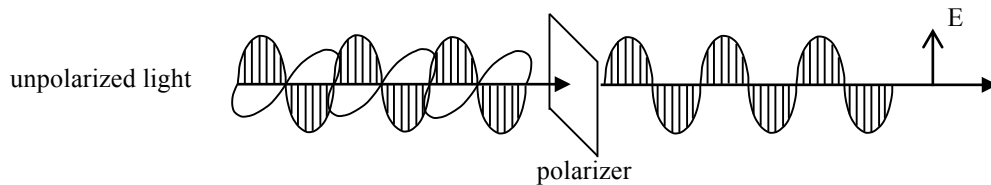


This lab explores the subject of optical polarization. The lab is divided into three parts, all of which employ polarizing sheets. You will have some freedom to decide how to carry out the experiments. Much of the data acquisition will be done visually but some will require measuring light intensity with a power meter. However, you should take detailed notes as much of the data will be qualitative. The write-ups should explain how each part was performed.

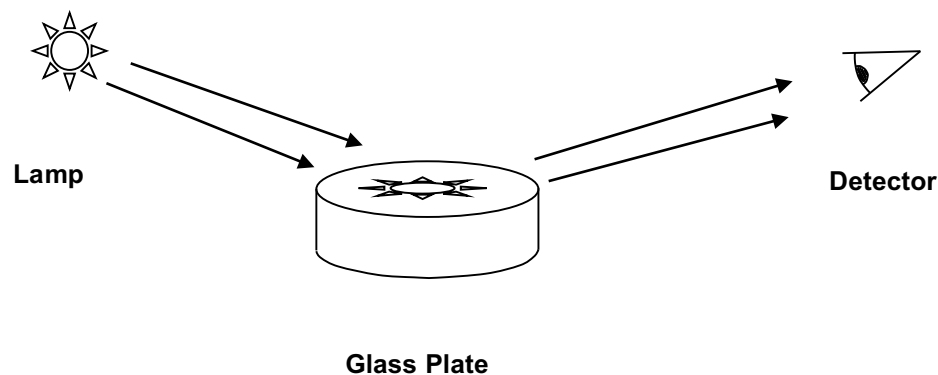
**Procedure:**

- A. Use a lamp (an unpolarized source) to determine if light reflected at grazing incidence from a glass plate is polarized (see figure below).

If so, what is the polarization direction? Can you explain why? Is there an angle of incidence dependence?

Instead of a glass plate, consider a road in the late afternoon sun. What orientation should your polarized sunglasses have?

Can you use this phenomenon to 'calibrate' your polarizing sheets (i.e., establish the orientation of the sheets)?



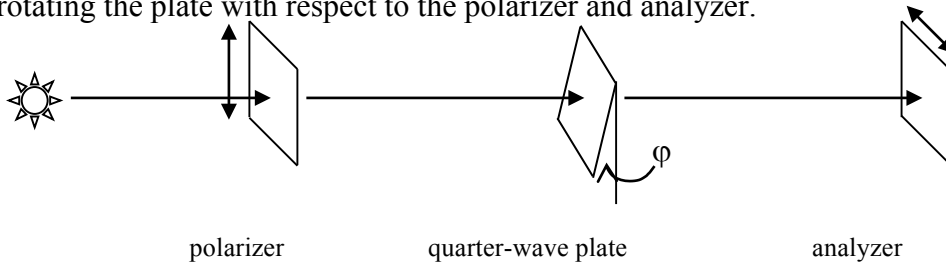
B. Now switch to a diode laser light source. Is the diode laser output polarized?

Add a second polarizing sheet (an ‘analyzer’). Using an optical power meter, measure the transmitted power as a function of angle of the analyzer. Plot the results using a computer and determine the trigonometric function that best describes the data (use a linear least-squares fit).

Two linear polarizers crossed at 90 degree with respect to each other should theoretically allow no light to pass through. Is this the case? How well you’re your single thin film polarizer reject orthogonally polarized light? Be careful to account for background light in the lab.

C. A quarter-wave plate is an optical element that introduces a relative phase shift of $\pi/2$ between orthogonal components of an incident wave. The reason this happens is that one component propagates through the plate more rapidly than the other. It should be apparent that linearly polarized light parallel to either principal axis will be phase-shifted but otherwise unaffected. If not aligned along a principal axis, a phase difference is developed between two orthogonal components. With the correct plate length with respect to the light wavelength, a $\pi/2$ phase difference is obtained.

Using the following set-up, determine the optical axis of a quarter-wave plate by rotating the plate with respect to the polarizer and analyzer.



(Is it easier to continue to use the laser and power meter for the measurement or a lamp and your eye?)

At what angle ϕ_0 do you expect to observe the least intensity?

Rotate the plate by 45° with respect to ϕ_0 . Do you expect this to be an intensity maximum? Why? Using the power meter, measure the intensity through the analyzer as you rotate the quarter-wave plate.

With the plate fixed at 45° with respect to ϕ_0 , what happens if you rotate the analyzer? Can you explain this effect?