

Biomicroscopy I - Exercise 03

September 24, 2024

1 Thin lenses: imaging

Consider a lens configuration shown in Figure 1. One lens is divergent, another is convergent. Answer the following questions using ABCD matrices:

- A. Assume there is a 1 cm tall object 15 cm before the first lens. Find out where its image is located. What is the magnification?
- B. Next, assume the object has moved 2.5 cm closer to the optical system and find its image. What magnification do you find here? Where is the image located? What is the axial magnification (ratio between image shift and object shift)?
- C. Repeat the same calculations but assuming the object was moved 2.5 cm farther away from the optical system (from its original position).

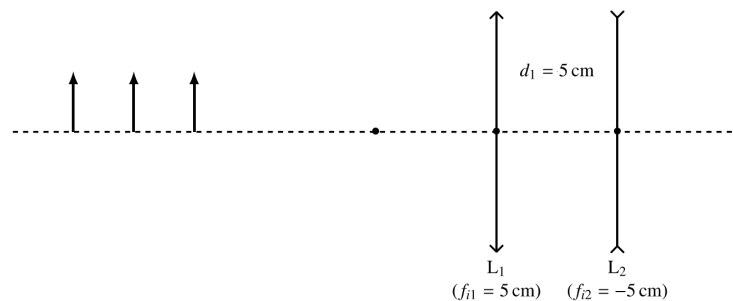


Figure 1: Two thin lenses and set of objects

2 Thin lenses: magnification

Let a lens L have a focal length $f = 20\text{mm}$. Answer the following questions using ABCD matrices:

- A. Consider an object located at a distance $d = 60\text{ mm}$.
 - (a) Where is the image located?
 - (b) What is the magnification?
- B. How can we generate an image with magnification $m = -2$?

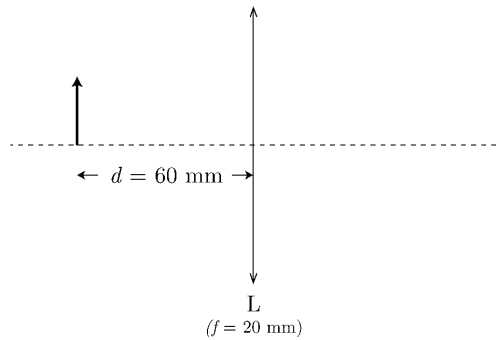


Figure 2: Magnification

3 Two thin lenses: cardinal planes

Consider the optical system in Figure 3 consisting of two thin lenses L_1 and L_2 with $f_1 = 4\text{cm}$ and $f_2 = -4\text{cm}$ focal lengths, respectively. Take the first lens as the reference plane (E).

- A. Find the locations of the principal planes of the system.
- B. Find the locations of the focal planes of the system.

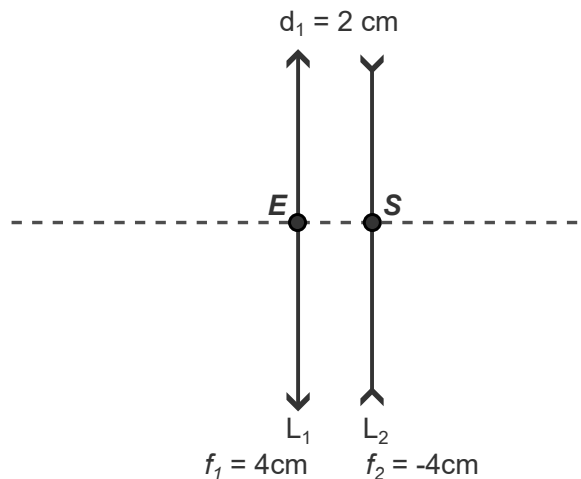


Figure 3: Two thin lenses

4 Thick lenses

A thick lens of thickness 2.8cm and an index of refraction $n = 1.6$ has two spherical surfaces of radius $r = 2.4\text{cm}$. A 2cm tall object is located on the optical axis, in air, 8cm in front of the first surface (see Figure 4). Answer the following questions using ABCD matrices:

- Where is the image location?
- What is the image size?
- Where are the focal planes?
- Where are the principal planes? Consider the E plane to be the reference plane.

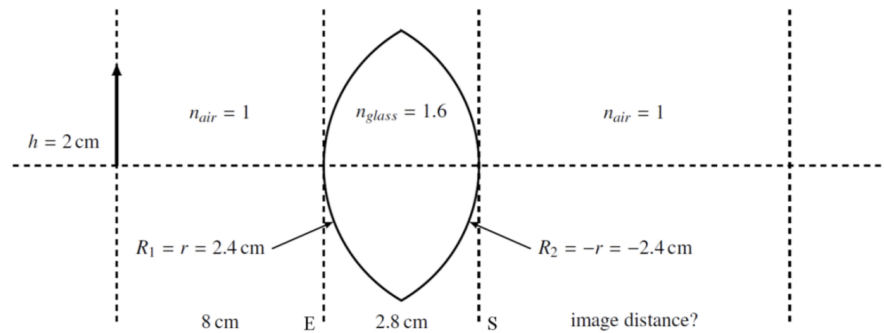


Figure 4: Thick lens