Answer on Question #52317-Physics-Optics

A prism is made of glass of unknown refractive index. A parallel beam of light is incident on a face of the prism. The angle of minimum deviation is measured to be 40°. What is the refractive index of material of prism? The refracting angle of the prism is 60°. If the prism is placed in water (refractive index 1.33), predict the new angle of minimum deviation of a parallel beam of light.

Solution

Angle of minimum deviation is $\delta_m = 40°$.

Angle of the prism is $A = 60°$.

Refractive index of water is $\mu = 1.33$.

Refractive index of the material of the prism is μ'.

The angle of deviation is related to refractive index as:

$$\mu' = \frac{\sin\frac{(A+\delta_m)}{2}}{\sin\frac{A}{2}} = \frac{\sin\frac{(60°+40°)}{2}}{\sin\frac{60°}{2}} = \frac{\sin 50°}{\sin 30°} = 1.532.$$

Hence, the refractive index of the material of the prism is 1.532.

Since the prism is placed in water, let δ'_m be the new angle of minimum deviation for the same prism.

The refractive index of glass with respect to water is given by the relation:

$$\mu_g^w = \frac{\mu'}{\mu} = \frac{\sin\frac{(A+\delta'_m)}{2}}{\sin\frac{A}{2}}.$$

$$\sin\frac{(A+\delta'_m)}{2} = \frac{\mu'}{\mu}\sin\frac{A}{2}.$$

$$\sin\frac{(A+\delta'_m)}{2} = \frac{1.532}{1.33}\sin\frac{60°}{2} = 0.5759.$$

$$\frac{(A+\delta'_m)}{2} = \sin^{-1} 0.5759 = 35.16°.$$

$$60° + \delta'_m = 70.32°.$$

$$\delta'_m = 10.32°.$$

Hence, the new minimum angle of deviation is $10.32°$.