University of California, Berkeley | *Spring 2007*
EECS 117 | *Prof. A. Niknejad*

EECS 117 Demonstration 6

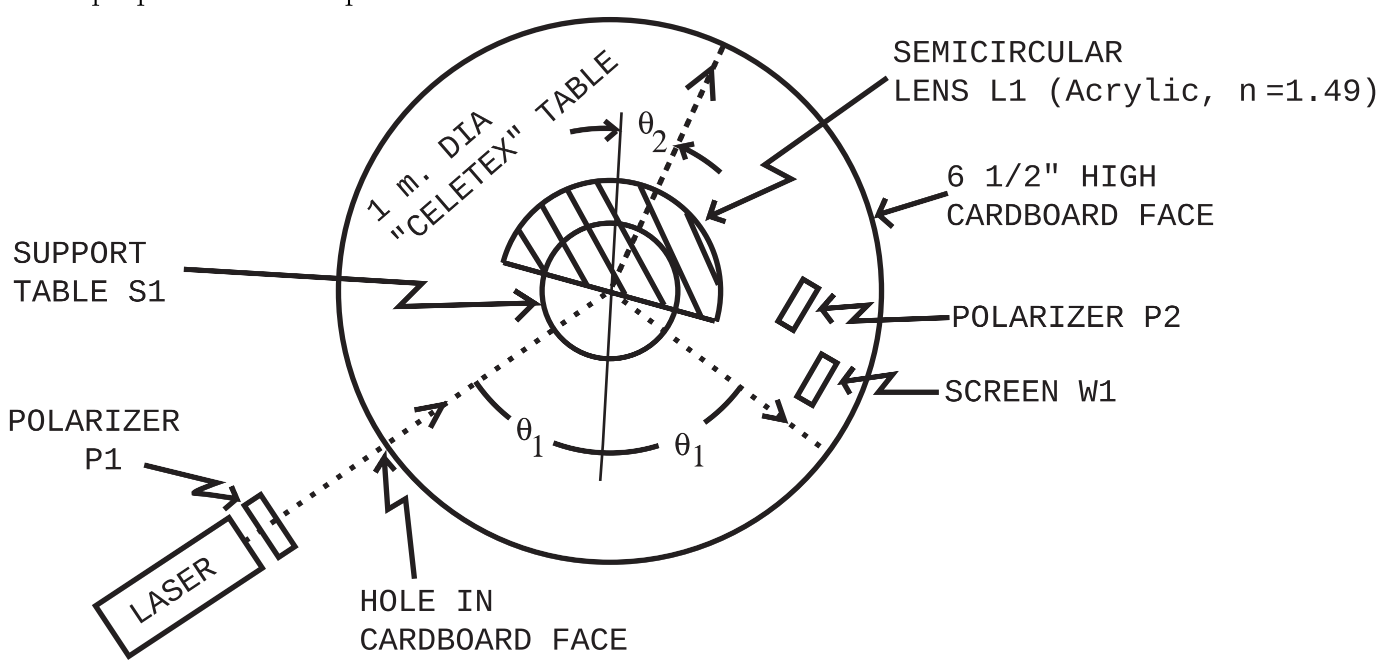
Plane Waves

NAME ________________________________

WARNING: SAFETY FIRST! ALWAYS WEAR SAFETY GOGGLES WHEN LASER IS ON. DO NOT ALLOW THE LASER BEAM, EITHER DIRECTLY OR AFTER REFLECTION FROM A SURFACE, TO ENTER ANYONE'S EYE. PERMANENT BLINDNESS MAY RESULT.

Introduction. Polarization, reflection and refraction of plane electromagnetic waves are described in Inan Chapter 8 . In this demonstration you will examine these phenomena for light waves, using a He-Ne laser as a source of electromagnetic waves (light) at wave-length 632.8 nm (red light).

You will study Snell's law, total internal reflection, and Brewster's angle, and their polarization properties. The experiment is shown below:



HANDLE ALL OPTICAL COMPONENTS WITH CARE. DO NOT TOUCH THE OPTICAL SURFACES WITH YOUR FINGERS.

Procedure:

1. Examine the LAS-101 HeNe laser. Note the gas discharge tube, Brewster's angle windows, and high reflectivity (for red light) mirrors. View the white light in the room through the mirrors. What color do you see, and why? ______________________________

   ____

2. Turn on the laser. Direct the beam through the hole in the cardboard face toward the rotating support S1. Place polarizer P1 between the laser and the cardboard face. To determine whether the laser beam is polarized, observe the amplitude of the transmitted beam on screen W1 as the polarizer is rotated within its holder. If the beam is polarized, the amplitude of the transmitted beam will change. Is the laser beam polarized? ______ . Next place polarizer P2 between the screen and the cardboard face, and use P2 to detect the polarization produced by P1. Minimum transmission results when the polarizing directions of P1 and P2 are at right angles.

3. Snell's law. Remove the polarizers. Place lens L1 (index of refraction = 1.49) on support S1, centered so that the laser beam is incident on the flat surface of L1 at the center of curvature. This alignment should be done carefully. The beam should exit the lens perpendicular to its surface. Rotate S1 and verify Snell's law [Sec. 6.11, eq. (3)] for a few angles of incidence:

   $\theta_1 =$ ______ ; θ_2 (measured) $=$ ______ ; θ_2 (Snell's law) $=$ ______ .

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   Insert P1 and vary the polarization. Does Snell's law depend on the polarization? ______ .

4. Total internal reflection. Remove the polarizers. Rotate S1 so that the laser beam is incident on the curved surface of L1. Rotate S1 and observe the angles and amplitudes of the waves transmitted and reflected from the flat surface of the lens L1. When the angle of incidence (on the flat surface) reaches the critical angle θ_c for total internal reflection, the transmitted wave emerges parallel to the flat surface of L1. For $\theta > \theta_c$, the transmitted beam disappears, and all incident wave energy is reflected. Measure the critical angle and compare with the theoretical value.

   θ_c (measured) $=$ ______ ; θ_c (theory) $=$ ______ .

   Insert P1. Does the phenomenon of total internal reflection depend on the polarization? ______ .

5. Brewster's angle. Insert P1 with the plane of polarization lying in the plane of incidence (E field parallel to the table.) Rotate S1 so that the laser beam is incident on the flat surface of L1. Examine the reflected wave as you vary the angle of incidence θ_1 by rotating S1. When θ_1 is equal to Brewster's angle θ_p, then the reflected beam will vanish. Verify this. Measure Brewster's angle and compare with the theoretical value. (You can remove the polarizer to measure the angle):

   θ_p (measured) $=$ ______ ; θ_p (theory) $=$ ______ .

Repeat the above with the E field perpendicular to the plane of incidence (E field perpendicular to the table). Is there a Brewster angle? _______ .