Questions

1. Why is the depth of field greater, and the image sharper, when a camera lens is "stopped down" to a larger f-number? Ignore diffraction.
2. Describe how diffraction affects the statement of Question 1. [*Hint*: see Eq. 24–3 or 25–7.]
3. Why must a camera lens be moved farther from the film to focus on a closer object?
4. Why are bifocals needed mainly by older persons and not generally by younger people?
5. Will a nearsighted person who wears corrective lenses in her glasses be able to see clearly underwater when wearing those glasses? Use a diagram to show why or why not.
6. You can tell whether a person is nearsighted or farsighted by looking at the width of the face through their glasses. If the person's face appears narrower through the glasses (Fig. 25–47), is the person farsighted or nearsighted?

FIGURE 25–47 Question 6.

7. In attempting to discern distant details, people will sometimes squint. Why does this help?
8. Is the image formed on the retina of the human eye upright or inverted? Discuss the implications of this for our perception of objects.
9. The human eye is much like a camera—yet, when a camera shutter is left open and the camera is moved, the image will be blurred; but when you move your head with your eyes open, you still see clearly. Explain.
10. Reading glasses use converging lenses. A simple magnifier is also a converging lens. Are reading glasses therefore magnifiers? Discuss the similarities and differences between converging lenses as used for these two different purposes.

* 11. Inexpensive microscopes for children's use usually produce images that are colored at the edges. Why?

* 12. Spherical aberration in a thin lens is minimized if rays are bent equally by the two surfaces. If a planoconvex lens is used to form a real image of an object at infinity, which surface should face the object? Use ray diagrams to show why.

* 13. Which aberrations present in a simple lens are not present (or are greatly reduced) in the human eye?

* 14. Explain why chromatic aberration occurs for thin lenses but not for mirrors.

15. By what factor can you improve resolution, other things being equal, if you use blue light ($\lambda = 450\,\text{nm}$) rather than red (700 nm)?
16. Give at least two advantages for the use of large reflecting mirrors in astronomical telescopes.
17. Which color of visible light would give the best resolution in a microscope? Explain.
18. Atoms have diameters of about 10^{-8} cm. Can visible light be used to "see" an atom? Explain.

Problems

25–1 Camera

1. (I) A 55-mm-focal-length lens has f-stops ranging from $f/1.4$ to $f/22$. What is the corresponding range of lens diaphragm diameters?
2. (I) A television camera lens has a 14-cm focal length and a lens diameter of 6.0 cm. What is its f-number?
3. (I) A light meter reports that a camera setting of $\frac{1}{250}$ s at $f/5.6$ will give a correct exposure. But the photographer wishes to use $f/11$ to increase the depth of field. What should the shutter speed be?
4. (I) A properly exposed photograph is taken at $f/16$ and $\frac{1}{60}$ s. What lens opening would be required if the shutter speed were $\frac{1}{1000}$ s?
5. (II) If an $f = 135$-mm telephoto lens is designed to cover object distances from 1.2 m to ∞, over what distance must the lens move relative to the plane of the film?
6. (II) A 200-mm-focal-length lens can be adjusted so that it is 200.0 mm to 206.0 mm from the film. For what range of object distances can it be adjusted?
7. (II) A nature photographer wishes to photograph a 28-m-tall tree from a distance of 58 m. What focal-length lens should be used if the image is to fill the 24-mm height of the film?
8. (II) A "pinhole" camera uses a tiny pinhole instead of a lens. Show, using ray diagrams, how reasonably sharp images can be formed using such a pinhole camera. In particular, consider two point objects 2.0 cm apart that are 1.0 m from a 1.0-mm-diameter pinhole. Show that on a piece of film 7.0 cm behind the pinhole the two objects produce two separate circles that do not overlap.
9. (III) Suppose that a correct exposure is $\frac{1}{250}$ s at $f/11$. Under the same conditions, what exposure time would be needed for a pinhole camera (Problem 8) if the pinhole diameter is 1.0 mm and the film is 7.0 cm from the hole?

25–2 Eye and Corrective Lenses

10. (I) A human eyeball is about 2.0 cm long, and the pupil has a maximum diameter of about 8.0 mm. What is the "speed" of this lens?