Forming Images Lab
How is an image formed?

Everything we have learned about light can be used to understand how the human eye sees. The eye works together with the optic nerve and your brain to help you see images. By focusing light onto specialized light sensitive cells, we are able to see the world around us.

Materials
• Light and Optics set
• Dry Erase Marker

Refracting light through a lens
Lenses are able to bend light rays so they come to a point called the **focal point**. This bending of the light rays is called **refraction**. You are going to use a laser to make a ray diagram to find the focal point of a lens.

A. Fix a sheet of graph paper to the optics table with a magnetic strip.

B. Set the laser so the back is tipped up on the magnetic strip and the beam is pointed down slightly at the paper. Align the laser so the beam follows a horizontal grid line straight across the paper.

C. Set the large flat lens on the paper and center it on the beam as shown in the diagram. Trace the shape of the lens on the graph paper. If you move the lens, you can easily put it back on its traced shape now.

D. Draw lines following the beam as it leaves the laser, enters the lens, and then exits the lens. Point the laser so it always follows one of the grid lines across the paper on its way to the lens.

E. Make a dot under the laser exactly where the beam starts and make another where it enters the lens. Do the same where the beam exits the lens and put another close to the edge where the beam goes off the paper. Connect the dots to mark the path of the beam.

F. After you have marked the path of the beam through the center of the lens move the laser to different parallel grid lines above and below the center of the lens. Mark two beam paths above and two paths below the center path.
Thinking about what you observed

1. Describe the path of the laser beam as it travels away from the laser and through the lens.

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   _________________________________________________________________
   _________________________________________________________________

2. What is the focal point of a lens? Mark the focal point on the ray diagram you just drew.

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   _________________________________________________________________
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3. What is the focal length of a lens? __________________________________________

   Measure the focal length of the flat glass lens from the ray diagram. ____________________

Making an image with a lens

A. Use the white board (it is at least 5 meters away from a lamp or sunlit window) to create a screen for seeing the image.

B. Get one of the round convex glass lenses in the metal holders. Move the lens toward and away from the screen until you get a sharp image of the lamp or window. Try distances between 10 and 20 centimeters away from your screen.

C. Use this technique and measure the distance from the lens to the screen to determine the image distance for both lenses (Table 1).

Table 1: Image distance and focal lengths of lenses

<table>
<thead>
<tr>
<th></th>
<th>Image distance (mm)</th>
<th>predicted focal length (mm)</th>
<th>actual focal length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Lens</td>
<td>4.</td>
<td>5.</td>
<td>6.</td>
</tr>
<tr>
<td>Black lens</td>
<td>7.</td>
<td>8.</td>
<td>9.</td>
</tr>
</tbody>
</table>

Now that you have seen the lenses create images, how do you think image distance is related to focal length?

A. Based on what you have learned about focal length, predict the focal lengths of the white and black lenses in Table 1.

B. Now it’s time to check your predictions. Place the wooden block flat on the optics board with the graph paper side up and shine the laser at it so the beam splashes across the wooden block.

C. Line the block up with the graph paper and put one of the lenses on the optics board so the beam goes through the lens and still splashes across the wooden block graph paper.

D. Use two beams to find the focal length. One beam will pass through the left edge of the lens, and one on the right. Once again, you will line the laser up on the graph paper and shine it perpendicular to the lens.
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E. Use the dry erase marker to mark the path of the two beams. Measure the distance from the surface of the lens to where the two paths cross to find the focal length of one lens and record it in Table 1. Erase the marks once you have recorded your data and try the other lens. Repeat steps 1-5 and record your data.

Thinking about what you observed

10. What did you find happened to the light rays as they passed through the lens?

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11. How did your focal length predictions compare to your measured values?

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12. How is the image distance related to the focal length of each lens?

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Projecting an image with a lens

Red or blue LED lamp

A. The red and blue LED lamps each have a letter F engraved on the front face. Take either color and place it near one edge of the optics table.

B. Take the white or black lens and set it on the optics table about 20 cm away from the LED lamp so the light shines through the lens. Think about our previous activities and predict the distance the lens will need to be from the LED to project a sharp, in focus image of the letter “F” onto the wall. Record your prediction in Table 2.

C. Place the wooden block under the optics board on the opposite side from the light.

D. This will tilt the optics table up and the LED will be aimed up onto the wall of your classroom.
E. Move the lens toward and away from the LED until you can see a sharp image of the letter “F” on the wall. Once the image is in focus, measure the distance from the LED to the lens and record it in Table 2. Look at the letter “F” and record its characteristics in Table 2.

F. Repeat the activity with the other lens.

**Table 2: Lens distance and characteristics of image**

<table>
<thead>
<tr>
<th>White Lens</th>
<th>Predicted lens distance (mm)</th>
<th>Measured lens distance (mm)</th>
<th>Larger or smaller?</th>
<th>Right-side-up or up-side-down?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13.</td>
<td>14.</td>
<td>15.</td>
<td>16.</td>
</tr>
<tr>
<td>Black lens</td>
<td>17.</td>
<td>18.</td>
<td>19.</td>
<td>20.</td>
</tr>
</tbody>
</table>

**Thinking about what you observed**

21. Describe the characteristics of the images formed by the lenses. Characteristics include whether the images are larger, smaller, right-side-up, or up-side-down.

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22. How is the focal length of a lens related to the lens distance required to project a sharp, in-focus image?

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23. How did your lens distance predictions compare to your measured values?

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24. How is projecting an image with a lens (the letter “F” on the wall) is similar to making an image with a lens (the image of the window on a screen).

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25. Lab left with materials in place ________________________________

Teacher’s or TA’s initials