Chapter 33

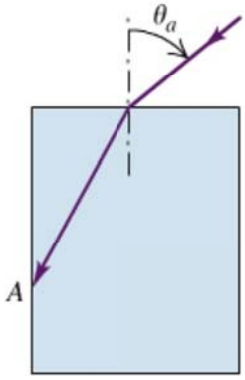
33.12 •• A horizontal, parallel-sided plate of glass having a refractive index of 1.52 is in contact with the surface of water in a tank. A ray coming from above in air makes an angle of incidence of 35.0° with the normal to the top surface of the glass. (a) What angle does the ray refracted into the water make with the normal to the surface? (b) What is the dependence of this angle on the refractive index of the glass?

33.13 •• In a material having an index of refraction n, a light ray has frequency f, wavelength λ, and speed v. What are the frequency, wavelength, and speed of this light (a) in vacuum and (b) in a material having refractive index n'? In each case, express your answers in terms of *only* f, λ, v, n, and n'.

33.26 • A beam of light strikes a sheet of glass at an angle of 57.0° with the normal in air. You observe that red light makes an angle of 38.1° with the normal in the glass, while violet light makes a 36.7° angle. (a) What are the indexes of refraction of this glass for these colors of light? (b) What are the speeds of red and violet light in the glass?

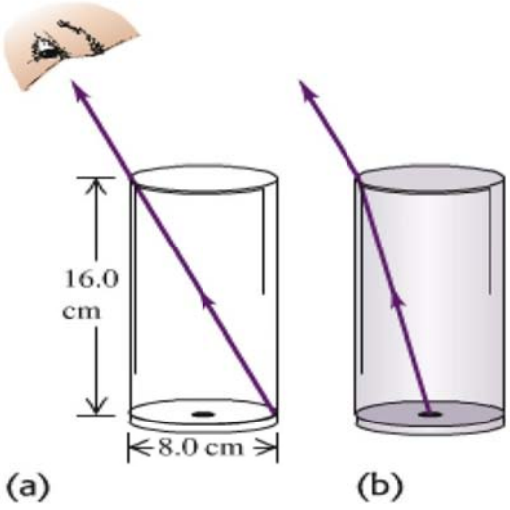
33.43 •• A ray of light is incident in air on a block of a transparent solid whose index of refraction is n. If $n = 1.38$, what is the *largest* angle of incidence θ_a for which total internal reflection will occur at the vertical face (point A shown in Fig. P33.43)?

Figure **P33.43**



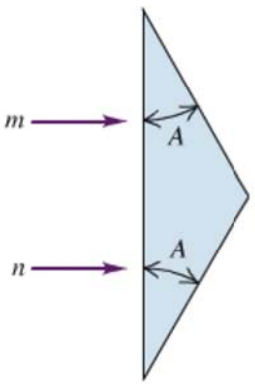
33.49 • You sight along the rim of a glass with vertical sides so that the top rim is lined up with the opposite edge of the bottom (Fig. P33.49a). The glass is a thin-walled, hollow cylinder 16.0 cm high. The diameter of the top and bottom of the glass is 8.0 cm. While you keep your eye in the same position, a friend fills the glass with a transparent liquid, and you then see a dime that is lying at the center of the bottom of the glass (Fig. P33.49b). What is the index of refraction of the liquid?

Figure **P33.49**



33.53 •• The prism shown in Fig. P33.53 has a refractive index of 1.66, and the angles A are 25.0°. Two light rays m and n are parallel as they enter the prism. What is the angle between them after they emerge?

Figure **P33.53**

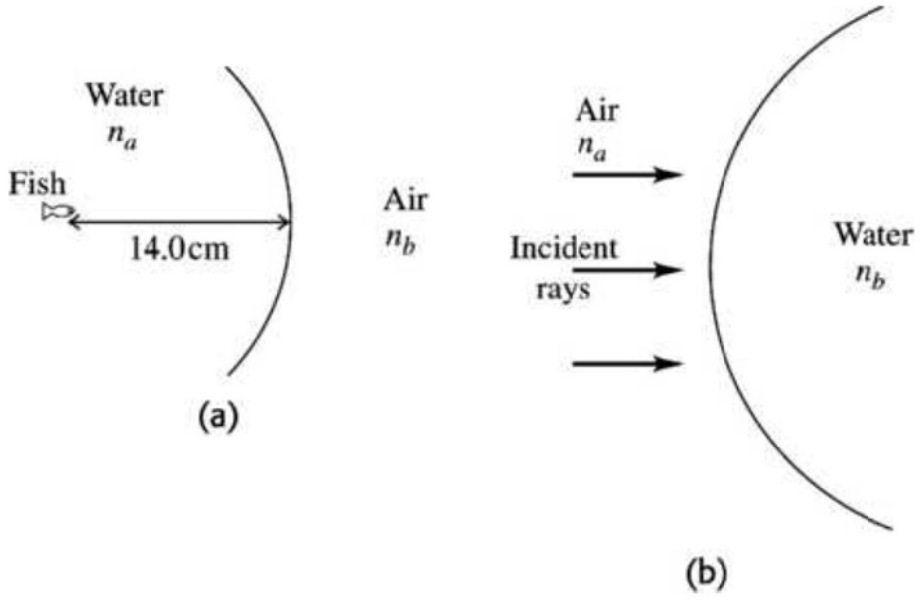


Chapter 34

34.5 • An object 0.600 cm tall is placed 16.5 cm to the left of the vertex of a concave spherical mirror having a radius of curvature of 22.0 cm. (a) Draw a principal-ray diagram showing the formation of the image. (b) Determine the position, size, orientation, and nature (real or virtual) of the image.

34.6 • Repeat Exercise 34.5 for the case in which the mirror is convex.

34.19 •• **A Spherical Fish Bowl.** A small tropical fish is at the center of a water-filled, spherical fish bowl 28.0 cm in diameter. (a) Find the apparent position and magnification of the fish to an observer outside the bowl. The effect of the thin walls of the bowl may be ignored. (b) A friend advised the owner of the bowl to keep it out of direct sunlight to avoid blinding the fish, which might swim into the focal point of the parallel rays from the sun. Is the focal point actually within the bowl?



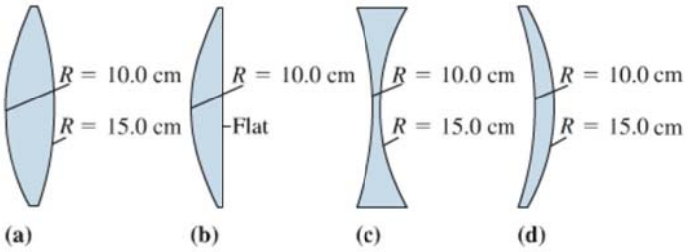
34.25 • An insect 3.75 mm tall is placed 22.5 cm to the left of a thin planoconvex lens. The left surface of this lens is flat, the right surface has a radius of curvature of magnitude 13.0 cm, and the index of refraction of the lens material is 1.70. (a) Calculate the location and size of the image this lens forms of the insect. Is it real or virtual? Erect or inverted? (b) Repeat part (a) if the lens is reversed.

34.26 • A lens forms an image of an object. The object is 16.0 cm from the lens. The image is 12.0 cm from the lens on the same side as the object. (a) What is the focal length of the lens? Is the lens converging or diverging? (b) If the object is 8.50 mm tall, how tall is the image? Is it erect or inverted? (c) Draw a principal-ray diagram.

34.31 •• A double-convex thin lens has surfaces with equal radii of curvature of magnitude 2.50 cm. Looking through this lens, you observe that it forms an image of a very distant tree at a distance of 1.87 cm from the lens. What is the index of refraction of the lens?

34.35 • For each thin lens shown in Fig. E34.35, calculate the location of the image of an object that is 18.0 cm to the left of the lens. The lens material has a refractive index of 1.50, and the radii of curvature shown are only the magnitudes.

Figure **E34.35**



34.39 •• **Combination of Lenses I.** A 1.20-cm-tall object is 50.0 cm to the left of a converging lens of focal length 40.0 cm. A second converging lens, this one having a focal length of 60.0 cm, is located 300.0 cm to the right of the first lens along the same optic axis. (a) Find the location and height of the image (call it I_1) formed by the lens with a focal length of 40.0 cm. (b) I_1 is now the object for the second lens. Find the location and height of the image produced by the second lens. This is the final image produced by the combination of lenses.

34.40 •• **Combination of Lenses II.** Repeat Problem 34.39 using the same lenses except for the following changes: (a) The second lens is a *diverging* lens having a focal length of magnitude 60.0 cm. (b) The first lens is a *diverging* lens having a focal length of magnitude 40.0 cm. (c) Both lenses are diverging lenses having focal lengths of the same *magnitudes* as in Problem 34.39.

34.44 • When a camera is focused, the lens is moved away from or toward the film. If you take a picture of your friend, who is standing 3.90 m from the lens, using a camera with a lens with a 85-mm focal length, how far from the film is the lens? Will the whole image of your friend, who is 175 cm tall, fit on film that is 24 × 36 mm?

34.53 •• **BIO** (a) Where is the near point of an eye for which a contact lens with a power of +2.75 diopters is prescribed? (b) Where is the far point of an eye for which a contact lens with a power of −1.30 diopters is prescribed for distant vision?

34.54 • **BIO** **Contact Lenses.** Contact lenses are placed right on the eyeball, so the distance from the eye to an object (or image) is the same as the distance from the lens to that object (or image). A certain person can see distant objects well, but his near point is 45.0 cm from his eyes instead of the usual 25.0 cm. (a) Is this person nearsighted or farsighted? (b) What type of lens (converging or diverging) is needed to correct his vision? (c) If the correcting lenses will be contact lenses, what focal length lens is needed and what is its power in diopters?

34.63 •• The focal length of the eyepiece of a certain microscope is 18.0 mm. The focal length of the objective is 8.00 mm. The distance between objective and eyepiece is 19.7 cm. The final image formed by the eyepiece is at infinity. Treat all lenses as thin. (a) What is the distance from the objective to the object being viewed? (b) What is the magnitude of the linear magnification produced by the objective? (c) What is the overall angular magnification of the microscope?

34.64 •• The eyepiece of a refracting telescope has a focal length of 9.00 cm. The distance between objective and eyepiece is 1.80 m, and the final image is at infinity. What is the angular magnification of the telescope?

34.66 •• Saturn is viewed through the Lick Observatory refracting telescope (objective focal length 18 m). If the diameter of the image of Saturn produced by the objective is 1.7 mm, what angle does Saturn subtend from when viewed from earth?

Svar till exercises (FYSA01 vågrörelselära och optik)

14:
E 7 a) 0.167 s b) 37.7 rad/s c) 0.0844 kg
E 9 a) 0.150 s b) 0.0750 s
E 24 0.377 m/s och -0.617 m/s^2
E 27 a) 1.20 m/s b) ±1.11 m/s c) 36 m/s^2 d) +13.5 m/s e) 0.360 J

15:
E 6 a) 1.2 m/s b) 0.31 m c) amplitude becomes 0.15 m but the wavelength, period and wave speed are unchanged
E 8 a) 6.50 mm b) 28.0 cm c) 27.8 Hz d) 7.78 m/s e) +x-riktningen
E 19 a) 18.6 N b) 29.1 m/s
E 23 4.51 mm
E 40 a) 3.00 m 16.0 Hz b) 1.00 m 48.0 Hz c) 0.75 m 64.0 Hz
E 49 a) 311 m/s b) 246 Hz c) 245 Hz 1.40 m

16:
E 15 a) $9.44 \cdot 10^{-11}$ m 0.434 m b) $5.66 \cdot 10^{-9}$ m 0.100 m
c) For a given frequency, the much less dense air molecules must have a larger amplitude to transfer the same amount of energy.
E 26 a) 0.290 m b) 1.16 m c) 297 Hz
E 36 1.00 m
E 40 16 Hz
E 45 a) 375 Hz b) 371 Hz c) 4 Hz
E 49 19.8 m/s
E 50 a) 302 Hz b)228 Hz
E 55 a) 36.0° b) 2.23 s

33:
E 12 a) 25.5° b) oberoende
E 13 a) – b) –
E 26 a) 1.36 och 1.40 b) 2.21 resp $2.15 \cdot 10^8$ m/s
E 43 72.0°
E 48 1.84
E 53 39.1°

34:
E 5 b) +11.0 cm, +33.0 cm, -1.20 cm
E 6 b) -11.0 cm, -6.60 cm, -0.240 cm
E 19 a) -14.0 cm, +1.33 b) ingen fara
E 25 a) $+18.6\ cm$; $+107\ cm$; $-1.78\ cm$ b) samma
E 26 a) -48.0 cm b) $+2.55\ cm$ c) –
E 31 1.67
E 35 a) $+12.0\ cm$;$+36.0\ cm$ b) $+20.0\ cm$; $-180\ cm$ c) $-12.0\ cm$; $-7.2\ cm$
d) $-60.0\ cm$; $-13.8\ cm$
E 39 a) $+200\ cm$; $-4.80\ cm$ b) $+150\ cm$; $+7.20\ cm$
E 40 a) $+200\ cm$; $-4.80\ cm$; $-37.5\ cm$; $-1.80\ cm$
b) $-22.2\ cm$; $+0.533\ cm$; $+73.7\ cm$; $-0.122\ cm$
c) $-22.2\ cm$; $+0.533\ cm$; $-50.6\ cm$; $+0.0837\ cm$
E 44 8.69 cm; $3.90\ cm$
E 53 a) 80.0 cm b) **76.9 cm**
E 54 a) **översynt** b) **positiva linser c) +56.25 cm; +1.78**
E 63 a) **8.37 mm** b) -21.4 c) -297
E 64 -19.0
E 66 $0.0054°$

35:

E 9 1.14 mm
E 10 0.193 mm
E 11 0.83 mm
E 16 3.17 mm
E 25 114 nm
E 36 a) 0.248 mm och 0.205 mm b) 0.043 mm

36:
E 1 506 nm
E 4 5.90 mm
E 12 a) 10.9 mm b) 5.4 mm
E 15 a) 6.75 mm b) 2.43 μW/m2
E 24 0.806 μW/m2
E 29 a) 4790 ritsar per cm b) 19.1° och 40.8° c) nej
E 30 20.2°
E 37 a) 17500 b) ja c) 587.7834 nm < λ < 587.8170 nm
E 38 2752 ritsar per cm
E 47 1.45 m