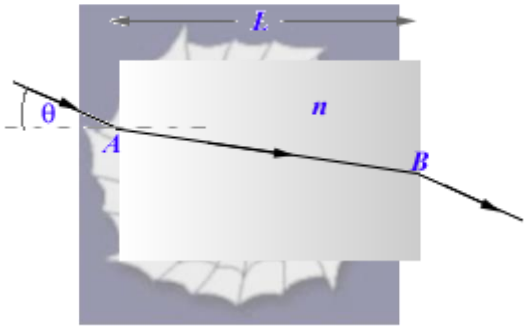
590.

Problem 43.12 (RHK)

Light from a laser enters a glass block at A and emerges at B; see the figure. The glass block has a length $L = 54.7$ cm *and an index of refraction* $n = 1.63$. *The angle of incidence is* $\theta = 24.0^0$. *We have to find the time needed for light to pass through the block.*



Solution:

The length of the glass block, $L = 54.7$ cm.

The index of refraction of the glass, $n = 1.63$.

The angle of incidence of the laser beam, $\theta_i = 24.0^0$.

Therefore, the angle of refraction of the laser beam inside the glass block can be determined from the Snell's law,

$$\sin\theta_r = \frac{\sin\theta_i}{n} = \frac{\sin 24^0}{1.63} = 0.249,$$

and

$$\theta_r = \sin^{-1}\left(0.249\right) = 14.45^0 \ .$$

The path length of the laser beam inside the glass block will therefore be

$$L' = \frac{L}{\cos\left(14.45^0\right)} = \frac{54.7}{0.968} \text{ cm} = 56.48\times10^{-2} \text{ m}.$$

The speed of light inside the glass block will be

$$v = \frac{c}{n} = \frac{3.0\times10^8}{1.63} \text{ m s}^{-1} = 1.84\times10^8 \text{ m s}^{-1}.$$

Therefore, the time needed for the light to pass through the block will be

$$t = \frac{56.48\times10^{-2}}{1.84\times10^8} \text{ s} = 3.06 \text{ ns}.$$