MASSACHUSETTS INSTITUTE OF TECHNOLOGY

2.710 Optics **Fall '05**
Problem Set #2 Posted Sept. 14, 2005 — Due Wednesday, Sept. 21, 2005

1. **The spoon** Compare the image of yourself that you observe looking at the convex surface of a spoon with the image from a flat mirror. Do some simple raytracing to explain the difference.

2. **Wanda's world** Your goldfish Wanda lives in a sphere of water (refractive index $n = 1.3$, radius $|R| = 20$cm). At one instance, Wanda has wandered to the center of here water world (see Fig. 2 below). Model Wanda as a stick perpendicular to the optical axis and the water sphere as a thick lens. You may ignore the effect of the glass container of Wanda's world

   a) Where is Wanda's image formed?

   b) Is the image erect or inverted?

   c) What is the magnification?

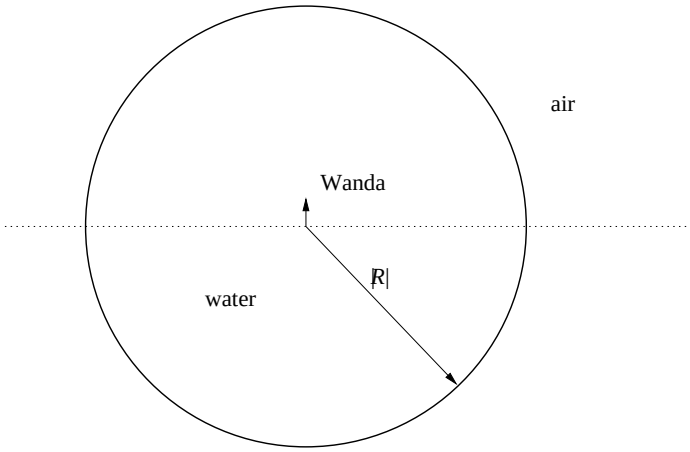

Figure 2: Wanda's world

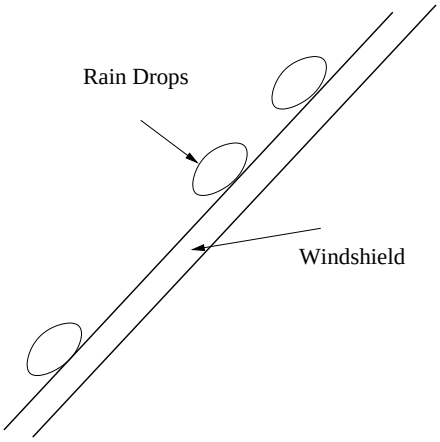

Figure 3

3. Design an optical system which can detect the amount of water present on a car's windshield to adjust the wiper speed.

Hint: indices of refraction $n_{\text{glass}} = 1.5, n_{\text{water}} = 1.33, n_{\text{air}} = 1.0$.

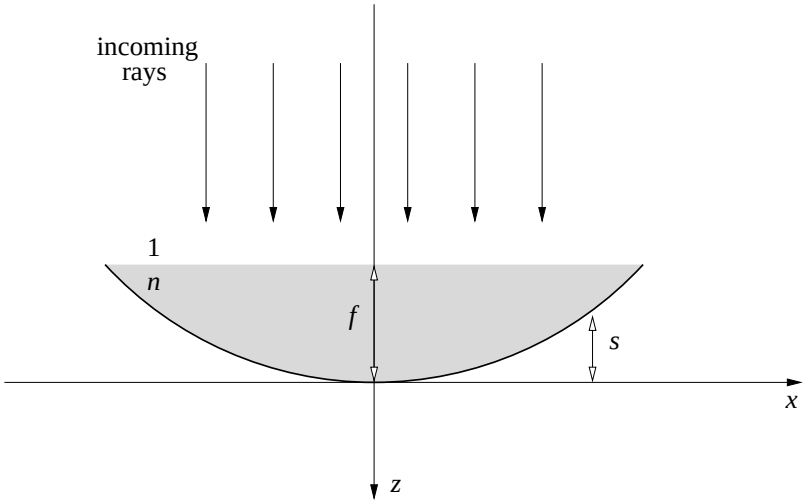

Figure 4

4. Lens-in-a-pool Consider a perfectly focussing one-dimensional paraboloid mirror filled with a fluid of refractive index n. The mirror surface is described by the equation $s(x) = x^2/4f$, where f is the focal length of the mirror. The fluid is present up to a height of f. Light is incident from the top as shown in Figure 4. You may neglect the slight reflection that occurs when the light rays go from the air into the fluid.

a) Calculate the portion of the incoming ray bundle which will exit from the fluid as a divergent ray bundle after focusing.

b) Show that the remaining rays will exit as a parallel ray bundle.

c) Suppose that the incoming ray bundle is shadowed by the letter "A." If you placed a camera just above the focal point (in air), what would you observe? You need not write any equations, just reason qualitatively.