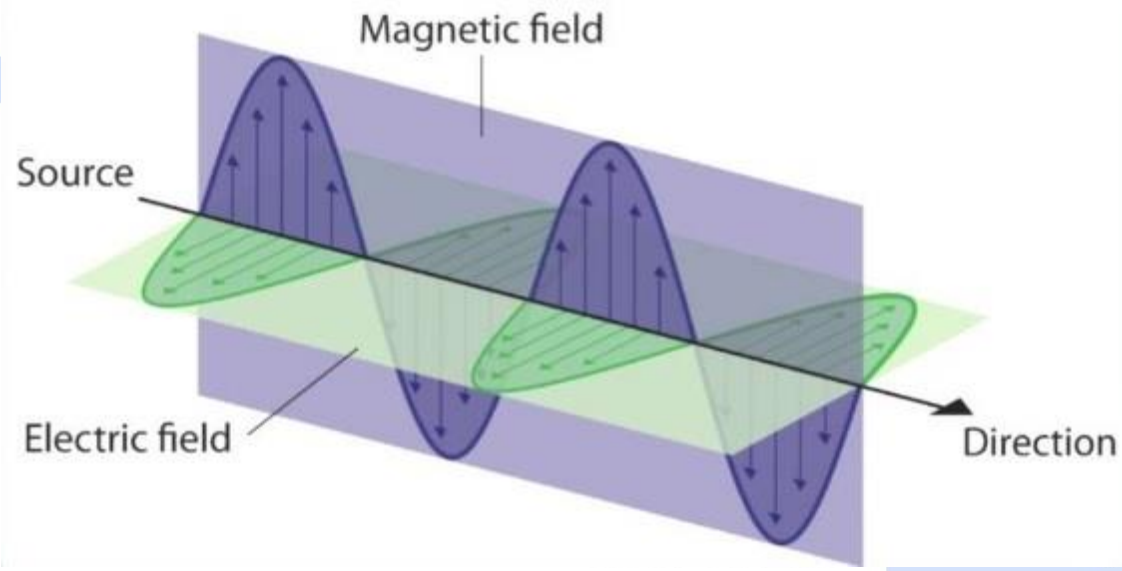
UV-Visible Spectrophotometer

Introduction:

- **What is EMR?**



Electromagnetic Radiation is an electric and magnetic disturbance traveling through space at the speed of light (2.998×10^8 m/s). It contains neither mass nor charge but travels in packets of radiant energy called photons, or quanta. Examples of EM Radiation include radio waves and microwaves, as well as infrared, ultraviolet, gamma, and x-rays. Some sources of EMR include sources in the cosmos (e.g., the sun and stars), radioactive elements, and manufactured devices. EMR exhibits a dual wave and particle nature.

- **What is spectroscopy/Spectrophotometry?**

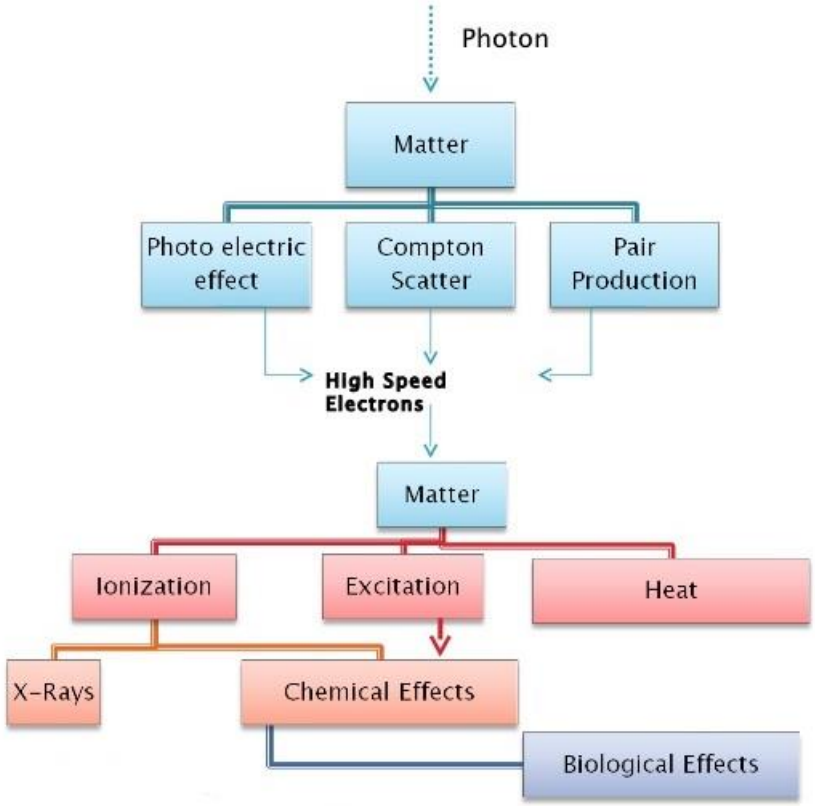
It is study of the absorption and emission of light and other radiation by matter, as related to the dependence of these processes on the wavelength of the radiation. More recently, the definition has been expanded to include the study of the interactions between particles such as electrons, protons, and ions, as well as their interaction with other particles as a function of their collision energy.

- **What is Spectrometer/Spectrophotometer?**

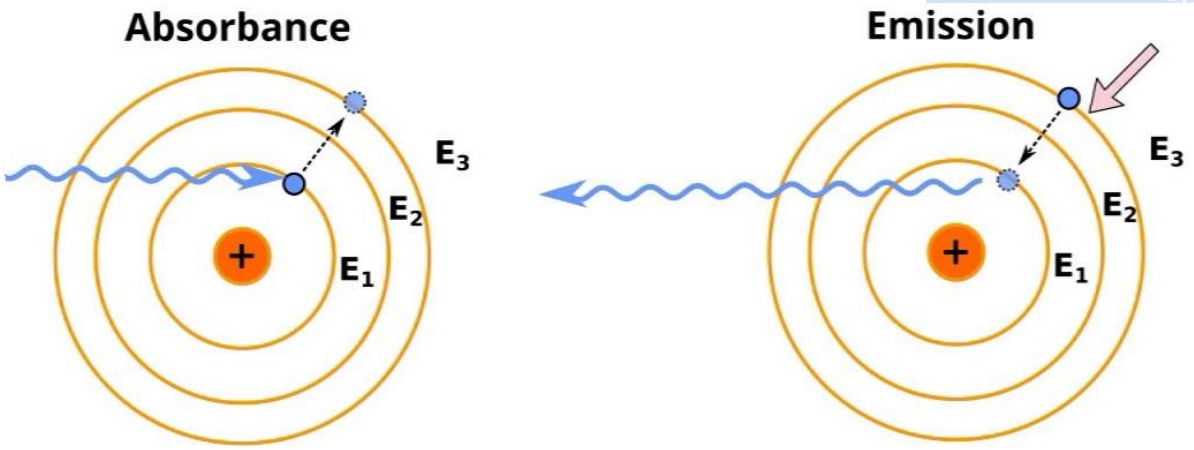
Analytical instruments used to identify the characteristics of materials by measuring the emissions and absorption of electromagnetic spectra.

- How does matter react with Radiation?

Process	Definition
Attenuation	Removal of radiation from the beam by the matter. Attenuation may occur due to **scattering** and **absorption**
Absorption	The taking up of the energy from the beam by the irradiated material. It is absorbed energy, which is important in producing the radiobiological effects in material or soft tissues.
Scattering	refers to a change in the direction of the photons and its contributes to both attenuation and absorption
Transmission	Any photon, which does not suffer the above processes is transmitted.



- What are Absorption & Emission?



$E_{photon} = \Delta E_{electron} = E_3 - E_1$

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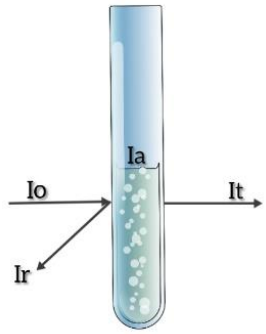
- What is UV–Visible Spectrophotometry?

This spectroscopy is used to obtain the absorbance spectra of a compound in solution or as a solid. What is actually being observed spectroscopically is the absorbance of light energy or electromagnetic radiation, which excites electrons from the ground state to the first singlet excited state of the compound or material. The UV-vis region of energy for the electromagnetic spectrum covers 1.5 - 6.2 eV which relates to a wavelength range of 800 - 200 nm.

- What is Beer–Lambert's Law?

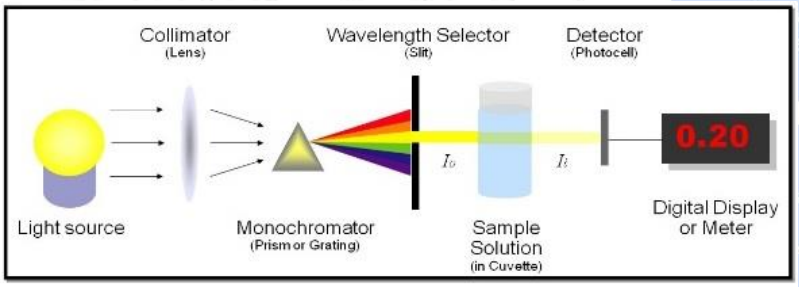
The Beer-Lambert law states that the quantity of light absorbed by a substance dissolved in a fully transmitting solvent is directly proportional to the concentration of the substance and the path length of the light through the solution.

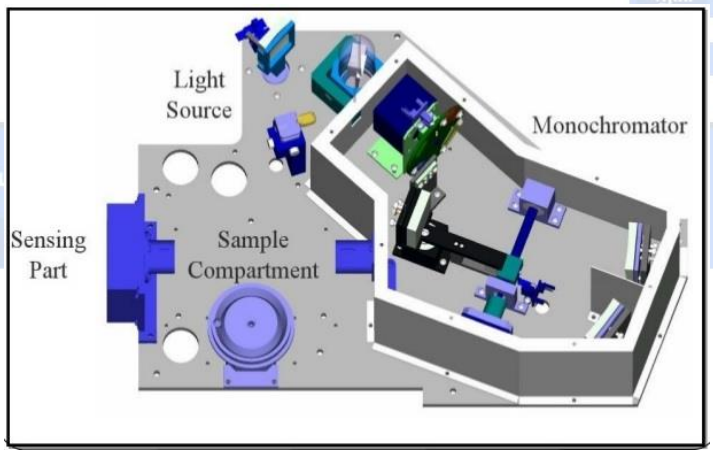


$$A = \varepsilon c l$$

A	Absorbance	
ε	Molar absorption coefficient	$M^{-1}cm^{-1}$
c	Molar concentration	M
l	optical path length	cm

- What is UV–Visible spectrophotometer and its structure?





- Radiation Source:

Continuum Sources

- Emit radiation over a wide range of wavelengths
- Intensity of emission varies slowly as a function of wavelength
- Used for most molecular absorption and fluorescence spectrometric instruments

- Examples
  - Tungsten filament lamp (visible radiation)
  - Deuterium lamp (UV radiation)
  - High pressure Hg lamp (UV radiation)
  - Xenon arc lamp (UV-VIS region)
  - Heated solid ceramics (IR region)
  - Heated wires (IR region)

Line Sources

- - Emit only a few discrete wavelengths of light
- - Intensity is a function of wavelength
- - Used for molecular, atomic, and Raman spectroscopy

- Examples
  - Hollow cathode lamp (UV-VIS region)
  - Electrodeless discharge lamp (UV-VIS region)
  - Sodium vapor lamp (UV-VIS region)
  - Mercury vapor lamp (UV-VIS region)
  - Lasers (UV-VIS and IR regions)

Various UV radiation sources are as follows

a. Deuterium lamp
b. Hydrogen lamp
c. Tungsten lamp
d. Xenon discharge lamp
e. Mercury arc lamp

Various Visible radiation sources are as follow

a. Tungsten lamp
b. Mercury vapour lamp
c. Carbonone lamp

Detectors:

Requirements of an ideal detector:-

- It should give quantitative response.
- It should have high sensitivity and low noise level.
- It should have a short response time.
- It should provide signal or response quantitative to wide spectrum of radiation received.

1. Barrier layer cell/Photovoltaic cell
2. Phototubes/ Photo emissive tube
3. Photomultiplier tube

- **Solution Conditions**:

I-Clear.

II-Homogeneous.

III-Colored (a MUST for Visible).

- **Applications**:

1. Detection of Impurities- UV absorption spectroscopy is one of the best methods for determination of impurities in organic molecules.

2. Structure elucidation of organic compounds- UV spectroscopy is useful in the structure elucidation of organic molecules, the presence or absence of unsaturation, the presence of hetero atoms.

3. Quantitative analysis- UV absorption spectroscopy can be used for the quantitative determination of compounds that absorb UV radiation.

4. Qualitative analysis- UV absorption spectroscopy can characterize those types of compounds which absorbs UV radiation. Identification is done by comparing the absorption spectrum with the spectra of known compounds.