Simple Optical Devices

In this lab activity, you will investigate lenses and ray optics. The setup will allow you to create images, real and virtual, and then project the real images on to a screen. The thin-lens equation will be used to design a simple optical instrument.

I. Materials needed

- Optical rail
- Light source and power supply
- 10, 15, and 20 cm lenses
- Screen

II. Real Image Formation

Place the light source near the end of the track, with the luminous source facing along the longer length of the track. Turn the dial to illuminate the number "4". Insert the 100 mm focal length lens into a holder, and place it 15 cm from the light source plane. Place the screen on the side of the lens opposite the light source.

1. Move the screen from just touching the lens to the point where the image comes into focus,
2. Are the rays diverging or converging as they leave the lens?
3. Where do you find a sharp image?
4. Is it where you expect it using the thin lens equation?
5. Record the positions of the lens, of the light source and of the screen. Record the size of the object and of the image.
6. What is the magnification?
7. Does the linear magnification you observe match the prediction from the thin-lens equation?

III. Virtual image

Set the screen and light source up as in II, but this time use the 200 mm lens.

1. Repeat steps 1-7 as in part II
2. Can you see an image on the screen?
3. What does the lens equation predict for the image position and magnification?

IV. Reconstruct the virtual image

Now place the 100 mm lens between the 200 mm lens and the screen. Where do you need to place the 100 mm lens so that you can create an image of the number "4" on the screen? You may want to move the 200 mm lens a little closer to the light source, say 10 cm. Record enough information to verify the lens equation's prediction of the image distance and magnification.

V. Concave lens

Place the 150 mm lens on the rail, 10 cm from the source and remove the 100 and 200 mm lenses.

1. Position the screen on the other side of the lens from the light source, as in Part II, and follow steps 1-7 as in part II.
2. Is it possible to place the source at any distance from the lens to create a visible (real) image? Use the lens equation to answer this question.
3. Use the 100 mm lens to create an image on the screen with the 150 mm lens (as in part IV). Again, record enough information to verify the lens equation's prediction of the image distance and magnification.

V. Collimated beam

Now dial the open hole in the light source to expose the LED. Using the 100 mm lens, place it in a position to create a collimated light beam. Record the position of the lens and explain in terms of the lens equation.

V. Telescope

Now use a second 100 mm and a 200 mm lenses and combine them to both expand and then contract the collimated beam. Be sure to position these so that a collimated beam comes into and out of the combination as a collimated beam. By how much does the beam expand (and shrink) in each of the two cases?