Name: KEY

Date:

Section C D F

The Masters School
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Physics

Total Internal Reflection

1. Calculate the critical angle for the glass-air boundary.

$\theta_c = \sin^{-1}\left(\frac{n_r}{n_i}\right) \quad n_i > n_r$

$\theta_c = \sin^{-1}\left(\frac{1.0}{1.5}\right) = 41.8°$

2. Suppose that the angle of incidence of a laser beam in water and heading towards air is adjusted to 50 degrees. Use Snell's law to calculate the angle of refraction. Explain your result (or lack of result).

$n_i \sin\theta_i = n_r \sin\theta_r$

$(1.33)(\sin 50) = (1.0)\sin\theta_r$

$1.02 = \sin\theta_r$

ERROR

No angle of refraction b/c beyond critical angle of 48.7°, thus T.I.R. occurs

3. Light strikes the surface of a prism, n = 1.7, as shown in Figure 15-20. If the prism is surrounded by a fluid, what is the maximum index of refraction of the fluid that will still cause total internal reflection within the prism?

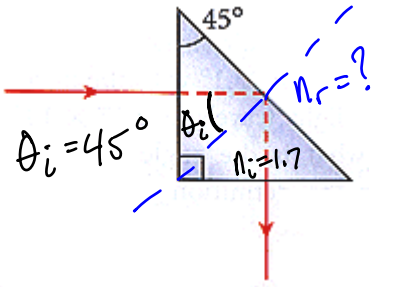

Figure 15.20

by Snell's Law

$n_i \sin\theta_i = n_r \sin\theta_r$

$(1.7)\sin 45 = n_r \sin 90$ (1)

$1.20 = n_r$

By Critical Angle Formula

$\theta_c = 45°$

$\theta_c = \sin^{-1}\left(\frac{n_r}{n_i}\right)$

$45° = \sin^{-1}\left(\frac{n_r}{1.7}\right)$

$(1.7)\sin 45 = n_r$

$1.20 = n_r$

4. A fiber-optic cable has an index of refraction of 1.50.
    a. For total internal reflection, what is the minimum angle of incidence to the inside wall of the cable if the cable is in air?

$$\theta_c = \sin^{-1}\left(\frac{1.0}{1.5}\right)$$

$$\theta_c = 41.8^\circ$$

    b. For total internal reflection, what is the minimum angle of incidence to the inside wall of the cable if the cable is in water?

$$\theta_c = \sin^{-1}\left(\frac{1.33}{1.5}\right)$$

$$\theta_c = 62.5^\circ$$