Appearances Can Be Deceiving

(Adapted from S.E.A. Lab by S. Uyeda, LAUSD)

Purpose:

To investigate the affects of different environments (air, fresh water and salt water) on a path of light.

Background:

First, here is a story. Sealth, the Northwest Indian boy, was told to spear some fish for the evening meal. So Sealth went down to the tide pools and looked for some tasty rockfish. Finally, he saw a large fish in the water. Slowly, he crept up to the edge of the tide pool and threw his spear. He missed !. The fish settled into another part of the pool, and Sealth tried again to spear the fish. Confused at having missed again, he sat down near the tide pool to figure out what happened. Sealth had thrown his spear directly at the fish , but missed both times. Where does Sealth need to aim his spear to catch the evening meal ? (NOTE: Sealth is another name for a famous leader of the Duwamish League of the Pacific Northwest, Chief Seattle.)

Materials:

A cereal bowl
masking tape
fresh water
a protractor
3 meter sticks
1 graduated cylinder, 50 ml
3.5 % salt water made with kosher salt
a coin

Procedure:

1. In this lab, you will be measuring heights. Find some empty wall space and tape a meter stick to the wall so it is perpendicular to the floor. Tape the second meter stick above the first meter stick so you can measure 2 meters in height from the floor.

2. Choose a person from the group who is less than 2 meters in height. Have this person stand next to the meter sticks. Measure the height of the person's eyes and record the measurement in the data table.

3. Using the third meter stick, measure a distance of 80 cm from the base of the meter sticks taped to the wall out into the room. Mark this distance with a piece of tape.

4. Now stand facing the wall in front of the meter sticks. Make sure that your eyes are directly above the tape mark on the floor. Put the coin in the center of the bowl. Hold the bowl in one hand and stretch out your arm towards the meter sticks. Move your hand and arm up so the rim of the bowl is the same height as

your eyes. Keeping your arm straight, lower your hand until you can just see the entire coin over the edge of the bowl. Measure the height of the upper edge of the bowl and record.

4. Add 100 mls of fresh water to the bowl and repeat step three. Make sure that the coin is in the center of the bowl. Record the bowl rim height for fresh water in the data table.

5. Remove the fresh water and add 100 mls of salt water to the bowl and repeat step three. Make sure that all the salt is dissolved in the water and the coin is in the center of the bowl. Record the bowl rim height for salt water height in the data table.

6. Now look at the Analysis sheets to continue the lab.

Conclusions

The purpose of these questions is to help guide your thinking in discovering the idea of the lab behind what actually happened in the lab.

1. Do you think the angle from the edge of the bowl to the center of the coin ever changed as different environments were tested ? Why or why not ?

2. Did the angle from the eyes to the edge of the bowl ever changed as different environments were tested ? Why or why not (use data to support your answer) ?

3. Compare the angles from eye to bowl with the angle from the center of the penny to the edge of the bowl. In which environment does the angle from eye to bowl closely match the angle from bowl edge to penny center ?

4. What must fresh water and salt water do to the light path in order for you to see the penny at different angles ?

Let's test this idea. Without putting water in the bowl, hold the bowl and penny at the same height as the fresh water height. Can you see the entire penny ? Now hold the bowl at the salt water height. Can you see the entire penny ? Do these results change the answer to number 4 ?

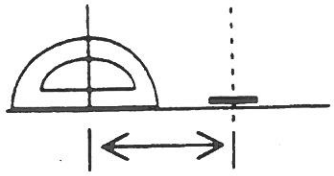
5. According to your data, what is happening to the light path as it enters the water ? This is called _____ (fill in the blank). Which environment has the greatest affect, air, fresh water or salt water ? WHY ?

6. Now, complete the story from the introduction. Include how Sealth discovers his error and how he corrects for his mistake. Don't forget to include a happy ending !

ADDITIONAL CREDIT: An archer fish shoots down insects from underwater. Where must the archer fish aim to hit the insect, above or below the image it sees ? JUSTIFY your answer !

TB - overhead 1

1. Measure from the edge of the bowl to the center of the coin.



2. Measure this distance on the diagram and, using a protractor, draw a perpendicular line.

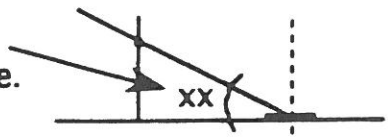
3. Measure the height of the bowl.

4. Place this measurement on the perpendicular line.

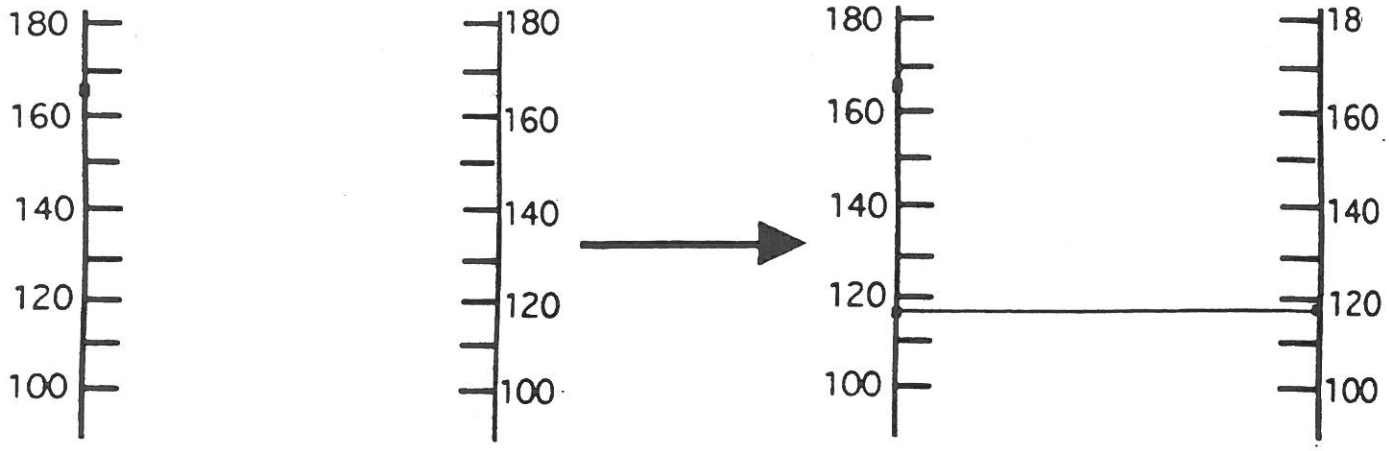
5. Draw a line from the center of the coin to the height of the bowl edge.

6. Using the protractor, measure the angle you drew.

Write the angle measurement here.

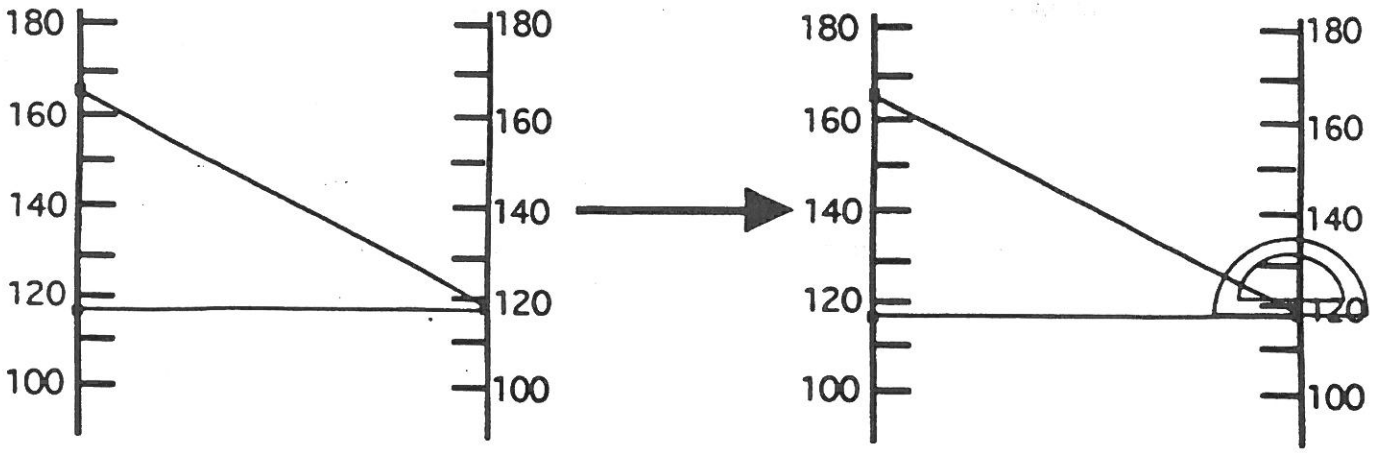


7. Record angle on the diagram as shown above.



1. Place a dot on Scale 1 at the eye height.

2. Make a dot at the bowl height on both Scale 1 & 2 and draw a straight line connecting these dots.



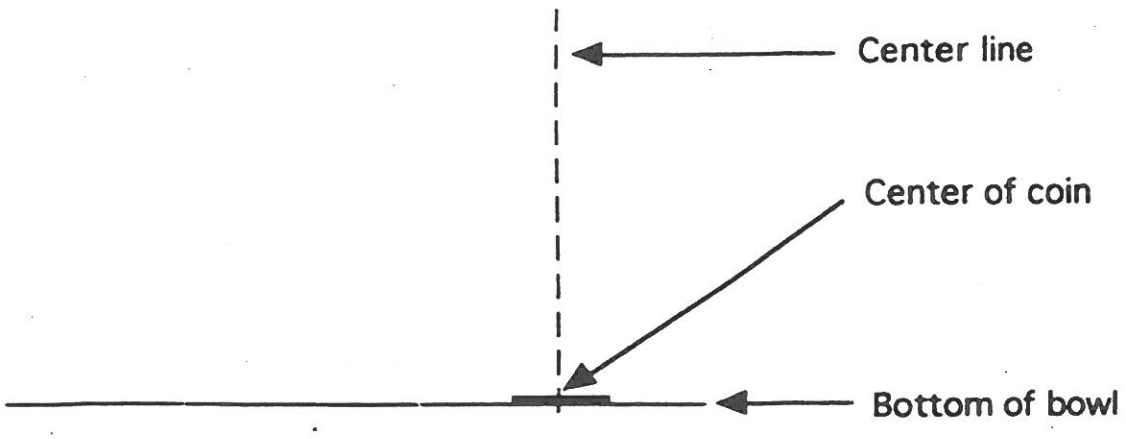
3. Draw a line from the eye height dot on Scale 1 to the bowl height dot on Scale 2.

4. Measure the angle and record the measurement you just drew on the diagram. Be sure to label the angle with the environment (air, fresh water or salt water).

Laboratory Analysis

Data Table	Eyes	Air	Fresh Water	Salt Water
Height (cm)				

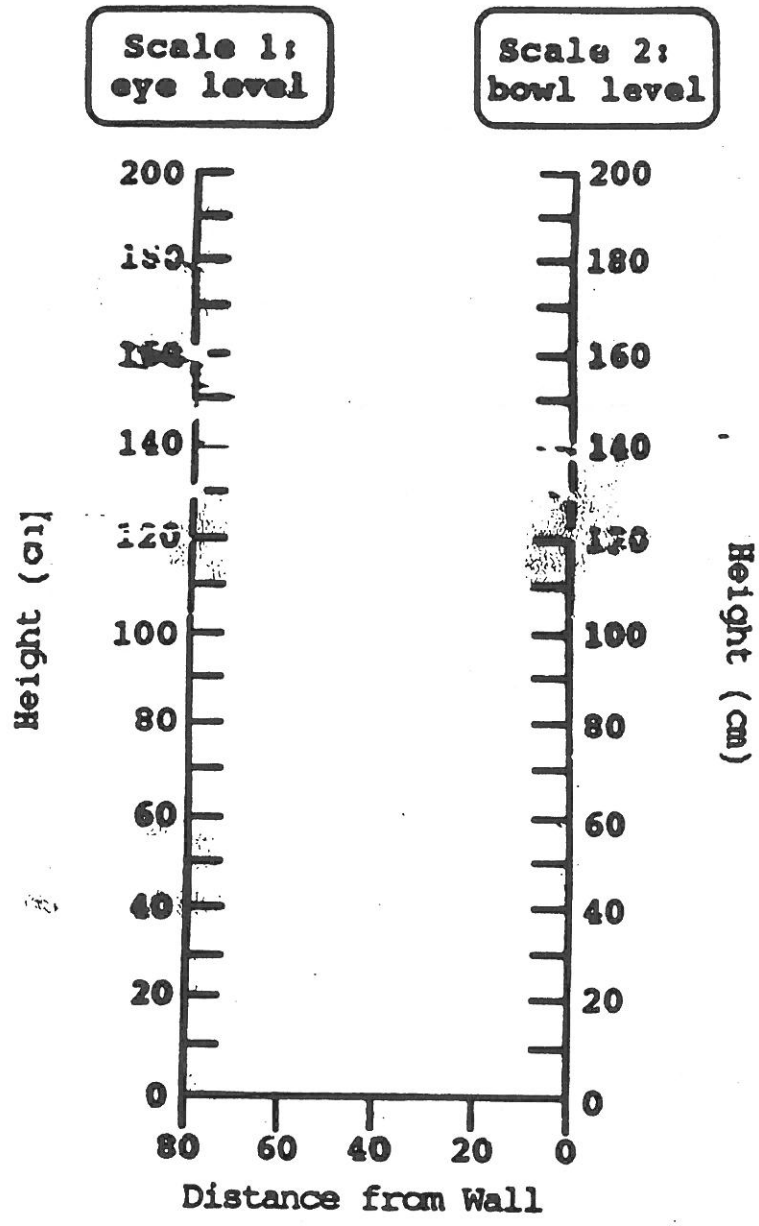
Diagram 1: Using the diagram and instructions below, determine the angle from the center of the penny to the edge of the bowl.



1. Measure the distance from the middle of the coin to the edge of the bowl in centimeters. Measure the same distance on the line labelled "bottom of bowl" in the diagram above and make a mark on the line. Using the protractor, make a perpendicular line centered on the mark you made. "Perpendicular" means at a 90 degree angle.

2. Measure the height of the bowl in centimeters. Measure the same distance on the perpendicular line in the diagram above and make a mark on that line.

3. Now draw a line from the center of the coin to the edge of the bowl and measure the angle with the protractor. Record this angle on the diagram.



Scale: 0.5 inches = 20 cm

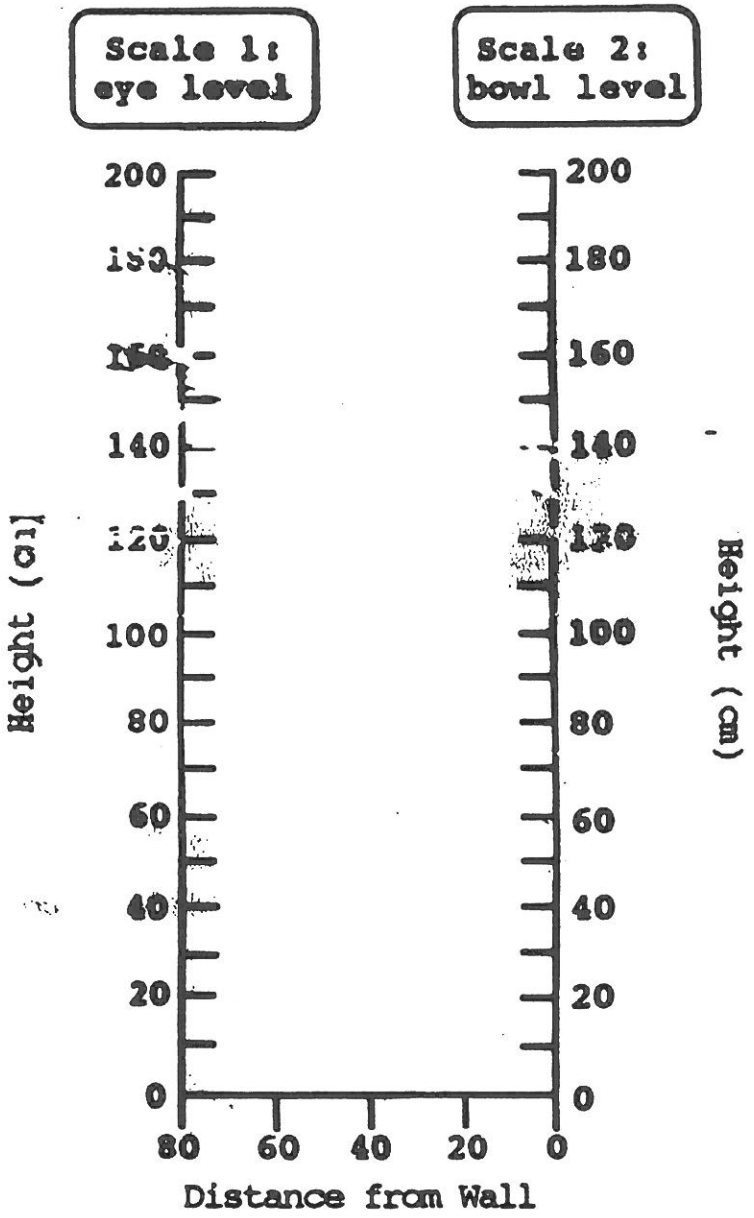
In this diagram, we will be looking at the change in the light path angle as the environment changes. We will be drawing and measuring the angle the light path follows.

1. From the data table, place a dot on Scale 1 at the height of the person's eyes .

2. From the data table, place a dot on both Scale 1 and Scale 2 at the height of the bowl when the environment was "Air". Draw a straight line from the dot that represents "bowl height" from Scale 1 to the dot on Scale 2. Extend the line beyond Scale 1 to make it easier to measure the angle of the line with a protractor.

3. Draw a straight line from the "eye height" dot on Scale 1 to the "bowl height" dot on Scale 2. Again, extend the line beyond Scale 1. There should now be two lines coming from Scale 1 to the same dot on Scale 2. Measure the angle these two lines make and write on the diagram above.

4. Repeat instructions 1 - 3 for the fresh water and salt water environments. Record all angles on the diagram above and be sure to label each angle with its environment.



Scale: 0.5 inches = 20 cm

In this diagram, we will be looking at the change in the light path angle as the environment changes. We will be drawing and measuring the angle the light path follows.

1. From the data table, place a dot on Scale 1 at the height of the person's eyes .

2. From the data table, place a dot on both Scale 1 and Scale 2 at the height of the bowl rim when the environment was "Air". Draw a straight line from the dot that represents "bowl height" from Scale 1 to the dot on Scale 2. Extend the line beyond Scale 1 to make it easier to measure the angle of the line with a protractor.

3. Draw a straight line from the "eye height" dot on Scale 1 to the "bowl height" dot on Scale 2. Again, extend the line beyond Scale 1. There should now be two lines coming from Scale 1 to the same dot on Scale 2. Measure the angle these two lines make and write on the diagram above.

4. Repeat instructions 1 - 3 for the fresh water and salt water environments. Record all angles on the diagram above and be sure to label each angle with its environment.