

Problem C

CRITICAL ANGLE

PROBLEM

Rutile, TiO_2 , has one of the highest indices of refraction: 2.80. Suppose the critical angle between rutile and an unknown liquid is 33.6° . What is the liquid's index of refraction?

SOLUTION

Given: $\theta_c = 33.6^\circ$

$$n_i = 2.80$$

Unknown: $n_r = ?$

Use the equation for critical angle.

$$\sin \theta_c = \frac{n_r}{n_i}$$

$$n_r = n_i \sin \theta_c = (2.80)(\sin 33.6^\circ) = 1.54$$

ADDITIONAL PRACTICE

1. Light moves from glass into a substance of unknown refraction index. If the critical angle for the glass is 46° and the index of refraction for the glass is 1.5, what is the index of refraction of the other substance?
2. The largest uncut diamond had a mass of more than 600 g. Eventually, the diamond was cut into several pieces. Suppose one of those pieces is a cube with sides 1.00 cm wide. If a beam of light were to pass from air into the diamond with an angle of incidence equal to 75.0° , the angle of refraction would be 23.3° . From this information, calculate the index of refraction and the critical angle for diamond in air.
3. A British company makes optical fibers that are 13.6 km in length. If the critical angle for the fibers in air is 42.1° , what is the index of refraction of the fiber material?
4. In 1996, the Fiberoptic Link Around the Globe (FLAG) was started. It initially involves placing a 27 000 km fiber optic cable at the bottom of the Mediterranean Sea and the Indian Ocean. Suppose the index of refraction of this fiber is 1.56 and the index of refraction of sea water 1.36, what is critical angle for internal reflection in the fiber?
5. The world's thinnest glass is 0.025 mm thick. If the index of refraction for this glass is 1.52, what is the critical angle of ocean water? How far will a ray of light travel in the glass if it undergoes one internal reflection at the critical angle?

