*For problems 36–38, see Sample Problem C.*
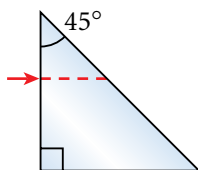
**36.** Calculate the critical angle for light going from glycerine into air.

**37.** Assuming that $\lambda = 589$ nm, calculate the critical angles for the following materials when they are surrounded by air:

    **a.** zircon
    **b.** fluorite
    **c.** ice

**38.** Light traveling in air enters the flat side of a prism made of crown glass ($n = 1.52$), as shown at right. Will the light pass through the other side of the prism or will it be totally internally reflected? Be sure to show your work.

45°

## MIXED REVIEW

**39.** The angle of incidence and the angle of refraction for light going from air into a material with a higher index of refraction are 63.5° and 42.9°, respectively. What is the index of refraction of this material?

**40.** A person shines a light at a friend who is swimming underwater. If the ray in the water makes an angle of 36.2° with the normal, what is the angle of incidence?

**41.** What is the index of refraction of a material in which the speed of light is $1.85 \times 10^8$ m/s? Look at the indices of refraction in **Table 1** to identify this material.

**42.** Light moves from flint glass into water at an angle of incidence of 28.7°.

    **a.** What is the angle of refraction?
    **b.** At what angle would the light have to be incident to give an angle of refraction of 90.0°?

**43.** A magnifying glass has a converging lens of focal length 15.0 cm. At what distance from a nickel should you hold this lens to get an image with a magnification of +2.00?



**44.** The image of the United States postage stamps in the figure above is 1.50 times the size of the actual stamps in front of the lens. Determine the focal length of the lens if the distance from the lens to the stamps is 2.84 cm.

**45.** Where must an object be placed to have a magnification of 2.00 in each of the following cases? Show your work.

    **a.** a converging lens of focal length 12.0 cm
    **b.** a diverging lens of focal length 12.0 cm

**46.** A diverging lens is used to form a virtual image of an object. The object is 80.0 cm in front of the lens, and the image is 40.0 cm in front of the lens. Determine the focal length of the lens.

**47.** A microscope slide is placed in front of a converging lens with a focal length of 2.44 cm. The lens forms an image of the slide 12.9 cm from the slide.

    **a.** How far is the lens from the slide if the image is real?
    **b.** How far is the lens from the slide if the image is virtual?

**48.** Where must an object be placed to form an image 30.0 cm from a diverging lens with a focal length of 40.0 cm? Determine the magnification of the image.

**49.** The index of refraction for red light in water is 1.331, and that for blue light is 1.340. If a ray of white light traveling in air enters the water at an angle of incidence of 83.0°, what are the angles of refraction for the red and blue components of the light?