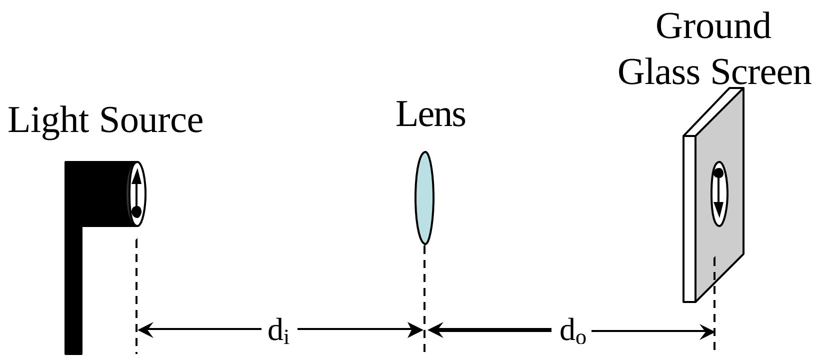
Physics 345 Pre-Lab 3 Single Converging Lens

Consider this lens set-up (drawn to scale) where an image is projected on a ground glass screen.



1) Is it possible to determine the ratio between the focal length and the image distance? If so, find it and explain your reasoning. If not, what additional information is needed to find this ratio?

2) How would the image change if we blocked just the LOWER half of the lens with opaque cardboard? Explain your reasoning.

3) Would there still be an image if we removed the ground glass screen? Explain your reasoning. What sort of experiment could one perform to check your prediction?

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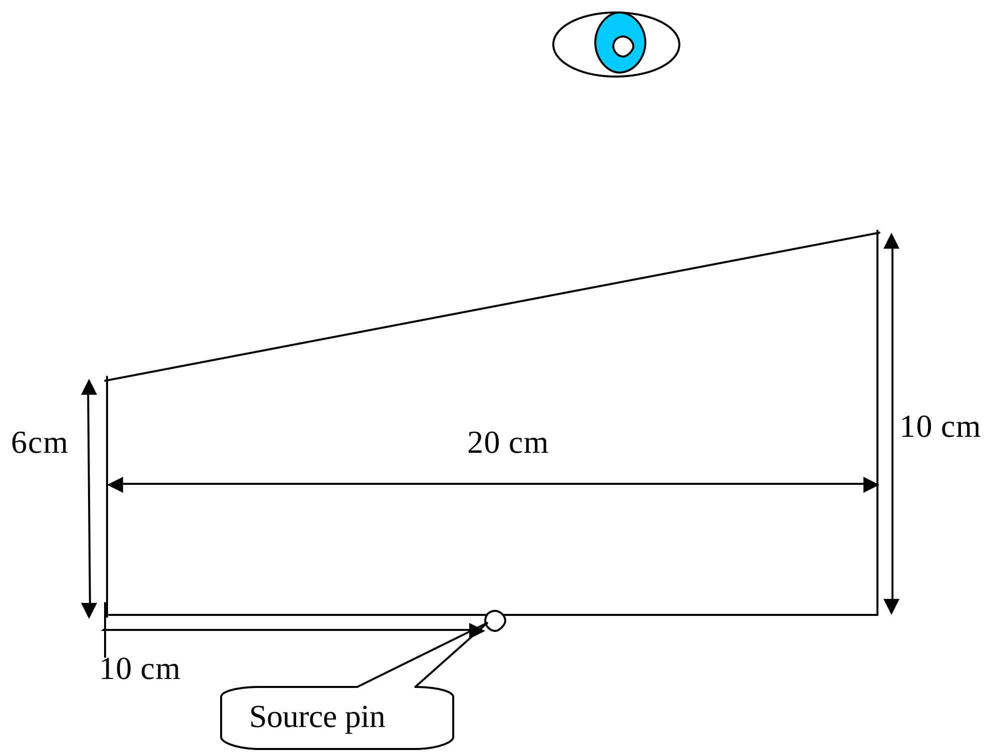
I. You have a water tank ½ filled with water shaped as shown below (viewed from top). The source pin is on the opposite side of the water tank of the viewer. Accurately and precisely determine the location where the viewer will observe the pin. Explain how you arrived at your answer.

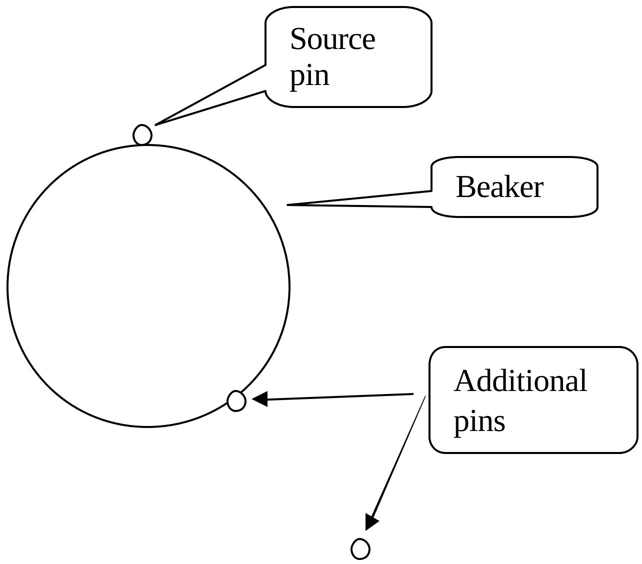


Show your prediction to your instructor.

Test your prediction, resolve any differences between your prediction and actual observations.

II. Curved surface refraction using 1-liter beaker

Predict: What would happen if you replaced the planar refracting surfaces with curved surfaces while placing the **source pin** in contact with the curved surface as diagramed below? Explain your answer



Perform the activity and determine the apparent location of the **source pin**. Compare your results with your predictions and resolve any differences.

Suppose you were to move the **source pin** further and further from the beaker. What would you expect the exiting rays to do and what would happen to the apparent location of the image? Explain.

Place the source pin close to, but less than 7 cm from the center of the beaker. Since we are interested in the rays that leave the source pin and enter the beaker and then exit the beaker, you will have to determine the optical ray path before and after the beaker. Repeat the determination of the apparent location of the **source pin**. Did the exiting optical ray paths behave as you expected?

Place the **source pin** approximately 15 cm from center of beaker. Try keeping your eye within 10 cm of the beaker. Can you see the **source pin**? Try moving farther from the beaker. What impact does moving farther away have on what you see? .

Determine the paths of the entering and exiting optical rays to determine the apparent location of the **source pin**. Does this help explain the previous observations?

How did the optical ray paths change as the **source pin** moved farther from the beaker surface? Compare your results with your prediction and resolve any differences.

Do the light rays really cross in any situation? If so, what does this imply?

Conclusion:

Because the size of the source pin is ________________, we can treat the plane in which it lies as a _____________ source.

In each situation, the apparent location of the **source pin** also corresponded to a __________ source so that there was a one to one correspondence between the point source and the *image point source (need better phrasing there).*

With plane refracting surfaces, the apparent location of the **source pin** was always found by tracing the optical ray path ____________towards the **source pin**.

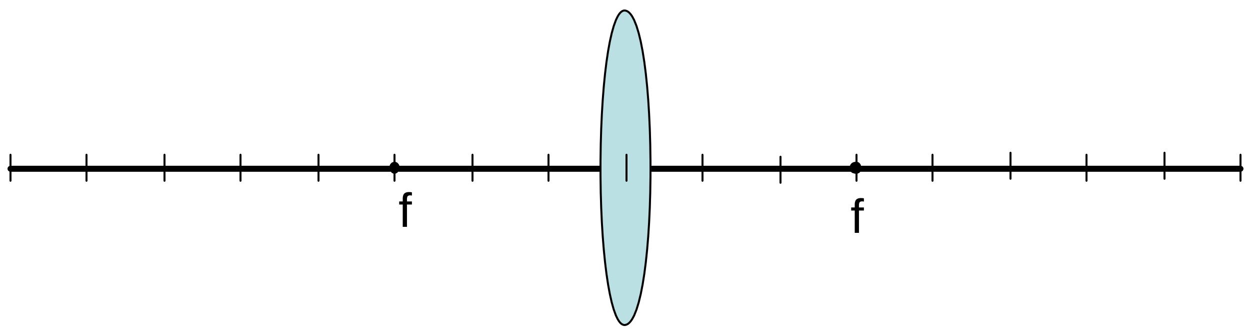
With a curved refracting surface, if the **source pin** were close to the beaker the apparent **source pin** location was found by tracing the optical ray path ____________ towards the **source pin**.

If the **source pin** were _____________ from the beaker than a certain distance then the apparent location of the **source pin** was found by tracing the optical ray paths ______________ until they crossed.

If the **source pin** were placed at that particular location, then the rays exiting the beaker would be _____________________.

III.	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. Using the scaled diagram shown below and rays, determine the following: Where (if anywhere) would one expect to find an image? What type of image is it? How is the image oriented? What magnification would you expect? Fully explain how you arrived at your answers!



SHOW YOUR ANSWERS TO YOUR INSTRUCTOR BEFORE PROCEEDING

Now attach the light source with the test pattern a distance 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 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.

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

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? What type of image is it? How is the image oriented? What magnification would you expect? Fully explain how you arrived at your answers!

SHOW YOUR ANSWERS TO YOUR INSTRUCTOR BEFORE PROCEEDING

Now Place the two optical rail carts on the optical rail such that the light source and the 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.

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

Is the image still present if the white screen is removed? Explain your reasoning. Make a prediction without any experimental testing (at this time).

Now remove the screen. This is assuming that previous set-up is still there. Take a picture with the webcam. Now remove the webcam and put your eye at the approximate position of the webcam. Can you see the image? Resolve any differences.

Aim the webcam **without the lens** at various objects in the room. Can you see a clear picture on the monitor screen? Explain how one can get a clear picture using this webcam set-up or explain why you believe it can't be done.

Attach the webcam to an optical rail cart using a post holder. Make sure the light source with the test pattern is turned on and that the rail cart with the lens is still present on the optical rail. Move the webcam along the optical rail until you find a clear image of the test pattern. How does seeing a pattern here relate to your answer to the previous question?

Back up the rail cart with the webcam on it and observe the orientation of the image on a piece of paper. Then move the webcam back to the position where a clear image is seen on the screen. Observe the orientation of this picture. Do these images have the same orientation? Why do you think it happens this way?

Make a prediction of what you think will happen to the picture on the monitor if you turn off the light source? Explain your reasoning.

Now turn off the light source. Resolve any differences you might have between this observation and your previous prediction.

Shine a flashlight beam on the target (light source still off). Does this improve or worsen the contrast of the picture seen on the monitor? Why might this happen?

Use a black cloth to cover the lens and the webcam while still allowing an optical path between these two devices. Does this improve or worsen the contrast of the picture seen on the monitor? Why might this happen?

For the current optical set-up, predict what we would see on the monitor if we covered the right side of the lens? Fully explain your reasoning.

Using a small piece of paper, cover the right side of the lens and observe the picture on the monitor screen. Resolve any differences you might have between this observation and your previous prediction.

Physics 345 Lab 3 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.