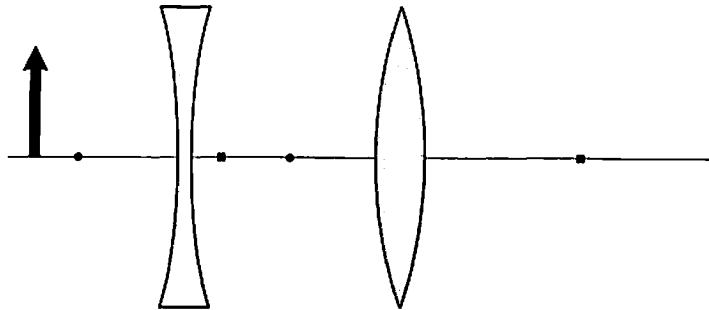


24 Optical Instruments

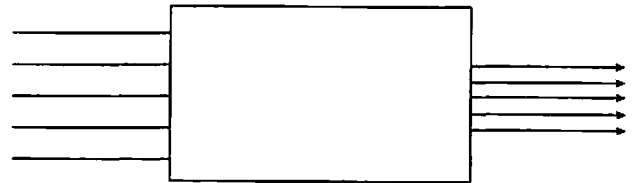
24.1 Lenses in Combination

24.2 The Camera

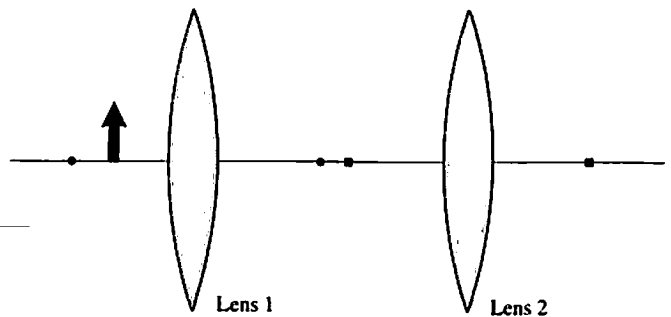
1. Use ray tracing to locate the final image of the following two-lens system.



2. Can you tell what's inside the box? Draw one possible combination of lenses inside the box, then show the rays passing through the box.



3. Two converging lenses, whose focal points are marked, are placed in front of an object.
- a. Suppose lens 2 is moved a little to the left. Is the final image of this two-lens system now closer to or farther from lens 2? Explain.



- b. With lens 2 in its original position, suppose lens 1 is moved a little to the left. Is the final image of this two-lens system now closer to or farther from lens 2? Explain.

4. A photographer focuses his camera on an object. Suppose the object moves closer to the camera. To refocus, should the camera lens move closer to or farther from the detector? Explain.

5. The aperture of a camera lens has its diameter halved.

a. By what factor does the f -number change?

b. By what factor does the focal length change?

c. By what factor does the exposure time change?

24.3 Vision

6. Two lost students wish to start a fire to keep warm while they wait to be rescued. One student is hyperopic, the other myopic. Which, if either, could use his glasses to focus the sun's rays to an intense bright point of light? Explain.
7. Suppose you wanted special glasses designed to let you see underwater, without a face mask. Should the glasses use a converging or diverging lens? Explain.

24.4 Optical Systems That Magnify

8. a. To double the angular magnification of a magnifier, do you want a lens with twice the focal length or half the focal length? Explain.
- b. Does doubling the angular magnification also double the lateral magnification? Explain.
9. For a telescope, increasing the focal length of the objective increases the overall magnification. For a microscope, increasing the focal length of the objective decreases the overall magnification. Why are they different?

24.5 The Resolution of Optical Instruments

10. A diffraction-limited lens can focus light to a $10\text{-}\mu\text{m}$ -diameter spot on a screen. Do the following actions make the spot diameter larger, smaller, or leave it unchanged?

- a. Decreasing the wavelength of the light: _____
- b. Decreasing the lens diameter: _____
- c. Decreasing the lens focal length: _____
- d. Decreasing the lens-to-screen distance: _____

11. An astronomer is trying to observe two distant stars. The stars are marginally resolved when she looks at them through a filter that passes green light near 550 nm . Which of the following actions would improve the resolution? Assume that the resolution is not limited by the atmosphere.

- a. Changing the filter to a different wavelength? If so, should she use a shorter or a longer wavelength?

- b. Using a telescope with an objective lens of the same diameter but a different focal length? If so, should she select a shorter or a longer focal length?

- c. Using a telescope with an objective lens of the same focal length but a different diameter? If so, should she select a larger or a smaller diameter?

- d. Using an eyepiece with a different magnification? If so, should she select an eyepiece with more or less magnification?