Date ______________ Period ______________ Name ______________________

CHAPTER 14

Physics Lab 14-1

Safety Precautions

Materials

- dowel
- eyedropper
- glass plate
- large sheet of plain white paper
- level tool
- light source
- parabolic ripple-tank barrier
- protractor
- ripple tank
- straight ripple-tank barrier
- washers

What do wave reflection and refraction look like?

Reflection occurs when a wave bounces off a barrier. The law of reflection states that the angle of incidence of a wave relative to a barrier is equal to the angle of reflection of the wave relative to the barrier. In other words, this bouncing effect causes the wave to change direction, but it does not cause the wave to change speed. When waves pass through a boundary from one medium into another, the waves undergo a change in speed, because wave speed is a property of the medium. This change in speed causes the wave to also change direction. This phenomenon is called *refraction*.

In this lab, you will investigate the wave phenomena that involve a changing of the direction of travel of waves, known as reflection and refraction. To do this, you will use a ripple tank. A ripple tank is an ideal medium for observing the behavior of waves. It projects images of waves in the water onto a paper screen below the tank. Light shining through water waves is seen as a pattern of bright lines and dark lines separated by gray areas. You will use these shadows of waves to observe reflection and refraction.

Objectives

- **Observe** wave reflection and wave refraction in a ripple tank.
- **Analyze** wave patterns in water.
- **Predict** the behavior of surface waves in water.

Procedure

A. Setup

1. Set up the ripple tank as shown in **Figure A.** Before adding water, place a level tool in the bottom of the tank and check the level. Check the level in the direction of the width of the tank and in the direction of the length of the tank. Adjust the level of the tank as necessary so that it is level in both directions. Add water to a depth of 5–8 mm.
2. Turn on the light source. While creating small waves with a pencil, adjust the light source so that clear images of waves appear on the picture screen made of paper.

B. Reflection

1. Place the dowel in the water against one side of the ripple tank. Test the use of the dowel by rolling it back and forth gently to generate plane wave pulses.

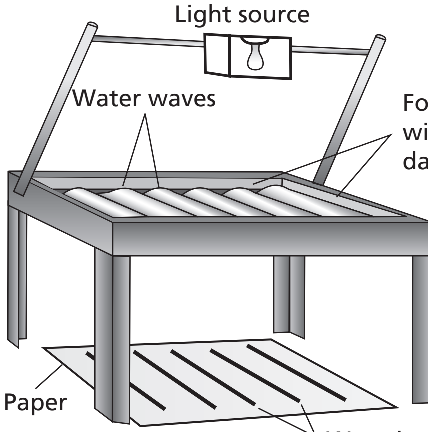

Figure A

2. Place a straight barrier at the opposite end of the tank such that it is parallel with the edge of the tank. Using the dowel, send plane wave pulses toward the straight barrier so that they strike the barrier head-on (angle of incidence = 0°). Using the paper screen, observe what happens to the pulses as they strike the barrier. Record a description of your observations in the item 1 space of **Table 1.**
3. Shift the position of the straight barrier such that it is at an angle relative to the end of the tank. Using the dowel, send plane-wave pulses toward the straight barrier. Using the paper screen, observe what happens to the pulses as they strike the barrier. Record a description of your observations in the item 1 space of Table 1. Sketch a picture of your observations in the item 2 space of Table 1. Remember that the behavior of pulses is the same as the behavior of waves.
4. Use your protractor to measure the angle of incidence and the angle of reflection of the waves. The angle of incidence, θ_i, is the acute angle between the line along the incoming plane wave front and the line along the straight barrier, so it is always less than or equal to 90°. The angle of reflection, θ_r, is the acute angle between the line along the reflected plane wave front and the line along the straight barrier, so it also is always less than or equal to 90°. Record these angle measurements in the item 3 space of Table 1.
5. Replace the straight barrier with a parabolic barrier, arranged such that the open side of the curve is toward the dowel. Using the dowel, send plane-wave pulses toward the parabolic barrier. Using the paper screen, observe what happens to the pulses as they strike the barrier. Record a description of your observations in the item 4 space of Table 1. Using the paper screen, locate the point where the reflected waves come together. Using a pencil, mark this point on the paper. This point is called the focus.
6. Stop making wave pulses with the dowel. Using an eyedropper, drip small drops of water on the focus point, or tap the water gently at this point with a pencil. Observe what happens to the waves that move from the point in a direction away from the parabolic barrier. Observe what happens to the waves that are reflected off the parabolic barrier. Record a description of your observations in the item 5 space of Table 1.
7. Remove the parabolic barrier from the ripple tank.

C. Refraction

1. Place a rectangular glass plate in the center of the tank and to one side, as shown in **Figure B1.** If necessary, support the plate with washers in order to produce an area of shallow water.
2. Using the dowel, generate plane-wave pulses in the tank. Carefully observe what happens to the waves at the glass plate boundary. In **Figure B1,** sketch the patterns you observe as waves move from the deep water of the tank into the shallow water above the glass plate.
3. Rotate the glass plate such that one corner is pointed toward the end of the tank with the dowel, as shown in **Figure B2.** Using the dowel, generate plane-wave pulses in the tank. In **Figure B2,** sketch the patterns you observe as the waves move from the deep water of the ripple tank into the shallow water above the glass plate.

Data and Observations

Table 1
1. Description of plane-wave pulses striking a straight barrier at 0° and at another angle
2. Sketch of incoming pulses and reflected pulses
3. θ_i = __________ θ_r = __________
4. Description of waves that are reflected from a parabolic barrier
5. Description of waves that are generated at the focus of a parabolic barrier

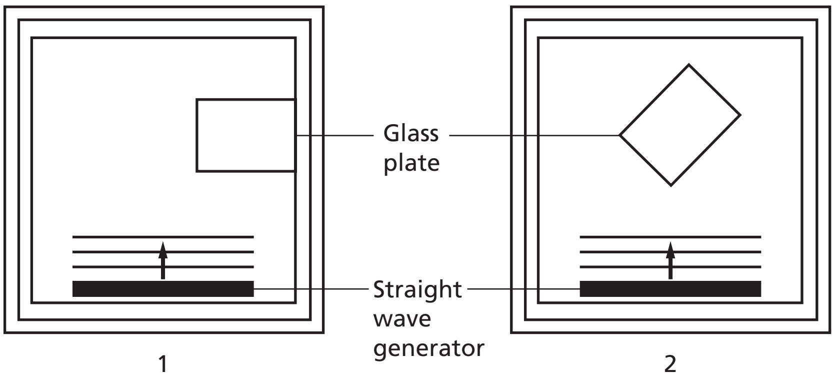

Figure B

Analysis and Conclusions

1. Recall your observations of reflecting waves in the ripple tank. Did the waves change speed or keep the same speed? Did the distance between waves (the wavelength) change?

2. Compare the angle of incidence and the angle of reflection that you recorded in Table 1.

3. Make an association between the law of reflection and your observations of the waves that reflected off the parabolic barrier. Does the law of reflection still apply in this case?

4. Compare and contrast your observations in item 4 of Table 1 with your observations in item 5 of Table 1.

5. Compare and contrast your observations of reflection with your observations of refraction.

6. Identify a cause-and-effect relationship of refraction. What caused the changes to the waves as they crossed into the shallow water?

Extension and Application

1. Relate the refraction model of the ripple tank to how an explorer could locate underwater reefs or sandbars.

2. Relate the reflection model of the ripple tank to sports like tennis, racquetball, and pool.