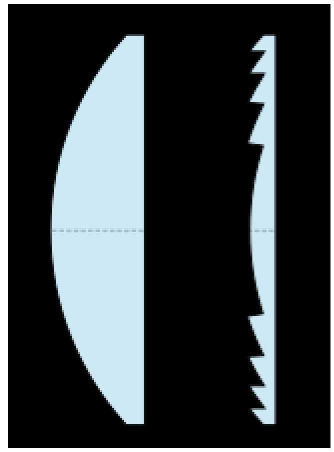
Name(s) > ______________________

The Fresnel Lens

The light that hits any lens changes direction at the front and back surfaces. The light travels in a straight line inside the glass, so that this material could be removed. A very clever Frenchman, Augustin Jean Fresnel (fra-NEL), decided to design a skinny, groovy lens. One of the first applications was for lighthouses. These new Fresnel lenses were extremely effective and revolutionized the design of glass lenses for lighthouses. Today, inexpensive, plastic, flat lenses are popular as hand-size or page-size magnifying glasses.

Left: This lighthouse lens system contains many Fresnel lenses. This design is both an exquisite piece of art and highly effective.

Right: Notice that the angles of the Fresnel cross-section match the angles of the typical lens.



This groovy, skinny lens has concentric circles, where the angle of each circle matches the angle of the curved surface of the converging lens (see sketch above!). The light still changes direction at the front and back of the lens. The advantage of the Fresnel is that it uses much less material than the typical, fat, glass lens. The (skinny) Fresnel lens offers a very large surface at a much lower cost. A large surface area allows the lens to **gather more pinhole images** to produce **brighter images**. The pinhole equation and lens equation are still valid.

Pinhole Equation: $\frac{h_i}{h_o} = \frac{d_i}{d_o}$ Lens Equation: $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$

Real Images from a Fresnel Lens

Use the 2 large clips to hold the Fresnel lens in a vertical position (Note—images will be slightly sharper when the flat side of the lens faces the object). Estimate the focal length by using the lens to form an image of a distant object (Hint—try using a distant tree, etc. as your object). When the $\mathbf{d_o}$ is huge, then the value of $\mathbf{d_i}$ is the focal length. Record the value.

f = _____ cm

Now use the "F" object and the suggested do values. For each $\mathbf{d_o}$, measure the values of $\mathbf{d_i}$ and $\mathbf{h_i}$ and record in the data table.

$\mathbf{d_o}$ (cm)	measured $\mathbf{d_i}$ (cm)	measured $\mathbf{h_i}$ (cm)	calculated $\mathbf{d_i}$ (cm)	calculated $\mathbf{h_i}$ (cm)
50				
70				
90				

Then, use the lens equation to calculate the predicted value of $\mathbf{d_i}$. Record in the data table.

Next, use the pinhole equation to calculate the value of $\mathbf{h_i}$ and record into the table below.
So far, you have used the screen to capture the images, but is the screen actually necessary?
Leave the lens at the 90 cm position and place the screen so that the image is clear and bright on the screen.

Now position yourself about 100 cm farther than the screen and **your eyes directly in line with the object, lens, and image.** Next have your lab partner slowly remove the screen. Can you still see the image (floating in space!)? Reach out to verify that the image is still the same distance from the lens.

You should see a sharp image, even when the LED lamps are turned off!

Repeat this procedure for each student in your lab group.

Virtual Images

Place your hand 20 cm behind the Fresnel lens and look through the Fresnel lens to see the image. Slowly move your hand away from the lens. Describe your results:

Next, place your hand 20 cm behind the Fresnel lens, palm facing the lens. Now slowly curl your fingers into a fist. Is the image of your hand 2 dimensional or 3-D? Describe your results.