Optical Density/ Turbidity Meter

Description

This project aims to create a low-cost gauge that can be used as an optical density meter or a turbidity meter using an LDR as a light sensor, a light source and a convex lens, Density measurement is widely used in research and clinical labs as it provides a rapid and inexpensive method of adjusting microbial suspensions to set concentrations.
Turbidity is the measure of the relative clarity of a liquid

Applications of OD\Turbidity calculations:

- Determine densities of microbes
- Used in turbidimetric titration
- Determine the concentration of protein molecules in biological fluids such as urine and CSF.

Light Parameters

Generally, visible light is defined as the wavelength that are visible to most humans.
We are using mobile flash to emit the light in our project.
Visible light is a form of electromagnetic (EM) radiation.
The primary properties/parameters of light are:
-Intensity / luminance -Propagation direction
-Polarization

- Frequency [420-750] THz
- Wavelength [400-700] nm
- Velocity = 3*10^8 m/s

There is also illuminance (light intensity measured in lux) that can be used to calculate I (watt per square meters) that's used in absorbance laws
We found out that the illuminance of used flash light is between 1800-2000 (lux)

Tissue properties And Type Of light-tissue Interaction

If a beam of light is passed through a cloudy sample, its intensity is decreased mainly by scattering and absorption. The amount of light attenuated depends on the concentration, distribution, type and shape of the particles.

Absorption : occurs when the photon frequency matches the frequency associated with the molecule's energy transition.
It depends on the number of molecules (concentration) according to beer-lambert law

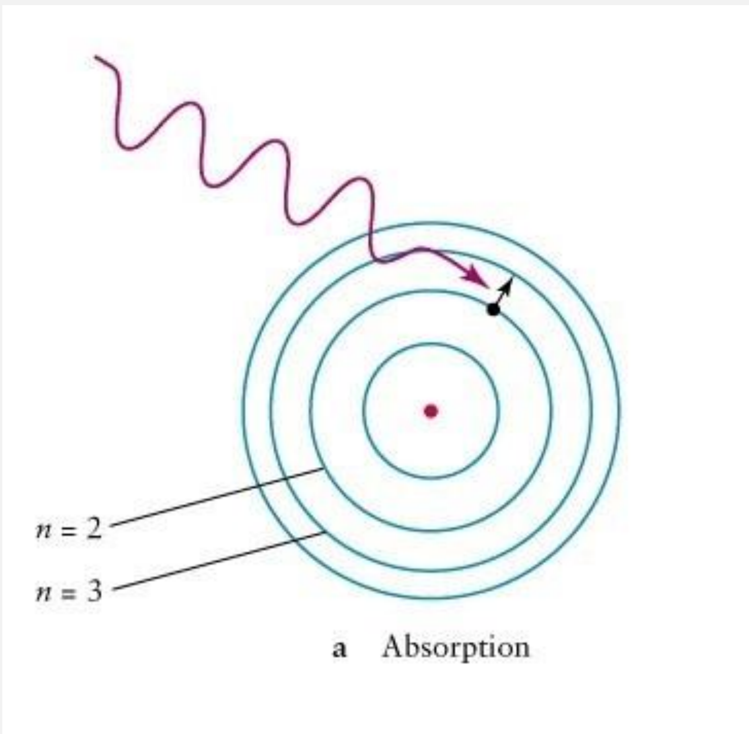


Figure 1.
Absorption diagram.

As for scattering , Particles interact with incident light absorbing it and scatters it in all directions. The spatial distribution of scattered light depends mainly on the ratio of particle size to wavelength of incident light according to this figure 2.

What happens usually is large particles scattering that results in more scattering to forward so that we put the sensor in front of the glass

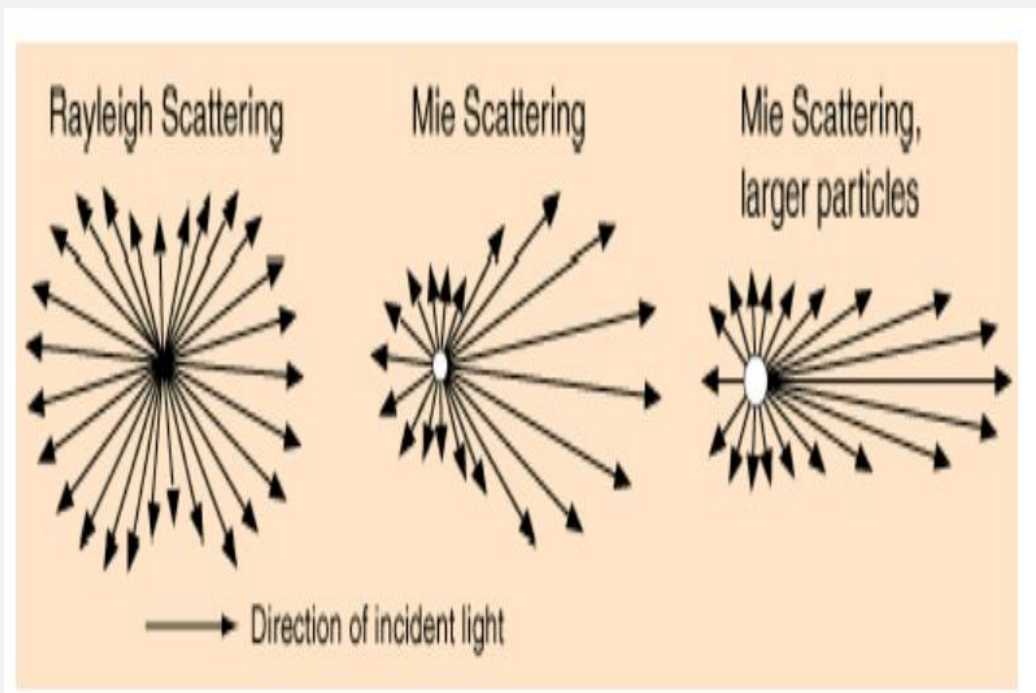


Figure 2.
Scattering diagram.

Experiment Notes:

We've tried to determine whether using a lens would make a difference or not, we firstly recorded the reading without using any lenses and then we increased the concentration of the material gradually and noticed that on using lenses the raw data read by the LDR is higher than that is read without using lenses.

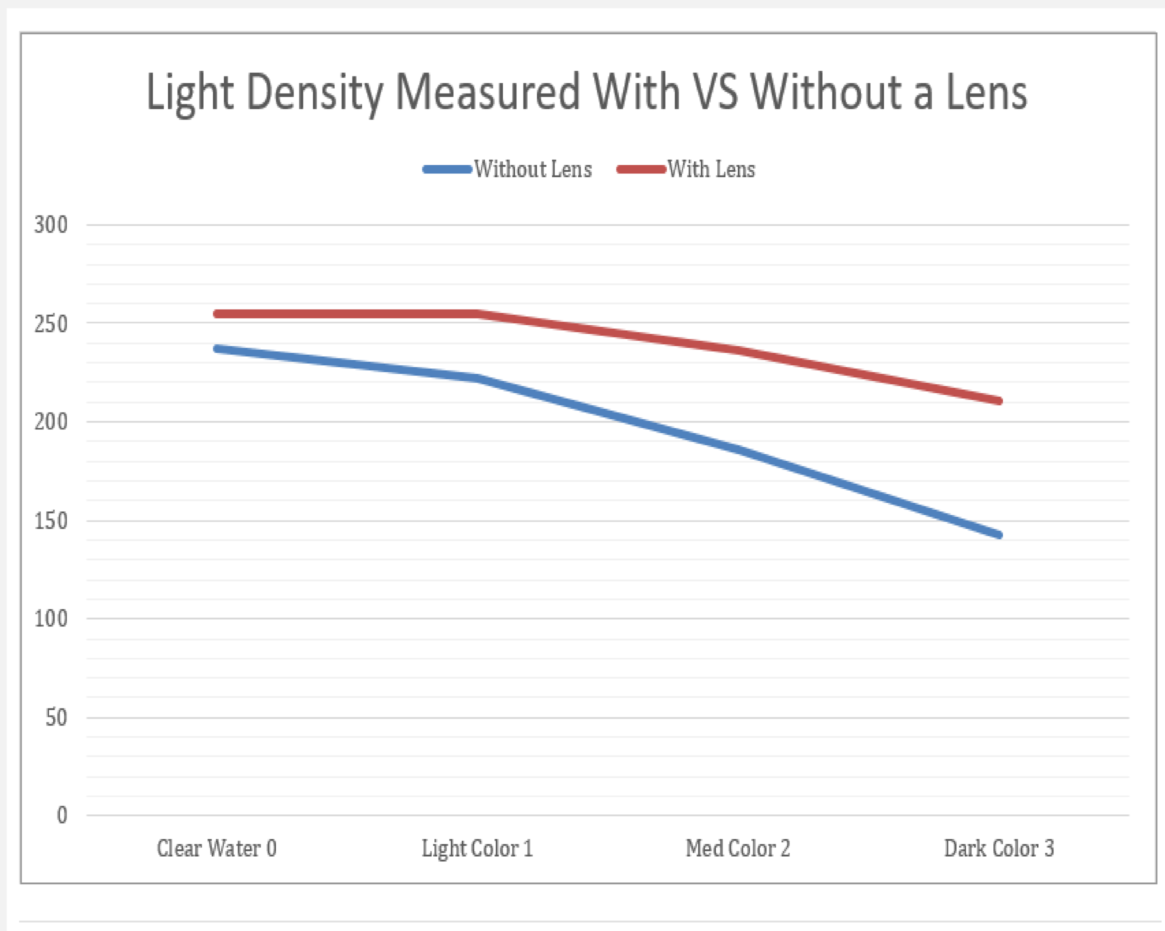
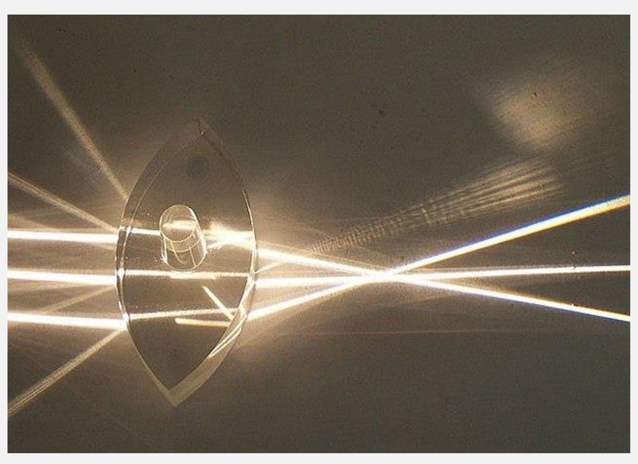


Figure 3.
The effect of using lenses.

The Theory Of Operation Of Optics

In our project we used a convex lens and a glass container to act as a cylinder lens.
The convex lens is used before the sample whose absorbance to be measured, to increase the intensity of the light incident on the sample and thus help both use a low-power light source and focus the light on the sample,
The glass container acts like a convex\cylinder lens to concentrate the scattered/transmitted light through the sample on the LDR.



Main Optics Component

The convex lens is a lens that converges rays of light that convey parallel to its principal axis which is relatively thick across the middle and thin at the lower and upper edges.

Formula:

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

Where, f is focal length,
v is denoted as the distance of the image from the optical center,
u is denoted as the distance of the object from the optical center.
In convex lenses, the focal length is positive.

Our Names (Team 7)

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