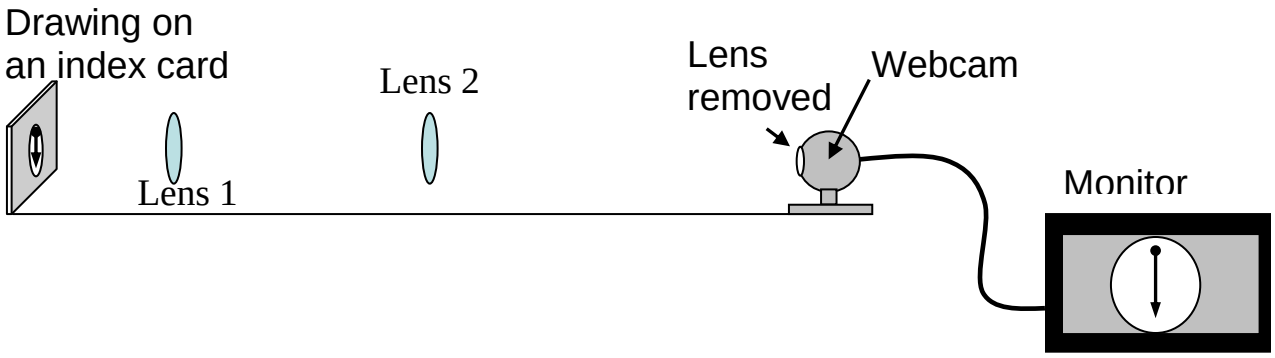
Physics 345 Pre-Lab 5 Lenses Part II

1) Consider the optics set-up shown below. The two lenses are converging lenses and there is a focused picture as shown on the monitor. LOOK CAREFULLY AT THE DIAGRAM BEFORE ANSWERING THE QUESTIONS! (Remember what you observed in the last lab concerning the orientation of images seen on the monitor while using a lens-less webcam).



a) Where does lens 2 form an image (if anywhere)? How do you know?

b) Where does the lens 1 form an image? Between lens 1 and lens 2, between lens 2 and the webcam, between lens 1 and the index card, behind the webcam, or behind the index card? How do you know?

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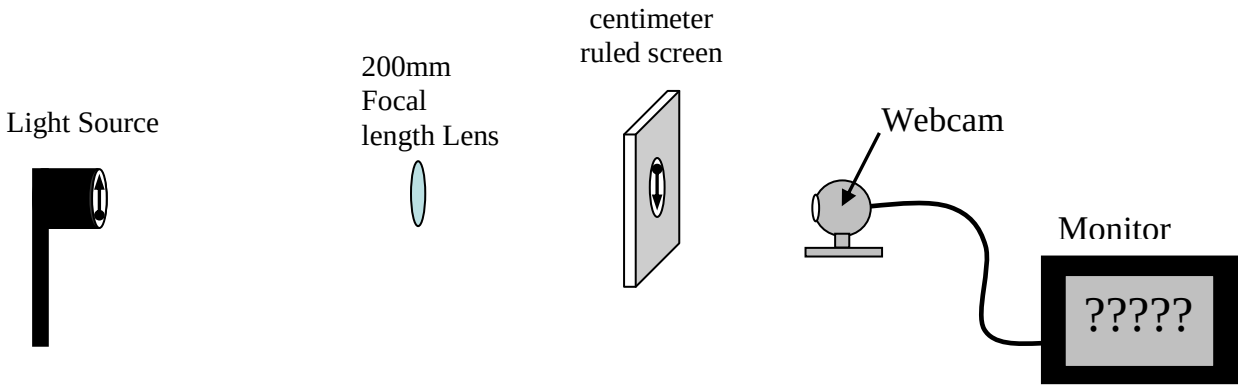
Physics 345 Lab 5 Lenses Part II

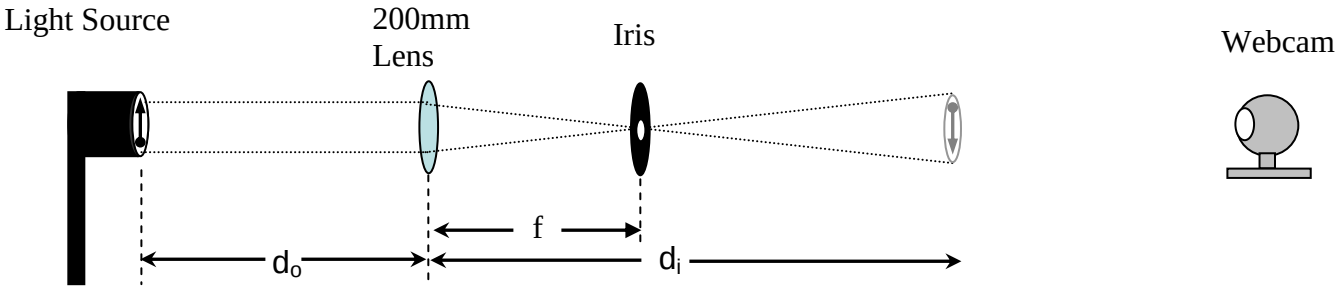
Section 1

This section explores the nature of a focal point in regard to the rays that form an image. This section also explores the effects on an image as a result of forcing all the rays to pass through a small hole.

Set up the light source, 200mm focal length lens, and a ruled screen on an optical rail. Adjust the distances between the screen, lens, and source so that a clear image appears on the screen. Place the webcam on the optical rail and get the image to appear on the monitor screen.



Consider what would happen if we add an iris to this set-up and remove the cm ruled screen. A student suggests that an iris will have a minimal effect if it is placed at the focal point of the 200mm lens (see the sketch shown below). The student explains that this works because all the rays must pass through the focal point. Do you agree or disagree with this students reasoning? EXPLAIN YOUR THOUGHTS.



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Try putting an iris at the location shown in the sketch above. Write down what the iris does to the image seen on the monitor.

Upon testing of the previous situation, a student comes up with the following reasoning. "The iris greatly disturbs the image because the rays coming out of the source are not always parallel with the optical axis. If all the rays left the source parallel to the optical axis, then the figure on page 4 would be accurate." Do you agree or disagree with the student's reasoning? EXPLAIN.

Using rays explain how the iris affects the formation of the image.

SHOW YOUR RESULTS TO YOUR INSTRUCTOR BEFORE PROCEDING

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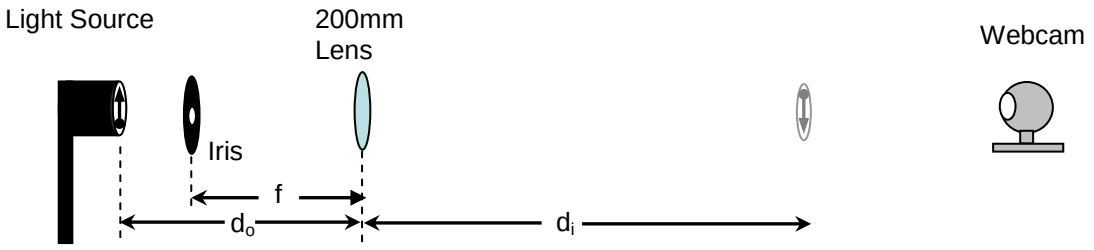
Now consider placing the iris anywhere between the light source and the 100mm lens (with the webcam assembly behind it). Make a prediction of where we could place the iris so that it will have a minimal effect on the viewable picture on the monitor?

Try multiple iris locations. Find the location where the iris will have a minimal effect. Resolve any differences with your predictions.

Predict what would happen if we placed the iris at the focal point between the light source and the 200mm lens. How would this affect what you would see on the monitor screen.



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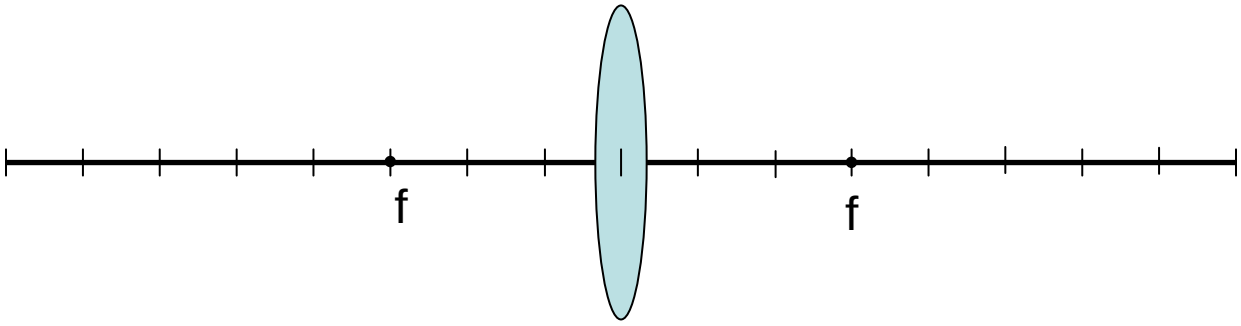
Test your prediction and resolve any discrepancies.

Section 2

In this section you will test your knowledge of ray diagrams and whether you can correctly predict information concerning images from a ray diagram.

Equipment: Optical Rail, optical rail carts, light source with test pattern, lens holder, lens set, ruled screen, webcam without lens, webcam with lens, optical posts, post holders and a computer.

Consider (i.e., predict) a light source that is a distance of 300mm from a 150mm focal length lens. In the figure below, each hash mark represents 50mm. Draw a ray diagram on the figure.



Where (if anywhere) would one expect to find an image? Explain

How is the image oriented? Explain

What magnification would you expect? Explain.

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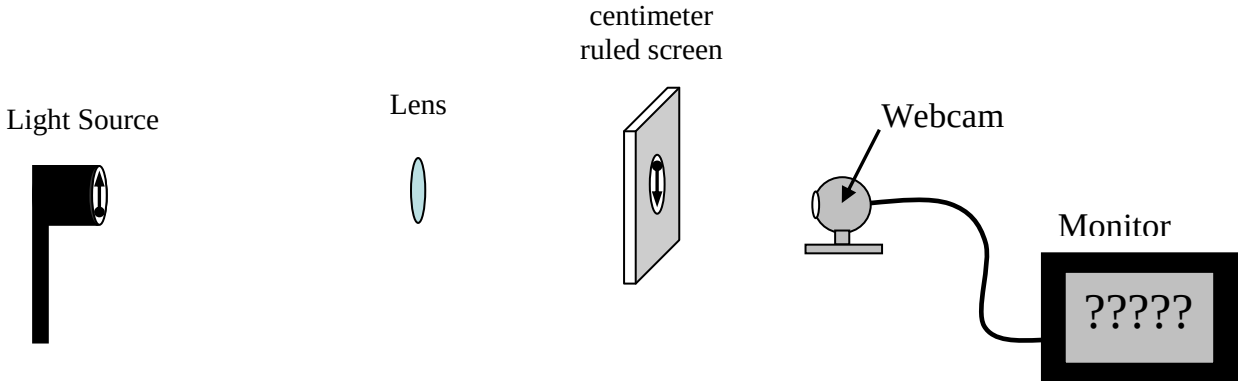
SHOW YOUR ANSWERS TO YOUR INSTRUCTOR BEFORE PROCEEDING
Set up the equipment as shown below with the light source off. Make sure that the monitor and the webcam's opening face the same direction (otherwise you could get confused by the orientation on the monitor). Attach the light source with the test pattern on an optical rail cart. Next put a 150mm focal length double convex lens in a lens holder. Connect the lens holder to an optical cart using a post and post holder. Place the two optical rail carts on the optical rail such that the light source and the lens are exactly 300mm apart. It is critical that the lens' faces are nearly perpendicular to the light beam path.



WITH YOUR INSTRUCTOR PRESENT AND THE LIGHT SOURCE OFF, PLACE THE SCREEN WHERE YOU WOULD EXPECT TO FIND THE IMAGE.

Using the equipment, determine the image distance (distance from the lens to the image), image orientation with respect to the object, and magnification. Take a picture of the screen using the webcam. Resolve any differences from your previous predictions!

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Section 3

In this section you will test your knowledge of the thin lens equation and whether you can predict information concerning images from it.

Consider a light source that is a distance of 400mm from a 150mm focal length lens. DO NOT SET THIS UP EXPERIMENTALLY AT THIS TIME. Using the thin lens equation $\left(\frac{1}{d_o}+\frac{1}{d_i}=\frac{1}{f}\right)$ determine the following:

Where (if anywhere) would one expect to find an image? Explain

What magnification would you expect? Explain

How is the image oriented? Explain

SHOW YOUR ANSWERS TO YOUR INSTRUCTOR BEFORE PROCEEDING

Now place the two optical rail carts on the optical rail such that the light source (TURNED OFF) and the 150mm focal length lens are exactly 400mm apart. It is highly important that the lens' faces are nearly perpendicular to the light beam path.

WITH YOUR INSTRUCTOR PRESENT AND THE LIGHT SOURCE OFF, PLACE THE SCREEN WHERE YOU WOULD EXPECT TO FIND THE IMAGE.

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Using the equipment, determine the image distance, image orientation with respect to the object, and magnification. Take a picture of the screen with the webcam. Resolve any differences from your previous predictions!

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Lab 5 TASK Single Converging Lens

A light source with a test pattern is separated from a screen by a distance of 900mm. The image on the screen is upside down and exactly twice as large as the test pattern. You will have only one attempt at setting up this situation using any double convex lens in the set.

HOWEVER,…

1. You must show all of your predictions to your instructor before turning on the light source
2. You are only allowed one choice of lens. That is, you may NOT try various lenses and see which works best.
3. You have to position the lens before turning on the light source.

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