Astronomy 203 Problem Set #1

Due 16 September 1999

1. Consider the situations, shown in the figure below, of dielectric media with refractive indices n_1 and $n_2 > n_1$. For the convex surface, show that

$$\frac{n_1}{o} + \frac{n_2}{i} = \frac{n_2 - n_1}{r} \quad ,$$

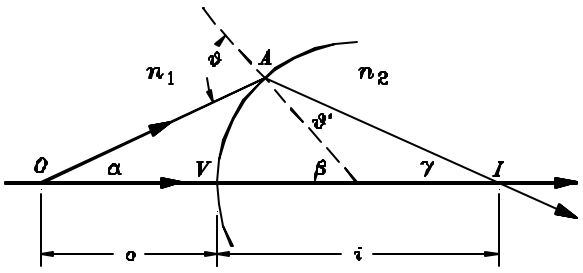
and for the concave surface, show that

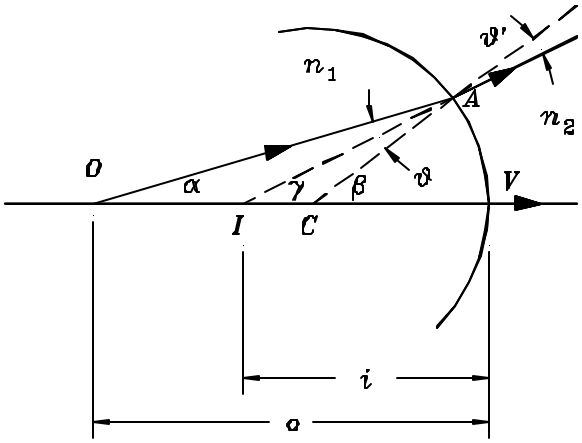
$$\frac{n_1}{o} + \frac{n_2}{i} = -\frac{n_2 - n_1}{r} \quad ,$$

and hence that the focal length is

$$f = \frac{n_2}{n_2 - n_1} r \quad .$$

subject to the sign convention $r > 0$ for the convex surface.and $r < 0$ for the concave one.





2. a. Derive an expression for the back focal length of the following combination: a thin lens with focal length f_1 and a convex spherical dielectric of radius *r* and index *n*, placed a distance *d* apart and illuminated from the lens' side.

   b. I am nearsighted, and am always seen wearing either contact lenses or eyeglasses. The correct power for my glasses is determined by my optometrist to be –2.25 diopters, by placing a variety of lenses in the normal "eyeglasses" position, 1 cm in front of each eye. What is the correct power for my contact lenses?

   c. The position of the most distant object on which I can focus, when I'm not wearing my glasses or contacts, is called my *far point.* How far away from my eyes is my far point?

3. Derive an expression for the back focal length of a *thick* biconvex lens: a lens for which the paraxial approximation applies to the surfaces, but for which the distance *d* between the apices is finite.

4. *Hecht problem 5.33*: Two thin lenses having focal lengths of +15.0 cm and –15.0 cm are positioned 60.0 cm apart. A page of print is held 25.0 cm in cront of the positive lens. Describe, in detail, the image of the print (i.e., insofar as it's paraxial).

5 The 200-inch (5 m) telescope at Palomar Observatory has a primary mirror with focal length 16.7 m. It is most often used with a Cassegrain focus behind the primary, a distance 3 m from the primary's apex.

   a. The secondary mirror's apex is 89 cm from the prime focus. What are its apex curvature and eccentricity?

   b. What is plate scale at the Cassegrain focus?

   c. Estimate the diameter *d* of the secondary mirror, and the final focal ratio $F = f_2 / d$, where f_2 is the relevant focal length of the secondary.