water. Example- water, ethanol, isopropyl alcohol etc.

Types of Non-aqueous titration—

A. **Non-aqueous titration of weak base**— Acetic acid is a very weak proton acceptor and thus does not compete effectively with weak base for proton only very strong acids will protonate acetic acid appreciably according to the equation shown below-



In this titration method weak bases compete very effectively with acetic acid for protons.

Non-aqueous titration with acetic perchloric acid is used in the pharmacopoeial assays of adrenaline, metronidazole, codeine, amitriptyline HCl, Lignocaine HCl, Quaternary amine salts such as Neostigmine bromide, and pancuronium bromide.

- Oracet blue, quinolidine red and crystal violet are used as indicator in this type of titration.

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B. Non-aqueous titration of weak acid— for Non-aqueous titration of weak acids a solvent such as an alcohol or an aprotic solvent is used that does not compete strongly with the weak acid for proton donation. Typical titrants are lithium methoxide in methanol or tetrabutyl ammonium hydroxide in dimethyl formamide.

Non- aqueous titration of acidic groups is carried out in pharmacopoeial assays of barbiturates, uracils, and sulphonamides.

For the end point detection may be carried out with thymol blue as an indicator.

Redox titration.

Chemical titration in which both the oxidation – reduction reaction is employ is known as Redox titration or oxidation – reduction titration.

Oxidation reaction— Oxidation reaction is defined as ‘addition of oxygen/loss of electron/removal of hydrogen’ is known as oxidation reaction.

Reduction reaction— Reduction reaction is defined as ‘removal of oxygen/gain of electron/addition of hydrogen’ is known as oxidation reaction.

Redox reaction-- $\text{MnO}_4^- + \text{I}^- \rightarrow \text{Mn}_2^+ + \text{I}_2$

Oxidizing agent— Oxidizing agent are defined as substances containing an atom/ion, which accept an electron during the reaction and result in either decrease in their positive valency or increase in their negative valency.

Reducing agent— Reducing agent are defined as substances containing an atom/ion, which loose an electron during the reaction and result in either increase of their positive valency or decrease of their negative valency.

Theory on redox titration— Reduction potential is a measure of how thermodynamically favorable it is for a compound to gain electrons.

A high positive value for a reduction potential indicates that a compound is readily reduced and consequently is a strong oxidizing agent that is it removes electrons

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from substances with lower reduction potential. The oxidized and reduced forms of a substance are known as a redox pair.

Some standard redox potential (E_0) given in the table—

| | |
|---|---------|
| $\text{Ce}^{4+} + e \rightarrow \text{Ce}^{3+}$ | 1.61v |
| $\text{Mn}^{7+} \rightarrow \text{Mn}^{2+}$ | 1.51v |
| $\text{Cl}_2 + 2e \rightarrow 2\text{Cl}^-$ | 1.36v |
| $\text{Br}_2 + 2e \rightarrow 2\text{Br}^-$ | 1.065v |
| $\text{Fe}^{3+} + e \rightarrow \text{Fe}^{2+}$ | 0.771v |
| $\text{I}_2 + 2e \rightarrow 2\text{I}^-$ | 0.536v |
| $\text{AgCl} + e \rightarrow \text{Ag} + \text{Cl}^-$ | 0.223v |
| $2\text{H}^+ + 2e \rightarrow \text{H}_2$ | 0v |
| $\text{Fe}^{2+} + 2e \rightarrow \text{Fe}$ | -0.440v |
| $\text{Ca}^{2+} + 2e \rightarrow \text{Ca}$ | -2.888v |

A substance with a higher reduction potential will oxidize one with a lower reduction potential. Example- $\text{Cl}_2 + 2\text{Br}^- \rightarrow 2\text{Cl}^- + \text{Br}_2$.

Direct Redox Titration— Iodine is a moderately strong oxidizing agent. During oxidation it will oxidize substances with lower reduction potential. Example titration of ascorbic acid.

In addition the end point is detected using starch indicator, which produces a blue coloration with excess iodine. The pharmacopoeial assays of this titration are- ascorbic acid, sodium stilbigluconate, dimercapral injection and acetarsal.

Displacement redox titration— this titration is used in the pharmacopoeial assays of-- liquefied phenol, Methyl hydroxybenzoate, Propyl hydroxybenzoate and phenidione.

Complex metric titration.

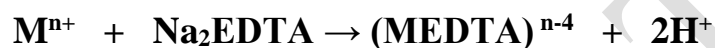
This type of titration involves formation of complex during the titration and is used in the estimation of metal and also for their salts. The titrant used in this titration is

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usually called as ligands. EDTA is the most widely titrant used in the complex metric titration.

EDTA(Ethylenediamine tetracetic acid or sodium edentate) is a very versatile complexing agent with greater water solubility and forms the most stable 1;1 ratio complexes with all metals except alkali metals such as sodium and potassium. The alkaline earth metal such as calcium and magnesium forms complexes which are unstable at low PH values and are titrated in ammonium chloride buffer at 10. The general equation for the titration—



Indicator used in the complex metric titration—the end point of the reaction is detected using an indicatory dye. The dye is added to the metal solution at the start of the titration, and forms a colored complex with small amount of the metal. The first drop of excess EDTA causes this complex to break up resulting in a color change. Example-- Calcein, Eriochrome black T, curcumin, calcon, Murexide (ammonium purpurate), Hematoxylin, fast sulphon black etc.

- Titration with EDTA is used in the pharmacopoeial assaya of- calcium acetate, calcium chloride, calcium gluconate, magnesium carbonate, magnesium hydroxide, magnesium trisilicate, bismuthsubcarbonate, bacitracin Zinc, zinc chloride, zinc undecanoate.

Types/classification of Complex metric titration method—

1. **Direct complex metric titration.**
2. **Back complex metric titration.**
3. **Replacement complex metric titration.**
4. **Indirect complex metric titration.**

→ Insoluble metal salts are estimated by **back titration**; the sample is heated with excess EDTA to form the soluble EDTA complex of the metal and then excess EDTA is titrated with salts solution containing Mg^{2+} or Zn^{+2} of known concentration. Back titration with EDTA is used in the pharmacopoeial assays of-

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Aluminium glycinate, aluminium hydroxide, aluminium sulphate, calcium hydrogen phosphate.

Precipitation titration.

A special type of titrimetric procedure involves the formation of precipitates during the course of titration. The titrant reacts with the analyte forming an insoluble product called precipitate. Thus, any titration in which the end product formed at the completion of reaction is insoluble precipitate, this titration is called as 'precipitation titration'. Precipitation is formed with rapid combination of two ionic (cation and anion) species to form very insoluble products.

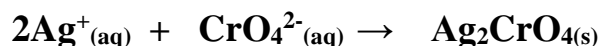
Methods of precipitation Titration—

- 1) Mohr's method
- 2) Volhard's method
- 3) Fajan's method

Mohr's method—This method involves determination of the chloride ion concentration of a solution by titration with silver nitrate. In his method, silver nitrate solution is slowly added to chloride solution to produce a precipitate of silver chloride.



When the entire chloride ion is precipitated, the excess of silver ions react with the chromate ions from potassium chromate which is the indicator. A red brown precipitate of silver chromate will be formed which gives the end point of the titration.



This method applied for the determination of chloride ion concentration in water samples for different sources including river water, sea water, stream water etc.

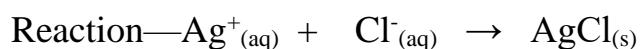
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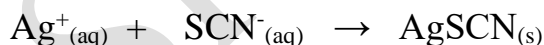
Mohr's titration should be carried out under condition of PH 6.5 – 9.0 at higher PH silver ions may be removed by precipitation with hydroxide ions, and at low PH chromate ions may be removed by an acid – base reaction to form hydrogen chromate ions or dichromate ions, and affecting the accuracy of the end point.

Volhard's Method— this method involves the determination of concentration of chloride ions in a solution using a back titration with potassium thiocyanate. Initially an excess volume of a silver nitrate solution is added to the solution containing chloride ions.

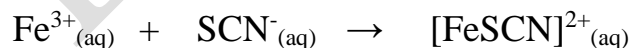
This is done before the titration and this produce a precipitate of silver chloride. The addition excess volume of silver nitrate allows the complete reaction of chloride ions present in the solution with silver nitrate.



- After this precipitation Fe^{3+} is added as indicator with and the solution is titrated with the potassium thiocyanate solution then excess silver form a pale yellow color silver thiocyanate precipitate.



- After completion of reaction excess of thiocyanate reacts with Fe^{3+} to produce the end point in the form of a dark red complex.



This method is used when the PH of the solution is acidic. if the PH is neutral or basic Mohr's method or Gravimetric method should be used.

Modified Volhard's Method— this method is used for, especially determination of NaCl or KCl. When silver nitrate is reacted with sodium chloride the silver chloride is formed and excess of silver nitrate is back titrated with potassium or ammonium thiocyanate using ferric alum as an indicator. This method is slightly modified to overcome the interference of silver chloride with the titration process.

Fajan's Method— Fajan's method involves the titration of chloride ions with silver ions using adsorption indicators. Fajan's introduced adsorption type of

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indicator for precipitation titration. These indicators are basically dyes that adsorb or desorb on the surface of the precipitate at the equivalence point and produces the color change. These indicators are either acid dyes ex- Fluorescein, eosin etc or basic dyes ex- rhodamine series.

Fluorescein is a weak acid and commonly used dye for the titration of chloride ions with silver. It forms fluoresceinate anion by dissociation in water thus produces a yellow-green color in solution.

NOTE—sodium chloride can be estimated using Volhard's method, Mohr's method, and Fajan's method.

Gravimetric Analysis.

Principle—Gravimetric analysis involves measurement of weight of the substance to be analyzed from a solution after isolating by precipitating the components as an insoluble compound of known chemical composition. The method is a quantitative analysis method by weight.

Methods involved in the gravimetric analysis—

1. **Precipitation method.**
2. **Volatilization method or Evolution.**
3. **Electro-analytical method.**

Precipitation method— In this method, the analyte is suitably converted into precipitate which is insoluble and separated from solution by filtration this filtrate is washed to remove impurities and heated to convert the filtrate to a product of known composition and then weighed

Volatilization method or Evolution— In this method, the analyte is subjected to volatilization process at specific temperature so that the possible decomposition products are volatilized leaving unvolatilized product. This product is then weighed and used. This product is then weighed and used for calculation.

Electro-analytical method—in this method suitable electrode is used on which the element to be estimated is deposited electrically. The sample solution containing ion is taken and electric current is passed in the solution. As per the

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second Faraday's law, the ions present in the solution will get deposited on the electrode and the concentration of ions deposited on the electrode will be depends on their chemical equivalent, this method has the advantages that, it avoid filtration and decomposition.

Gravimetric procedure of calculation.

Gravimetric principle is based on the quantitative estimation of components on the basis of measurement of mass.

Steps involved in gravimetric calculation is given below.

1. **Sample preparation and dissolution**— The sample which is weight for quantitative analysis is very small. it is necessary to take a representative sample correctly to ensure that, results are accurate. The sample should be homogeneous and in the form of powder. After that sample is taken in a clean beaker and water is added to dissolve the sample completely. Stirring is done to achieve clear solution or the solution can be warmed gently if necessary.

Further the condition can be adjusted in such a way to obtain the precipitate which should have low solubility so that it should be more suitable for filtration.

- In case of certain substances, which are likely to evolve gases when soluble in acid or base, the reaction is allowed to take place to cease the evolution of gases.
 - For the adjustment of solution condition factors including Temperature, PH, Volume of solution, Presence of other constituents and their concentration should be considered.
2. **Precipitation**— Precipitation is generally carried out in a resistant glass beaker with slow addition of dilute solution of precipitant with sufficient stirring. This reaction should be carried out in hot solution.

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Selection of precipitant is important to obtain precipitate. The choice of precipitant is based on the specificity of reagent, only a moderate excess of precipitant is generally required. A very large excess of precipitant may lead to increase in solubility.

After precipitate settled down, add a few drops of precipitant to the solution to check complete precipitation. For the ideal precipitant, it should react with analyte to form the precipitate which can be easily filtered, washed free of contaminating impurities, low solubility, stable and should have constant known.

3. **Digestion**— Digestion is generally carried out at high temperature to speed up the process but in some cases it is done at room temperature. It improves the purity and rate of filtration of precipitate.
4. **Filtration**— Filtration is the procedure through which the filter and filtrate are separate out each other or precipitate is separate from the mother liquor.

Various type of filter media are used for this purpose. The choice of filter media is based on the nature of precipitating and the heating temperature required for drying. Different filter media used in gravimetric analysis.

- **Filter paper.**
- **Filter mats.**
- **Filter pulp.**
- **Permanent porous filter disc.**

5. **Washing of precipitate**— after filtering the precipitate, the impurities on the surface of precipitate can be removed by washing of precipitate. If the precipitate is very stable and there is no effect of solubility or no effect leading to peptization or no effect leading to hydrolysis of precipitate, the precipitate can simply be washed with distilled water ex- washing the precipitate of BaSO_4 with distilled water. Some solution is washed by water then precipitate may be peptized ex- lead sulphate precipitate is washed by dilute solution of nitric acid.
6. **Drying and ignition of precipitate**— In this procedure heated the solution or substance to remove water and remove the adsorbed electrode from

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washing solution. Drying and ignition process will depend on the nature of precipitates and the filter media used for the purpose.

Drying is the term used when temperature is below 250^oc and ignition is above 250^oc and below 120^o.c. During is possible for precipitates filter on filter paper.

Ignition is done by heating with appropriate burner and it depends upon whether the precipitate can be ignited in contact with filter paper or in absence of filter paper.

7. **Weighing and calculation**—after the drying procedure solution are cooled to room temperature in the desiccators and then weight accurately an analytical balance to find out the weighed form. The calculations are generally made in terms of percentage.

$$\%A = \frac{GA}{G_{\text{sample}}} \times 100$$

GA = Grams of analyte

G_{sample} = Gram of sample taken for analysis

Colloidal states.

Colloidal suspension is not suitable in gravimetric analysis because of particle size. They cannot be readily filtered. The stability of these suspensions can be decreased by stirring, heating and by adding and electrolytes. This cause individuals colloidal particle to bind together to give colloidal mass and is filterable.

The process of converting colloidal is in general exhibit by substances of particle size ranging in between 0.1 μ and 1 μ . Ordinary quantitative filter paper will retain particle up to 10 μ and so the colloidal solution in this respect behave like true solution.

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Colloidal suspension is stable because all colloidal particles are either positively or negatively charged. The ions are retained on the surface by process known as adsorption. If the powerful beam of light is passed through colloidal solution and the solution is viewed at right angle to incident light, scattering of light is observed. It is called as 'Tindal effects'.

In general colloids are classified into two groups as Lyophilic and lyophobic colloids.

| | Lyophobic colloids (Suspensoids) | Lyophilic colloids (Emulsoids) |
|----|---|--|
| 1. | These are only slightly viscous in nature. | These are very viscous almost jelly like known as gel. |
| 2. | Addition of water has no effect on these colloids. | Addition of water or solvent has effect on these colloids. |
| 3. | Comparatively small concentration Of electrolyte results in flocculation of these colloids. | Comparatively large concentration of electrolyte results is required for flocculation. |
| 4. | They pass electrical charge of definite sign which can be change only by specific method. | They also pass the charge but they change their charge easily. |
| 5. | Ultra microscope revels the bright particle in vigorous motion as Brownian movement Ex- gold solution | Under ultra microscope only a diffuse light cone is exhibited ex-gelatin. |