

98. (a) When examining Fig. 34-73, it is important to note that the angle (measured from the central axis) for the light ray in air, θ , is not the angle for the ray in the glass core, which we denote θ' . The law of refraction leads to

$$\sin \theta' = \frac{1}{n_1} \sin \theta \quad \text{assuming } n_{\text{air}} = 1 .$$

The angle of incidence for the light ray striking the coating is the complement of θ' , which we denote as θ'_{comp} and recall that

$$\sin \theta'_{\text{comp}} = \cos \theta' = \sqrt{1 - \sin^2 \theta'} .$$

In the critical case, θ'_{comp} must equal θ_c specified by Eq. 34-47. Therefore,

$$\frac{n_2}{n_1} = \sin \theta'_{\text{comp}} = \sqrt{1 - \sin^2 \theta'} = \sqrt{1 - \left(\frac{1}{n_1} \sin \theta \right)^2}$$

which leads to the result: $\sin \theta = \sqrt{n_1^2 - n_2^2}$.

- (b) With $n_1 = 1.58$ and $n_2 = 1.53$, we obtain

$$\theta = \sin^{-1} (1.58^2 - 1.53^2) = 23.2^\circ .$$