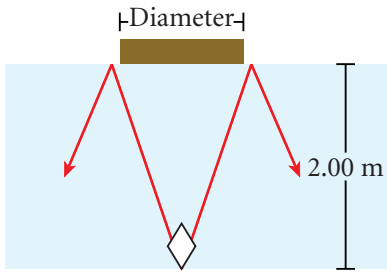
50. A ray of light traveling in air strikes the surface of mineral oil at an angle of 23.1° with the normal to the surface. If the light travels at 2.17×10^8 m/s through the oil, what is the angle of refraction? (Hint: Remember the definition of the index of refraction.)

51. A ray of light traveling in air strikes the surface of a liquid. If the angle of incidence is 30.0° and the angle of refraction is 22.0°, find the critical angle for light traveling from the liquid back into the air.

52. The laws of refraction and reflection are the same for sound and for light. The speed of sound is 340 m/s in air and 1510 m/s in water. If a sound wave that is traveling in air approaches a flat water surface with an angle of incidence of 12.0°, what is the angle of refraction?

53. A jewel thief decides to hide a stolen diamond by placing it at the bottom of a crystal-clear fountain. He places a circular piece of wood on the surface of the water and anchors it directly above the diamond at the bottom of the fountain, as shown below. If the fountain is 2.00 m deep, find the minimum diameter of the piece of wood that would prevent the diamond from being seen from outside the water.



54. A ray of light traveling in air strikes the surface of a block of clear ice at an angle of 40.0° with the normal. Part of the light is reflected, and part is refracted. Find the angle between the reflected and refracted light.

55. An object's distance from a converging lens is 10 times the focal length. How far is the image from the lens? Express the answer as a fraction of the focal length.

56. A fiber-optic cable used for telecommunications has an index of refraction of 1.53. For total internal reflection of light inside the cable, what is the minimum angle of incidence to the inside wall of the cable if the cable is in the following:

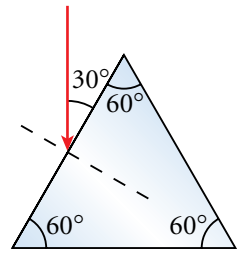
a. air

b. water

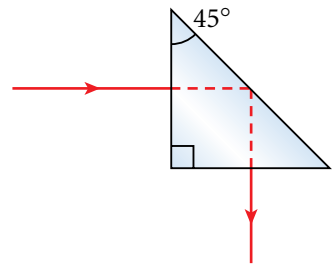
57. A ray of light traveling in air strikes the midpoint of one face of an equiangular glass prism ($n = 1.50$) at an angle of exactly 30.0°, as shown below.

a. Trace the path of the light ray through the glass, and find the angle of incidence of the ray at the bottom of the prism.

b. Will the ray pass through the bottom surface of the prism, or will it be totally internally reflected?



58. Light strikes the surface of a prism, $n = 1.8$, as shown in the figure below. 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?



59. A fiber-optic rod consists of a central strand of material surrounded by an outer coating. The interior portion of the rod has an index of refraction of 1.60. If all rays striking the interior walls of the rod with incident angles greater than 59.5° are subject to total internal reflection, what is the index of refraction of the coating?