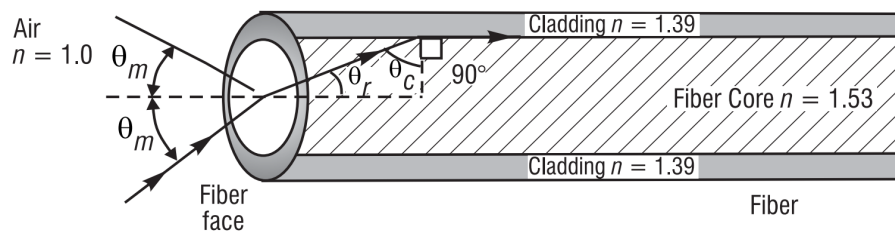


Total Marks = 100

Question 1: 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° .

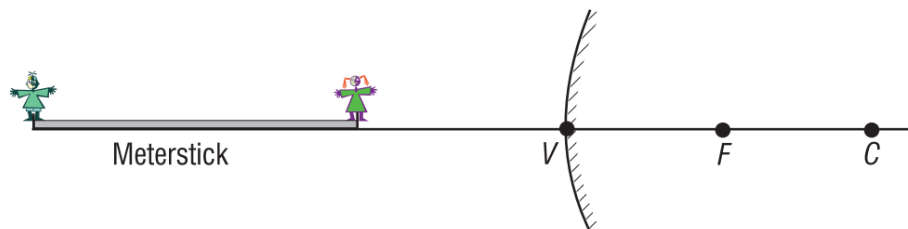
- What is the angle of reflection of light off the flint glass? (**3 Marks**)
- Does the refracted ray bend toward or away from the normal? (**4 Marks**)
- What is the angle of refraction in the flint glass? (**3 Marks**)

Question 2: A step-index fiber 0.0025 inch in diameter has a core index of 1.53 and a cladding index of 1.39. See figure below. Such clad fibers are used frequently in applications involving communication, sensing, and imaging.



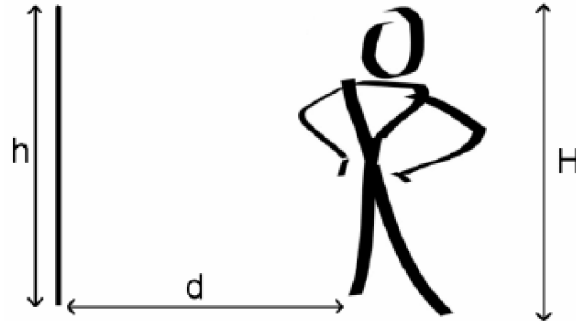
What is the maximum acceptance angle θ_m for a cone of light rays incident on the fiber face such that the refracted ray in the core of the fiber is incident on the cladding at the critical angle? (**20 Marks**)

Question 3: A meterstick lies along the optical axis of a convex mirror of focal length 40 cm, with its near end 60 cm from the mirror surface. Five-centimeter toy figures stand erect on both the near and far ends of the meterstick.



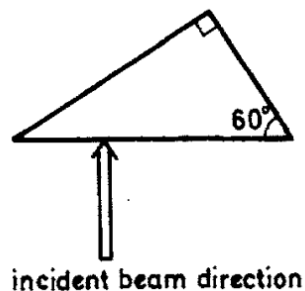
- How long is the virtual image of the meterstick? (**10 Marks**)
- How tall are the toy figures in the image, and are they erect or inverted? (**20 Marks**)

Question 4: James is a vain man (See the figure below). He loves to look at himself in the mirror all the time. Unfortunately, his pet just broke his favourite mirror, and so James is shopping for a new one.



How tall (h) would the new mirror have to be in order for James, whose height is H , to be able to see his whole body if the distance between him and the mirror (d) = $H/2$? What if $d = H$? (20 Marks)

Question 5: (a) A narrow beam of light is incident on a 30° - 60° - 90° prism as shown below. The index of refraction of the prism is $n = 2.1$. Show that the entire beam emerges either from right hand face, or back along the incident path. (10 Marks)



(b) A spherical concave shaving mirror has a radius of curvature of 12 inches. What is the magnification when the face is 4 inches from the vertex of the mirror? Include a ray diagram of the image formation. (10 Marks)