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INQUIRY LAB – GUIDED

Reflection and Refraction

How can you model the behavior of light waves, and describe what they do when they bounce off of objects or pass from one medium into another?

Visible light is a form of energy that is given off by natural or human-made objects such as the sun or a lightbulb. Other objects may reflect light, making them visible. Light waves change direction as they are reflected by other objects, and may also change speed and direction as they pass from one transparent medium into another. Explore the principles of reflection and refraction as these properties of visible light are investigated.

Focus on Science Practices

SEP 2 Develop and Use Models
SEP 7 Engage in Argument from Evidence
SEP 8 Obtain, Evaluate and Communicate Information

Materials Per Group

- Cork
- Mirror, plane
- Mirror, support
- Protractor sheet
- Pin
- Semicircular lens, 1
- Water, 100 mL

Safety 

Optics materials are considered safe. Do not look through lenses at bright light objects especially the sun, as it can be harmful to the eyes. Follow all laboratory safety guidelines.

Procedure

Part I: Reflection

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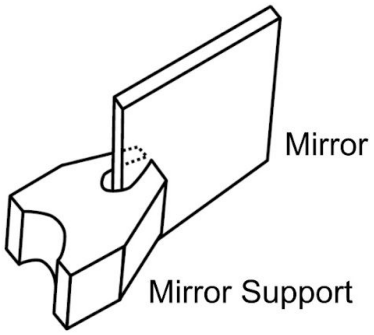
What is the relationship between the angle of incidence and the angle of reflection?

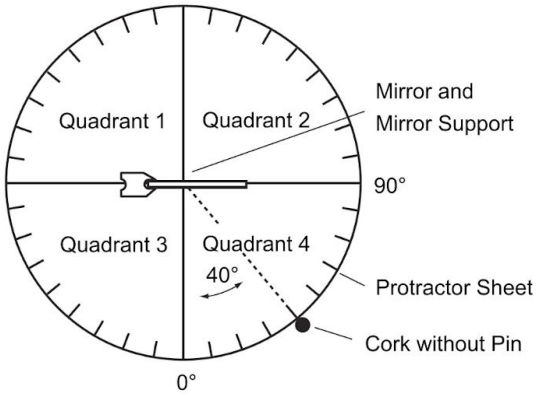
1. Insert the pin into the narrow end of one cork and set aside for step 7.
2. Place the mirror in the mirror support as shown in Figure 1. Note: Make sure the bottom of the mirror support is flat against the work surface so the mirror stands upright without leaning forward or back.

Figure 1



3. Place the mirror in the center of the protractor sheet as shown in Figure 2. The mirror should be on the horizontal line (90°) on the protractor sheet.

Figure 2



4. Place the cork without the pin at the 40° mark in Quadrant 4 on the protractor sheet as seen in Figure 2.
5. Close one eye and look at the reflection of the cork in the mirror from Quadrant 3.
6. Adjust your line of sight so the image of the cork is in line with the center of the protractor. Identify your line of site by noting the angle on the protractor

corresponding to your eye position. Record the angle and Quadrant number in your data table.

7. Place the cork with the pin in it behind the mirror—either in Quadrant 1 or 2—at the location where the image of the first cork appears to be. Use the pin as a guide to more accurately position this cork behind the mirror.

8. Look at the angle on the protractor where the cork and pin were placed behind the mirror. Record the angle and Quadrant number in the data table for the cork and pin position. Observe and record the size of the cork with the pin compared to the virtual image. Also note the distance the cork was placed behind the mirror compared to the distance from the first cork to the mirror.

9. Repeat steps 4–8, choosing a different cork position in Quadrant 4. Record the new angle for this position in the data table.

10. Repeat steps 4–8, placing the cork in a different position in Quadrant 3. In what Quadrant will your line of sight be?

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Table 1

Reflection						
Cork Position		**Eye Position**		**Position of Cork with Pin**		**Observations**
Quadrant	**Angle**	**Quadrant**	**Angle**	**Quadrant**	**Angle**	
4	40°					
4						
3						

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Part II: Refraction

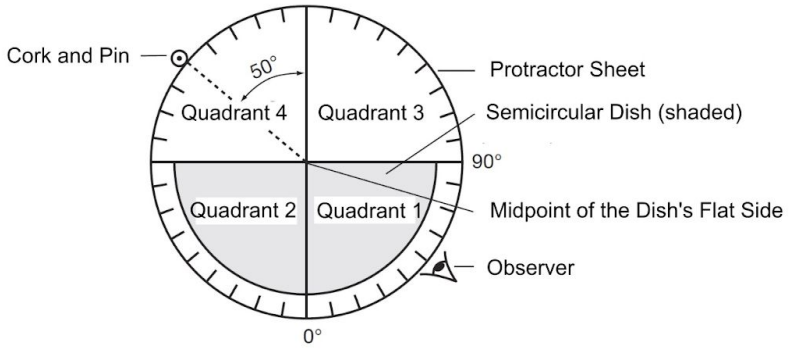
What happens to the direction of light as it moves from one medium into another, does it change?

11. Fill the semicircular dish ¾ -full with water.

12. Place the protractor sheet on the work surface so Quadrants 1 and 2 are toward the observer.

13. Carefully place the dish on the protractor sheet so the flat side faces Quadrants 3 and 4, the midpoint line on the dish is centered at the intersection of the quadrants, and the curved section is in Quadrants 1 and 2 as seen in Figure 3.

Figure 3



14. Insert the pin into the narrow end of the cork.

15. Place the cork at the 50° mark in Quadrant 4 on the protractor sheet.

16. Close or cover one eye and look through the water-filled dish from Quadrant 1 so your line of sight is from the 50° mark to the center vertical line on the dish. Note: For best results, keep your eye level at the same height as the tabletop.

17. Are you able to see an image of the cork and pin in the water? Record your observations for 50° in the data table.

18. Keeping one eye closed, move your head and line of sight along the curved part of the dish until the cork-and-pin image appears in the water. Which way did your line of sight move with respect to the normal line (0°)? Add to your observations for 50° in the data table.

19. Continue to move your head and line of sight along the curved part of the dish until the cork-and-pin image in the water lines up with the vertical line on the flat side of the dish.

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20. With the image of the pin and vertical line aligned, take the toothpick and place it vertically along the outside of the curved part of the dish so it is aligned with the vertical line and the image of the pin. This will mark your line of sight.

21. Note the angle on the protractor where the toothpick is placed and record the angle and Quadrant number in the data table.

22. Repeat steps 15–21 two more times, placing the cork and pin in Quadrant 4 at 30° and 70°, respectively.

23. Carefully rotate the dish and protractor sheet together so the flat side of the dish is toward the observer.

24. Repeat steps 15–21 three times, placing the cork and pin next to the curved side of the dish in Quadrant 1 at 45°, 30°, and 10°, respectively. The observer should look through the flat side of the dish, starting from the corresponding angles in Quadrant 4 as shown in Figure 4. The toothpick should be placed along the circumference of Quadrant 4 to mark the line of sight. Record observations in the "Water to Air" portion of the data table.

Figure 4

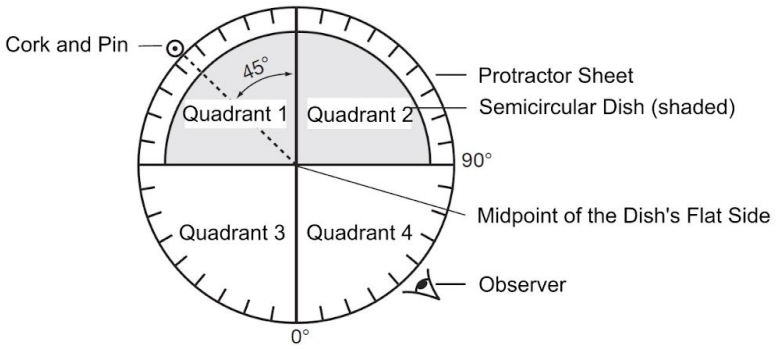

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Table 2

Part II. Refraction					
Light Transmission	**Observations**	**Pin Quadrant**	**Pin Angle**	**Toothpick Quadrant**	**Toothpick Angle**
Air to Water		4	50°		
Air to Water		4	30°		

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Air to Water		4	70°		
Water to Air		1	45°		
Water to Air		1	30°		

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Water to Air		1	10°		

Analyze and Interpret Data

1. **SEP Communicate Scientific Information** The relationship between the angle of incidence and the angle of reflection is known as the law of reflection. Based on your observations, write the law of reflection.

2. **SEP Evaluate Evidence** Five students are seated at their desks, which are spaced equally apart, in the front row of a classroom (see diagram). The instructor places a large plane mirror on the board directly in front of the middle student. When student 1 looks at the center of the mirror, which student's image will be seen? Use observations from the lab to support your explanation.

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3. **SEP Evaluate Evidence** The archer fish captures its prey by knocking insects off a branch with a stream of water from its mouth. To compensate for the refraction of light as it is transmitted from air into water, would the fish aim above or below the image of the insect it sees? Use observations from the lab to support your explanation.