Physics 216
Polarization

1. Polarization by absorption:

A. Set up a light bulb using one of the lab stands. Look at the bulb through a large sheet of Polaroid linear polarizer. Rotate the polarizer. Does the bulb emit plane polarized light? Briefly explain, based on your observation.

B. Take two of the sheets of Polaroid and look through them at the bulb as you hold one fixed and rotate the second around an axis perpendicular to the plane of the sheet. Qualitatively describe what happens.

C. With the two sheets of Polaroid arranged to give minimum transmitted intensity, have a lab partner slide a third one in between and rotate it around. Describe and explain your observations.

D. Set up the light sensor (probably on the 6000 scale) and use the LabPro to take quantitative data. Place one large sheet of Polaroid between the bulb and the light sensor. By what fraction is the intensity from the bulb reduced (be sure to account for background room light)? Does this agree with what you expect?

Checkpoint 1!

E. Now let's be more quantitative. Set up two rotateable polarizers between the light bulb and the light sensor. Keeping the polarizers close to the light sensor will reduce the amount of room light that gets to your sensor. Check whether the maximum intensity is transmitted when the transmission axes of the polarizers are aligned, and that the minimum intensity is transmitted when the axes are crossed (at 90º). Then use the light sensor to measure carefully the transmitted relative intensity when the polarizers are aligned, when they are crossed, and at 10º intervals in between. Record data in the table below. Include estimates of uncertainties in angle and intensity.

Angle of 1st polarizer	Angle of 2nd polarizer	Difference	Light sensor reading

Use LoggerPro to plot the data (intensity vs. angle between the transmission axes) and also fit the data to the theoretical expectation (from Malus' Law $I(\theta)=I_0\cos^2(\theta)$). You will probably have to define your own function for this. How will you deal with any background light hitting the sensor? Comment on how ideal the polarizers are, based on your data. Print out your graph with the fit and staple it to the rest of this lab.

Checkpoint 2!

2. Polarization by reflection:

Background: Electromagnetic waves travel slower than c when traveling through materials other than vacuum. The ratio of c to the speed of light in the material (v) is called the index of refraction (which we will see in more detail in the next section of the class) and is given by n=c/v. When unpolarized light is incident at Brewster's angle ($\theta_p = \tan^{-1}\frac{n_2}{n_1}$) (with respect to the perpendicular to the surface) on an interface between two dielectrics with indices of refraction n_1 and n_2, the reflected light is polarized parallel to the interface.

A. Shine a flashlight or light bulb on a piece of glass, and observe the reflection through a piece of Polaroid. What happens as you turn the Polaroid?

B. At Brewster's angle, you will be able to (almost) extinguish the reflected light when the polarizer is in the proper orientation. Find this angle experimentally, and use your measurement of Brewster's angle to obtain a value for the index of refraction of glass (note the index of refraction of air is 1.00 to two decimal points so we'll treat it as 1.00. Estimate the error in n (a quick and dirty way to do this is to estimate an uncertainty in your measured angle, then plug in the maximum and minimum angles to obtain a range for n). Is your value reasonable?—check against some reliable source.

C. Since you know the reflected light at Brewster's angle is polarized parallel to the interface, you can determine the direction of the transmission axis of your Polaroid sheet (that is, the direction of polarization of light that is transmitted by the polarizer). Do so and record whether reflected light is polarized horizontally or vertically.

D. Higher priced sunglasses are often marketed as being made of polarizing material to reduce glare. In light of the above observations, explain why this would help and how the axis of the polarizer in the sunglasses should be oriented.

Checkpoint 3!