

## 1.1: Introduction to Elemental Analysis

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The purpose of elemental analysis is to determine the quantity of a particular element within a molecule or material. Elemental analysis can be subdivided in two ways:

- Qualitative: determining what elements are present or the presence of a particular element.
- Quantitative: determining how much of a particular or each element is present.

In either case elemental analysis is independent of structure unit or functional group, i.e., the determination of carbon content in toluene ( $C_6H_5CH_3$ ) does not differentiate between the aromatic  $sp^2$  carbon atoms and the methyl  $sp^3$  carbon.

Elemental analysis can be performed on a solid, liquid, or gas. However, depending on the technique employed the sample may have to be pre-reacted, e.g., by combustion or acid digestion. The amounts required for elemental analysis range from a few gram (g) to a few milligram (mg) or less.

Elemental analysis can also be subdivided into general categories related to the approach involved in determining quantities.

- Classical analysis relies on stoichiometry through a chemical reaction or by comparison with known reference sample.
- Modern methods rely on nuclear structure or size (mass) of a particular element and are generally limited to solid samples.

Many classical methods they can be further classified into the following categories:

- Gravimetric in which a sample is separated from solution as a solid as a precipitate and weighed. This is generally used for alloys, ceramics, and minerals.
- Volumetric is the most frequently employed involves determination of the volume of a substance that combines with another substance in known proportions. This is also called titrimetric analysis and is frequently employed using a visual end point or potentiometric measurement.
- Colorimetric (spectroscopic) analysis requires the addition of an organic complex agent. This is commonly used in medical laboratories as well as in the analysis of industrial wastewater treatment.

The biggest limitation in classical methods is most often due to sample manipulation rather than equipment error, i.e., operator error in weighing a sample or observing an end point. In contrast, the errors in modern analytical methods are almost entirely computer sourced and inherent in the software that analyzes and fits the data.

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