

# **EE 119 Lab 1: Properties of Light**

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## **Objective**

The purpose of this lab is to demonstrate various ways that light can be viewed: as rays, waves, and particles. We will also investigate the polarizations of light. The lab consists of four small experiments.

## **1 Light as a Ray**

### **Experimental Setup**

Using a visible laser (HeNe 632.8nm) and a cylindrical lens, construct an optical system to focus the beam horizontally while spreading it out vertically. Attach a triangular glass prism to a white paper and place the prism in the light path. By rotating the prism, you should be able to see how the beam traverses the prism. Note the incident angle, reflection, and refraction at the air-glass interfaces as well as the total angle of deviation.

### **Discussion Questions:**

- (a) As you rotate the prism, the exit beam should disappear at a certain point. What causes this? What angle of incidence leads to this?
- (b) If blue light was used instead of red light, how would this affect how the light traverses the prism?
- (c) At what angle of incidence is the deviation minimized?
- (d) What do you notice about the path of the beam when the angle of deviation is minimized?
- (e) With this lab in mind, what is one method to determine the index of refraction of an unknown transparent material? How would you determine the dispersion of a material?

## **2 Light as a Wave**

### **Experimental Setup**

Place a white card about 2 meters from a visible laser source (HeNe laser). Obtain three various sized pinholes, with diameters roughly on order of the wavelength of light.

### **Discussion Questions:**

- (a) What do you predict will happen when you place a pinhole in the path of the light? (Confirm your guess by doing so.)
- (b) What do you predict will happen when you place a pinhole with a slightly larger diameter? (Confirm your guess by asking your TA.)
- (c) What causes this? What does this lead you to believe about the nature of light?

## **3 Light as a Particle**

### **Experimental Setup**

Obtain a photo-multiplier tube and an oscilloscope. (The tube should be configured to allow approximately one photon in per millisecond with the room lights on, and the oscilloscope should be configured to observe this quantized effect.) Your TA will give a brief introduction to how the photo-multiplier tube works.

### **Discussion Questions:**

- (a) How does the light in this experiment behave differently than in the last one?
- (b) If you were to only shine light of a higher energy (i.e. x-rays) or only light of a lower energy (i.e. microwaves), what would you notice about the photon count?

## **4 S- and P-Polarizations**

### **Experimental Setup**

Using three linear polarization filters, one half-wavelength plate, a block of glass, and a HeNe laser, examine the properties of polarized light and polarization filters.

### **Discussion Questions:**

- (a) Place one linear polarization filter in the path of a HeNe laser beam and observe the intensity of the laser spot on the wall. Also rotate the filter and observe the intensity. What happens? What can you say about the polarization of the HeNe laser beam?
- (b) Add one more linear polarization filter to the setup for part (a). Rotate the second polarization filter so that its polarization axis makes  $90^\circ$  with that of the first filter.

What happens to the laser spot on the wall? Why?

- (c) Now add third linear polarization filter between the first and the second filters, with its polarization axis at  $45^\circ$  with that of the first filter. What happens to the intensity of the exit beam?
- (d) Now replace the third filter that you added in part (c) with a half-wavelength plate. What happens? Rotate the half-wavelength plate and observe the laser spot intensity on the wall. What does the half-wavelength plate do?
- (e) Let's find out if the Brewster's angle really exists. Use the prism from part 1 to reflect the HeNe laser beam at its Brewster's angle. Place and rotate a linear polarization filter in the path of the reflected beam. What happens? What can you say about the polarization of the reflected beam?