

Section 26.6 Lenses, Section 26.7 The Formation of Images by Lenses, Section 26.8 The Thin-Lens Equation and the Magnification Equation

(Note: When drawing ray diagrams, be sure that the object height h_o is much smaller than the focal length f of the lens or mirror.)

49. ssm An object is located 30.0 cm to the left of a converging lens whose focal length is 50.0 cm. (a) Draw a ray diagram to scale and from it determine the image distance and the magnification. (b) Use the thin-lens and magnification equations to verify your answers to part (a).

50. The owner of a van installs a rear-window lens that has a focal length of -0.300 m. When the owner looks out through the lens at a person standing directly behind the van, the person appears to be just 0.240 m from the back of the van, and appears to be 0.34 m tall. (a) How far from the van is the person actually standing, and (b) how tall is the person?

51. A converging lens ($f = 12.0$ cm) is held 8.00 cm in front of a newspaper that has a print size with a height of 2.00 mm. Find (a) the image distance (in cm) and (b) the height (in mm) of the magnified print.

52. A tourist takes a picture of a mountain 14 km away using a camera that has a lens with a focal length of 50 mm. She then takes a second picture when she is only 5.0 km away. What is the ratio of the height of the mountain's image on the camera's image sensor for the second picture to its height on the image sensor for the first picture?

53. A slide projector has a converging lens whose focal length is 105.00 mm. (a) How far (in meters) from the lens must the screen be located if a slide is placed 108.00 mm from the lens? (b) If the slide measures 24.0 mm \times 36.0 mm, what are the dimensions (in mm) of its image?

54. GO To focus a camera on objects at different distances, the converging lens is moved toward or away from the image sensor, so a sharp image always falls on the sensor. A camera with a telephoto lens ($f = 200.0$ mm) is to be focused on an object located first at a distance of 3.5 m and then at 50.0 m. Over what distance must the lens be movable?

55. A diverging lens has a focal length of -25 cm. (a) Find the image distance when an object is placed 38 cm from the lens. (b) Is the image real or virtual?

56. GO An object is placed to the left of a lens, and a real image is formed to the right of the lens. The image is inverted relative to the object and is one-half the size of the object. The distance between the object and the image is 90.0 cm. (a) How far from the lens is the object? (b) What is the focal length of the lens?

57. A camper is trying to start a fire by focusing sunlight onto a piece of paper. The diameter of the sun is 1.39×10^9 m, and its mean distance from the earth is 1.50×10^{11} m. The camper is using a converging lens whose focal length is 10.0 cm. (a) What is the area of the sun's image on the paper? (b) If 0.530 W of sunlight passes through the lens, what is the intensity of the sunlight at the paper?

58. Concept Simulation 26.4 at www.wiley.com/college/cutnell provides the option of exploring the ray diagram that applies to this problem. The distance between an object and its image formed by a diverging lens is 49.0 cm. The focal length of the lens is -233.0 cm. Find (a) the image distance and (b) the object distance.

59. ssm An office copier uses a lens to place an image of a document onto a rotating drum. The copy is made from this image. (a) What kind of lens is used, converging or diverging? If the document and its copy are to have the same size, but are inverted with respect to one another, (b) how far from the document is the lens

located and (c) how far from the lens is the image located? Express your answers in terms of the focal length f of the lens.

***60.** When a converging lens is used in a camera (as in Figure 26.26b), the film must be at a distance of 0.210 m from the lens to record an image of an object that is 4.00 m from the lens. The same lens and film are used in a projector (see Figure 26.27b), with the screen 0.500 m from the lens. How far from the projector lens should the film be placed?

***61. ssm** An object is 18 cm in front of a diverging lens that has a focal length of -12 cm. How far in front of the lens should the object be placed so that the size of its image is reduced by a factor of 2.0?

***62.** An object is in front of a converging lens ($f = 0.30$ m). The magnification of the lens is $m = 4.0$. (a) Relative to the lens, in what direction should the object be moved so that the magnification changes to $m = -4.0$? (b) Through what distance should the object be moved?

***63.** A converging lens ($f = 25.0$ cm) is used to project an image of an object onto a screen. The object and the screen are 125 cm apart, and between them the lens can be placed at either of two locations. Find the two object distances.

***64.** A filmmaker wants to achieve an interesting visual effect by filming a scene through a converging lens with a focal length of 50.0 m. The lens is placed between the camera and a horse, which canters toward the camera at a constant speed of 7.0 m/s. The camera starts rolling when the horse is 40.0 m from the lens. Find the average speed of the image of the horse (a) during the first 2.0 s after the camera starts rolling and (b) during the following 2.0 s.

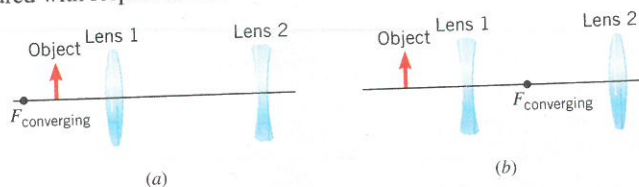
Section 26.9 Lenses in Combination

65. Two identical diverging lenses are separated by 16 cm. The focal length of each lens is -8.0 cm. An object is located 4.0 cm to the left of the lens that is on the left. Determine the final image distance relative to the lens on the right.

66. GO A converging lens ($f_1 = 24.0$ cm) is located 56.0 cm to the left of a diverging lens ($f_2 = -28.0$ cm). An object is placed to the left of the converging lens, and the final image produced by the two-lens combination lies 20.7 cm to the left of the diverging lens. How far is the object from the converging lens?

67. Two converging lenses are separated by 24.00 cm. The focal length of each lens is 12.00 cm. An object is placed 36.00 cm to the left of the lens that is on the left. Determine the final image distance relative to the lens on the right.

68. GO Two systems are formed from a converging lens and a diverging lens, as shown in parts a and b of the drawing. (The point labeled " $F_{\text{converging}}$ " is the focal point of the converging lens.) An object is placed inside the focal point of lens 1 at a distance of 10.00 cm to the left of lens 1. The focal lengths of the converging and diverging lenses are 15.00 and -20.0 cm, respectively. The distance between the lenses is 50.0 cm. Determine the final image distance for each system, measured with respect to lens 2.



69. ssm A converging lens ($f = 12.0$ cm) is located 30.0 cm to the left of a diverging lens ($f = -6.00$ cm). A postage stamp is placed 36.0 cm to the left of the converging lens. (a) Locate the final image of the stamp relative to the diverging lens. (b) Find the overall magnification. (c) Is the final image real or virtual? With respect