1. Classification of quantitative chemical analysis

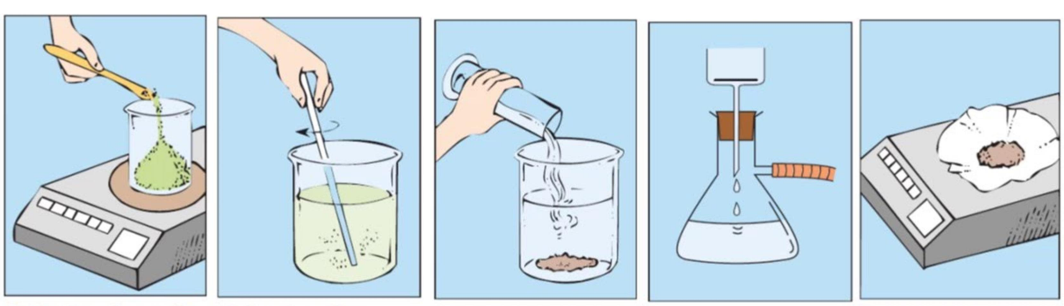
1. Gravimetric analysis

The principles behind the gravimetric analysis are that once an excess of reagent is added to the aqueous solution containing the analyte, a precipitate is formed. The precipitate is then filtered, washed, dried, and weighed. The resulted mass is used to calculate the concentration or amount of the analyte using appropriate stoichiometric ratios. In general, gravimetric analysis refer to a set of methods used in analytical chemistry for the quantitative determination of an analyte (the ion being analyzed) based on its mass.

For example, to determine the chloride ion content in drinking water, Silver Nitrate (AgNO3) will be added to the sample solution, resulting in the precipitation of silver chloride (AgCl), as below equation:

$$Ag(aq) + Cl^{-}(aq) \longrightarrow AgCl(s)$$

Then the precipitate is filtered, washed, dried and it's mass determined. From the mass of the Silver Chloride, the mass of Chloride in the Solution can be determined.

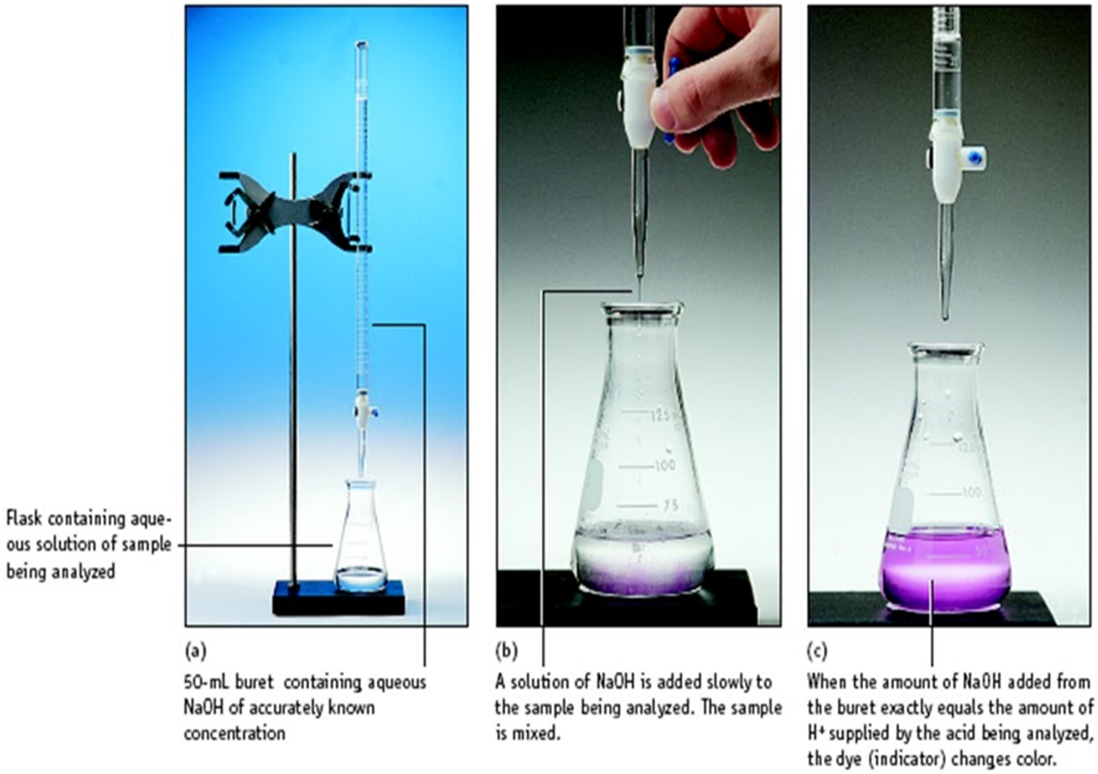


(a) Weighing the sample to be analysed (b) Dissolving this sample in water (c) Adding a suitable chemical to form a precipitate (d) Filtering to collect the precipitate (e) Repeated drying and weighing until a constant mass of precipitate is obtained

2. Volumetric analysis

Volumetric analysis is also known as titrimetric analysis. The reagent (the titrant) is added gradually or stepwise to the analyte from a buret. The key to performing a successful titrimetric analysis is to recognize the equivalence point of the titration (the point at which the quantities of the two reacting species are equivalent), typically observed as a color change. If no spontaneous color change occurs during the titration, a small amount of a chemical indicator is added to the analyte prior to the titration. Chemical indicators are available that change color at or near the equivalence point of acid-base, oxidation-reduction, complexation, and precipitation titrations. The volume of added titrant corresponding to the indicator color change is the end point of the titration. The endpoint is used as an approximation of the equivalence point and is employed, with the known concentration of the titrant, to calculate the amount or concentration of the analyte.

As an example of biological titration, the production of viral vaccines requires virus quantification to monitor the process in order to optimize production yields and respond to ever-changing demands and applications. Virus quantification involves counting the number of viruses in a specific volume to determine the virus concentration in an assay called biological titration. Serial dilutions are performed on a sample in a fixed ratio (such as 1:1, 1:2, 1:4, 1:8, etc.) until the last dilution does not give a positive test for the presence of the virus. This value is known as the titer.



Having explained the volumetric analysis (titration), few expression needs to be explained to fully understand the process:

1. Solution: is a homogenous mixture of two or more substance.
2. Solute: the substance which is dissolved.
3. Solvent: The substance in which the solute is dissolved.

A common example of a solution in everyday life is salt or sugar (solute) dissolved in water (solvent)

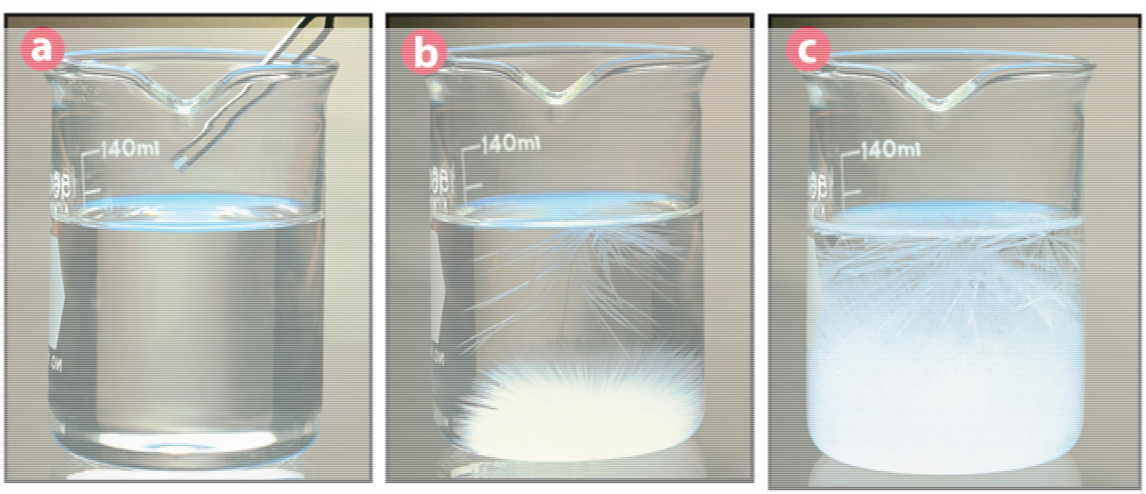
$NaCl_{(s)} + H_2O_{(l)} \longrightarrow$ Salt solution

4. Classification of solutions

The solution can be classified according to the amount of solute, solute particle size and concentration of solvent as follow:

1. Classification according to the amount of solute:

1. Unsaturated solution: A solution (*with less solute than the saturated solution*) that completely dissolves, leaving no remaining substances (a).
2. Saturated solution: A saturated solution is a chemical solution containing the maximum amount of a solute dissolved in the solvent. The additional solute will not dissolve in a saturated solution (b).
3. Supersaturated solution: the definition of a supersaturated solution is one which contains more dissolved solute than could ordinarily dissolve into the solvent. A minor disturbance of the solution or introduction of the tiny crystal of solute will force crystallization of excess solute (c).



4. According to solute particle size:

	Solution	Suspension	Colloid
Definition	A mixture of two or more chemical substances.	A mixture between two substances, one of which is finely divided and dispersed in the other.	Intermediate between a solution and a suspension.
Appearance	Clear, transparent and homogeneous	Cloudy, heterogeneous, at least two substances visible	Cloudy but uniform and homogeneous
Particle Size	molecule in size (10^{-7}-10^{-8} cm)	(10^{-3}-10^{-5} cm)	(10^{-3}-10^{-7} cm)
Separation	A solution cannot be filtered but can be separated using the process of distillation	Many particles of a suspension can be separated through a filter	a colloid will not separate
Visibility	Particles non visible even under The	Particles visible even with naked eye	Particles visible under ultramicroscope

	ultramicroscope		
Example	Sugar in water	include sand in water, dust in the air, and droplets of oil in air	milk

Having explained the solution classification; a return to the quantitative analysis classification:

C. Instrumental analysis

Scientific instruments are used in this field of analytical chemistry to investigate the analyte. Instrumental methods can be divided into three main categories: Chromatography including liquid chromatography (LG), gas chromatography (GC), High-performance liquid chromatography (HPLC), and paper chromatography (PG), the second category is spectrometry such as UV/Visible and infrared.

The third category contains electrochemical instrument including potentiometry, coulometry, and voltammetry. The qualitative and quantitative analysis can be performed, often with the same instrument and may use light interaction, heat interaction, electric fields or magnetic fields. Often the same instrument can separate, identify and quantify an analyte.

5. Application

Having gone through an overview of the background of the quantitative analysis, the subsequent section will focus on the application, exploring how it is carried out in the real world:

1. **Quantitative analysis is crucial to the formulation and testing of food and drugs, as it is used to measure nutrient levels and provide an accurate accounting of dosage**.
2. It is also critical in determining the level of contaminants or the impurity of a sample. While qualitative analysis might be able to determine the presence of lead in the paint on a toy, for example, it is a quantitative analysis that detects how much concentration exists.
3. If you're performing a chemical reaction, quantitative analysis helps you predict how much product to expect and to determine your actual yield.
4. Some reactions take place when the concentration of one component reaches a critical level. For example, an analysis of a radioactive material might indicate there is enough of a key component for the specimen to undergo spontaneous fission!

5. Medical tests rely on quantitative analysis for information about a patient's health. For example, the quantitative analysis could determine blood cholesterol levels or the ratio of lipoproteins in plasma or the amount of protein excreted in urine. Here again, quantitative analysis complements qualitative analysis, since the latter identifies the nature of a chemical while the former tells you how much there is.

6. Recent development in analytical chemistry

A new development in analytical chemistry consists of the use of a technology that takes analysis outside of the laboratory setting and away from the use of more costly conventional methods, it is time-saving, more efficient and integrated several processes into one device.

As a result, there is a need for construction of a portable, disposable, automated and miniaturized systems, such as lab-on-a-chip (LOC) devices , point -of -care (POC) systems, micro total analysis system (μTAS), and drug delivery system (DDS), etc., which can provide valuable information. Due to the minimization of the device the in/out fluid must be minimized to microfluidic size. The design and approach for these components can vary greatly within research groups but with each sharing an end goal, to produce a device which can function easier and just as well as the conventional methods currently available.

This encouraged researches to apply it in the diverse area including chemistry, medicine, engineering, forensics and bioanalytical researches, for example for DNA separation and analysis, cell separation and manipulation, enzyme kinetic studies, drug discovery, and immunoassay, etc.