

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. **Anamorphic demagnifier** Consider the geometry shown in Figure 2, which uses a right-angle prism to laterally translate a horizontal incident ray. The ray experiences TIR at the first two glass-air interfaces and exits at the third interface. The prism has index of refraction n and a tip angle θ .

- a) If $\theta = 15^\circ$, find n so that the outgoing ray propagates in the horizontal direction, as shown in the Figure 2.
- b) Calculate the vertical demagnification ratio

$$m = \frac{h_2}{h_1}$$

when $\theta = 15^\circ$.

- c) Can the requirement of horizontal orientation for the outgoing ray be satisfied if $\theta = 45^\circ$?

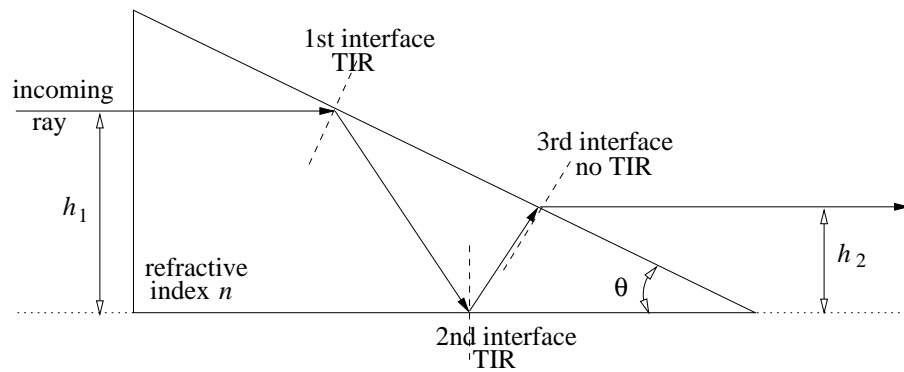


Figure 2

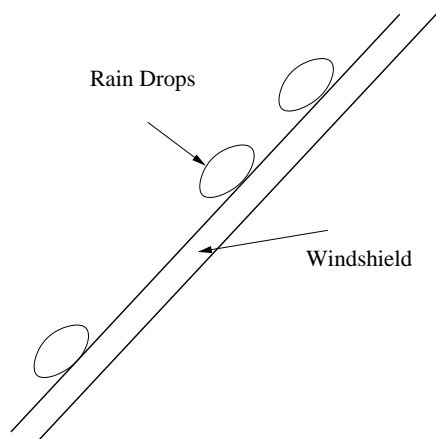


Figure 3

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 $n_{\text{glass}} = 1.5$, $n_{\text{water}} = 1.33$, $n_{\text{air}} = 1.0$.

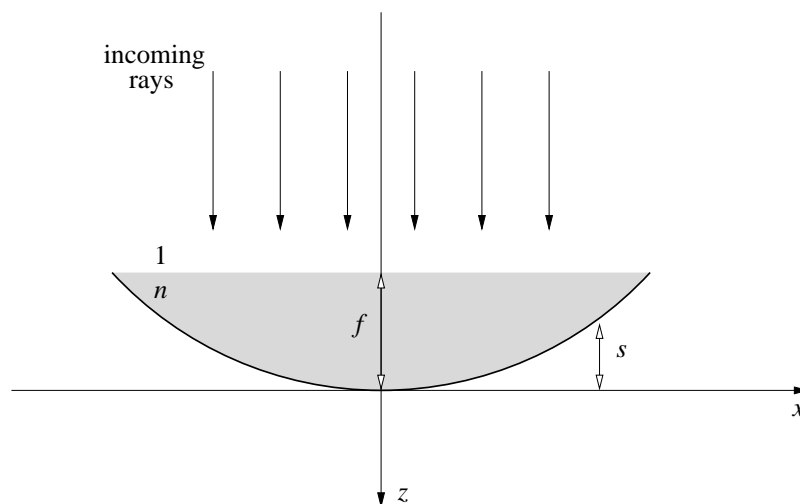


Figure 4

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.