Physics 47 — Fall 2017

Problem Set 3
Due Wed, Oct 4, 2017
(before start of class)

Textbook Problems

1. Hecht 5.7 *and* 5.9 [8 pts.]
   These two linked problems will require you to to handle a thick two interface optical system, finding the relation between object and image for one interface, then determining how a second interface changes the location and magnification of the final image. Note that you'll have to use the more general version of the Gaussian optics equation (Hecht Eqn. 5.8).

2. Hecht 5.41 [3 pts.]
   This problem should make it very clear why and how transverse and longitudinal magnification are not the same thing.

3. Hecht 5.53 [2 pts.]
   This is a bit of a tricky challenge to "sanity check" a ray diagram and exercise your understanding of the basic ideas behind ray tracing. It isn't too hard to pick out the flaw in (a), but the problem with (b) is a little more subtle.

4. Hecht 5.77 [3 pts.]
   This simple, but slightly unusual, problem will require you to think about a *catadioptric* system, one which involves both refraction and reflection.

5. Hecht 6.16 [3 pts.]
   This is a simple first exercise in using the ray matrix formalism. For this problem and the next, please note that Hecht's convention for ray matrices is transposed compared to most other optics texts and references.

6. Hecht 6.29 [4 pts.]
   The result of this ray matrix problem is much more important than it may presently appear. We'll come back to this "confocal cavity" transfer matrix when talking about Fabry-Perot interferometers and lasers.

Additional Problems

A1. [4 pts.] – Show that the smallest possible separation between a *real* image and *real* object is four times the focal length of the (positive) thin lens, and that the lens is then midway between the object and image.

A2. [4 pts.] – Consider a thick lens made of a material with index of refraction n_2 surrounded by a liquid medium of index n_1. The curvatures of the first and second surfaces are R_1 and R_2, and the thickness is d.

a) Derive the ABCD matrix for this lens
b) Show that in the limit that d goes to zero, this matrix reduces to the matrix for a thin lens. Assume the index of the medium outside the lens to be $n_1 = 1$.