Biomicroscopy I - Exercise 04

September 30, 2025

1 Two thin lenses forming a thick lens

Consider a two thin lens configuration shown in Figure 1. Two thin lenses having 1.5 refractive index, are separated by 5cm. The first lens is biconvex, while the second is biconcave. The object is placed 15cm before the first lens. Both lenses have radii of curvature of 5cm on both sides.

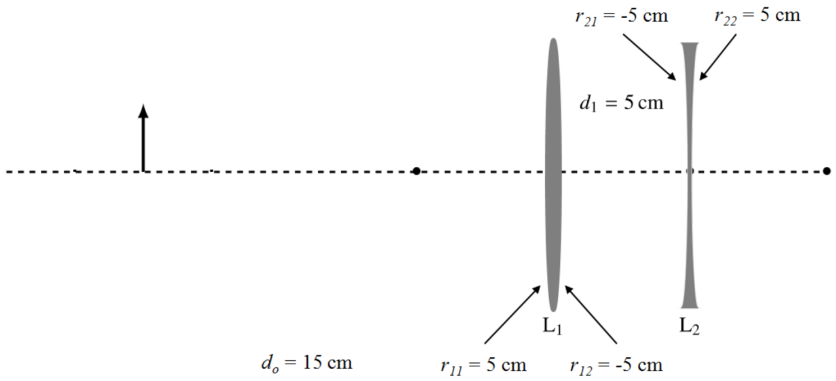

Figure 1: Two thin lenses

A. By using the Lensmaker's equation, find the focal length of each thin lens.
Note: remember to properly use the sign convention for the radii.

B. By ray tracing through the two lenses, find out where the image is located. What is the magnification?

C. Solve **B.** by using ABCD matrix calculations.

D. Find the principal and the focal planes by the ray tracing method.

E. What could this system be useful for? Think about the working distance (distance between object and the first optical component).

F. Imagine the object is moved 2.5cm closer to or farther away from the optical system. How could you use the principle planes to find the image?

G. Now consider the optical configuration in Figure 2, where the space between two thin lenses is filled with the same glass material having the same refractive index of 1.5. By using ABCD matrix calculation, find out where the image is located and the magnification. Compare these values with the previous optical setup.

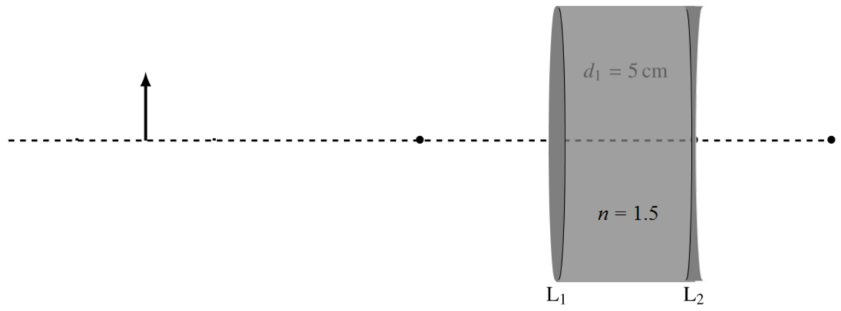

Figure 2: Two thin lenses forming a thick lens

2 Two thin lenses with extra optical components

Consider the lens configuration shown in Figure 3. A diaphragm is located on the front focal plane of the total system and a screen is located in the image plane 10 cm after the image side principal plane.

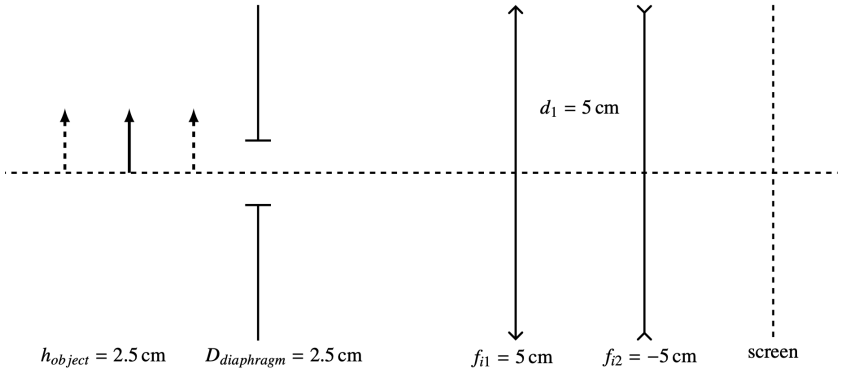

Figure 3: Two thin lenses with diaphragm and screen

A. Find the cardinal points as well as the image of the object located 5 cm before the diaphragm. Trace the marginal rays. Which element defines the pupils? Where are the entrance and the exit pupils?

B. Trace the chief ray. Which element is the field stop? Where are the entrance and exit windows?

C. Suppose the lenses are infinitely large (only the diaphragm is limiting laterally). Consider the chief ray and draw also the two rays from the object extremity that touch also the diaphragm boundaries. Then move the screen 1 cm forth and back. What happens with the image seen on the screen in this particular configuration? What is the image size? What is the reason for this behavior?

D. Now let the screen be at the original position, but move the object 2.5 cm forth and back. Under the same assumption of the lenses being infinitely large, what do you now see on the screen? What is the image size in this case?