PHY385H1F – "Introductory Optics"
Problem Set 3
Due: **Tuesday October 23**, 2012 by 1:10pm

Instructions: Please complete the following problems on separate paper. SHOW ALL YOUR WORK. You will be graded more on correct method than correct answer. If you take an equation from the Hecht text, please give the equation number and page number.

Based on Chapter 5 of Optics (4th Edition) by Eugene Hecht, ©2002 by Addison-Wesley:

1. A double convex lens has a diameter of 5 cm and zero thickness at its edges. A point object on an axis through the center of the lens produces a real image on the opposite side. Both object and image distances are 30 cm, measured from a plane bisecting the lens. The lens has a refractive index of 1.52. Using the equivalence of optical path lengths through the center and edge of the lens, determine the thickness of the lens at its center.

2. A plano-convex lens having a focal length of 25.0 cm is to be made with glass of refractive index 1.520. Calculate the radius of curvature of the convex side of this lens.

3. A meter stick lies along the optical axis of a convex mirror of focal length 40 cm, with its nearer end 60 cm from the mirror surface. How long is the image of the meter stick?

4. A small goldfish is viewed through a spherical glass fishbowl 30 cm in diameter. Determine the apparent position of the fish's eye when its actual position is
   a. at the center of the bowl.
   b. nearer to the eye, halfway from center to glass, along the line of sight.

Assume that the glass is thin, and of equal thickness around the edges of the bowl, so that its effect on the refraction may be neglected.

5. Two thin lenses have focal lengths of –5 cm and +20 cm. Determine their effective focal lengths when
   a. cemented together.
   b. separated by 10 cm. [In this case, please report the "back focal length", or the distance from the last lens to the final image.]

6. (sketch template provided on the back of this page) An object measures 2 cm high above the axis of an optical system consisting of a thin diverging lens of –30 cm focal length and 5 cm diameter, a 2 cm diameter aperture stop and a thin converging lens of 4 cm focal length and 5 cm diameter. The object is 7 cm in front of the diverging lens, the diverging lens is 1 cm in front of the aperture stop, and the aperture stop is 2 cm in front of the converging lens.
   a. Determine the position and vertical size of the image. Sketch the image on the sketch template provided.
   b. Determine the position and size of the entrance pupil. Label it on the sketch template provided.

Sketch template for Problem 6.