Optical Instruments Prelab

by

Dr. Christine P. Cheney, Department of Physics and Astronomy, 401 Nielsen Physics Building, The University of Tennessee, Knoxville, Tennessee 37996-1200

Read the introduction to Optical Instruments in your lab manual.[1] An optical instrument aids in seeing objects. The eye can focus on objects far away like the stars or on items that are as close as 10 cm. Put your hand up to your eye and vary its distance from your eye. What range of objects can you focus on? Your lens changes its shape to adjust its curvature for focusing at different distances. Things close up are harder to focus on and can strain your eyes. For example, it is important to look away from your computer to something far away every now and then instead of staring at the same thing for hours at a time. Your eye is an important part of optical instruments. In the Optical Instruments lab you will use a simple magnifier, a simple telescope, and a compound telescope where your eye will be close to one of the optics.[1] All of the lenses that you will use are converging lenses.

In the simple magnifier used in this lab, your eye will be close to optical lens. In designing a simple magnifier, the image formed on the retina should be as large as the retina will accommodate. The object is placed inside the focal point of the lens. You should recall that an upright, virtual image is formed in this scenario just like seen in the Simple Lens Prelab. If you did not have a lens, then the eye would not be able to focus on an object that close to the eye.

A simple telescope can be used to view things that are far away. The simple telescope that you will use in lab uses two lenses. The first lens has a long focal length that focuses light from a distant object at approximately the focal point of the lens. This occurs since the object is so far away, the light rays are considered parallel coming into the lens (Shown in Figure 1a). The second lens is placed so that the real, inverted image formed with the first lens (which now becomes the object of the second lens) is inside the focal length of the second lens. Thus a virtual image is formed by the second lens (shown in Figure 1b).

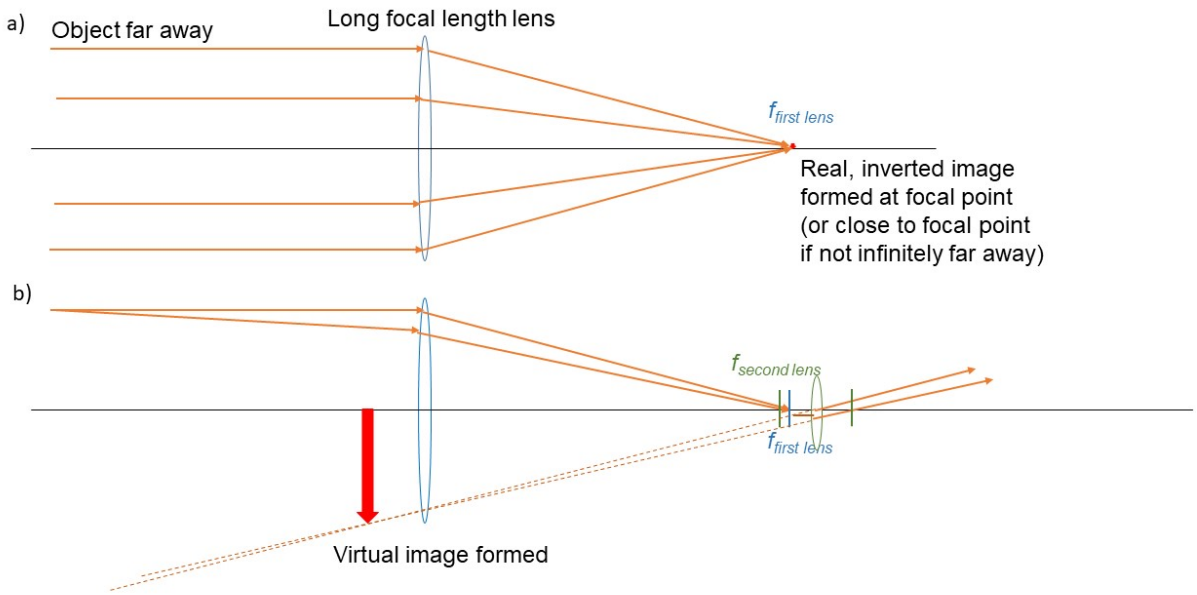

Figure 1. a) An object that is very far away forms at or close to the focal point of a long focal length lens. If the object is infinitely far away, then the light rays coming in are parallel and focus at the focal point of the lens. b) The image of the first lens becomes the object of the second lens and is inside the focal point of the second lens such that a virtual image is formed by the second lens.

The third instrument that you will build is a compound microscope. It is used to magnify closeby, small objects. See Figure 3 on page 323 of your lab manual.[1] In this scenario the object is close to the focal point of the first lens. The first lens has a very short focal point so that the real, inverted image is magnified. The second lens is placed some distance from the first lens and the image of the first lens is placed inside the focal point of the second lens such that a virtual image is again formed. The original object is magnified greatly.

Questions:

1. Create an Excel sheet as shown in Figure 6 on page 326 of your lab manual.[1]
2. How does a Galilean telescope differ from the simple telescope (Keplerian) discussed in your lab manual? You may find this website[2] helpful: https://brunelleschi.imss.fi.it/esplora/cannocchiale/dswmedia/esplora/eesplora2.html
3. How much more light is collected with a 4” diameter lens compared to a 2” diameter lens?

Things to remember during the lab:

1. **DO NOT TOUCH THE OPTICS WITH YOUR FINGERS!!!!** Touch the black holders not the optics.

References:

[1] Parks, James E. *Contemporary Introductory Physics Experiments, 2nd Edition*, Hayden-McNeil Publishing: Plymouth 2014.

[2] https://brunelleschi.imss.fi.it/esplora/cannocchiale/dswmedia/esplora/eesplora2.html