Physics 1C, Summer 2011 (Session 1)

Practice Midterm 2 (50+4 points)

Problem 1 (5x2 = 10 points)

Label the following statements as True or False, with a one- or two-sentence explanation for why you chose your answer. Even if you get the answer correct, you will receive no credit unless your explanation is clear.

a. In order to have total internal reflection for light, you must be in a medium that has a smaller index of refraction than the surrounding medium.

b. When you walk away from a flat mirror, the size of your image does not change.

c. A lens can produce an upright, magnified, real image.

d. When looking at the intensity distribution for diffraction from a small single slit, projected onto a screen very far away from the slit, the width of the central bright spot is twice that of surrounding bright spots.

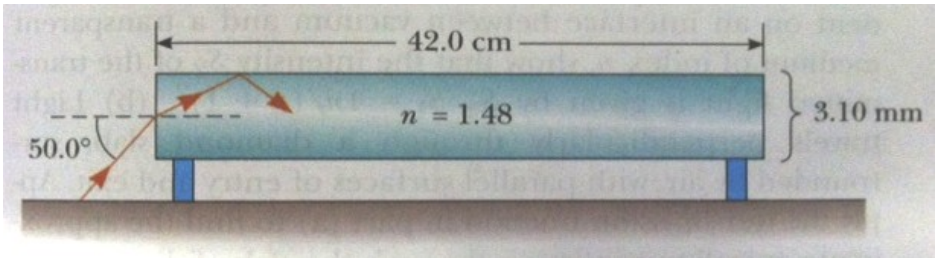
e. To resolve two very close objects, it is helpful to use light with a small wavelength.

Problem 2 (5+5 = 10 points)

A laser beam strikes one end of a slab of material as shown in the figure below. The index of refraction of the slab is 1.48.

a. Determine the number of internal reflections of the beam before it emerges from the opposite end of the slab.

b. Is there an incident angle ψ (instead of 50.0^0) such that the beam inside leaks out of the slab (that is, the beam is not undergoing total internal reflection)?



Problem 3 (5+5 = 10 points)

Light of wavelength 590 nm passes through two narrow slits 0.60 mm apart. The screen is 1.70 m away, perpendicular to the line connecting the slits to the screen.

a. How far away from the central maximum is the second-order fringe? The second-order fringe is not the bright spot next to the central maximum, but the bright spot that is two away from the central maximum.

b. A second source of unknown wavelength produces its second-order fringe 1.33 mm closer to the central maximum than the 590-nm light. What is the wavelength of the unknown light?

Problem 4 (6+3+3 = 12 points)

A collimated laser beam (meaning the light is coming out parallel) emerging from a commerial HeNe laser has a diameter of 1.00 mm. In order to convert this beam into a well-collimated beam of diameter 10.0 mm, two convex lenses are to be used. The first lens is of focal length 1.50 cm and is to be mounted at the output of the laser.

a. Draw a (neat) ray diagram to show the beam's width as it passes through the two lenses. Make sure you include the location of the focal points of the lenses.

b. What is the focal length of the second lens?

c. How far from the first lens should the second lens be placed?

Problem 5 (8 points)

Blue light of wavelength 480 nanometers is most strongly reflected off a thin film of oil on a glass slide when viewed near normal incidence. The index of refraction of the oil is 1.2 and that of the glass is 1.6. What is the minimum thickness of the oil film (other than zero) ?

Extra Credit (2+2 = 4 points)

Suppose we have light of initial intensity $2I_0$, and three polarizers. The first polarizer is fixed in the +x-direction, the third polarizer is fixed in the +y-direction, and the second polarizer (in between the two) can be rotated to lie at an angle θ with respect the +x-axis toward the +y-axis.

a. What is the intensity of the light passing through the entire system, as a function of θ?

b. Graph the intensity of light as a function of theta, for $0 <= \theta <= 90^0$.