Pre-Lab 3

1) Two source pins are located behind a rectangular tank filled with water (see figure below). Accurately draw (using rays) where the image of both pins will be located. Assume the index of refraction of water is 1.3.

Source Pins

2) The two source pins are now replaced by a large arrow (see figure below). Accurately draw (using rays) where the image of the arrow will be located. Assume the index of refraction of water is 1.3.

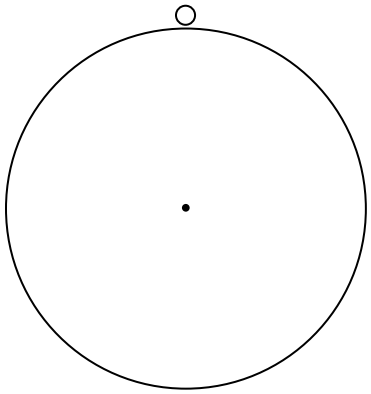
Source

Investigation 3

I. Curved surface refraction using 1-liter beaker

A.

Suppose you were to place the **source pin** in contact with the surface of a beaker filled with water. Sketch two different light rays leaving the **source pin** and passing through the beaker. Explain why you chose the paths you did. Be certain to take into account the information from previous sections.



Predict where the method of triangulation (as seen by an observer on the opposite side of the beaker from the **source pin**) would locate the **source pin**?

If you look through the beaker, **predict** where the **source pin** will appear to be located? Explain your answer as accurately as possible (this includes predicting where you would see the image of the **source pin**).

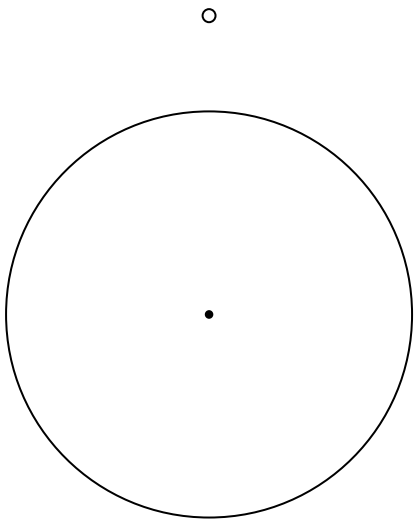
Place a fresh sheet of paper on the wooden cutting board. Then insert the **source pin** into the board through the paper. Place a beaker, ½ filled with water, next to the **source pin** and determine the image location through triangulation. Did your observations agree with your prediction? Resolve any discrepancies.

Determine the paths of the entering and exiting optical rays to determine the image of the **source pin**. How do your results help your explain the previous observations?

Do the all the light rays from the **source pin** actually pass through the image location?

B.

Suppose you were to move the **source pin** 2.5 cm further from the beaker. Sketch two different light rays leaving the **source pin** and passing through the beaker. Explain why you chose the paths you did. Be certain to take into account the information from previous sections.



Predict where the method of triangulation (as seen by an observer on the opposite side of the beaker from the **source pin**) would locate the **source pin**?

If you look through the beaker, **predict** where the **source pin** will appear to be located? Explain your answer as accurately as possible (this includes predicting where you would see the image of the **source pin**).

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 a beaker ½ filled with water 2.5 cm from the **source pin** and determine the image location through triangulation. Did your observations agree with your prediction? Resolve any discrepancies.

Determine the paths of the entering and exiting optical rays to determine the location of the image. How do your results help your explain the previous observations?

Do the all the light rays actually pass through the image location?

C.

Place the source pin 5cm 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 image of the **source pin**. Did the exiting optical ray paths behave as you expected?

D.

Place the **source pin** approximately 15 cm from center of beaker. With your eye within 10 cm of the beaker, can you see the **source pin**? Try moving farther from the beaker (at least a meter away). Can you see the **source pin** now?

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

Do the all the light rays actually pass through the image location?

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?

E.

Suppose there are two different source pins, separated by 1cm, 2.5 cm from the water-filled beaker. Predict where the image from each pin will form. Draw a sketch clearly indicating which image corresponds with which source.

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 two **source pins (**with tape on one to distinguish it from the other) into the board through the paper. Place a beaker ½ filled with water 2.5 cm from the **source pins** and determine the image location through triangulation for each pin. Did your observations agree with your prediction? Resolve any discrepancies.

Suppose there are two different source pins, separated by 1cm, 15 cm from the water-filled beaker. Predict where the image from each pin will form. Draw a sketch clearly indicating which image corresponds with which source.

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 two **source pins (**with tape on one to distinguish it from the other) into the board through the paper. Place a beaker ½ filled with water 15 cm from the **source pins** and determine the image location through triangulation for each pin. Did your observations agree with your prediction? Resolve any discrepancies.

Suppose we replace the two **source pins** (still 15cm from the beaker) with an arrow drawn on a piece of paper. The arrow is 1cm long. Predict how the arrow will appear when viewed from the opposite side of the beaker.

Draw a 1.0cm arrow on an index card. The length of the arrow should equal the separation distance between the two pins that were 15cm from the beaker. Looking through the opposite side of the beaker, observe the arrow. Resolve any discrepancies with your prediction

II. Questions for consideration using your collected data.

Consider the two definitions for a real and virtual image:

- *For a real image, all of the rays forming the image will pass through the image location.*
- *For a virtual image, most rays will not actually pass through the image location.*

Fill out the table indicating with an X which images were real images and which images were virtual images. If both real and virtual images are simultaneously present check both boxes.

Image	**Real Image**	**Virtual Image**	**Neither**
Single pin next to the beaker			
Single pin 2.5cm from the beaker			
Single pin 5.0cm from the beaker			
Single pin 15cm from the beaker			
Two pins 2.5cm from the beaker			
Two pins 15cm from the beaker			
Arrow 15cm from the beaker			

III. Task

Imagine that you have a water filled 0.4-liter beaker. How would the image location and the type of image change from your three previous measurements when the **source pin** was located 5.0 cm from the beaker surface. Explain your reasoning.

SHOW YOUR INSTRUCTOR YOUR PREDICTIONS

Compare your results with your prediction and resolve any differences.

Extra question for pre-lab 3

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.