

UNIVERSITY OF ALABAMA
 Department of Physics and Astronomy
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PH 495/ECE 493 LeClair & Kung

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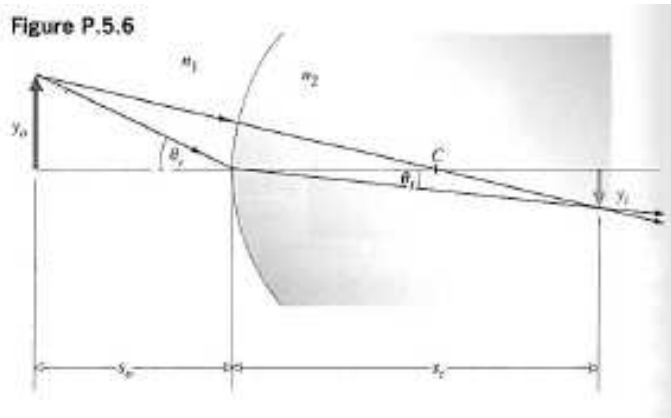
Problem Set 3

Instructions:

1. Answer all questions below. All questions have equal weight. Show your work for full credit.
2. All problems are due Thursday February 17, 2011 by 11:59pm.
3. You may collaborate, but everyone must turn in their own work.

1. *Hecht 5.6.* Show that, in the paraxial approximation, the magnification produced by a single spherical interface between two continuous media, as shown below, is given by:

$M_T = \frac{y_i}{y_o} = -\frac{n_1 s_i}{n_2 s_o}$. Use the small-angle approximation for Snell's Law and approximate the angles by their tangents.



2. *Hecht 5.11.* Prove that, for a lens immersed in medium of index n_m , we have:

$$\frac{1}{f} = \frac{(n_l - n_m)}{n_m} \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$
. Imagine a double-concave air lens surrounded by water. Determine if it is converging or diverging.
3. *Hecht 5.22.* Determine the focal length in air of a thin spherical planar convex lens having a radius of curvature of 50.0 mm and air index of 1.50. What, if anything, would happen to the focal length if the lens were placed in a tank of water?
4. *Hecht 5.23.* We would like to place an object 45 cm in front of a lens and have its image appear on a screen 90 cm behind the lens. What must the focal length of the appropriate convex lens?

5. *Hecht 5.39.* Draw a ray diagram for the combination of two convex lenses wherein their separation equals the sum of their respective focal lengths. Do the same for the case in which one of the lens is concave.
6. *Hecht 5.40.* Two convex lenses are used as a laserbeam expander. An axial 1 mm diameter beam enters a short focal length (50 mm) lens, followed by a longer focal length lens from which it emerges with a diameter of 8 mm. Determine the focal length of the second lens and the separation between the lenses. Draw a diagram.
7. *Hecht 5.42.* Using a ray diagram, show that if a second lens L_2 is placed at the focal point of L_1 , the magnification does not change. That is a good reason to wear eyeglasses, whose lenses are different, at the correct distance from the eye.
8. *Hecht 5.54.* A thin lens having a focal length of +50 cm is positioned 250 cm on the left of a plane mirror. An ant sits on the central axis 250 cm to the left of the lens. Locate the positions of the three images of the ant.