Physics 123, Fall 2022 Name ________________________________

Polarization Lab Exercise

You are provided with: 2 sources of light (white light source, laser), 3 magnetic Polaroid sheets and holders, and an optical bench.

1. Set up the white light source. Use a Polaroid sheet to show whether or not the source is polarized. Look through the sheet toward the light source. Draw a sketch below of the E fields before and after passing through the Polaroid. Rotate the Polaroid slowly through 360 degrees and comment on the intensity of the light.

2. Use the first Polaroid to create plane-polarized light. Use a second Polaroid to prove that the light passing through the first is plane polarized. Make a sketch below, showing the E fields and the orientation of the Polaroids. Rotate the second Polaroid slowly through 360 degrees and comment on the variation in the intensity of the light.

When unpolarized light passes through a polaroid sheet, the intensity drops in half. Why? Is this consistent with your observations?

When plane-polarized light passes through a polaroid sheet, the E-field amplitude is reduced by

$$E = E_0 cos\theta$$

where θ is the angle between the polarizing direction and the plane of the entering light.
As will be discussed in class, the flux or power per unit area transfered, I, is proportional to E^2, and so the flux of polarized light through a polariod filter follows the following relationship, known as Malus's Law:

$$I = I_0 cos^2\theta$$

Say that unpolarized light passes through two polarizing sheets, one oriented at an angle of 0 degrees with respect to the vertical, and one oriented at an angle of 20 degrees with respect to the vertical. What is the flux, I, of the light after it has passed through both sheets, assuming that it started with a flux of I_0 and suffered no losses to reflection?

3. Orient two Polaroids so that no light passes through and then rotate a third Polaroid in between the two. What do you find? Make a sketch of your observations below, indicating the directions of the E fields and the planes of polarization after each Polaroid sheet.

4. Now test whether a laser is polarized. **Do not look through the Polaroid at the laser!** Instead, project the laser light on the magnetic holder with the attached white screen. Place the Polaroid(s) between the laser and the white screen. Rotate the Polaroid and observe the effect on the projected beam. Describe what you see.

What do you conclude about the polarization of lasers?

5. Set up the white light source again. Place a Polaroid sheet in front of the light. Get a piece of cellophane and place in front of the sheet. Look through another polaroid sheet and rotate the sheet slowly. What do you see? What do you conclude about cellophane?

6. Examine the calcite crystal set up in the room. Ask for help from your instructor. Calcite exhibits *birefringence.* Explain what this means, based on your experiments and chat with your instructor.

7. If time allows, take a polarizing sheet to the window(s) and explore the polarization of the sky. **Do not look directly at the Sun.** Look in several different directions. Describe your observations and conclusions.