Experimental Physics III

Submission due: October 20, 2022, before the lecture starts

Exercise Sheet 1

1.1

Imagine a 1.62 m tall person wants to see oneself completely in a vertically standing, rectangular plane mirror.

- Calculate the minimal vertical extension of the mirror.
- Calculate at which height the mirror must be placed if the person's crown is 12 cm above the eyes. Draw a sketch and explain your answer.

1.2

A light ray in air hits a transparent material under an angle of 58° to the vertical. The reflected and the refracted rays are perpendicular to each other.

- Calculate the index of refraction of the transparent material.
- Calculate the critical angle for the total internal reflection.

1.3

Given is a step-index multi-mode optical fiber with core and cladding having refractive indices of $n_c = 1.68$ and $n_g = 1.44$, respectively (Figure 1).

- Calculate the acceptance angle θ_{max} at the air–core interface, i.e., the biggest angle of incidence at which light will travel down the fiber (refractive index of ambient air $n_0 = 1.00$).
- Calculate the numerical aperture of this fiber.

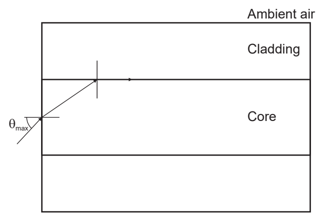

Figure 1: Sketch of an optical fiber.

1.4

Consider a light ray that travels from a point A in a medium (refractive index n_1) to a point B located in a second medium (refractive index n_2) such that total internal reflection does not occur at the plane interface of both media. Point A and B have a horizontal distance of l from each other as well as a vertical distance of h_1 and h_2 to the interface of both media, respectively (Figure 2). Using Fermat's principle derive Snell's law.

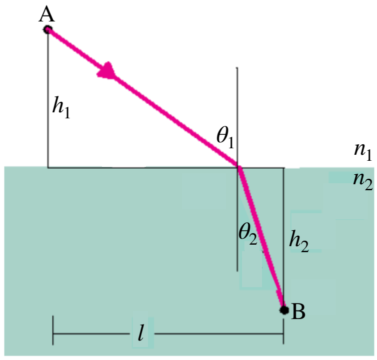

Figure 2: Light beam traveling from a point A to a point B via the interface of two media.