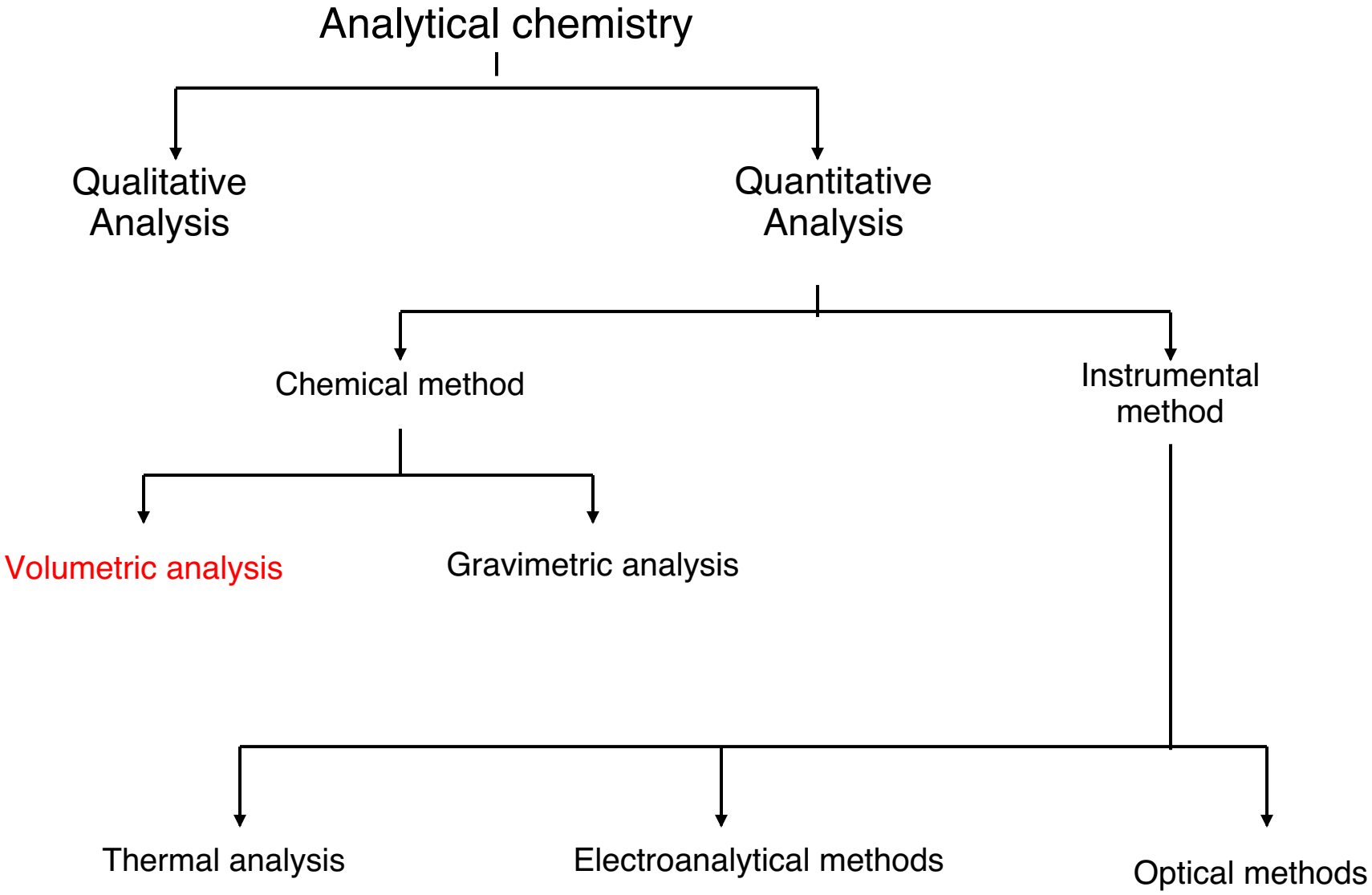
Volumetric Analysis

Glassware's for Volumetric measurements

Analytical chemistry: Is applied throughout industry, medicine and all the sciences it is classified to:

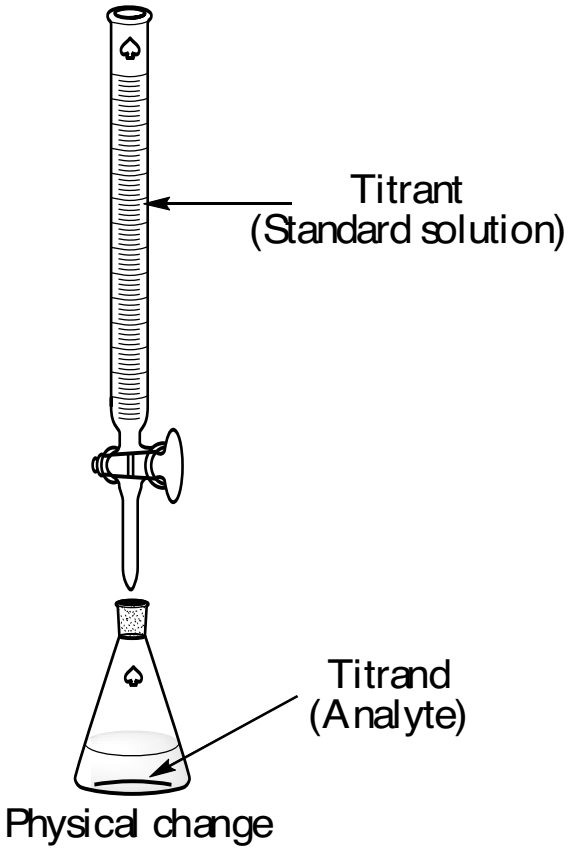

Analytical chemistry
Qualitative Analysis
Quantitative Analysis
Chemical method
Instrumental method
Volumetric analysis
Gravimetric analysis
Thermal analysis
Electroanalytical methods
Optical methods

Qualitative analysis: reveals the identity of the elements and compounds in a sample.

Quantitative analysis: indicates the amount of each substance in a sample.

Volumetric analysis: It is based on accurate measurements of final volume of a standard reagent solution of known concentration needed to react with the analyte in a known volume of sample.

Titration: is a process in which a standard reagent (known conc.) is added to a solution of an analyte until the reaction between the analyte and standard reagent is attained equivalence point.



Equivalence point: Is the point in a titration when the amount of added standard reagent is exactly equivalent to the amount of analyte.

At equivalent point:

(no. of eq.wt titrant) = (no. of eq.wt. titrand)

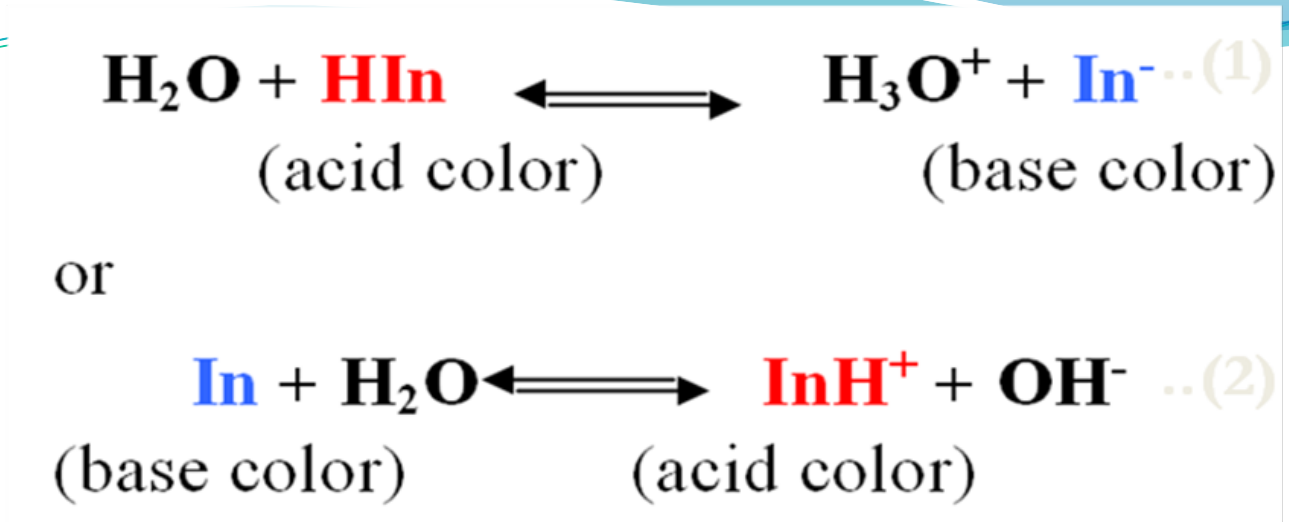
(N = no.of eq.wt / V)

$$(N \times V)_{Standard} = (N \times V)_{Analyte}$$

End point: Is the point in a titration when a physical change occurs that is associated with the condition of chemical equivalence.

Indicators: Chemical compounds undergo change in colour during titration which indicates the equivalence point.

Acid-base indicators are generally weak organic acids or bases which, upon dissociation or association, undergo internal structural changes at a specific range of pH that give rise to alterations in color. We can symbolize the typical reaction of an acid-base indicator as follows:



•For the first indicator (1), HIn will be the major constituent in strongly acidic solutions and will be responsible for the "acid color" of the indicator, whereas In^- will represent its "base color"

•For the second indicator (2), the species In will predominate in basic solutions and thus be responsible for the “base color”, whereas InH^+ will constitute the “acid color”.

Indicator	Color in acidic medium	Color in basic medium	pH range
Thymol blue	Red	Yellow	1.2 – 3.0
Methyl orange	Red	Yellow	3.1 – 4.4
Methyl red	Red	Yellow	4.2 – 6.2
Phenolphthalein	Colorless	Pink	8.3 – 10

Primary standards

It is a highly purified compound that serves as a reference material in volumetric (titrimetric) method.

Important requirements for a primary standard are the following:

1. High purity.
2. High stability.
3. It has a large molecular weight to minimize the relative error during weighing the substance.
4. It must be not hygroscopic.
5. Low cost.
6. The substance must not be poison.
7. Soluble in a solvent (especially water).

Secondary standard:

Is a compound whose purity has been established by titration with the primary standard and serves as the reference material for a titrimetric method of analysis.

Standard solution:

Is a reagent of exactly known concentration that is used in a titrimetric analysis, and it's prepared either from primary standard material or its concentration determined by standardization with primary standard material.

For using in titrimetric analysis a reaction must fulfill the following conditions:

1. There must be a simple reaction which can be expressed by a chemical equation. The substance to be determined should react completely with the reagent.

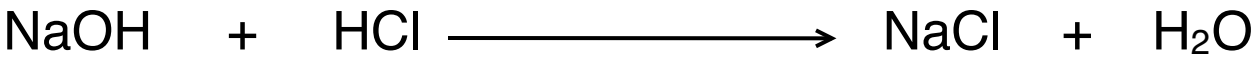
2. The reaction should be relatively fast. (Most ionic reactions satisfy this condition).

3. There must be an alteration in some physical or chemical property of the solution at equivalence point.

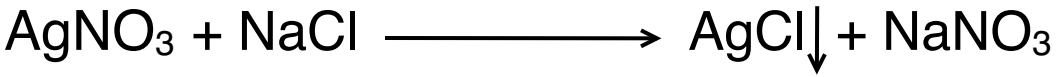
4. An indicator should be available which, by a change in physical properties (color or formation of a precipitate), should sharply define the end point of the reaction.

Types of titration according to the chemical reaction

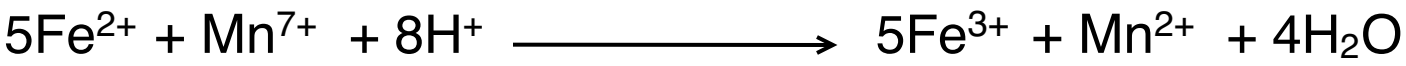
1-Neutralization titration (Acid-base titration).



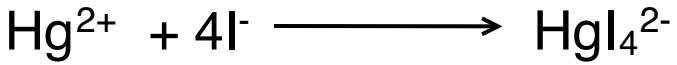
2-Precipitation titration.



3-Reduction-oxidation titration (Redox titration).



4-Complexation titration.



1- Neutralization titration (Acid-base titration)

These include the titration of free bases with a standard acid, and the titration of free acids with a standard base. These reactions involve the combination of hydrogen and hydroxide ions to form water.

$$H^+ + OH^- \longrightarrow H_2O$$

Example:

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

$$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + CO_2\uparrow + H_2O$$