**8.18** For some types of glass, the index of refraction varies with wavelength. A prism made of a material with

$$n = 1.71 - \frac{4}{30}\lambda_0 \qquad (\lambda_0 \text{ in } \mu\text{m}),$$

where $\lambda_0$ is the wavelength in vacuum, was used to disperse white light as shown in Fig. P8.18. The white light is incident at an angle of 50°, the wavelength $\lambda_0$ of red light is 0.7 $\mu$m, and that of violet light is 0.4 $\mu$m. Determine the angular dispersion in degrees.

**Solution:**

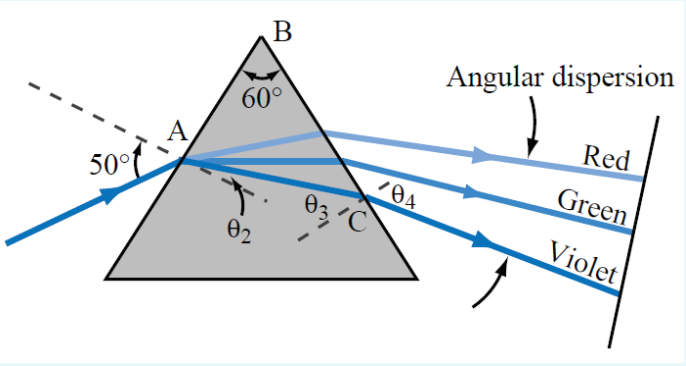


**Figure P8.18** Prism of Problem 8.18.

For violet,

$$n_v = 1.71 - \frac{4}{30} \times 0.4 = 1.66, \qquad \sin\theta_2 = \frac{\sin\theta}{n_v} = \frac{\sin 50^\circ}{1.66},$$

or

$$\theta_2 = 27.48^\circ.$$

From the geometry of triangle *ABC*,

$$180^\circ = 60^\circ + (90^\circ - \theta_2) + (90^\circ - \theta_3),$$

or

$$\theta_3 = 60^\circ - \theta_2 = 60 - 27.48^\circ = 32.52^\circ,$$

and

$$\sin\theta_4 = n_v \sin\theta_3 = 1.66 \sin 32.52^\circ = 0.89,$$

or

$$\theta_4 = 63.18^\circ.$$

For red,

$$n_r = 1.71 - \frac{4}{30} \times 0.7 = 1.62,$$
$$\theta_2 = \sin^{-1}\left[\frac{\sin 50^\circ}{1.62}\right] = 28.22^\circ,$$
$$\theta_3 = 60^\circ - 28.22^\circ = 31.78^\circ,$$
$$\theta_4 = \sin^{-1}\left[1.62 \sin 31.78^\circ\right] = 58.56^\circ.$$

Hence, angular dispersion $= 63.18^\circ - 58.56^\circ = 4.62^\circ$.