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A Review on Absorption Spectra of Inorganic Compounds

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Abstract

Spectroscopy is the study of absorption and emmision of light and other radiation by matter.It is the branch of science concerned with the spectra of electromagnetic radiation as a function of its wavelength or frequency measured by spectrographic equipment, and other techniques in order to obtain information concerning the structure and properties of matter.
It is an experimental method which aims at obtaining molecular information on the system under study. The link between observation and information is provided by the theory of the molecular interaction between electromagnetic or particle radiation and matter. In the present study, we are going to study in detail the scope, principle and applications of UV spectroscopy where in the lambda max of various compounds were determined.

Keywords: Spectroscopy, Electronic Transitions, UV –Visible Spectroscopy,

INTRODUCTION:

Spectroscopy is the study of the properties of matter through its interaction with various types of radiation (mainly electromagnetic radiation) of the electromagnetic spectrum. Spectrometric techniques are a large group of analytical methods that are based on atomic and molecular spectroscopy. Spectrometry and spectrometric methods refer to the measurement of the intensity of radiation with a photoelectric transducer or other types of electronic device. The UV-VIS spectrometry is one of the oldest instrumental techniques of analysis and is the basis for a number of ideal methods for the determination of micro and semi micro quantities of analytes in a sample. It concerns with the measurement of the consequences of interaction of Electromagnetic radiations in the UV and/or visible region with the absorbing species like, atoms, molecules or ion. [1]
Spectroscopy as a science began with Isaac Newton splitting light with a prism and was called optics. Therefore, it was originally the study of visible light which we call color that later under the studies of James Clerk Maxwell came to include the entire electromagnetic spectrum. Spectroscopy is the branch of science dealing with the study of interaction of electromagnetic radiation with matter. The most important consequence of such interaction is that energy is absorbed or emitted by the matter in discrete amounts called quanta. The absorption or emission processes are known throughout the electromagnetic spectrum ranging from the gamma region (nuclear resonance absorption or the Mossbauer effect) to the radio region (nuclear magnetic resonance). When the measurement of radiation frequency is done experimentally, it gives a value for the change of energy involved and from this one may draw the conclusion about the set of possible discrete energy levels of the matter. The ways in which the measurements of radiation frequency (emitted or absorbed) are made experimentally and the energy levels deduced from these comprise the practice of spectroscopy.[2]

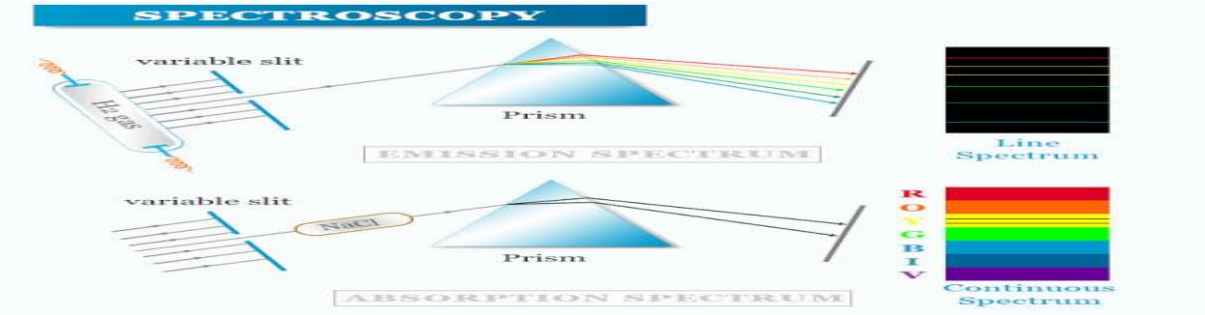


Figure 1: Spectroscopy

TYPES OF SPECTROSCOPY:

Absorption Spectroscopy:

Absorption spectroscopy refers to spectroscopic techniques that measure the absorption of electromagnetic radiation, as a function of frequency or wavelength, due to its interaction with a sample. The sample absorbs energy, i.e., photons, from the radiating field. The intensity of the absorption varies as a function of frequency, and this variation is the absorption spectrum. Absorption spectroscopy is performed across the electromagnetic spectrum.
Absorption spectroscopy is employed as an analytical chemistry tool to determine the presence of a particular substance in a sample and, in many cases, to quantify the amount of the substance present. Infrared and ultraviolet–visible spectroscopy are particularly common in analytical applications. Absorption spectroscopy is also employed in studies of molecular and atomic physics, astronomical spectroscopy and remote sensing.[3]

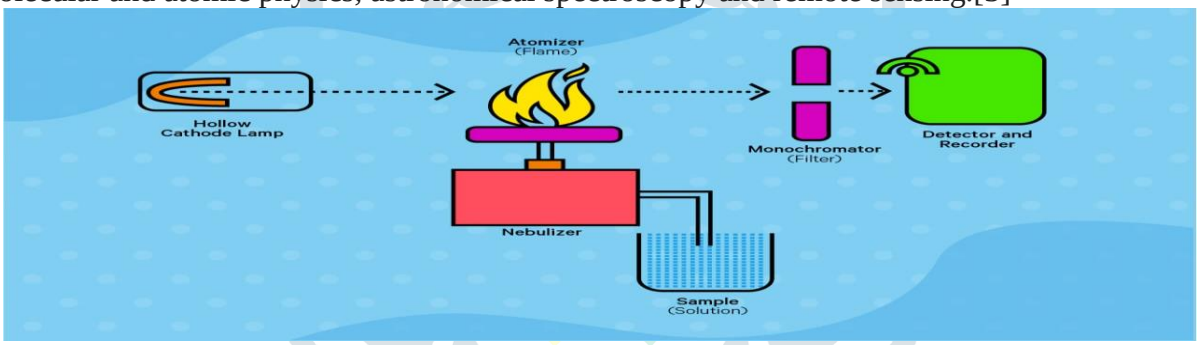


Figure 2: Absorption Spectroscopy

Fluorescence Spectroscopy:

Fluorescence spectroscopy (also known as fluorimetry or spectrofluorometry) is a type of electromagnetic spectroscopy that analyzes fluorescence from a sample. It involves using a beam of light, usually ultraviolet light, that excites the electrons in molecules of certain compounds and causes them to emit light; typically, but not necessarily, visible light. A complementary technique is absorption spectroscopy. In the special case of single molecule fluorescence spectroscopy, intensity fluctuations from the emitted light are measured from either single fluorophores, or pairs of fluorophores.[4]

Devices that measure fluorescence are called fluorometers.

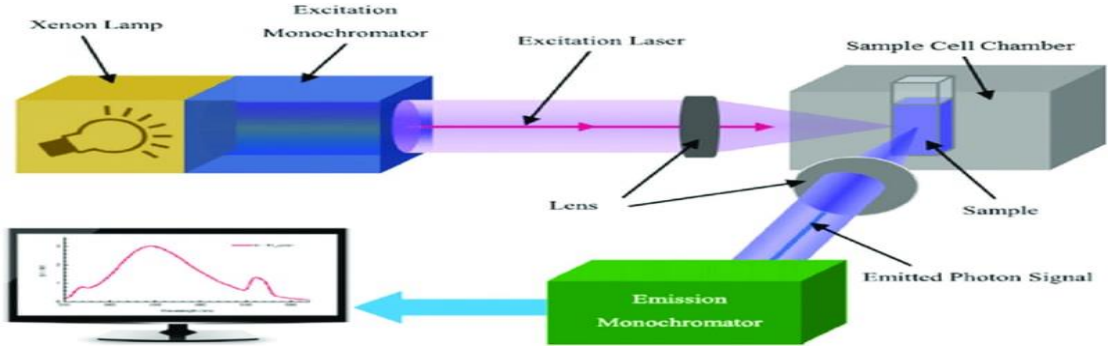


Figure 3: Fluorescence Spectroscopy

Infrared Spectroscopy (IR):

Infrared spectroscopy (IR spectroscopy or vibrational spectroscopy) is the measurement of the interaction of infrared radiation with matter by absorption, emission, or reflection. It is used to study and identify chemical substances or functional groups in solid, liquid, or gaseous forms. It can be used to characterize new materials or identify and verify known and unknown samples. The method or technique of infrared spectroscopy is conducted with an instrument called an infrared spectrometer (or spectrophotometer) which produces an infrared spectrum.[5]

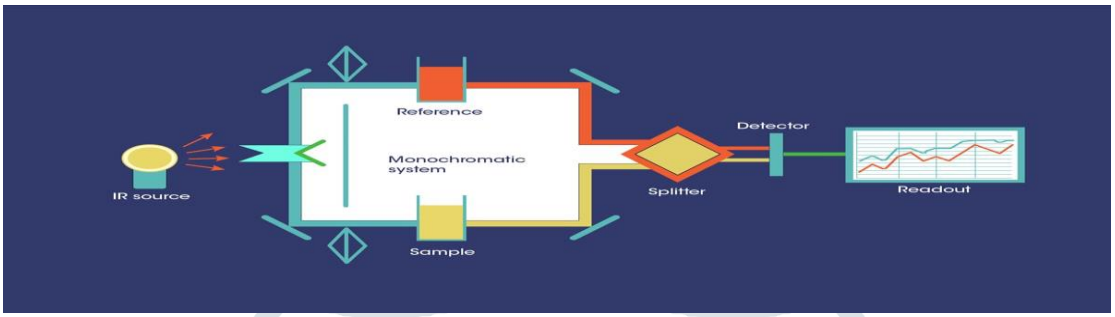


Figure 4: Infrared Spectroscopy

Raman Spectroscopy:

Raman spectroscopy (named after Indian physicist C. V. Raman) is a spectroscopic technique typically used to determine vibrational modes of molecules, although rotational and other low-frequency modes of systems may also be observed. Raman spectroscopy is commonly used in chemistry to provide a structural fingerprint by which molecules can be identified.

Raman spectroscopy relies upon inelastic scattering of photons, known as Raman scattering. A source of monochromatic light, usually from a laser in the visible, near infrared,or near ultraviolet range is used, although X-rays can also be used. The laser light interacts with molecular vibrations, phonons or other excitations in the system, resulting in the energy of the laser photons being shifted up or down. The shift in energy gives information about the vibrational modes in the system.[6]

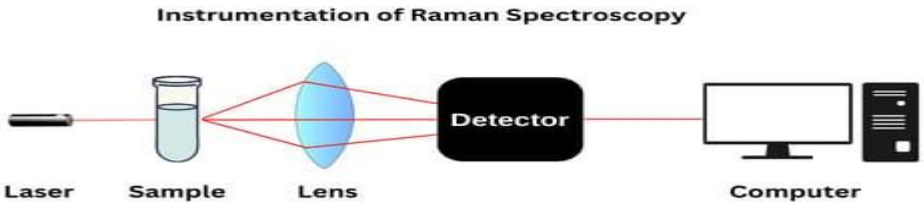


Figure 5: Raman Spectroscopy

Nuclear Magnetic Resonance (NMR) Spectroscopy:

Nuclear magnetic resonance spectroscopy, most commonly known as NMR spectroscopy or magnetic resonance spectroscopy (MRS), is a spectroscopic technique to observe local magnetic fields around atomic nuclei. This spectroscopy is based on the measurement of absorption of electromagnetic radiations in the radio frequency region from roughly 4 to 900 MHz. Absorption of radio waves in the presence of magnetic field is accompanied by a special type of nuclear transition, and for this reason, such type of spectroscopy is known as Nuclear Magnetic Resonance Spectroscopy.[7]

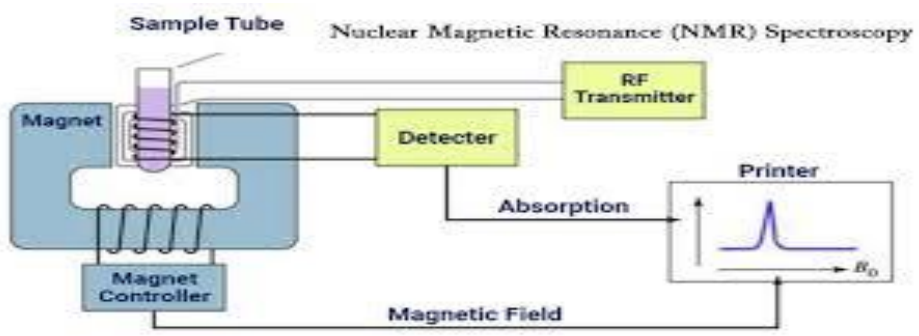


Figure 6: Nuclear Magnetic Resonance

Mass Spectrometry (MS):

Mass spectrometry measures the mass-to-charge ratio of ions, providing information about the molecular weight and structure of compounds. It's commonly used for identifying unknown compounds and studying their fragmentation patterns.

Mass spectrometry (MS) is an analytical technique that is used to measure the mass-to-charge ratio of ions. The results are presented as a mass spectrum, a plot of intensity as a function of the mass-to-charge ratio. Mass spectrometry is used in many different fields and is applied to pure samples as well as complex mixtures.

A mass spectrum is a type of plot of the ion signal as a function of the mass-to-charge ratio. These spectra are used to determine the elemental or isotopic signature of a sample, the masses of particles and of molecules, and to elucidate the chemical identity or structure of molecules and other chemical compounds.[8]

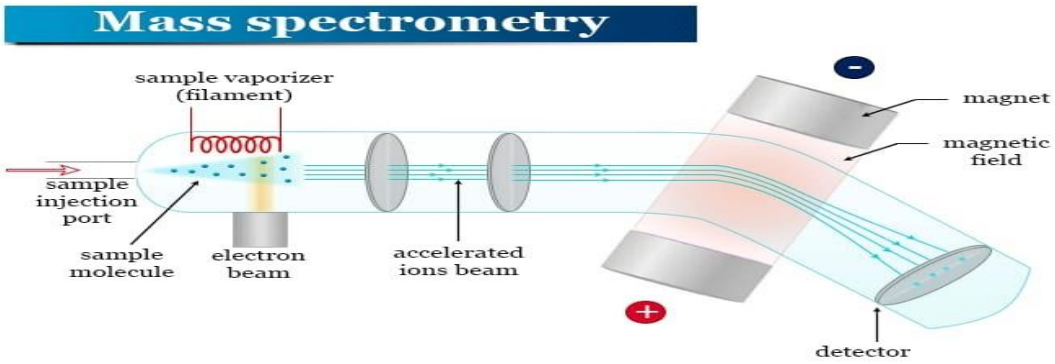


Figure 7: Mass Spectroscopy

X-ray Spectroscopy:

X-ray spectroscopy is a general term for several spectroscopic techniques for characterization of materials by using x-ray radiation. X-ray spectroscopy techniques, such as X-ray absorption spectroscopy (XAS) and X-ray emission spectroscopy (XES), provide information about the electronic structure and bonding of atoms in materials.[9]

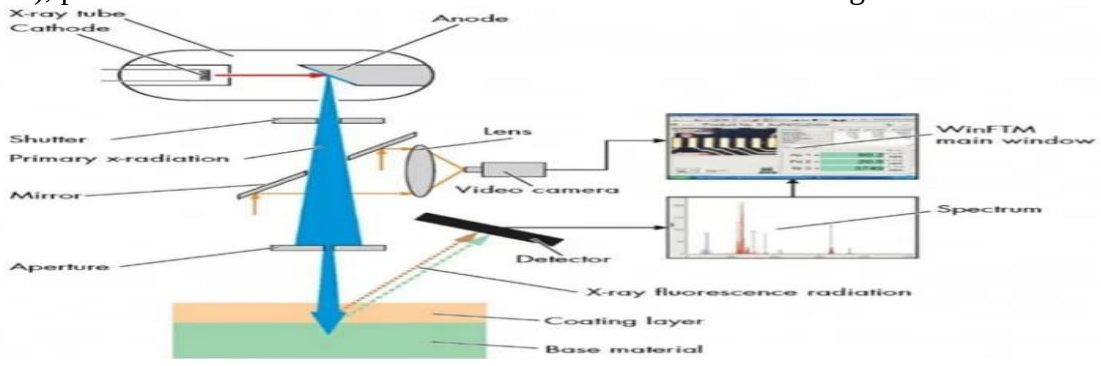


Figure 8: X- ray Spectroscopy

Electron Paramagnetic Resonance (EPR) Spectroscopy:

Electron Paramagnetic Resonance (EPR) spectroscopy, also known as Electron Spin Resonance (ESR) spectroscopy, is a powerful analytical technique used to study materials with unpaired electrons, particularly paramagnetic compounds. It provides information about the electronic structure, coordination environment, and dynamic properties of these materials.[10]

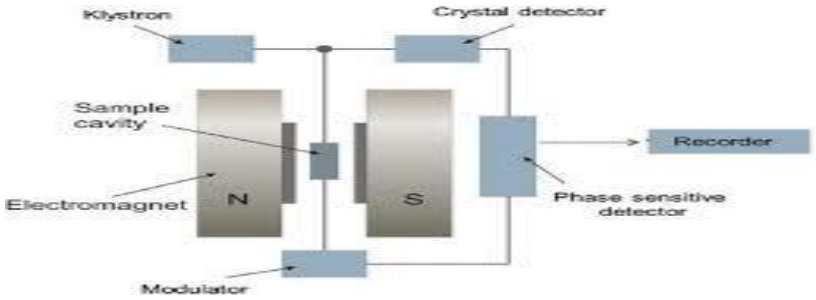


Figure 9: Electron Paramagnetic Resonance Spectroscopy

Dichroism (CD) Spectroscopy:

CD spectroscopy measures differences in absorbance of left- and right-circularly polarized light. It's particularly useful for studying chiral molecules and determining their secondary structures Circular Dichroism (CD) spectroscopy is a powerful analytical technique used in chemistry, biochemistry and structural biology to study the optical activity of chiral molecules, particularly biomolecules like proteins, nucleic acid, and certain small organic molecules. CD spectroscopy measures the difference in the absorption of left handed circularly polarized light (L-CPL) and right handed circularly polarized light (R-CPL) as it passes through a sample. This technique provides valuable information about the secondary and tertiary structure of molecules, including their conformation and folding.[11]

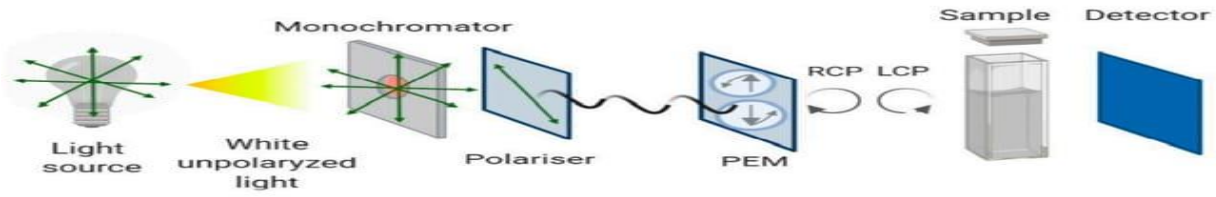


Figure 10: Dichroism Spectroscopy

UV-Visible Spectroscopy:

UV spectroscopy or UV–visible spectrophotometry (UV–Vis or UV/Vis) refers to absorption spectroscopy or reflectance spectroscopy in part of the ultraviolet and the full, adjacent visible regions of the electromagnetic spectrum. This technique involves measuring the absorption or transmission of ultraviolet and visible light by a sample. It's useful for studying electronic transitions in molecules and determining their concentration.[12]

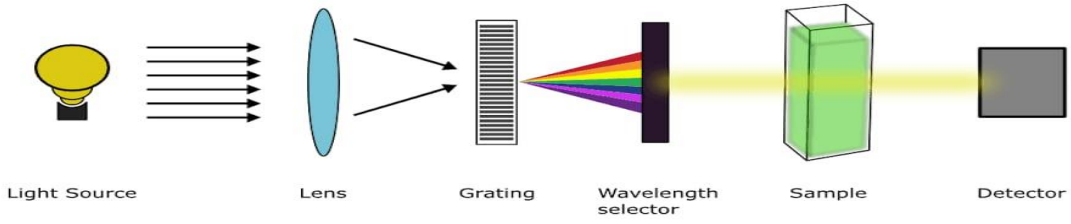


Figure 11: UV –Visible Spectroscopy

Each of these spectroscopic techniques offers unique insights into the properties and behavior of molecules, materials, and compounds across various scientific disciplines.

UV SPECTROSCOPY:

UV-Vis (ultraviolet visible) spectroscopy is frequently used to provide characterization data for a variety of materials. Inorganic or organic, solid or liquid groups, such as organic molecules and functional groups, can be observed using UV-Visible spectroscopy, as can reflectance measurements for coatings, paints, textiles, biochemical analysis, band gap measurements, etc.UV-Vis provides these detailsby depending on the degree of absorbance or transmittance of a different wavelength of beam light and the various responses of samples, the uv visible provides these details.[13]

Electromagnetic Spectrum:

The ability of electromagnetic radiation to discretely interact with atoms and molecules and produce distinctive absorption or emission profiles is essential for spectroscopic activities. The wavelength of electromagnetic radiation is the characteristic that governs the perceived color spectrum. The visible section of the electromagnetic spectrum is that portion of the spectrum that the human eye can see. These visible wavelengths span a region between 400 and 800 nm. A specific wavelength or color of visible light corresponds to the optical density when it is measured with spectrophotometers. This light is absorbed, vanishes, and becomes invisible. The approximate complimentary connection between the light wavelengths that are absorbed and those that are transmitted is shown in Figure.
For instance, the complimentary color of light, orange, would be strongly absorbed by a blue substance.

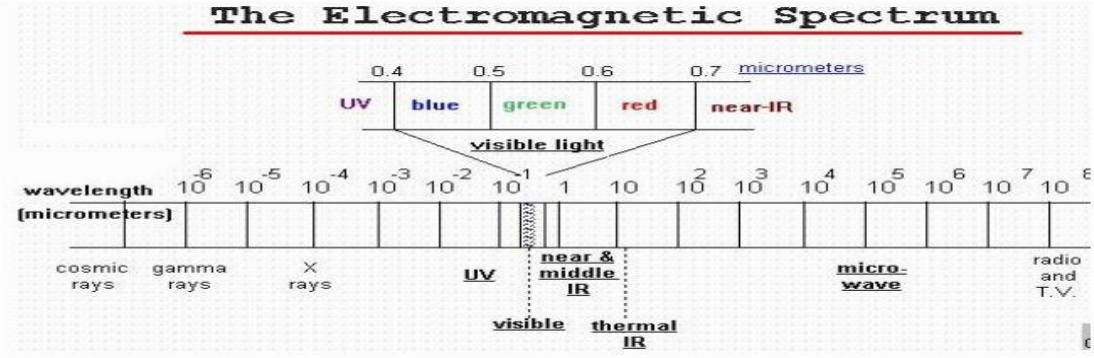


FIGURE 12 :The electromagnetic spectrum

The distance between neighbouring peaks or troughs is known as the wavelength. The following straightforward equation can be used to define the wavelength, of EMR as a function of its frequency v, and the speed of light c

$v = c/\lambda$ (1)

EMR has both particle and wave behaviour (the dual nature of light), and the relationship between energy and the wavelength of such a particle, a photon, is given by the equation

E = hc/ λ *10^9 (2)

Where c is the speed of light in a vacuum (2.998 x 108 ms-1), c is the Planck's constant (6.63 x 10-34 Js), E is the photon's energy, and is the wavelength in nm.

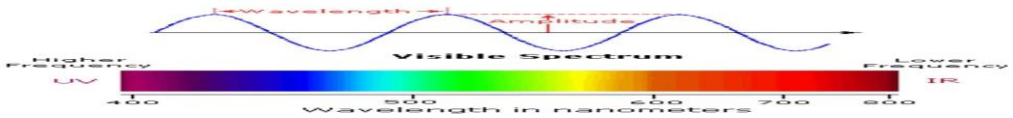


FIGURE13: sine wave representation of electromagnetic radiation and electromagnetic spectrum

The longest visible wavelength is red and the shortest is violet. Other common colors of the spectrum, in order of decreasing wavelength, may be remembered by the mnemonic: ROY G BIV. The wavelengths of what we perceive as particular colors in the visible portion of the spectrum are displayed and listed below,

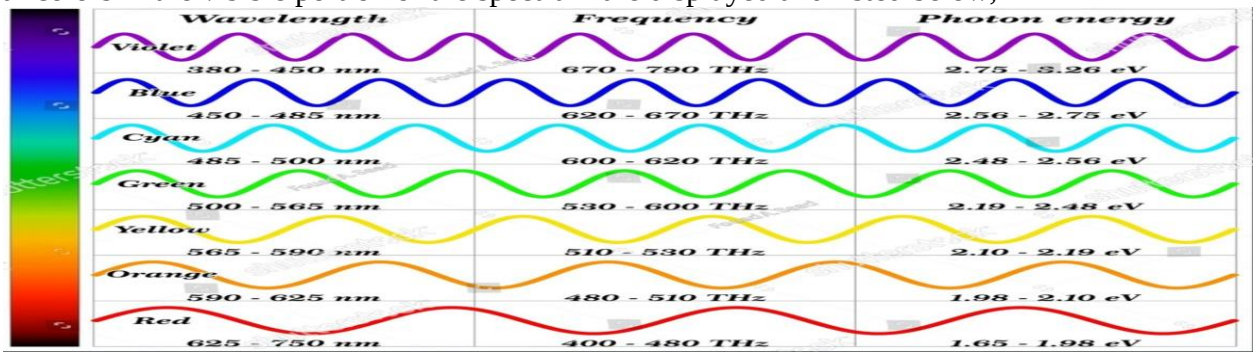


FIGURE 14: Electromagnetic spectrum wavelength of visible light.

COLOUR	Violet	Indigo	Blue	Green	Yellow	Orange	Red
WAVELENGTH REGION	400 - 420 nm	420 - 440 nm	440 - 490 nm	490 - 570 nm	570 - 585 nm	585 - 620 nm	620 - 780 nm

When white light passes through or is reflected by a colored substance, a characteristic portion of the mixed wavelengths is absorbed. The remaining light will then assume the complementary color to the wavelength(s) absorbed.

Thus, absorption of 420-430 nm light renders a substance yellow, and absorption of 500-520 nm light makes it red. Green is unique in that it can be created by absorption close to 400 nm as well as absorption near 800 nm.

BEER LAMBERT'S LAW:

The Beer-Lambert law, also known as the Beer-Lambert-Bouguer law, is a principle in spectroscopy that describes the relationship between the concentration of a solute in a solution and the amount of light absorbed by that solution. It states that the absorbance of light is directly proportional to both the concentration of the absorbing substance and the path length of the light through the solution.

Mathematically, it can be expressed as

$$A = \varepsilon lc,$$

where A is absorbance, ε is the molar absorptivity or molar extinction coefficient, l is the path length, and c is the concentration of the solute. This law is commonly used in various scientific fields, including chemistry and biology, for quantitative analysis ofsolutions.

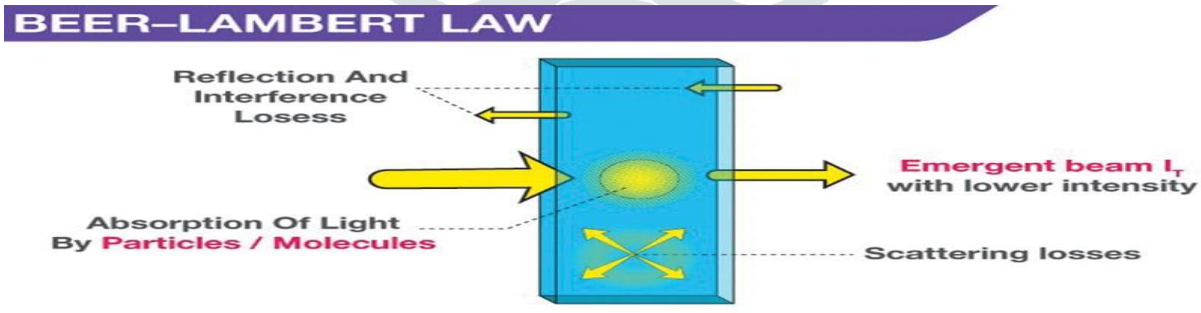
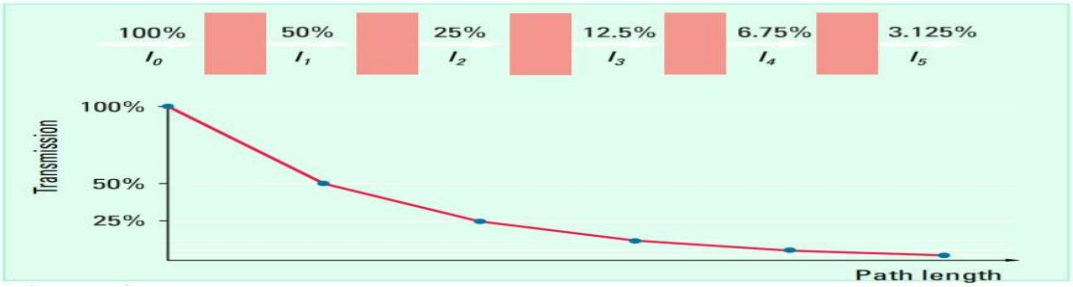


Figure 15: Beer Lambert Law

If 100 photons of light enter a cell and only 50 emerge from the other side, the transmittance is 0.5, or 50 %. If these 50 photons then pass through an identical cell, only 25 will emerge, and so forth.

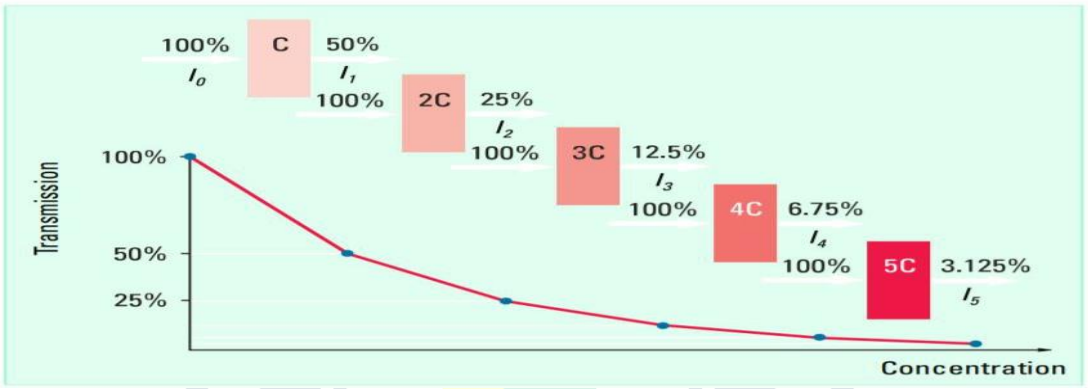


Graph 1. Plot of transmittance against path length.

Lambert (1760) generally is credited with the first mathematical formulation of this effect, although it now appears that Bouguer first stated it in 1729. The mathematical expression is:

$$T = I/Io = e^{-kb}$$

where *I*o is the incident intensity, *I* is the transmitted intensity, *e* is the base of natural logarithms, *k* is a constant, and *b* is the path length (usually in centimeters). Beer's law is identical to Bouguer's law, except that it is stated in terms of concentration. The amount of light absorbed is proportional to the number of absorbing molecules through which the light passes.



Graph 2. A plot of transmittance against concentration.

Combining the two laws gives the Beer-Bouguer-Lambertlaw:

$$T = I/Io = e^{-kbc}$$

where *c* is the concentration of the absorbing species (usually expressed in grams per liter or milligrams per liter). This equation can be transformed into a linear expression by taking the logarithm and is usually expressed in the decadic form:

$$A = -\log T = -\log(I/Io) = \log(Io/I) = \varepsilon bc$$

where ε is the molar absorption or extinction coefficient. This expression is commonly known as Beer's law.

Graph 3. A plot of absorbance against concentration.

The extinction coefficient (ε) is characteristic of a given substance under a precisely defined set of conditions, such as wavelength, solvent, and temperature. In practice, the measured extinction coefficient also depends partially on the characteristics of the instrument used. For these reasons, predetermined values for the extinction coefficient usually are not used for quantitative analysis.

Instead, a calibration or working curve for the substance to be analyzed is constructed using one or more standard solutions with known concentrations of the analyse.

For electronic transitions, the difference in energy between ground and excited states is relatively large. Therefore, at room temperature, it is highly likely that all molecules are in the electronic ground state. Absorption and return to ground state are fast processes, and equilibrium is reached very quickly. Thus, absorption of UV-visible light is quantitatively highly accurate.

The simple linear relationship between absorbance and concentration and the relative ease of measurement of UV-visible light have made UV-visible spectroscopy the basis for thousands of quantitative analytical method.[14]

Principle of UV-Vis Spectroscopy:

The Principle of UV-Visible Spectroscopy is based on the absorption of ultraviolet light or visible light by chemical compounds, which results in the production of distinct spectra. Spectroscopy is based on the interaction between light and matter. When the matter absorbs the light, it undergoes excitation and de-excitation, resulting in the production of a spectrum.

When matter absorbs ultraviolet radiation, the electrons present in it undergo excitation. This causes them to jump from a ground state (an energy state with a relatively small amount of energy associated with it) to an excited state (an energy state with a relatively large amount of energy associated with it). It is important to note that the difference in the energies of the ground state and the excited state of the electron is always equal to the amount of ultraviolet radiation or visible radiation absorbed by it.

UV spectroscopy, or ultraviolet-visible spectroscopy, is a technique used to analyze the absorption and transmission of light in the ultraviolet and visible regions of the electromagnetic spectrum. It is based on the principle that molecules absorb light energy at specific wavelengths, causing electronic transitions within the molecules.

When radiation induces an electronic transition in a molecule or ion's structure, the object will exhibit absorption in the visible or ultraviolet range. As a result, when a sample absorbs 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 orbital to a higher energy, excited state orbital by the energy from the light. or anti-bonding orbital. [15]

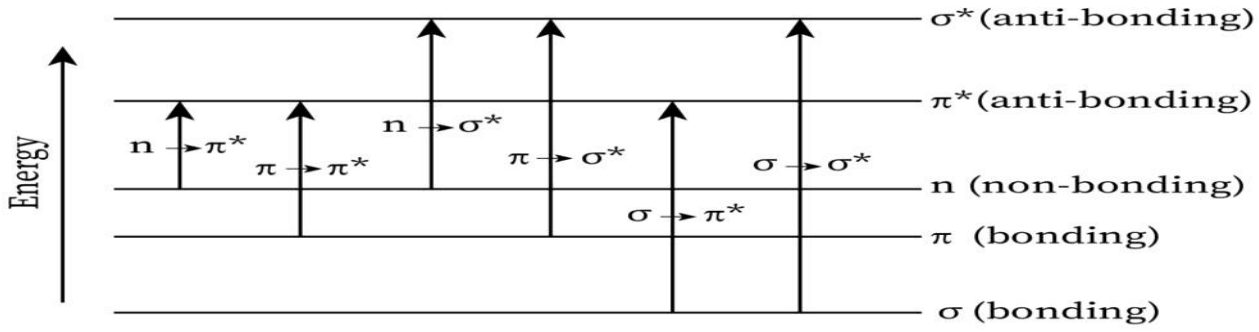
Types of Electronic Transitions: UV-visible spectroscopy involves transitions of electrons between different energy levels within a molecule's electronic structure. When a molecule absorbs light, it promotes electrons from lower energy (ground) states to higher energy (excited) states.

When radiation induces an electronic transition in a molecule or ion's structure, the object will exhibit absorption in the visible or ultraviolet range. As a result, when a sample absorbs 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 orbital to a higher energy, excited state orbital by the energy from the light. or anti-bonding orbital.

Potentially, three types of ground state orbitals may be involved.

1) σ (bonding) molecular

2) π (bonding) molecular orbital
3) n (bonding) atomic orbital
In addition, two types of anti-bonding orbitals may be involved in the transition
1) σ* (sigma star) orbital
2) π* (pi star) orbital
There is no such thing as an n* anti-bonding orbital as the n electrons do not form bonds). Thus, the following electronic transitions can occur by the absorption of ultraviolet and visible light.
1) σ to σ*
2) n to σ*
3) n to π*
4) π to π*
Due to their high energy requirements, the σ to σ* and n to σ* transitions both take place in the far ultraviolet area or sporadically in the range of 180–240 nm. Saturated groups consequently do not show high absorption in the common UV range. In contrast to transitions to the π* anti-bonding orbital, transitions from then to the π* and to π* type occur in molecules with unsaturated centers. They need less energy and take place at longer wavelengths. It will soon be clear that molecule structure controls both the absorption's maximum wavelength and its intensity. If a molecule's chemical structure is changed, transitions to the π* anti-bonding orbital that normally take place in the UV range could very well occur in the visible region. Many inorganic compounds in solution also show absorption in the visible region. These include salts of elements with incomplete inner electron shells (mainly transition metals) whose ions are complexed by hydration. Such absorptions arise from a charge transfer process, where electrons are moved from one part of the system to another by the energy provided by the visible light.



Graph 4. Electron Transition graphically represented.

Electronic transitions in UV-visible spectroscopy which are important are n→ π^* & π→ π^*transitions.

(a) n→ π^* transitions: In this transition, an electon of unshared electron pair on a hetero atom is excited to π^* antibonding orbital. This transition involves least amount of energy than all the transitions and therefore, this transition gives rise to an absorption band at longer wavelengths. In saturated aliphatic ketones, e.g., the **n→ π^***transitions around 280 nm is the lowest energy transitions. This **n→ π^*** transitions is "forbidden" by symmetry considerations, thus the intensity of the band due to this transition is low, although the wavelength is long (lower energy).

(b) π→ π^* transitions :This transition is available in compounds with unsaturated centres, e.g., simple alkenes, aromatics, carbonyl compounds, etc. this transition requires lesser energy then transition in a simple alkene, although several transitions are available , the lowest energy transition is the **π→ π***transition and a absorption band around 170nm-190nm in unconjugated alkenes is due to this transition in the case of , e.g., saturated ketones, the most intense band around 150nm is due to **π→ π***transition.[16]

DIFFERENT EFFECTS:

Effect of solvent:

The transitions of polar bonds, like c=o but not ethylene, are affected by solvent polarity as solvent polarity is increased, **π→ π***bands undergo red shifts. This is so since excited state is more polar than the ground state and hence stabilization is greater relative to the ground state with two n electrons receives greater stabilization than the

excited state with only n electron. These opposite trends are clear by examining the data of mesityl oxide. There is more on shift of bands with solvents.

Effect of conjugation:

Absorption in near UV that is above 200 nm is invariably associated with the presence of unsaturated groups or atoms with unshared pairs of electrons the saturated hydrocarbon which do not have these structural elements observe below 200nm reason, not of much significance for structural study of organic compounds. Thus interstically a complex steroid molecule cholest-4-ene-3 one is easily recognized to have an α-ß unsaturated keton moiety, similar to that in mesityl oxide by their spectral resemblance.[18]

Effect of pH:

In alkaline pH $\pi \rightarrow \pi^*$ transition is more favoured and in acidic pH $n \rightarrow \pi^*$ transition is more favoured. For eg.

(1) P- nitrophenol ---> p- nitrophenol (+M effect increased)

Alkaline pH

$\pi \rightarrow \pi^*$ transition more favoured

less energy is required

absorption would take place at longer wavelength

(2) p-amino phenol ---> P-amino phenol

Acidic pH

$n \rightarrow \pi^*$ transition is more favoured

More energy required

Blue shift

Absorption at shorter wavelength

Determine Wavelength For The Sample By UV/Vis Spectroscopy:

A spectrometer is a device for measuring wavelengths of light over a wide range of the electromagnetic spectrum. It is widely used for spectroscopic analysis of sample materials.

Absorbance measurements are always carried out at fixed wavelength.

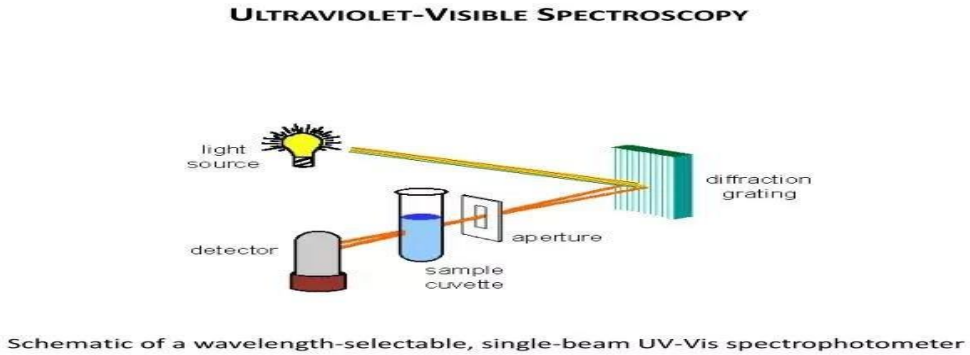
To select the suitable wavelength for analysis, follow the next steps:

1. Prepare a standard solution of the analyte.
2. Insert the solution into the instrument.
3. Run a full-scan of the wavelength in the range from 200 to 900 nm.

The suitable wavelength is the one that is responsible for the Highest Sensitivity, or the Highest Absorbance.

INSTRUMENTATION (Spectrophotometers)

Single Beam Spectrophotometer:



Schematic of a wavelength-selectable, single-beam UV-Vis spectrophotometer

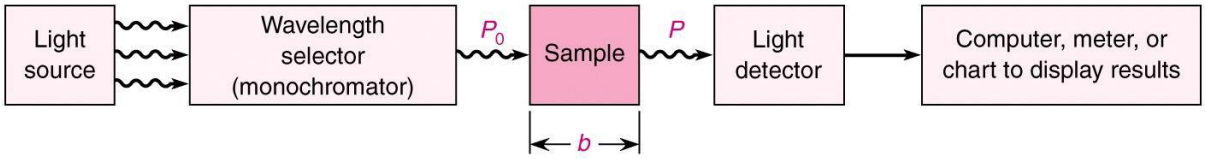


Figure 16: Single Beam Spectrophotometers

Components of spectrophotometer:

Source of light:

Continuous sources emit radiation of all wavelengths within the spectral region for which they are to be used.

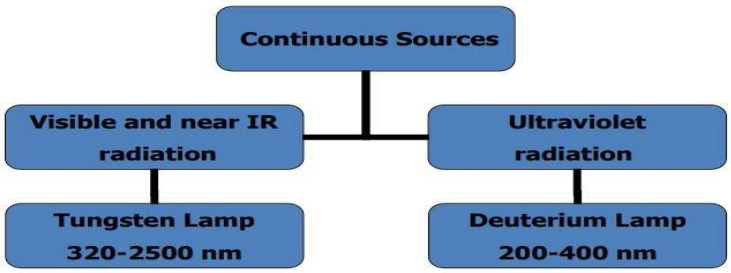


Figure 17: Continuous sources emit radiation

SAMPLE CELLS (CUVETTES):

For visible and uv spectrophotometry , a liquid sample is usually contained in a cell called a cuvette.
Glass is suitable for visible but not for uv spectroscopy because it absorbs uv radiation.
Quartz can be used in uv as well as in visible spectrophotometry.

Detectors:

It is a device that converts Radiant energy into Electrical signal.

A Detector should be sensitive, and has a fast response over a considerable range of wavelengths. In addition, the electrical signal produced by the detector must be directly proportional to the transmitted intensity (linear response).

There are three examples of the widely-used detectors: Photo tube, Photomultiplier tube, and Photodiode array.

A. Photo tube:

When the Photosensitive Cathode is Bombarded by a Photon, it emits an Electron.

Emitted electron is attracted to the Anode producing current, its Intensity is proportional to radiation intensity.

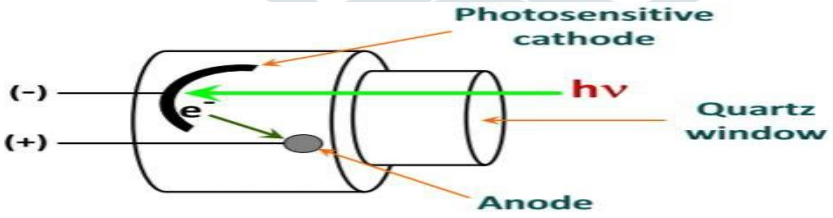


Figure18: Phototube

B. Photomultiplier tube:

A very sensitive device in which electrons emitted from the photosensitive cathode strike a second surface called dynode which is positive with respect to the original cathode.

Electrons are accelerated and can emit more than one electron from the dynode.

If the above process is repeated several times, more than 10^6 electrons are finally collected at the anode for each photon striking the first cathode.

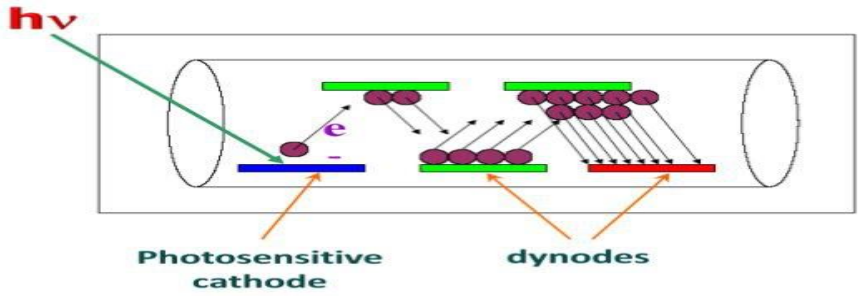


Figure 19 :Photomultiplier tube

C. Photodiode array:

It is possible to record the entire spectrum in a fraction of a second by the use of photodiode array detector.
The monochromator disperses the radiation light into its component wavelengths and directs the light at the diode array.
Each diode receive a different wavelength and thus all wavelengths are measured simultaneously.

Figure20: Photodiode array

Instrumentation (Spectrophotometers):

Double beam spectrophotometer:

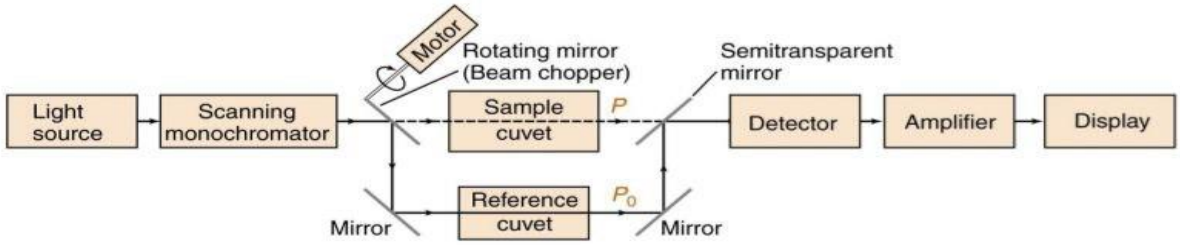
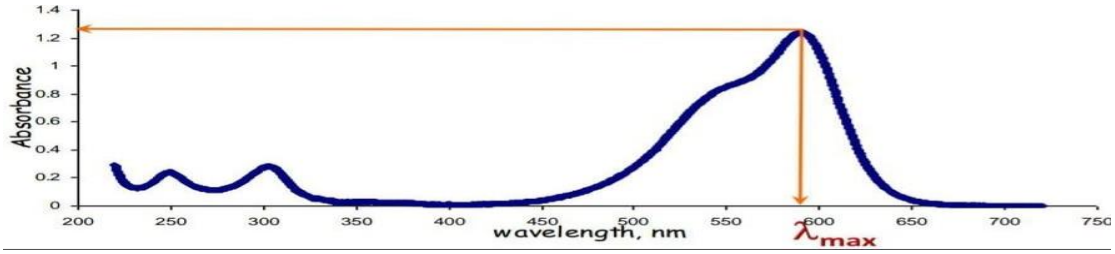


Figure 20: Double beam Spectrophotometer.

In double beam arrangement, the light passes through the sample and reference (blank), by a rotating mirror (chopper).
When light passes through the sample, the detector measures P. When the chopper diverts the beam through the blank solution, the detector measures Po.

Selection of the suitable Wavelength:

Absorbance measurements are always carried out at fixed wavelength.
To select the suitable wavelength for analysis, follow the next steps:
1. Prepare a standard solution of the analyte.
2. Insert the solution into the instrument.
3. Run a full-scan of the wavelength in the range from200 to 900 nm.
The suitable wavelength is the one that is responsible for the Highest Sensitivity, or the HighestAbsorbance.



Graph 21. Crystal Violet Absorption Spectrum

The Absorbance of a Solution:

For each wavelength of light passing through the spectrometer, the intensity of the light passing through the reference cell is measured. This is usually referred to as Io. That's I for Intensity. The intensity of the light passing through the sample cell is also measured for that wavelength given the symbol I. If I is less than Io of the sample has absorbed some of the light.

Chromophores:

The word chromophore derived from two words chromo means color and phores mean bearing; Any structural feature which is responsible for absorption of light called chromophores.

Auxo chromes:

An auxo chrome is a functional group of atoms with one or more lone pairs of electrons when attached to a chromophore, alters (lengthen or shorten) both the wavelength and intensity of absorption.

Determination of Lambda Max of given samples:

1.Nickel chloride
2.Methylene Blue
3.Potassium Dichromate
4.Potassium Permanganate
5.Erichrome Black T
6.Methylene Red

1.NICKEL CHLORIDE:

METHODOLOGY

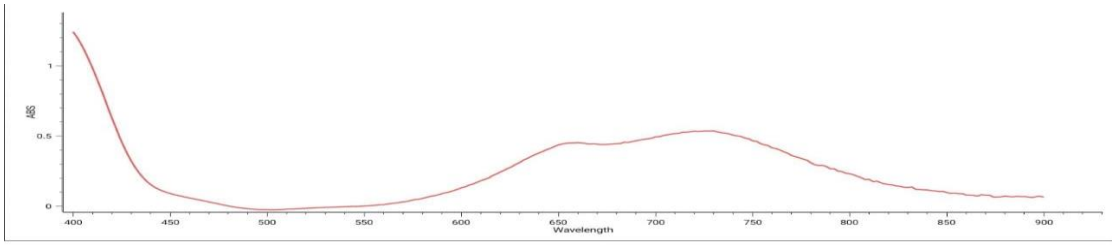
This section summarizes the experimental work and research methodology in characterizing the nickel chloride-water mixture by using spectroscopy technique. We diluted nickel chloride crystals in 100ml of water.

Measurement Procedure

The measurement process was started with adding nickel chloride-water solution into the cuvette until it is filled two-third . Spectrometer will qualitatively and quantitatively compare the fraction of the light that passes through a reference solution and the test solution. Their absorbance spectrum was taken once the reading became stabled. After that, the cuvette was rinsed in the way of injecting de-ionized water into cuvette several times. For each measurement, the cuvette was rinse thoroughly with de-ionized water as to ensure no residual particle from the previous test sample.

RESULTS AND DISCUSSION

The absorbance spectrum of nickel chloride-water mixture is analyzed based on their wavelength, intensity and the stability of the baseline spectrum. Plotting the Absorbance Spectrum of nickel chloridegraph 6. shows the results for the absorption spectrum of nickel chloride-water mixture at the UV VISIBLE



Graph 6. Absorption spectrum of nickel chloride-water mixture at UV visible wavelength region

Maximum absorption peak of nickel chloride- water mixture at UV Visible wavelength region is 730nm.

2 .METHYLENE BLUE

METHODOLOGY

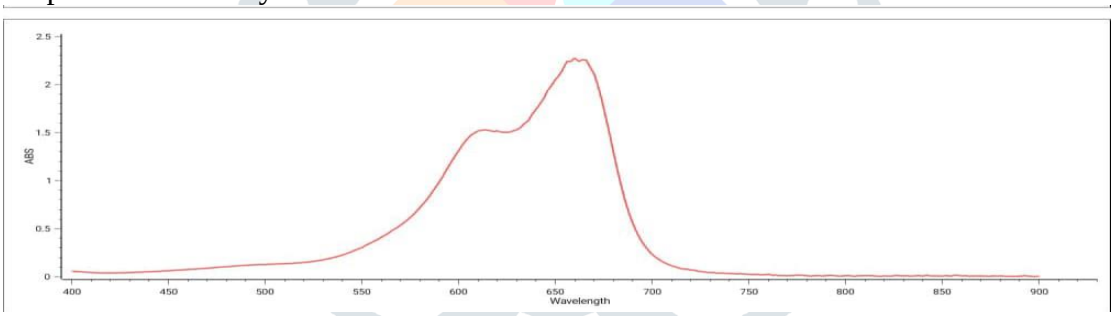
This section summarizes the experimental work and research methodology in characterizing the methylene blue-water mixture by using spectroscopy technique.we diluted methyle blue in 100ml of water.

Measurement Procedure

The measurement process was started with adding methylene blue-water solution into the cuvette untilit is filled two-third . Spectrometer will qualitatively and quantitatively compare the fraction of the light that passes through a reference solution and the test solution. Their absorbance spectrum was taken once the reading became stabled. After that, the cuvette was rinsed in the way of injecting de-ionized water into cuvette several times. For each measurement, the cuvette was rinse thoroughly with de-ionized water as to ensure no residual particle from the previous test sample.

RESULTS AND DISCUSSION

The absorbance spectrum of methylene blue-water mixture is analyzed based on their wavelength, intensity and the stability of the baseline spectrum. Plotting the Absorbance Spectrum of methylene blue Graph 7. shows the results for the absorption spectrum of methylene blue-water mixture at the UV VISIBLE



Graph 7. Absorption spectrum of methyl blue-water mixture at UV visible wavelength region

Maximum absorption peak of methyl blue- water mixture at UV Visible wavelength region is 664.

3. POTASSIUM DICHROMATE:

METHODOLOGY

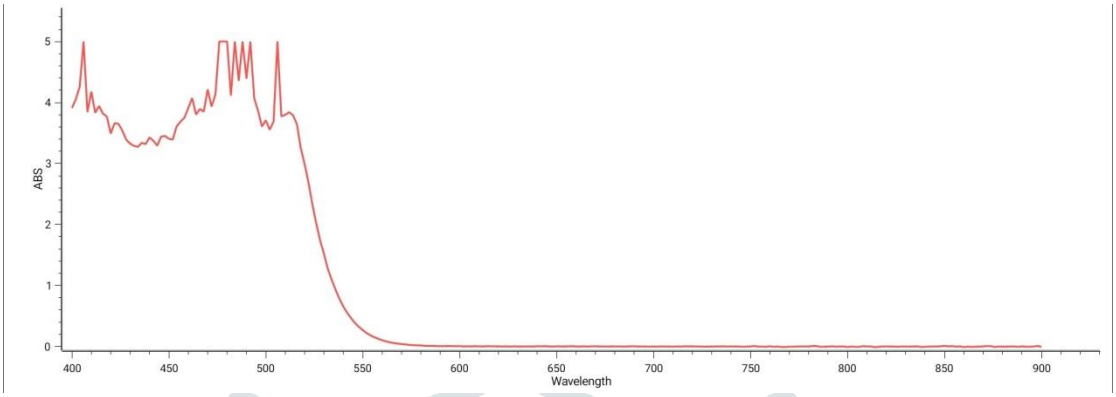
This section summarizes the experimental work and research methodology in characterizing the potassium dichromate-water mixture by using spectroscopy technique. We diluted potassium dichromate in 100ml of water.

Measurement Procedure

The measurement process was started with adding potassium dichromate -water solution into the cuvette untilit is filled two-third.Spectrometer will qualitatively and quantitatively compare the fraction of the light that passes through a reference solution and the test solution. Their absorbance spectrum was taken once the reading became stabled. After that, the cuvette was rinsed in the way of injecting de-ionized water into cuvette several times. For each measurement, the cuvette was rinse thoroughly with de-ionized water as to ensure no residual particle from the previous test sample.

RESULTS AND DISCUSSION

The absorbance spectrum of potassium dichromate -water mixture is analyzed based on their wavelength, intensity and the stability of the baseline spectrum. Plotting the Absorbance Spectrum of potassium dichromate graph 8. shows the results for the absorption spectrum of potassium dichromate -water mixture at the UV VISIBLE.



Graph 8. Absorption spectrum of potassium dichromate -water mixture at UV visible wavelength region

Maximum absorption peak of potassium dichromate -water mixture at UV Visible wavelength region is 506

4. POTASSIUM PERMANGANATE:

METHODOLOGY

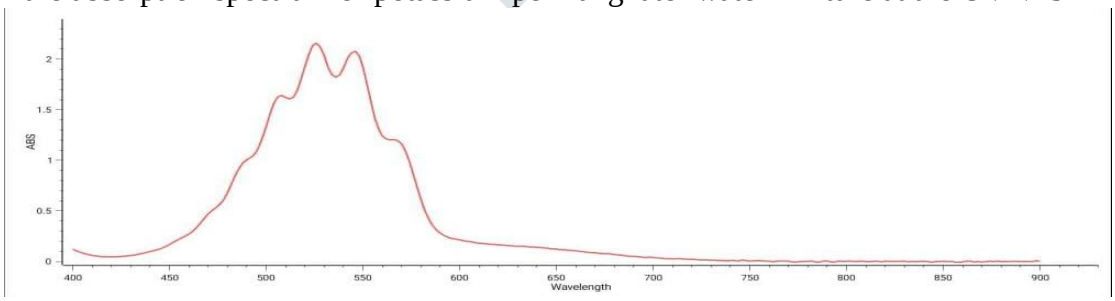
This section summarizes the experimental work and research methodology in characterizing the potassium permangnate-water mixture by using spectroscopy technique. We diluted nickel chloride crystals in 100ml of water.

Measurement Procedure

The measurement process was started with adding potassium permangnate -water solution into the cuvette until it is filled two-third.Spectrometer will qualitatively and quantitatively compare the fraction of the light that passes through a reference solution and the test solution. Their absorbance spectrum was taken once the reading became stabled. After that, the cuvette was rinsed in the way of injecting de-ionized water into cuvette several times. For each measurement, the cuvette was rinse thoroughly with de-ionized water as to ensure no residual particle from the previous test sample.

RESULTS AND DISCUSSION

The absorbance spectrum of potassium permangnate -water mixture is analyzed based on their wavelength, intensity and the stability of the baseline spectrum. Plotting the Absorbance spectrum of potassium permangnateGraph 9. shows the results for the absorption spectrum of potassium permangnate -water mixture at the UV VISIBLE



Graph 9. Absorption spectrum of potassium permangnate -water mixture at UV visible wavelength region

Maximum absorption peak of potassium permangnate- water mixture at UV Visible wavelength region is 530

5. ERICHROME BLACK T:

METHODOLOGY

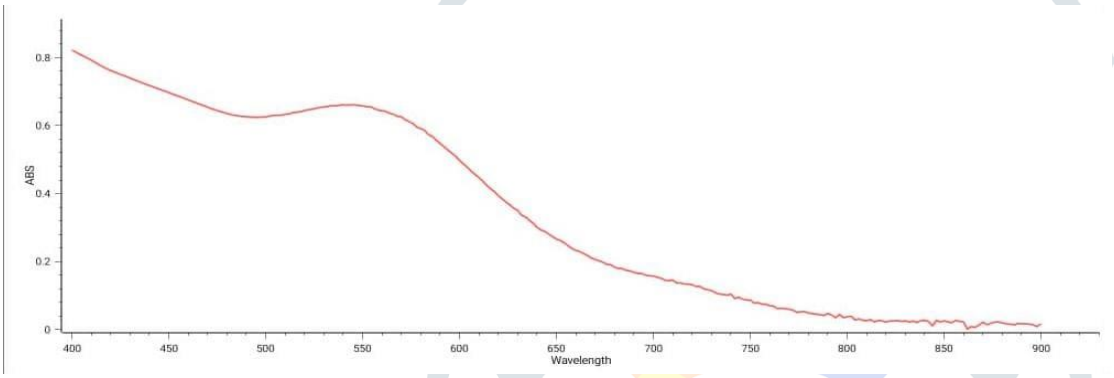
This section summarizes the experimental work and research methodology in characterizing the erichrome black T-water mixture by using spectroscopy technique. We diluted erichrome black T crystals in 100ml of water.

Measurement Procedure

The measurement process was started with adding erichrome black T -water solution into the cuvette untilit is filled two-third. Spectrometer will qualitatively and quantitatively compare the fraction of the light that passes through a reference solution and the test solution. Their absorbance spectrum was taken once the reading became stabled. After that, the cuvette was rinsed in the way of injecting de-ionized water into cuvette several times. For each measurement, the cuvette was rinse thoroughly with de-ionized water as to ensure no residual particle from the previous test sample.

RESULTS AND DISCUSSION

The absorbance spectrum of erichrome black T-water mixture is analyzed based on their wavelength, intensity and the stability of the baseline spectrum. Plotting the Absorbance Spectrum of erichrome black T Graph 10. shows the results for the absorption spectrum of erichrome black T -water mixture at the UV VISIBLE



Graph 10. Absorption spectrum of erichrome black T -water mixture at UV visible wavelength region

Maximum absorption peak of erichrome black T - water mixture at UV Visible wavelength region is 489

6. METHYLENE RED

METHODOLOGY

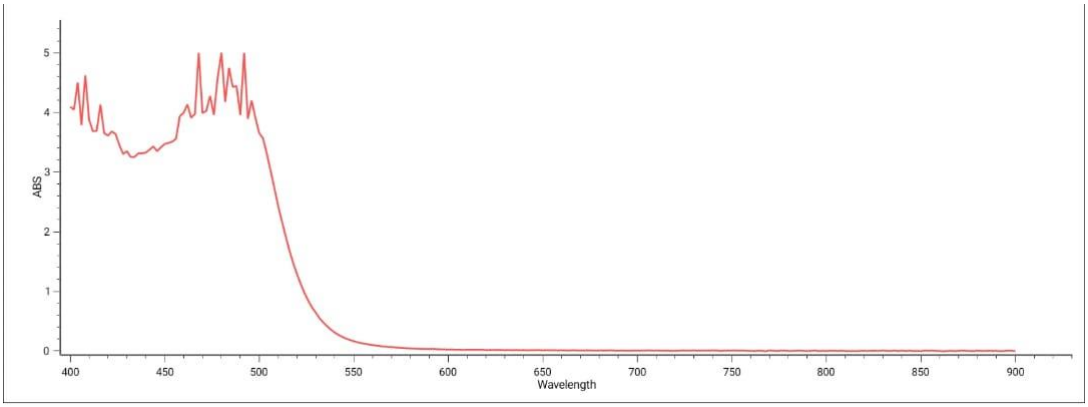
This section summarizes the experimental work and research methodology in characterizing the methylene red-water mixture by using spectroscopy technique. We diluted methylred in 100ml of water.

Measurement Procedure

The measurement process was started with adding methylene red–water solutionsolution into the cuvette until it is filled two-third. Spectrometer will qualitatively and quantitatively compare the fraction of the light that passes through a reference solution and the test solution. Their absorbance spectrum was taken once the reading became stabled. After that, the cuvette was rinsed in the way of injecting de-ionized water into cuvette several times. For each measurement, the cuvette was rinse thoroughly with de-ionized water as to ensure no residual particle from the previous test sample.

RESULTS AND DISCUSSION

The absorbance spectrum of methylene red -water mixture is analyzed based on their wavelength, intensity and the stability of the baseline spectrum. Plotting the Absorbance Spectrum of methylene red Graph 11. shows the results for the absorption spectrum of methylene red -water mixture at the UV VISIBLE



Graph 11. Absorption spectrum of methylene red-water mixture at UV visible wavelength region
Maximum absorption peak of methylene red- water mixture at UV Visible wavelength region is 410nm

CONCLUSION

UV spectroscopy, is a versatile analytical technique with numerous applications in the field of physics, providing valuable insights into electronic structure, chemical kinetics, material properties, and environmental monitoring, among others.
UV Spectroscopy is based upon Beer Lambert's Law and various electronic transition take place there like Sigma to anti-bonding sigma electrons , Pi to anti-bonding pi electrons , N to anti-bonding sigma or anti-bonding pi electrons.

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