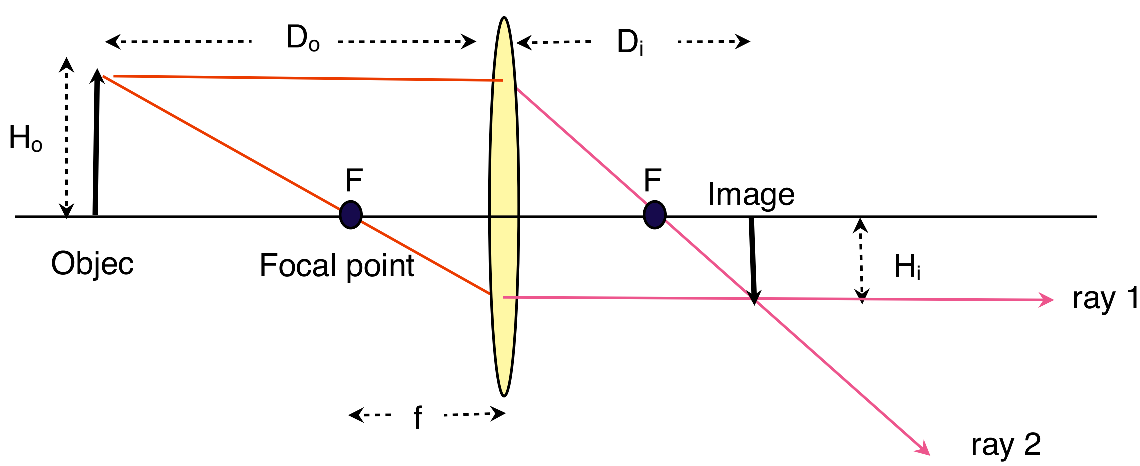
LAB 10 Lens Lab- The image from a converging lens

<u>Purpose:</u> To locate, diagram and view the image formed by a converging lens.

<u>Materials</u>: Converging lens, lens holder, object of your design, white viewing screen, 1 meter platform, light bulb, sliding clamps and ruler.

<u>Discussion</u>:
As we learned in the refraction lab, light changes its direction of propagation as it goes from one substance to another. Although Snell's law applies to lenses, there are several rules that simplify the process of locating and diagramming the image formed b a lens. There are different but similar rules for different types of lenses. In this lab., we will learn the rules that apply to converging lenses. In the ray diagram below, notice that ray 1 comes from the top of the object on the left of the lens, passes through the focal point, strikes the lens, and then exits parallel to the axis. Ray 2 also leaves the top of the object, but is moving parallel to the axis. Ray 2 strikes the lens and then is refracted toward the focal point on the far side of the lens. Both ray 1 and ray 2 contain information about the top of the object. Rays 1 and 2 cross at only one point. A clear image of the top of the object will form where the two rays cross. A third ray moving away from the base of the object along the axis would pass through the center of the lens without being refracted. That ray is used to locate the base of the image. Please take a moment and reread the discussion and trace the rays that locate the image as you read.

Ray diagram:



Thin lens equations for a converging (double convex) lens.

eq. 1: $\dfrac{H_i}{H_o} = \dfrac{D_i}{D_o}$ eq. 2: $\dfrac{1}{f} = \dfrac{1}{D_o} + \dfrac{1}{D_i}$ eq. 3: Magnification: $M \equiv \dfrac{H_i}{H_o}$

In the equations above, '**f**' is the distance from the lens to the focal point, F. '$\mathbf{D_o}$' is the distance from the object to the center of the lens, '$\mathbf{D_i}$' is the distance between the image and the lens and The focal length '**f**' of a lens is an important property of that lens. You can determine the focal length of a converging lens by measuring the image distance '$\mathbf{D_i}$' of a bright, ***<u>distant</u>*** object. If the object is far, far away, 'D_o' is large. Therefore $1/D_o = 0$, and 'f' equals 'D_i' for this special case.

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Lab 10 preparation Name_________________________
Hand in before the lab begins.

1. Draw and label a ray diagram that includes lens, object, image, object height, image height, object distance from the lens, image distance from the lens, the focal point and the focal length.

2. Write down and know equations 1, 2 and 3.

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<u>Procedure:</u>

Part 1- Finding the focal length of the lens.

1) Take the lens, ruler and a piece of paper outside on a sunny day. If it is too cloudy or dark outside you will have to do this part inside. Use a light at the other end of a darkened room to replace the sun.

2) Place the lens between the paper and the sun. Move the lens toward and away from the paper and try to make the bright spot (the image of the sun) as small as possible.

3) Measure the distance between the lens and the paper. That distance, 'D_i' , is equal to the focal length 'f' of your lens. This is only true when the object is far from the lens. Take three trials and record each value on the data sheet. Then calculate the average focal length 'f' and enter its value in the data sheets on page 3 and 4.

Part 2- Calculated values for image size and location.

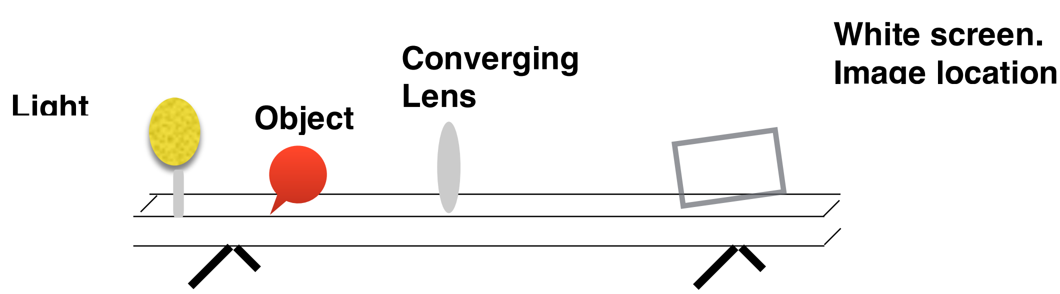
1) Measure the **height of the object**, (not its distance above the table) and enter its value in the data sheet.

2) Using the object distance given on the data sheet, the objects height, and the focal length that you have already determined, calculate the image distance and image size. Enter these values in the chart on the data sheet.

3) Draw a ray diagram for each trial.

Part 3- Experimental values for image size, magnification and location.

1) Set up the equipment as in the diagram below. Note that the light bulb is not the object and that the light bulb should be as far away from the object as possible.



2) Position the object at the first 'D_o' listed on the data sheet.

3) Move the white image screen back and forth until the image of the object is as clear as possible on the screen.

4) Determine and record the experimental image distance, size, and magnification for the given object distance.

5) Repeat for each new object distance indicated on the data sheet.

Name________________ sect.___

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Data sheet:

Part 1: Determining the focal length of your converging lens.

Trial Image distance D_i

1______ 2______ 3_____ Average D_i =______________

With the object so far away, the average D_i equals the focal length. f = ______________

Part 2: Mathematically predicting the image size and its distance from the lens. Object height = _______.
Do the calculations and draw ray diagrams below.

1) Object distance = 20 cm <u>(Note that the object should be at least 4 cm outside the focal point.</u>

2) Object distance = <u>25 cm</u>

3) Object distance = <u>30 cm</u>

4) Object distance = <u>40 cm</u>

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Name_______________/ Sect.___

Data sheet: focal length of your lens =____________

CHART

Trial	D_o	Calc. D_i	Exper. D_i	Calc. H_i	Exper. H_i	M
1)	20 cm					
2)	25 cm					
3)	30 cm					
4)	40 cm					

A camera produces an image that is much smaller than the object. It then places the image on the film
Which trial is most like a camera? ___________________

A projector produces an image that is larger than the object.
Which trial is most like a projector? _________________