UV-Visible Spectroscopy

UV-Visible Spectroscopy Principle:

UV-Visible spectroscopy is a technique that involves the study of the absorption of ultraviolet (UV) and visible light by molecules. The principle is based on the fact that molecules absorb light in the UV and visible regions of the electromagnetic spectrum, leading to electronic transitions between energy levels. The absorption of light corresponds to the promotion of electrons from lower energy levels to higher energy levels.

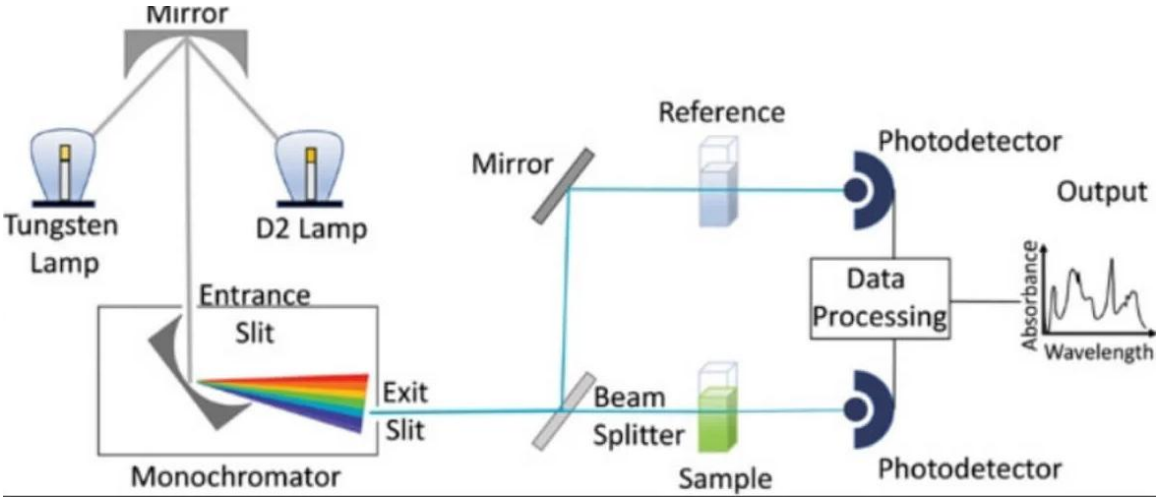
The basic principle can be summarized as follows:

- When a molecule absorbs UV or visible light, electrons in the ground state are excited to higher energy levels.
- The energy of the absorbed light corresponds to the energy difference between the ground state and the excited state.

Instrumentation:

The basic components of a UV-Visible spectrophotometer include a light source, a monochromator, a sample holder or cuvette, a detector, and a data display or output. Here's an overview of each component:

1. **Light Source:** The light source emits a broad spectrum of UV and visible light. Common sources include deuterium lamps for the UV region and tungsten filament lamps for the visible region.
2. **Monochromator:** The monochromator selects a narrow wavelength range from the broad spectrum emitted by the light source. It ensures that only the desired wavelength reaches the sample.
3. **Sample Holder (Cuvette):** The sample is placed in a transparent container called a cuvette. The cuvette allows light to pass through the sample for analysis.
4. **Detector:** The detector measures the intensity of the transmitted or absorbed light after it passes through the sample. Photodiode arrays or photomultiplier tubes are commonly used detectors.
5. **Data Display/Output:** The instrument displays the absorbance or transmittance values at different wavelengths. A spectrum is obtained by scanning through a range of wavelengths.



In UV-Visible (UV-Vis) spectroscopy, electronic transitions involve the movement of electrons between different energy levels in a molecule. There are four main types of electronic transitions that can occur, each associated with specific changes in the electron configuration.

The various electronic transition is σ-σ*, n-σ*, π-π*, n-π*. The energy required for various transition obey the order of σ-σ*> n-σ*> π-π*> n-π*.

σ-σ* transition= It is a high-energy process. Saturated hydrocarbon like methane shows σ-σ* transition.

n-σ* transition = Saturated compounds containing one heteroatom show n-σ* transition. Here the transition from nonbonding orbital to sigma antibonding orbital takes place.

π-π* transition= Molecules having double and triple bonds show π-π* transition. This type of electronic transition normally occurs at lower energy.

n-π* transition = In this transition, one electron of the heteroatom gets excited to π antibonding orbital. This process requires low energy.