Homework 2 & Thin Lens Lab

Reading for February 9-16th: Hecht §5.7 & §§6.1-3

Equipment

- Source Bulb & Power Supply
- Adjustable Aperture
- Flat Mirror
- 2 Converging Lenses & 1 Diverging Lens
- Optical Mounts, Posts, Clamps, and Screws
- Paper and Tissue for Imaging

Lab Tasks

1. One piece of optical equipment rare in the lab but ever-present are the adjustable lenses you carry around in your eyes. Based on how far away and how close you can focus, and the fact that there is around 2 cm distance from your eye-lens to your retina where objects are imaged, what range of focal lengths can your eye-lens have?

2. Turn on the source bulb, use a piece of aluminum foil to shield light not emanating along the table, and place the aperture close to the bulb (within 1"). Use a folded piece of paper placed within 1 m from the aperture to view the beam of light; adjust the aperture height so the beam is approximately parallel to the table. With the aperture open, why is the circle of light blurry rather than sharp? As the aperture is closed down, what shape is the light spot on the paper? Why is it not circular (you may return to this question later if it's not clear)? Sketch the geometrical ray paths of the set-up to explain your answers.

3. With the aperture open place the mirror approximately 1 m from the source to reflect the light; image the reflection with the piece of paper—why is the reflected light a sharp circle when the incoming light is a blurry one? Adjust the height and orientation of the mirror to reflect back to the aperture. Clamp the source, aperture, and mirror and use the thumb screws for fine adjustment to make the reflected light collinear.

4. Close down the aperture and place the large converging lens between it and the mirror. Find the light reflected from the mirror back through the lens and adjust the lens position and orientation to focus it on or near the center of the aperture. Draw a ray diagram of this set-up and make a measurement to find the f for the lens.

5. Putting the piece of paper back in place, adjust the lens to image the source on it. Measure the distance from the source to the lens and lens to image and calculate f for the lens. Draw a ray diagram with these distances to explain why the image is the orientation it is.

6. Using the small converging lens, image the *aperture*. Measure the aperture and image size and the distance d from aperture to image. From these measurements find the f of this lens. Compare your measurement to the value of f printed on the side of the lens mount.

7. Now place the diverging lens in the system. Where is the image produced by this lens? Use a diverging and converging lens to make an image, measure distances to determine the f of the diverging lens, and make a ray tracing diagram of the set-up.

8. It is often desirable to have a beam of light that is *collimated*, i.e. where the light rays are all parallel. How would one produce collimated light? What set-up with aperture, lenses, and mirrors produces the maximum amount of collimated light from the source?

9. How can one produce an upright image of the source using this equipment? Make this set-up and draw a ray diagram showing how it works.

10. How can one produce the largest image of the source using this equipment? Make this set-up. On magnification are there details of the source you can see that you couldn't before?

Theory Tasks

1. Hecht Problem 5.15

2. Hecht Problems 5.27 & 5.42. If you find yourself in the lab again, you could test the latter method out too.

3. Hecht Problem 5.29

4. Hecht Problem 5.75