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# A review on advances in UV spectroscopy

**Sargar Komal Bharat[1], Alfa Jain[2]**
[1] Institute of Pharmaceutical Science and Research, (for girls), Swami-Chincholi Bhigwan, Pune, Maharashtra, India
[2] Guide, Department of Pharmaceutical Quality Assurance, Institute of Pharmaceutical Science and Research (for girls), Pune, Maharashtra, India

**Abstract**
The term used for the analytical assessment of various types of solvents and compounds is UV- Vis spectroscopy for the past 37 years, UV- Vis visible spectrometers is typically chosen, especially by small-scale enterprises, because the equipment is less expensive and has less maintenance issues.
The analytical approach is based on evaluating the monochromatic light's absorption by colorless substances in the near ultraviolet path of spectrum (200-400nm). The process required to ascertain the "identification, strength, quality and purity" of such chemicals is included in the pharmaceutical analysis. Additionally, it covers the study of starting material and in the production of pharmaceuticals. This paper describes the various applications of UV spectroscopy qualitatively as well as quantitatively.

**Keywords:** UV spectroscopy, detector, analytical, spectra

## Introduction
The molecular absorption is investigated in the wavelength range of 190 to 800 nm of the electromagnetic spectrum, in the ultraviolet region from 190-400nm, and in the visible region from 400-800nm [1].
Ultraviolet (uv) spectroscopy is a physical technique of optical spectroscopy that uses light in the visible, ultraviolet, and near infrared ranges. The thickness (b) and concentration (c) of a homogenous solution affect how much monochromatic radiation is released when it passes through the solution in a cell.
I0 is the radiation intensity that is incident, and I is the radiation intensity that is transmitted [2].

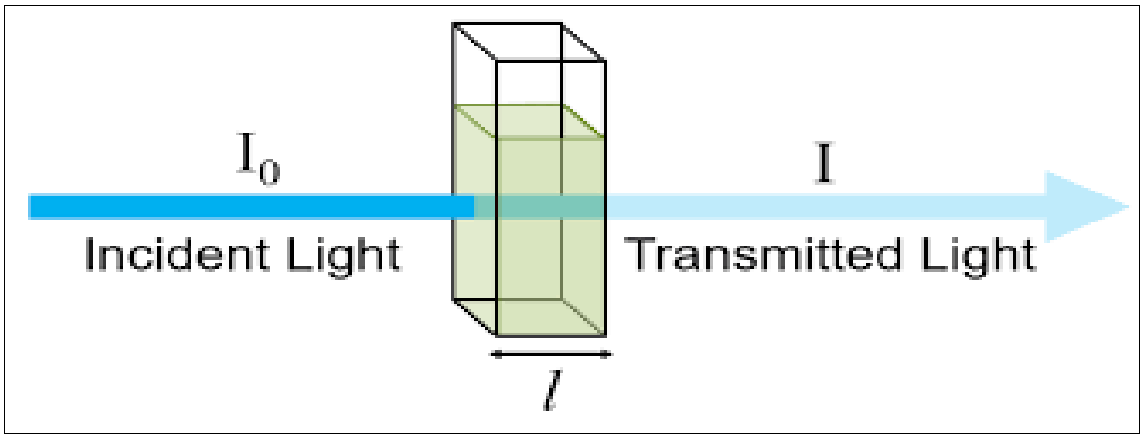



**Fig 1:** Mechanism of absorbance

Transmittance is a method for calculating the amount of radiation absorbed.
Transmittance T=I/I0
Transmittance %T= 100xT
Absorbance A = 2-log10%T
transmittance percentage in this instance is 100%. If all of the light is absorbed, then there is infinite absorption and 0% transmission [3].

## Principle
According to the Beer lambert equation, a solution's absorbance (A) is inversely correlated with the concentration of the absorbing species (c) present in the solution and path length(b) [4].

Absorbance A= molar absorptivity constant X Cell length X concentration
A= abc
C=A/ab
In where absorbance is A
A stand for molar absorptivity, b for path length and c for concentration.

## Electronic transition
When radiation induces an electronic transition within a molecule or ion, the molecule or ion will show absorption, the molecule or ion will show absorption in the visible or ultraviolet area. As a result, when a sample absorb light in the ultraviolet or visible range, the molecules inside the sample experience a change in their electronic state.

Electrons will be promoted from their ground state orbitals to higher energy excited state orbitals or antibonding orbitals by the energy provided by light [5].

The following electronic transitions can occur by the absorption of ultraviolet and visible light.

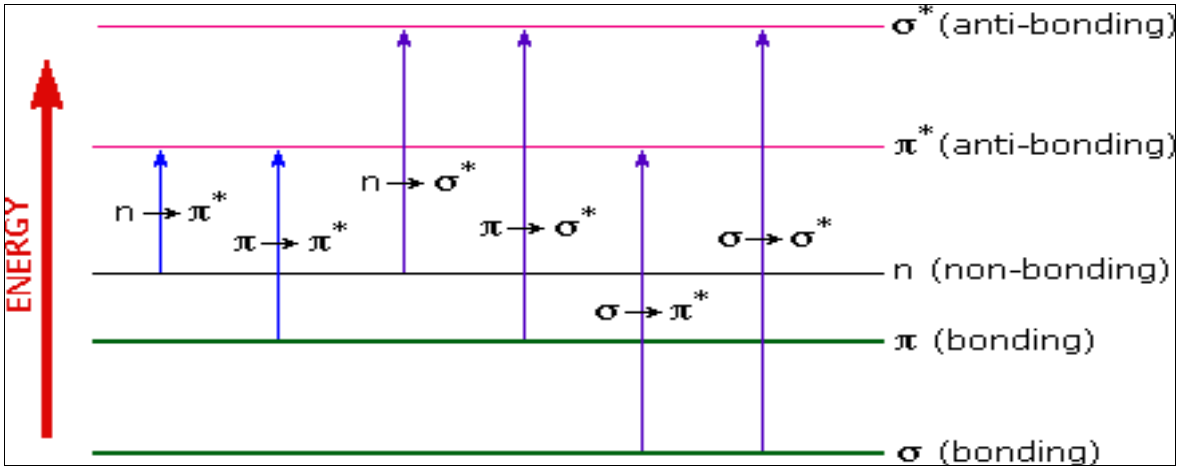



**Fig 2:** Electronic transition of σ, π and n electrons.

1. σ to σ* Transitions
2. n to σ* Transitions
3. n to π* and π to π* Transitions

**Instrumentation**

The essential components of UV-Vis spectrophotometer are as follows.

1. Sources (UV- Visible)
2. Monochromator
3. Sample containers (cuvette)
4. Detector
5. Amplifier and recorder [6].

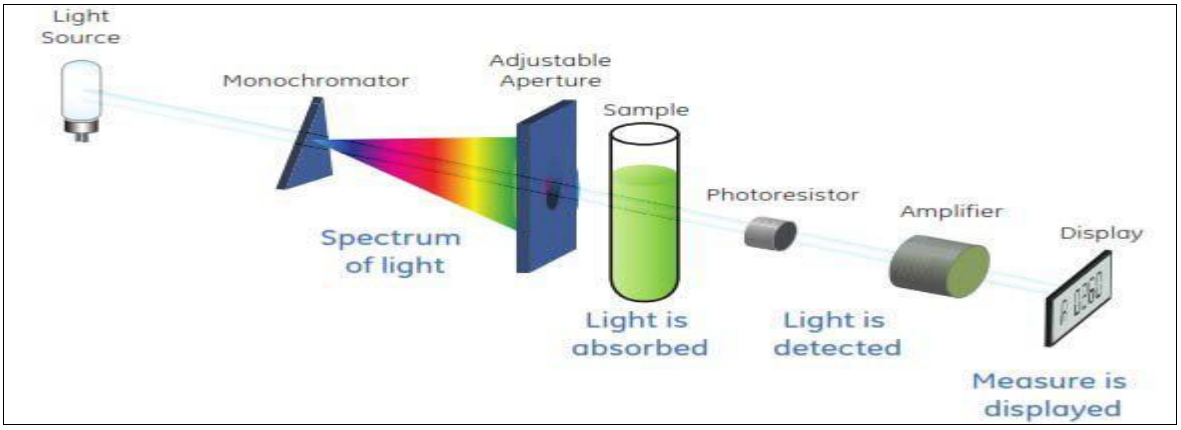



**Fig 3:** schematic diagram of uv spectrophotometer

**1. Sources**

A continuous source, or one that emits radiation at a variety of wavelengths, is necessary for UV- Vis spectroscopy.

The following are many sources of uv radiation:

1. Hydrogen lamp
2. Deuterium lamp
3. Tungsten lamp
4. Xenon discharge lamp

**2. Monochromator**

A Monochromator subtracts undesirable wavelengths from the radiation source light to produce Monochromator light. Through the entrance slit, multi-wave length polychromatic light enters Monochromator. following collimation, the beam is directed at an angle toward the dispersion component. The grating or prism separates the beam's wavelengths into their individual components. Only radiation of specific wavelength exists the Monochromator through the exit slit when the dispersing element or exit slit is moved [7].

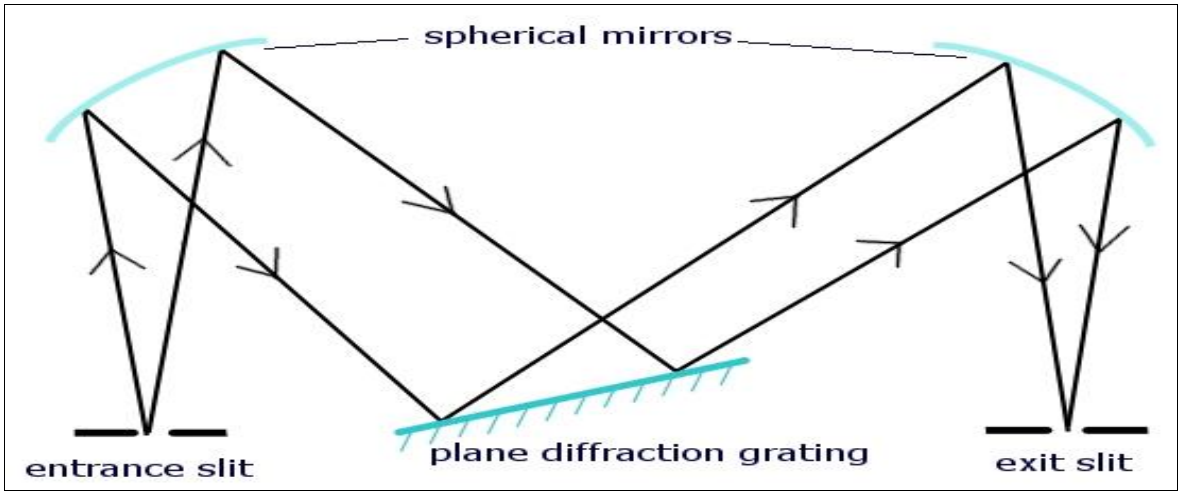
**The Monochromator (wavelength selector)**

All monochromators contain the following component parts.

- An entrance slit
- A collimating lens
- A dispersing device (usually a prism or grating)
- A focusing lens
- An exit slit [8].

Radiation with many wavelengths, or polychromatic radiation, enters the monochromator through the entrance slit.

After being collimated, the beam angles toward the dispersing component. The grating or prism separates the beam's wavelengths into their individual components. Only radiation of a specific wavelength exits the monochromator through the exit slit when the dispersing element or exit slit are moved [9].




**Figu4:** Turner grating monochromator.

**3. Sample cell:** To allow radiation to travel through them, the containers holding the sample and reference solution must be transparent. For UV spectroscopy, quartz or fused silica cuvettes are necessary. Additionally transparent in the visual range are these cells. To create cuvettes for use between 350 and 200nm, silicate glasses can be utilized [10].

**Fig 5:** Sample solution in cuvette

**4. Detector**

A semiconductor device called a photodetector transforms light energy into electrical energy. It is made up of a straightforward P-N junction diode and intended to function when reverse biased. As photons approach the diode, the photodiode absorbs them and produces electricity

**Types of detectors**

1. Barrier layer cell/photovoltaic cell
2. Phototubes/photo emissive tube
3. Photomultiplier tube [11].

**Chromophores**

The presence of a certain functional group in many organic compounds causes them to absorb ultraviolet and visible light. The groups that absorb the radiation are called chromophores. Some electronic transitions of predicted to be statically probable (said to be allowed, and these absorptions are powerful and typically have values in the excess of 10000), according to mathematical analyses of the energy levels of orbital systems. Other transition, which arte believed to be banned at commonly happen, have a probability of zero, are not predicted to happen at all, and produce weak bands with values that seldom ever go beyond 1000.

The $\pi$ - $\pi^*$ absorption of aromatic compound at Ca 230-330nm, depending on the substituents on the benzene ring, and the n - $\pi^*$ absorption of carbonyl groups at Ca 280nm.Eg NO2 [12,13].

**Auxochromes**

group termed auxochromes which typically do not absorb appreciably in the 200-800nm area but will change the spectrum of the chromophore to which they are linked, can

intensity the colour of a molecule. The most significant auxochrome groups have acidic (phenolic) or basic characteristics, and they include OH, NH4, CH3 and NO2. The real impact of an auxochrome and chromophore is determined n-1 the auxochromes, polarity, such as groups like CH3-. In general, the action of non-polar or weakly dollar auxochromes should be predictable. Auxochrome effect is also highly influenced by the availability of non-bonding electrons that may undergo transitions. CH3CH2- and – cl have a very little effect, usually a small red shift of 5-10nm. Popular other groups that fully change the spectra of chromophores, include -NH2 and No2. [12,13].

**Application of uv spectroscopy**

Since all compounds that absorb ultraviolet and visible electromagnetic radiation may be quantitatively analysed using UV spectroscopy, it is widely utilised in teaching, research, and analytical laboratories.

**1. Qualitative analysis:** UV-Vis spectroscopy has been used to reveal the structures of organic compounds, identify the various organic compounds that are present in a mixture, and separate the compounds using various analytical techniques such thin layer chromatography.

**a. elucidation of organic compounds**

To understand the structure of organic substances, UV spectroscopy is helpful. A certain chromophore's presence or absence in the compound may be inferred from the presence or absence of a specific absorption band at a specific wavelength [14].

**b. Impurity detection**

**2. Quantitative evaluation**

a. **Determining the concentration of the compound**
   Quantitative analysis of substances can be done using UV absorption spectroscopy. Absorb ultraviolet rays. This decision is based on Beer's law, which states that the concentration, c, is directly proportional to the absorbance, A of a material at a given wavelength [15].

   $$A = \log 10\ I0 / I = \log 1/ T = – \log T = \varepsilon bc$$

b. Dissociation constants of acid and base
c. In the quantification and thermal denaturation of DNA

3. Determination of configurations of geometrical isomers
4. Distinction in conjugated and non-conjugated compounds
5. Differentiating between equatorial and axial conformation

**Conclusion**

spectroscopy is used for two measurements techniques; how much analyte is in the sample (quantitative analysis) and which analyte is in the sample (qualitative analysis). An area under curve method is "the area under two points on the mixture spectra is directly proportional to the concentration of the compound of interest" particularly suitable for the compounds where there are no sharp peak or broad spectra are obtained. The pharmaceutical analysis by UV-Visible Spectroscopy comprises the procedures necessary to determine the "identity, strength, quality and purity" of compounds. Present review concludes various applications of UV spectroscopy qualitatively as well as quantitatively.

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