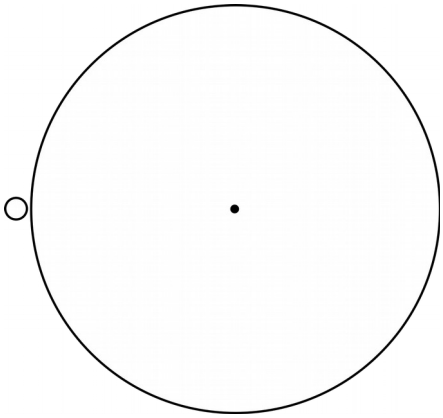
INVESTIGATIONS[1]

I. CURVED SURFACE REFRACTION

Use a 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 labs. (Note: these drawings are approximately ½ scale.)



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).

1 © T.T. Grove and M.F. Masters, IPFW.edu, 2007, 2008

Place a fresh sheet of paper on the wooden cutting board. Then insert the **source pin** into the board through the paper. Place a 1 liter beaker, filled to the height of the source pin of water, next to the **source pin** and determine the image location through triangulation.

Hint: Stand back at least a meter when looking through the beaker.

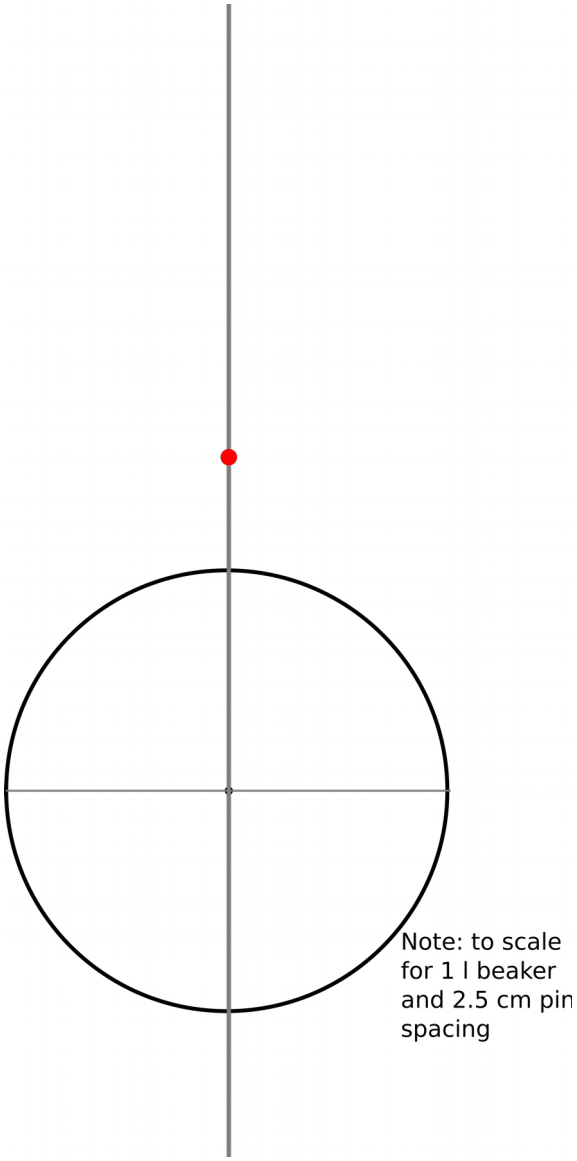
After you have finished the triangulation, put the beaker back and confirm your location by having a partner hold an object above the water and moving it until it stays above the image of the pin when you move your head. Did your observations agree with your prediction? Resolve any discrepancies.

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 you see from the **source pin** actually pass through the **image** location?

B. Suppose you were to move the source pin 2.5 cm back 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. ***Note***: There is a scaled version of this situation on the next page.

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 filled to the height of the source pin 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 you see from the source actually pass through the **image** location?

C. Place the source pin approximately 15 cm from *back* 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?

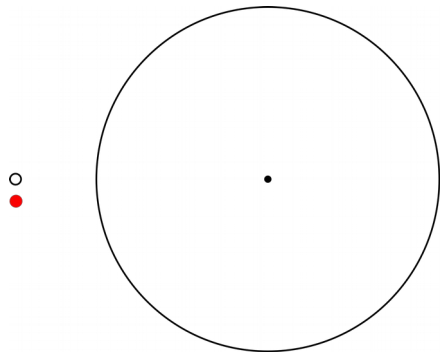
Looking through the beaker at the pin from about 1 m away, determine the paths of the entering and exiting optical rays to determine the location of the image of the **source pin**. Does this help explain the previous observations?

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

D. Consider your observations with the pin against the beaker and at distances of 2.5 and 15 cm. 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, 1cm apart, 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.



Place a fresh sheet of paper on the cork board. Then insert two source pins (use two different colors of pins) 1 cm apart into the board through the paper. Place a beaker filled to the height of the pin 2.5 cm inf front of the source pins and determine the image locations 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.

Place a fresh sheet of paper on the wooden cutting board. Then insert two different **source pins** into the board through the paper 1 cm apart. Place a beaker 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. Look at the location of each pin. Is anything different than you predicted?

Suppose we replace the two source pins (still 15 cm 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 through the beaker.

Take an index card with a 1.0 cm and place it 15cm from the beaker. Looking through the opposite side of the beaker and observe the arrow. Resolve any discrepancies with your prediction.

QUESTIONS FOR CONSIDERATION USING YOUR COLLECTED DATA.

Consider the definitions for real and virtual images:

- *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			

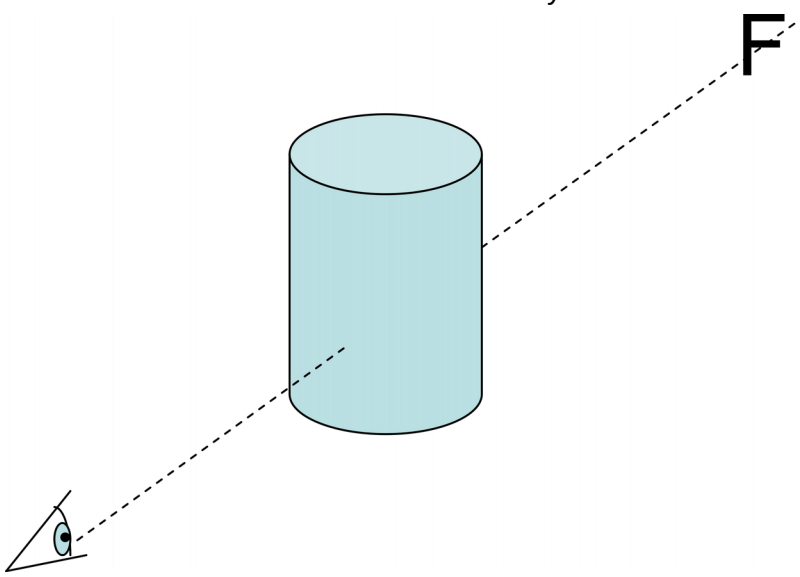
TASKS

A. The 1 liter beakers are 10.8 cm in diameter, and the 0.4 liter (400 ml) beakers are 7.7 cm in diameter. Imagine that you have a water-filled 0.4-liter beaker. How would the image locations and the type of images change from your previous measurements with the 1 liter beaker and the pin a) against the beaker, 2.5 cm behind the beaker and 15 cm behind the beaker. Explain your reasoning.

SHOW YOUR INSTRUCTOR YOUR PREDICTIONS BEFORE PROCEEDING

Set up the 0.4 liter beaker and source pin at different distances, then compare your results with your prediction and resolve any differences.

B. The figure below shows a beaker glass filled with water and a large letter **F** on a card on one side of the beaker. You look at the **F** through the water in the beaker. Describe carefully what you will see as the **F** starts near the beaker and is then moved far away.



SHOW YOUR INSTRUCTOR YOUR PREDICTIONS

Do the experiment & compare your results with your prediction and resolve any differences in the space below.

C. Make a prediction for the semi-circular flat lens for a source pin 1 cm behind the flat edge of the lens. The diameter of the lens is 7.5 cm, and the index of refraction is 1.5. You may use the figure on the next page; it is to scale.

Set up the lens and locate the image using triangulation. How did your prediction and location compare?