48. (II) A −5.5-D lens is held 14.0 cm from an object 4.0 mm high. What are the position, type, and height of the image?

49. (II) An 80-mm-focal-length lens is used to focus an image on the film of a camera. The maximum distance allowed between the lens and the film plane is 120 mm. (*a*) How far ahead of the film should the lens be if the object to be photographed is 10.0 m away? (*b*) 3.0 m away? (*c*) 1.0 m away? (*d*) What is the closest object this lens could photograph sharply?

50. (II) It is desired to magnify reading material by a factor of 2.5× when a book is placed 8.0 cm behind a lens. (*a*) Draw a ray diagram and describe the type of image this would be. (*b*) What type of lens is needed? (*c*) What is the power of the lens in diopters?

51. (II) An object is located 1.5 m from an 8.0-D lens. By how much does the image move if the object is moved (*a*) 1.0 m closer to the lens, and (*b*) 1.0 m farther from the lens?

52. (II) How far from a converging lens with a focal length of 25 cm should an object be placed to produce a real image which is the same size as the object?

53. (II) (*a*) How far from a 50.0-mm-focal-length lens must an object be placed if its image is to be magnified 2.00× and be real? (*b*) What if the image is to be virtual and magnified 2.00×?

54. (II) Repeat Problem 53 for a −50.0-mm-focal-length lens. [*Hint*: consider objects real or virtual (formed by some other piece of optics).]

55. (II) (*a*) A 2.00-cm-high insect is 1.20 m from a 135-mm-focal-length lens. Where is the image, how high is it, and what type is it? (*b*) What if $f = -135$ mm?

56. (III) How far apart are an object and an image formed by a 75-cm-focal-length converging lens if the image is 2.5× larger than the object and is real?

57. (III) A bright object and a viewing screen are separated by a distance of 66.0 cm. At what location(s) between the object and the screen should a lens of focal length 12.5 cm be placed in order to produce a crisp image on the screen? [*Hint*: first draw a diagram.]

* 23–9 Lens Combinations

* 58. (II) Two 28.0-cm-focal-length converging lenses are placed 16.5 cm apart. An object is placed 36.0 cm in front of one lens. Where will the final image formed by the second lens be located? What is the total magnification?

* 59. (II) A diverging lens with $f = -31.5$ cm is placed 14.0 cm behind a converging lens with $f = 20.0$ cm. Where will an object at infinity be focused?

* 60. (II) A 31.0-cm-focal-length converging lens is 21.0 cm behind a diverging lens. Parallel light strikes the diverging lens. After passing through the converging lens, the light is again parallel. What is the focal length of the diverging lens? [*Hint*: first draw a ray diagram.]

* 61. (II) The two converging lenses of Example 23–12 are now placed only 20.0 cm apart. The object is still 60.0 cm in front of the first lens as in Fig. 23–41. In this case, determine (*a*) the position of the final image, and (*b*) the overall magnification. (*c*) Sketch the ray diagram for this system.

* 62. (II) Two converging lenses are placed 30.0 cm apart. The focal length of the lens on the right is 20.0 cm, and the focal length of the lens on the left is 15.0 cm. An object is placed to the left of the 15.0-cm-focal-length lens. A final image from both lenses is inverted and located halfway between the two lenses. How far to the left of the 15.0-cm-focal-length lens is the original object?

* 63. (II) A diverging lens with a focal length of −14 cm is placed 12 cm to the right of a converging lens with a focal length of 18 cm. An object is placed 33 cm to the left of the converging lens. (*a*) Where will the final image be located? (*b*) Where will the image be if the diverging lens is 38 cm from the converging lens?

* 64. (II) Two lenses, one converging with focal length 20.0 cm and one diverging with focal length −10.0 cm, are placed 25.0 cm apart. An object is placed 60.0 cm in front of the converging lens. Determine (*a*) the position and (*b*) the magnification of the final image formed. (*c*) Sketch a ray diagram for this system.

* 65. (III) A diverging lens is placed next to a converging lens of focal length f_C, as in Fig. 23–42. If f_T represents the focal length of the combination, show that the focal length of the diverging lens, f_D, is given by

$$\frac{1}{f_D} = \frac{1}{f_T} - \frac{1}{f_C}.$$

* 23–10 Lensmaker's Equation

* 66. (I) A double concave lens has surface radii of 34.2 cm and 23.8 cm. What is the focal length if $n = 1.52$?

* 67. (I) Both surfaces of a double convex lens have radii of 31.0 cm. If the focal length is 28.9 cm, what is the index of refraction of the lens material?

* 68. (II) A planoconcave lens ($n = 1.50$) has a focal length of −23.4 cm. What is the radius of the concave surface?

* 69. (II) A Lucite planoconcave lens (see Fig. 23–29b) has one flat surface and the other has $R = -18.4$ cm. What is the focal length?

* 70. (II) A symmetric double convex lens with a focal length of 25.0 cm is to be made from glass with an index of refraction of 1.52. What should be the radius of curvature for each surface?

* 71. (II) A prescription for a corrective lens calls for +1.50 D. The lensmaker grinds the lens from a "blank" with $n = 1.56$ and a preformed convex front surface of radius of curvature of 40.0 cm. What should be the radius of curvature of the other surface?