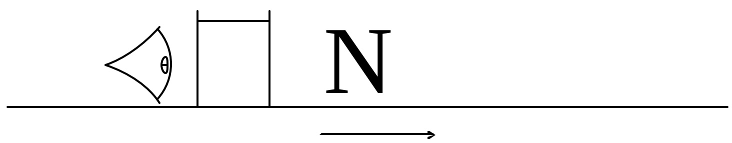
PHYS 345 Pre-Laboratory Exercise 2

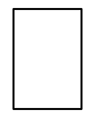
Due Wednesday January 18 at 3PM

1) The figure below shows a water glass filled with water and a large, 3 cm wide and 8 cm high, letter N on a card on one side of the glass. You look at the N through the water in the glass. Describe carefully what you will see as the N starts near the glass and is then moved far away from the glass. Explain fully using PHYSICS and ray paths.

2) The figure below shows a rectangular container filled with water and a large, 3 cm wide and 8 cm high, letter N on a card on one side of the glass. You look at the N through the water in the container. Describe carefully what you will see as the N starts near the container and is then moved far away from the glass. Explain fully using PHYSICS and ray paths.



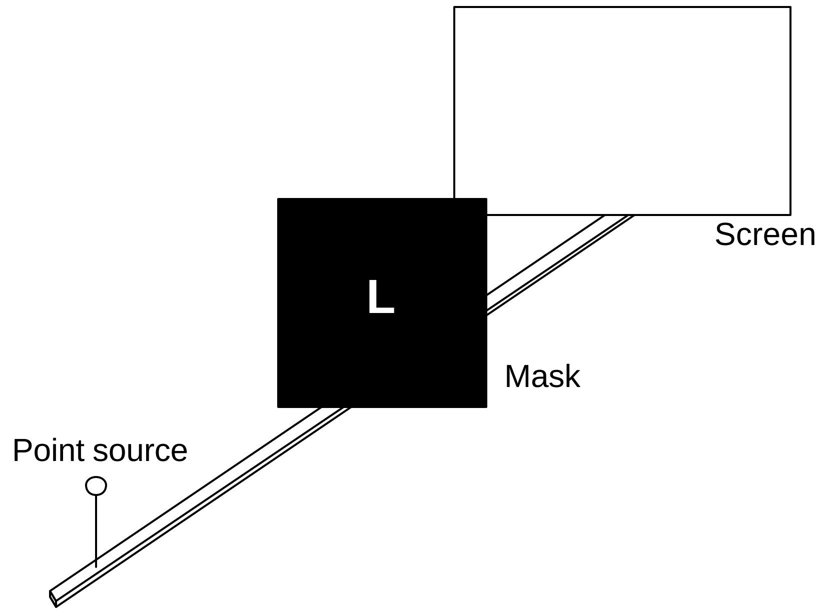
Top View of
Container



Lab I continued

IV Non-symmetric apertures

A mask containing a hole in the shape of the letter L is placed between a screen and a very small bulb as shown below. On the diagram, sketch what you would see on the screen when the bulb is turned on. Explain your reasoning.



Now test your prediction. Open the Iris to its maximum size and attach (with tape) an aluminum square with a “L” shaped aperture to the back of the black mask. Record a picture using the webcam.

V. Fill in the blank questions

1. Using a circular aperture, the region of illumination from a single point source on the screen is __________________ shaped.

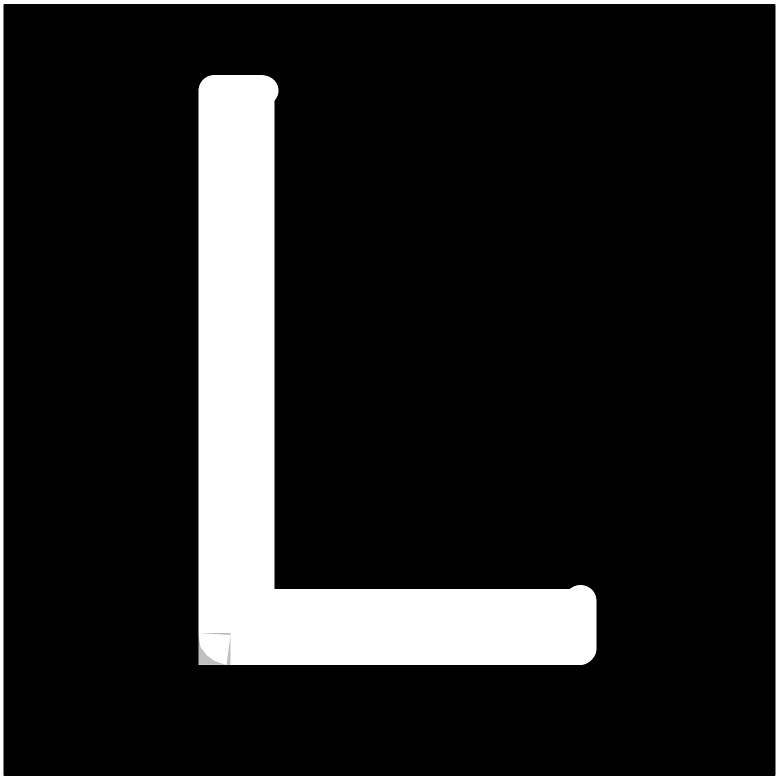
2. An extended source is a collection of __________________.

3. With a circular aperture and an extended source (shaped like a line), the region of illumination is ___________________ shaped.

4. To make the region of illumination on the screen the most accurate, scaled representation of the extended source's shape, the aperture should be ______________ shaped.

5. To make the region of illumination on the screen the most accurate, scaled representation of the extended source's shape, the aperture should have a ______________ size.

A baffle has a “L” shaped hole as shown below. Predict the shape one would see on the screen if one used a vertical line extended source.



SHOW YOUR PREDICTION TO YOUR INSTRUCTOR!

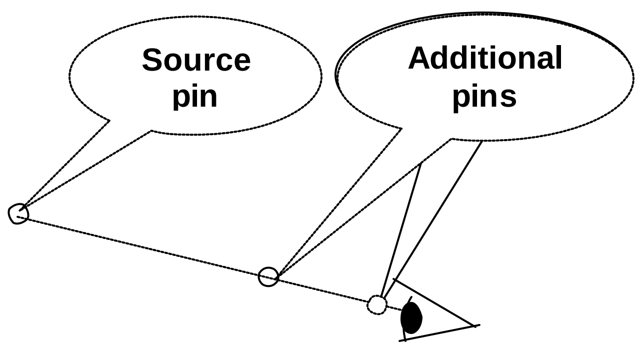
Set up and perform the above experiment. Resolve any differences between your prediction and the experiment.

Physics 345 Lab 2 Refraction

I. The method of parallax

Place a piece of paper on the wooden cutting board. Then insert a pin (**source pin**) into the board through the paper. Attach a colored piece of tape to the pin to distinguish it from other pins. How many lines (in the plane of the cutting board) are needed to exactly locate the pin's position on the board? Explain you reasoning.

Using your eye, line up two additional pins with your **source pin** so that they are all in a line (see below). This defines a single line that will pass through the **source pin**.



Using the same sighting method as above, define more lines passing through the **source pin** (each new line defined by a set of two additional pins). Move your eye to a slightly different location and add pin sets until you can determine the **source pin's** location based on your lines **defined by each additional pin set**. (It is easiest [I think so anyhow] to leave the pins in place and place a straight edge along each set of **additional pins**. Do not place the straight edge on the source pin since that would defeat the purpose) Be certain to circle and label the pin marks on the paper for easy interpretation. It would be advisable to put the section number (this is section I) on each page. How many lines did you need? Resolve any differences with your prediction.

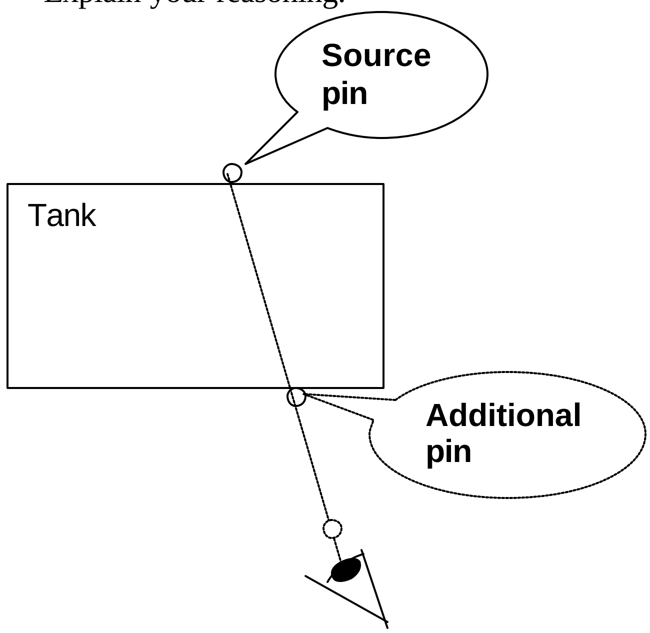
When looking and locating the **source pin,** what is the eye sensing? Why does the method of parallax work for locating the **source pin**?

DISCUSS YOUR RESULTS WITH YOUR INSTRUCTOR BEFORE PROCEEDING.

II. Empty rectangular water tank

You are going to place a rectangular tank between the **source pin** and your eye. The tank is made of acrylic (methyl methacrylate) with walls approximately 5mm thick. The **source pin** is going to be placed directly against the side of the tank.

<u>Prediction</u>: Will you be able to determine the **source pin's** exact location using the same method as in part I when the two additional pins are on the <u>opposite</u> side of the tank? Explain your reasoning.



Remove all pins from the cutting board and save AND label your paper from the previous exercise. Place a fresh sheet of paper on the wooden cutting board. Perform the measurements by adding sets of pins to define two optical ray paths. Using the two optical ray paths, where is the **source pin** located (you might need to remove the fish tank to do this)? Does this agree with your prediction? Resolve any discrepancies between your prediction and observations.

III. Rectangular tank with water

Suppose you were to fill the tank **half** full of water (at least as deep as the pin is long). What impact will the addition of water to the tank have on the location you determine for the **source pin** based on the method of parallax? Explain your answer.

Remove all pins from the cutting board and save your paper from the previous exercise. Place a fresh sheet of paper on the wooden cutting board. Then insert the target pin into the board through the paper. Place the fish tank <u>now ½ filled with water</u> just to the side of the **source pin** as before. Did your observations agree with your prediction? Resolve any differences.

In sections II and III, were the optical ray paths from the **source pin** to your eye straight? Explain.

On your diagram for section III, draw the approximate optical ray path (a different color or dashed lines would be wise) light followed from the **source pin** to your eye.

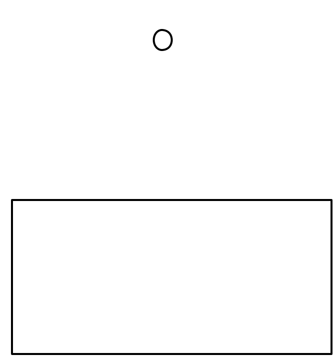
What did light do when it exited the water?

Is it possible to determine a composite index of refraction of the water tank based on your measurements? If so, please determine it including your uncertainty in the measurements. If not, please explain why it is not possible.

IV. Rectangular water tank with source pin not in contact with tank.

Suppose you were to place the **source pin** approximately 10 cm from the surface of the tank filled with water. As you looked through the tank, where would the **source pin** appear to be located? Explain your answer as accurately as possible (this includes predicting where the image will occur). Be certain to take into account the information from previous sections.

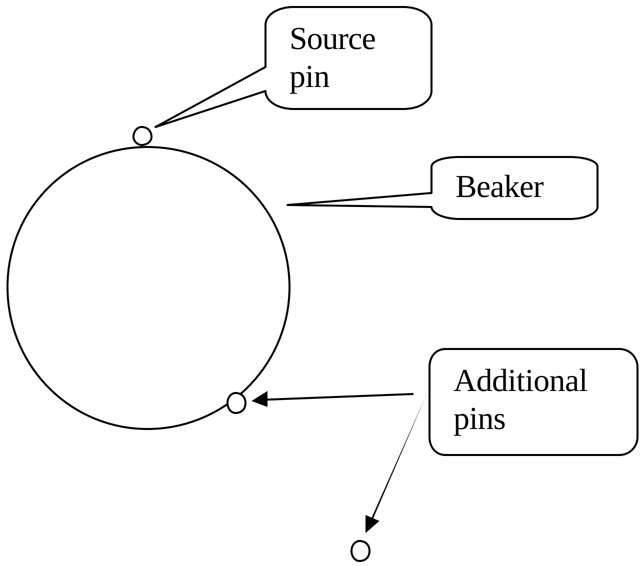
Sketch a estimated path of two light rays leaving the **source pin** and passing through the tank. Explain why you chose the paths you did.



Remove all pins from the cutting board and save your paper from the previous exercise. Place a fresh sheet of paper on the wooden cutting board. Then insert the **source pin** into the board through the paper. Place the tank now ½ filled with water 10 cm from the **source pin** and perform determine the apparent location of the **source pin** by adding additional pins on the side of the tank opposite the **source pin**. Additionally, you should determine the optical ray path from the source to the tank that corresponds with the exiting rays. Did your observations agree with your prediction? Resolve any differences.

V. 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 *(I want it to be a virtual image but have the rays close to parallel)* 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?

VI. Curved surface refraction using 0.5-liter beaker

How would your results of the previous section change is you use a beaker with a smaller radius? Explain.

Perform 3 measurements with the **source pin** in contact with beaker, the source pin 7 cm from the beaker surface and the source pin 15 cm from the beaker center. Compare your results with your prediction and resolve any differences.

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 _____________________.

Final Tasks

If we have a given beaker shaped like that shown below, with light rays drawn as shown for a particular situation, where would the source be located if the image were …

Compare to one with a tighter radius of curvature with one with a larger curvature

Compare to one with concave curvature.