Module 10 Homework

1. Suppose a man stands in front of a mirror as shown in Figure 1. His eyes are 1.65 m above the floor, and the top of his head is 13 cm higher.
    1. Find the height above the floor of the top and bottom of the smallest mirror in which he can see both the top of his head and his feet.
    2. If the man stands 1.00 m in front of the mirror, determine the angle of incidence of the rays originating from his head and feet.
2. Figure 2 shows a ray reflected off of two mirrors placed next to each other at some angle b. The incoming ray strikes the first mirror at an angle a and the outgoing ray makes an angle c with the incoming ray.
    1. Derive an expression for the angle c between the incoming and outgoing rays in terms of the angle between the mirrors and the incident ray angle.
    2. If the mirrors make an angle of $b = 135°$ and the incident angle is $a = 15°$, what is the angle between the incoming and outgoing rays?
    3. If the mirrors make an angle of $b = 90°$, what is the angle between the incoming and outgoing rays?
3. Figure 3 shows a ray of light incident on a piece of plastic from air. The incident ray is refracted as it enters the plastic and then completely reflected off the side surface. The refractive index of the plastic is 1.3. Determine the maximum incident angle (θ) for which this can occur.
4. Consider the light ray incident on the surface of a spherical mirror of diameter D (Figure 5). The incoming ray is parallel to the surface normal that passes through the center of the mirror (the dashed line) and is reflected to the focal point of the mirror. Using the small angle approximation, determine the focal length f of this mirror.
5. Consider Figure 4. A light ray is incident on a quarter spherical piece of glass, parallel to the horizontal. It passes through the glass and exits at some angle θ with respect to the horizontal. Assume that l and Δy are known values, and that the refractive index n of the glass is also known. Use the small angle approximation to determine the angle θ in terms of the known parameters.
6. **Example Problem Write-up:** A piece of plastic with unknown refractive index sits in air. A ray of light strikes the plastic surface at angle of 40° *with respect to the plastic surface* and is observed to bend by an angle of 10° from its original path. What is the refactive index of the plastic?

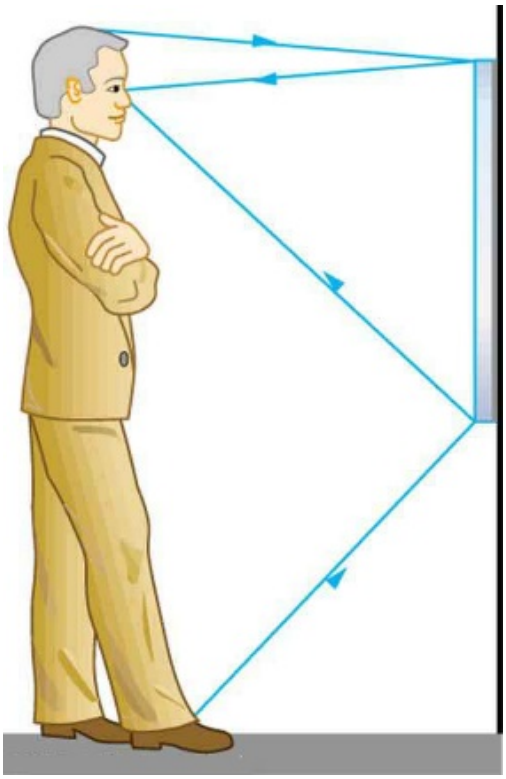

Figure 1: Rays scattered by the body can be reflected back by a mirror. Any rays that are reflected back toward the eye can be "seen".

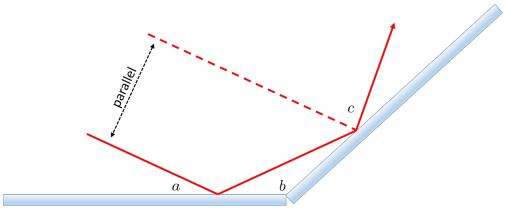

Figure 2: Two mirrors are placed next to each other at an angle. A ray incident on one mirror is reflected into the second and reflected back. The dashed line is parallel to the incoming ray.

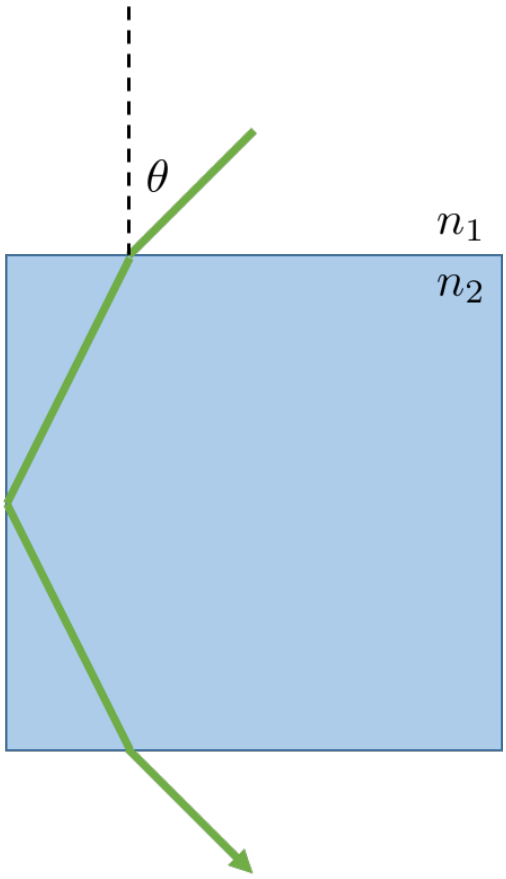

Figure 3: A light ray refracts into a material and then undergoes total internal reflection off the side surface.

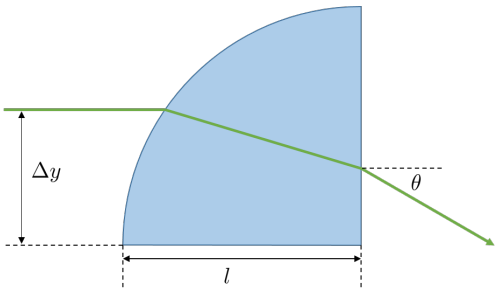

Figure 4: A ray refracts across a spherical surface and then a flat surface.

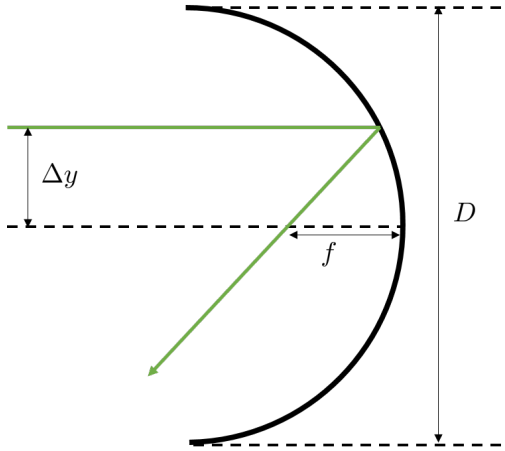

Figure 5: A light ray incident on a spherical mirror is reflected to the focal point of the mirror. The dashed line from which Δy is measured is perpindicular to the mirror's surface.