The University of Zambia
School of Natural Sciences
Department of Physics

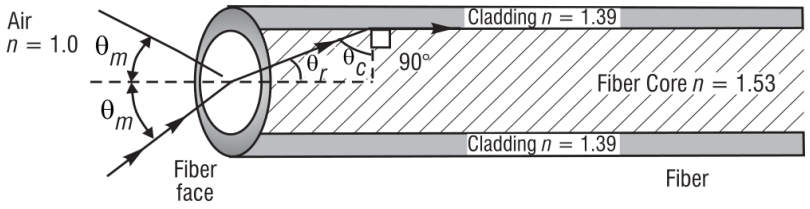
PHY2712: Geometric and Wave Optics

2022-2023 Academic year-Part II

Assignment 1

Hand in on Thursday 27th July

1. Consider a cuboid made of crown glass which has inner space filled with water. A ray of light is incident onto the 10 cm thick block of glass on the top face of the cuboid at 60° from the normal. It then meets the glass-water boundary and is refracted again and continues through a water thickness of 5 cm before reaching another water-glass boundary. The ray of light is again refracted and continues in the 10 cm thick block of glass on the base of the cuboid and eventually exits into air.
   (a) Draw a clearly labelled diagram of the path the ray of light takes.
   (b) Calculate all the angles of refraction and incidence at each boundary.
   (c) Calculate the optical path of the ray of light from the point it is incident on the surface of the cuboid to the point it exits into air on the other end.
2. In a handheld optical instrument used under water, light is incident from water onto the plane surface of flint glass at an angle of incidence of 45°.
   (a) What is the angle of reflection of light off of the flint glass?
   (b) Does the refracted ray bend towards or away from the normal?
   (c) What is the angle of refraction in the flint glass?
3. A step-index fibre 0.0065 cm in diameter has a core with a refractive index of 1.53 and a cladding with a refractive index of 1.39 (See the Figure). What is the maximum acceptance angle θ_m for a cone of light rays incident on the fibre face such that the refracted ray in the core of the fibre is incident on the cladding at the critical angle?



4. The dispersion powers of crown and flint glasses are 0.03 and 0.05 respectively. If the difference in the refractive indices of violent and red colors is 0.014 for crown glass and 0.023 for flint glass, calculate the angles of the two prisms for a deviation of 10° (without dispersion).

5. A piece of dense flint glass is to be made into a prism. If the refractive indices for red, yellow, and blue light are specified as $n_C = 1.64357$, $n_D = 1.64357$, and $n_F = 1.66270$, respectively. Find,

   (a) the dispersive power.

   (b) the dispersion constant for this glass.