

Refraction

Problem A**SNELL'S LAW****PROBLEM**

The smallest brilliant-cut diamond has a mass of about 15 μg and a height of just 0.11 mm. Suppose a ray of light enters the diamond from the air and, upon contact with one of the gem's facets, refracts at an angle of 22.2° . If the angle of incidence is 65.0° , what is the diamond's index of refraction?

SOLUTION

Given: $\theta_i = 65.0^\circ$ $\theta_r = 22.2^\circ$ $n_i = 1.00$

Unknown: $n_r = ?$

Use the equation for Snell's law.

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

$$n_r = n_i \frac{\sin \theta_i}{\sin \theta_r} = (1.00) \frac{(\sin 65.0^\circ)}{(\sin 22.2^\circ)} = 2.40$$

ADDITIONAL PRACTICE

1. Extra dense flint glass has one of the highest indices of refraction of any type of glass. Suppose a beam of light passes from air into a block of extra dense flint glass. If the light has an angle of incidence of 72° and an angle of refraction of 34° , what is the index of refraction of the glass?
2. The index of refraction of a clear oil is determined by passing a beam of light through the oil and measuring the angles of incidence and refraction. If the light in air approaches the oil's surface at an angle of 47.9° to the normal and moves into the oil at an angle of 29.0° to the normal, what is the oil's index of refraction? Assume the index of refraction for air is 1.00.
3. Someone on a glass-bottom boat shines a light through the glass into the water below. A scuba diver beneath the boat sees the light at an angle of 17° with respect to the normal. If the glass's index of refraction is 1.5 and the water's index of refraction is 1.33, what is the angle of incidence with which the light passes from the glass into the water? What is the angle of incidence with which the light passes from the air into the glass?
4. A beam of light is passed through a layer of ice into a fresh-water lake below. The angle of incidence for the light in the ice is 55.0° , while the angle of refraction for the light in the water is 53.8° . Calculate the index of refraction of the ice, using 1.33 as the index of refraction of fresh water.
5. An arrangement of three glass blocks with indices of refraction of 1.5, 1.6, and 1.7 are sandwiched together. A beam of light enters the first block from air at an angle of 48° with respect to the normal. What is the angle of refraction after the light enters the third block?