Analytical Chemistry

Vocabulary of Curriculum:

- General Introduction.
- Classification of Analytical Chemistry.
- Methods of expressing concentration.
- Qualitative Analysis.
- Quantitative Analytical.
- Volumetric Analytical.
- Types of Titration.
- Gravimetric Analysis.
- Calculations of equilibrium Constant.
- Solubility product constant.
- Calculations of KSP.
- Buffer Solutions.
- AnalyticalStatistics.

References

- Fundamental of Analytical Chemistry.
  by Skoog & West, Holler , Crouch. 10^{th}-Ed 2022
- Fundamental of Analytical Chemistry.
  by Skoog & West. 9^{th} -Ed 2013
- Analytical Chemistry.
  by Christian. 2004
- Analytical Chemistry.
  (An Introduction) by Skoog & West. 1994.
- Principle of Instrumental Analysis 7^{Th} Edition
  By Douglas A. Skoog, F.Games Holler, Stanley R. Crouch 2016.
- Fundamental Chemistry for Medical Science
  By Dr. Jameel M. Dhabab 2020

General Introduction

Define Chemistry:

Chemistry is the science which deals with materials (elements or compounds) and their reactions.

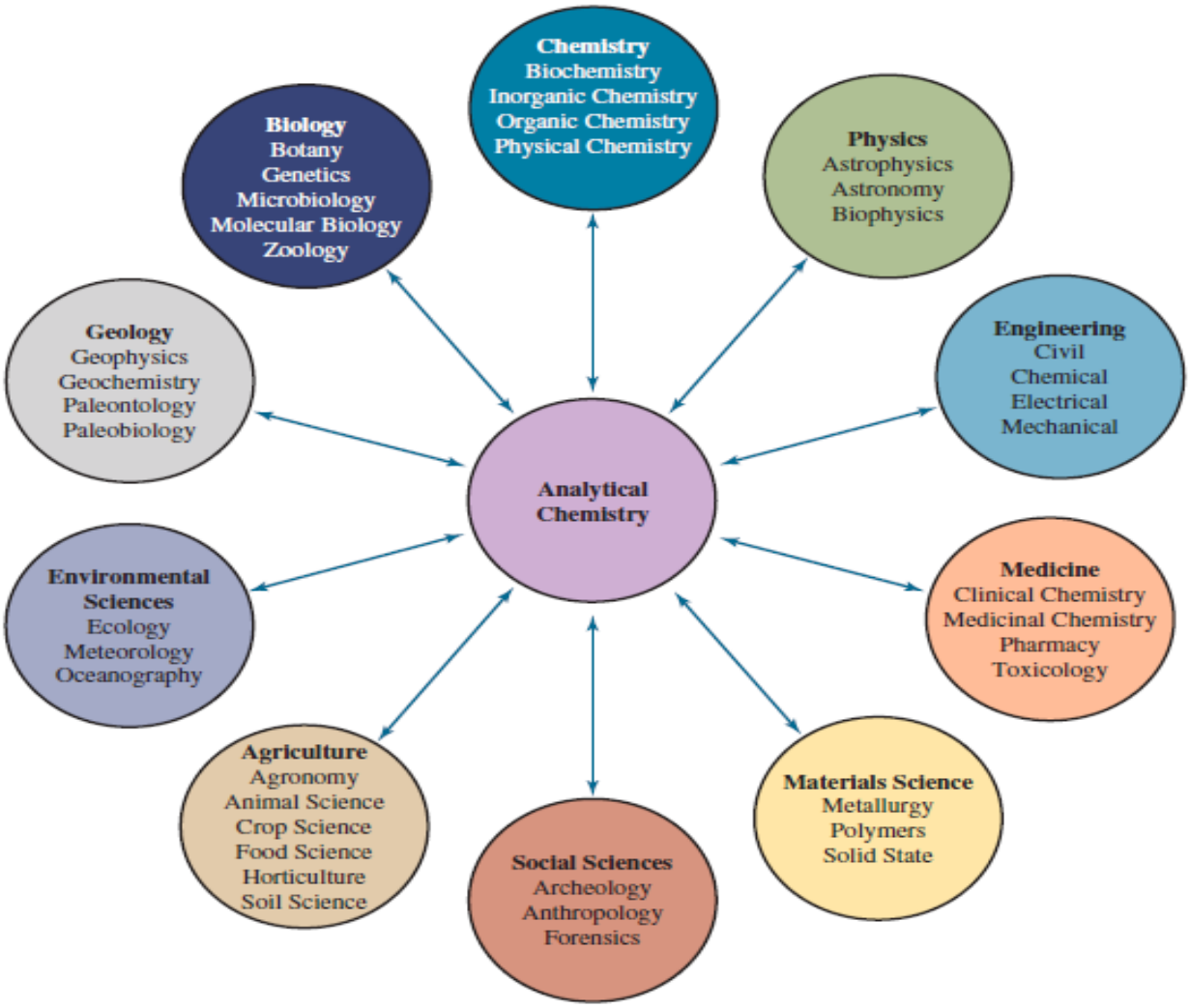
Classified the Chemistry:

1. ***Analytical chemistry:*** is the science which deal with the analysis of substances qualitatively and quantitatively.
2. ***Biochemistry:*** interest with studying the bio compounds which exist inside the living organisms.
3. ***Organic chemistry:*** studying of carbon compounds and their reactions.
4. ***Inorganic chemistry:*** studying of all elements in periodic table except carbon.
5. ***Physical chemistry:*** deals with physical properties substances during reaction such as: heat, solubility, and conductivity…etc.
6. ***Industrial chemistry:*** this branch deals with manufacturing of materials and their use in our life.

Analytical Chemistry

Define Analytical Chemistry

Is a branch of chemistry science which defined as the means that are detected elements and materials and the method of separated and know the compounds of those substances in a mixture of them in addition to determined of those components quantitatively.

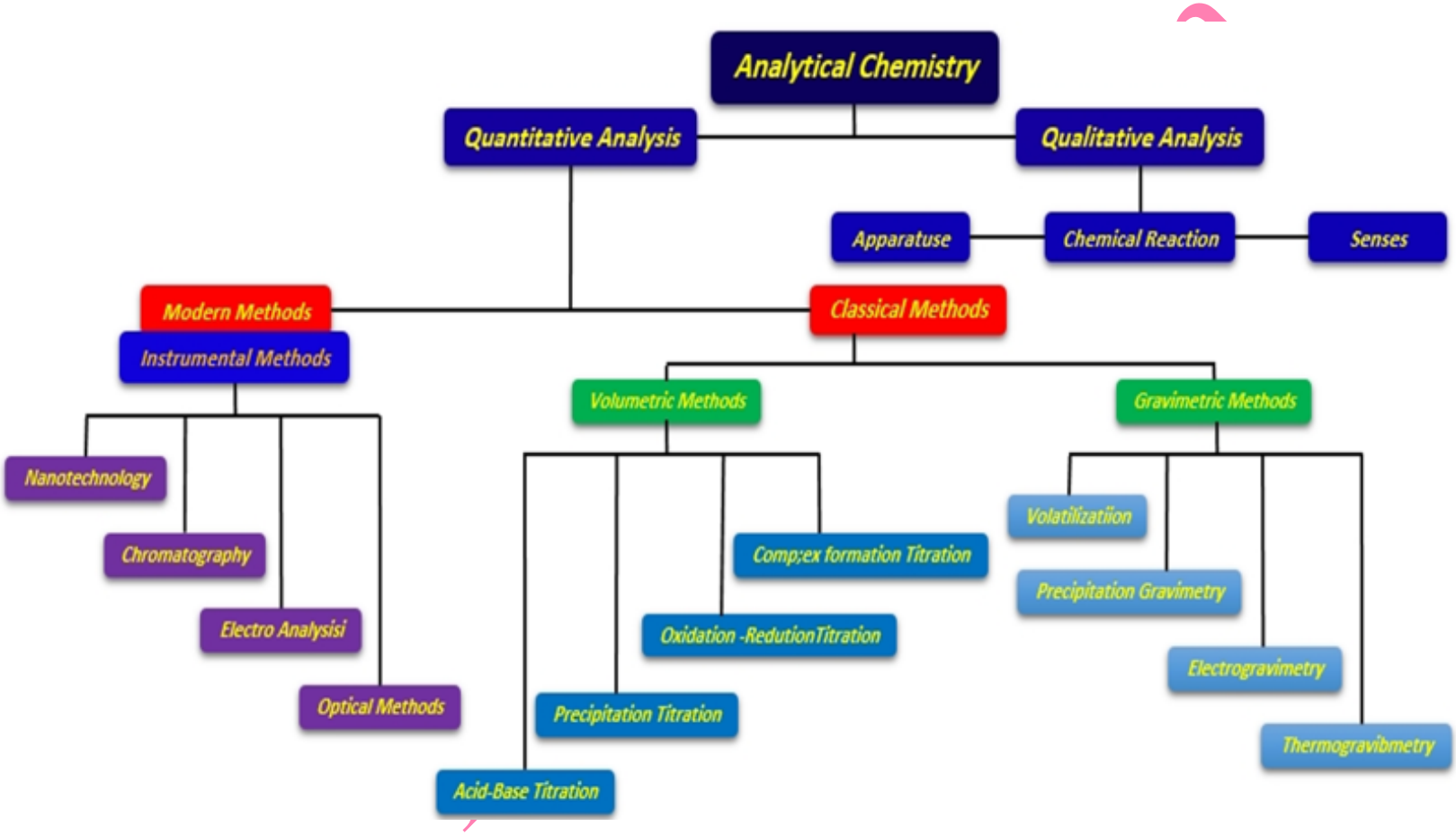


Figure

The relationship between analytical chemistry, other branches of chemistry, and the other sciences. The central location of analytical chemistry in the diagram signifies its importance and the breadth of its interactions with many other disciplines.

Classification of Analytical Chemistry

The following scheme for the classification of analytical chemistry.



- Analytical chemistry deals with separating, identifying, and quantifying the relative amounts of the components of an analyte.

- ***Analyte***: the thing to analyzed; the component(s) of a sample that are to be determined.

Steps of Analysis:

1. The aim of analysis (determination, identification, separation)
2. Select the analysis method (which depends on: Accuracy in analysis, time, amount of sample to be determined.
3. Prepare the sample.
4. Using separation technique if it's necessary.
5. Analysis.
6. Results and discussion.

Solutions

A homogeneous mixture of two or more of substances.

That is mean: overlapping molecules or ions of solute between molecules or ions of solvent, the product called ***Solution***.

Solution = Solute + Solvent

There are different types of solution

A. According to the size of atoms or molecules:

1. ***Real Solution***: The solution which it's molecules pass through the filter paper fully and easily.
2. ***Suspension solution***: In this solution some of the molecules don't pass through the filter paper fully and easily.
3. ***Colloidal solution***: In this solution the molecules don't pass through the filter paper as well as don't precipitate if let the solution to stable.

B. According to the concentration of solute:

- ***Unsaturated Solution (Normal solution):***
  The solution which can added more amount of solute in it at room temperature.

- ***Saturated Solution:*** The solution which contain the solute in dynamic equilibrium state with solvent at room temp.

- ***Super Saturated Solution:*** The solution that contains more amount of solute than those found in saturated solution at high temperature when return to room temperature some of the solute will be precipitate.

Concentrated Solution: that is mean the solution contains amount of solute.

Diluted Solution: It is opposite the concentrated solution that is mean the solution contains less amount of solute.

C. According to the Nature of Solvent:

Liquid Solution , Organic Solution

How can change concentrated solution to the diluted one

by added solvent.

Concentrated Solution **Diluted Solution**

by removal solvent

Standard Solutions:

Is a reagent of exactly known concentration which come from dissolve exactly weight of primary standard material in known volume of solvent.

There are two types of standard materials:

I. Primary Standard Material:

Is a highly purified compound that serves as reference material for a titrimetric method of analysis and which can directly prepared primary standard solution.

such as: Na_2CO_3, KCl, NaCl, Na_2SO_4, $MgSO_4.7H_20$…ect.

II. Secondary Standard Material:

Is a compound whose purity has been established by chemical analysis that serves as the reference material for a titrimetric method analysis. And can't prepared primary standard directly from these compound unless standardization it.

such as: NaOH, H_2SO_4, KOH, HCl, $KMnO_4$…ect.

Important requirements for a primary standard material are the following:

1. High purity establish methods for confirming purity should be available.
2. Atmospheric stability.
3. Absence of hydrate water so that the confirming of the solid does not change with variations in humidity.
4. Modest cost.
5. Reasonable solubility in the titration medium.
6. Reasonably large molar mass so that the relative error associated with weighing the standard is minimized.

Methods of Expressing Concentration:

Concentration: The amount of solute located in a certain solvent or solution.

Mole: Is Avokadro's number of particles.
Particles: ions, electrons, atoms, molecules.

$$\textbf{Mole} = \frac{\boldsymbol{Weight\ (w)}}{\boldsymbol{Molecular\ weight\ (M.wt.)}} = \frac{\boldsymbol{W}}{\boldsymbol{M.wt.}}$$

Molecular weight = (M.wt): is a total of atomic weight in the compound.

$$\textbf{M.wt.} = \frac{\boldsymbol{W}}{\boldsymbol{Mole}} \quad \text{g / mole}$$

Example 1:

Calculate the M.wt. of benzoic acid $C_7H_6O_2$?
A.wt.: C=12, H= 1, O= 16

Example 2:

How many grams of sodium ion Na^+ are contained in 20g. of sodium carbonate Na_2CO_3 ? A.wt.: Na = 23, C=12, O =16

Specific gravity (Sp.gr.): It's the ratio between density of substance to the density of water.

Density of Water = 1 g/L

$$d = Sp.gr. = \frac{1}{1} = 1$$

There are ***Two*** types of the methods for expressing the concentration:

First: Physical methods for expressing concentration:

I. Percentage %:

A. Weight percent : W/W %

The number of grams of solute in 100 gram of solution.

$$W/W\ \% = \frac{Weight\ (wt) solute\ (g)}{weight\ (wt)\ solution\ (g)} \times 100$$

Weight solution would be more properly called mass percent and abbreviated m /m.

B. Volume percent :V/V %

The number of milliliters of solute in 100 milliliter of solution.

$$V/V\ \% = \frac{Volume\ solute\ (mL)}{Volume\ solution\ (mL)} \times 100$$

Volume of solution = V. of solute + V. of solvent

C. Weight – Volume percent : W/V%

The number of grams of solute in 100 mL of solution.
It's used for two miscible and diluted liquids.

$$W/V\ \% = \frac{Weight\ solute\ (g)}{Volume\ solution\ (mL)} \times 100$$

Example 1.:
How many grams of NaCl needed to prepare 500mL of normal saline solution in concentration W/V= 70%?

Example 2.
Calculate the weight percent of solution prepared by dissolve 5g of $AgNO_3$ in 100 mL of water? Note; water density =1.