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# LEC1: Introduction to Analytical Chemistry ,Definition, Scope and Classification .

Analytical Chemistry

**Analytical chemistry** is the branch of chemistry that deals with the analysis of different substances, and it involves the separation, identification, and the quantification of matter. by using of classical methods along with modern scientific instruments to achieve all these purposes. Analytical chemistry is often described as the area of chemistry responsible for:

1. Characterizing the composition of matter, both qualitatively and quantitatively.

2. Improving established analytical methods.

3. Extending existing analytical methods to new types of samples.

4. Developing new analytical methods for measuring chemical phenomena...

## υ The scope of analytical chemistry:

The science seeks ever-improved means of measuring the chemical composition of natural and artificial materials by using techniques to identify the substances that may be present in a material and to determine the exact amounts of the identified substance. Analytical chemistry involves the analysis of matter to determine its composition and the quantity of each kind of matter that is present. Analytical chemists detect traces of toxic chemicals in water and air. A detection of the component in qualitative analysis can be the basis of the method or the procedure of its quantitative analysis. The reaction may be incomplete in qualitative analysis, while in quantitative analysis the reaction should be complete and give clear and known products.

## ט Analytical chemistry consists of:

**(A) Qualitative analysis:** which deals with the identification of elements, ions, or compounds present in a sample (tells us what chemicals are present in a sample).

**(B) Quantitative analysis:** which is dealing with the determination of how much of one or more constituents is present (tells how much amounts of chemicals are present in a sample). This analysis can be divided into three types:

**(1) Volumetric analysis (Titrimetric analysis):** is measured the volume of a solution containing sufficient reagent to react completely with the analyte.

**(2) Gravimetric analysis:** Gravimetric methods, determine the mass of the analyte or some compound chemically related to it.

**(3) Instrumental analysis:** These methods are based on the measurement of physical or chemical properties using special instruments. These properties are related to the concentrations or amounts of the components in the sample. These methods are compared directly or indirectly with typical standard methods. These methods consist of:

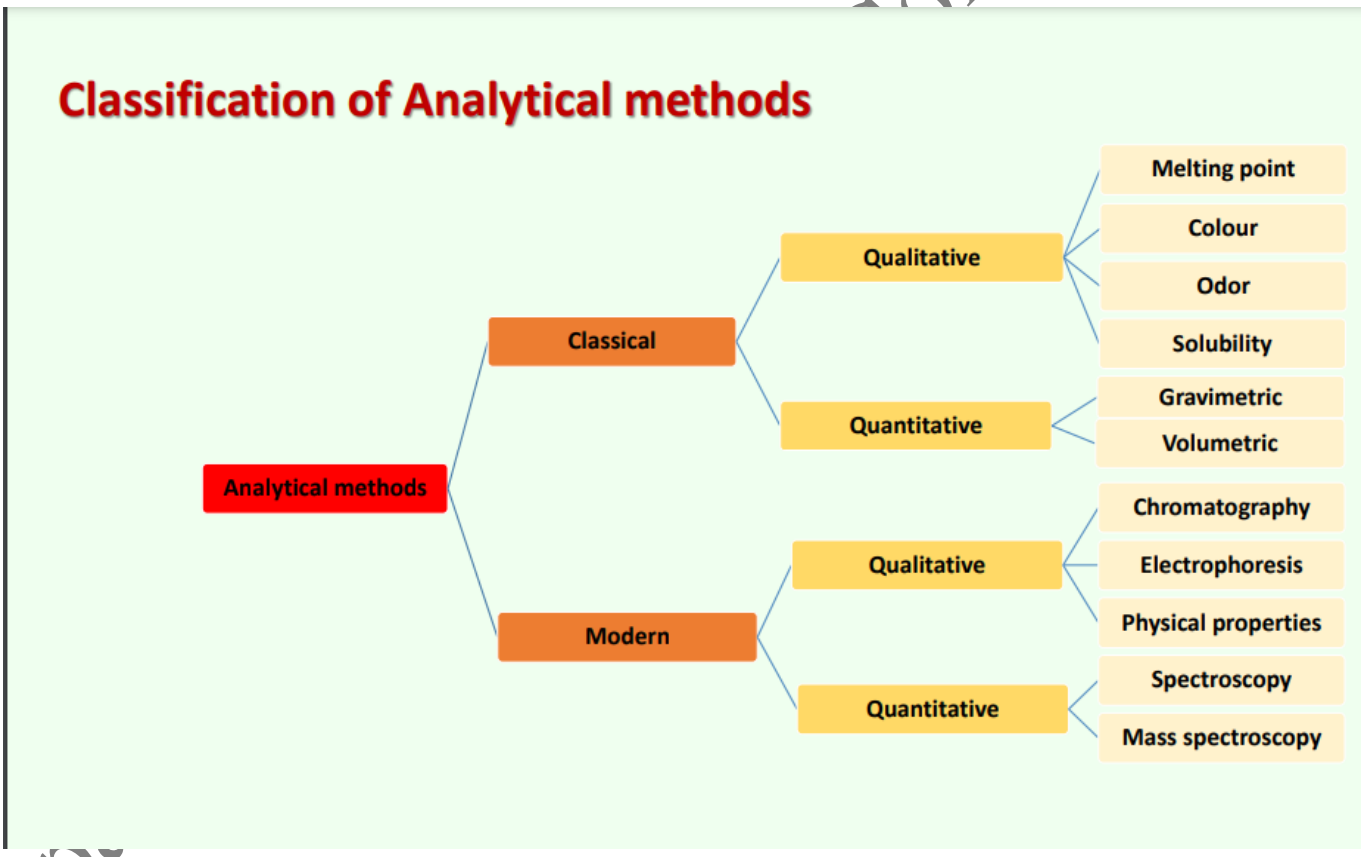
**a) Spectroscopic methods:** are based on measurement of the interaction between electromagnetic radiation and analyte atoms or molecules or on the production of such radiation by analytes (ultraviolet, visible, or infrared), fluorimetry, atomic spectroscopy (absorption, emission), mass spectrometry, nuclear magnetic resonance spectrometry (NMR), X-ray spectroscopy (absorption, fluorescence).

**b) Electroanalytical methods:** involve the measurement of such electrical properties that wanted to be determined, such as pH measurements, electrodeposition, voltametry, thermal analysis, potential, current, resistance, and quantity of electrical charge.

**c) Separation methods:** They mean the isolation of one component or more from a mixture of components in solid, liquid and gas cases. These methods are included with instrumental methods since the instruments and equipment's are used in separation processes. These methods involve precipitation, volatilization, ion exchange, extraction with solvent and various chromatographic methods.

## υ Measurements in Analytical Chemistry:

Units of Measurement: A measurement usually consists of a unit and a number expressing the quantity of that unit. These units are called SI units after the Système International 'Unités. Sometimes it is preferable to express measurements without the exponential term,




**Solvent (larger amount) + Solute (lesser amount) = Solution Solvent**

The medium in which the molecules or ions are dissolved. Solute: Any substance dissolved in a solvent.

**Analyte:** Constituent of the sample which is to be studied by quantitative measurements or identified qualitatively.

**Molarity and Formality** : Both molarity and formality express concentration as moles of solute per liter of solution; however, there is a subtle difference between them. Molarity is the concentration of a particular chemical species. Formality, on the other hand, is a substance's total concentration without regard to its specific chemical form. There is no difference between a compound's molarity and formality if it dissolves without dissociating into ions. The formal concentration of a solution of glucose, for example, is the same as its molarity. **Normality:** Normality defines concentration in terms of an equivalent, which is the amount of one chemical species that reacts stoichiometrically with another chemical species.

**Molality** :It is used in thermodynamic calculations where a temperature independent unit of concentration is needed. Molarity is based on the volume of solution that contains the solute. Since density is a temperature dependent property, a solution's volume, and thus its molar concentration, changes with temperature. By using the solvent's mass in place of the solution's volume, the resulting concentration becomes independent of temperature.

**Weight, Volume, and Weight-to-Volume**: Percents Weight percent (% w/w), volume percent (% v/v) and weight-to volume percent (% w/v) express concentration as the units of solute present in 100 units of solution.

**Parts Per Million and Parts Per Billion**: Parts per million (ppm) and parts per billion (ppb) are ratios that give the grams of solute in, respectively, one million or one billion grams of sample. If we approximate the density of an aqueous solution as 1.00 g/mL, then we can express solution concentrations in ppm or ppb using the following relationships.

$$\text{ppm} = \frac{\mu g}{g} = \frac{mg}{L} = \frac{\mu g}{mL} \qquad \text{ppb} = \frac{ng}{g} = \frac{\mu g}{L} = \frac{ng}{mL}$$

Detection Limit: The smallest amount or concentration of an analyte that can be detected by a given procedure and with a given degree of confidence.

Table 2. Common Units for Reporting Concentration

| Name | Units | Symbol |
|---|---|---|
| molarity | $\frac{\text{moles solute}}{\text{liters solution}}$ | M |
| formality | $\frac{\text{moles solute}}{\text{liters solution}}$ | F |
| normality | $\frac{\text{equivalents solute}}{\text{liters solution}}$ | N |
| molality | $\frac{\text{moles solute}}{\text{kilograms solvent}}$ | m |
| weight percent | $\frac{\text{grams solute}}{\text{100 grams solution}}$ | % w/w |
| volume percent | $\frac{\text{mL solute}}{\text{100 mL solution}}$ | % v/v |
| weight-to-volume percent | $\frac{\text{grams solute}}{\text{100 mL solution}}$ | % w/v |
| parts per million | $\frac{\text{grams solute}}{10^6 \text{ grams solution}}$ | ppm |
| parts per billion | $\frac{\text{grams solute}}{10^9 \text{ grams solution}}$ | ppb |