Date _____ Period _____ Name _____

CHAPTER 14

Physics Lab 14-2

Safety Precautions

Materials

- dowel
- large sheet of plain white paper
- level tool
- light source
- ripple tank
- two-point-source wave generator
- variable power supply for wave generator
- wood or paraffin blocks

What do wave diffraction and interference look like?

In this lab, you will explore phenomena associated with wave superposition. One such phenomenon is known as diffraction. A wave front is the result of the superposition of Huygens' wavelets all along the wave front. This type of superposition occurs with all waves and results in a traveling wave front that can maintain its size, like a plane wave, or spread and grow, like a circular wave. When a plane wave front passes by an edge, the edge cuts the wave front, causing the Huygens' wavelets where the wave front is cut to start propagating as circular waves. The result is a wave front that appears to bend around the edge, when, in actuality, the wave is spreading as a circular wave.

Interference is the phenomenon that occurs when two or more separately traveling waves pass through each other. When the peaks or troughs of waves are in the same place at the same time, they build on each other. This is called constructive interference. When a peak and a trough from two different waves are in the same place at the same time, they cancel each other such that the resulting wave has a smaller peak or trough than either of the original two waves. This is called destructive interference.

You will use a ripple tank to observe the phenomena of diffraction and interference. Rather than using barriers to reflect waves, you will use barriers to cut waves and observe the resulting diffraction. Then, you will use a two-point-source wave generator to observe the result of two waves interfering.

Objectives

- **Operate** a ripple tank to observe diffraction and interference wave phenomena.
- **Analyze** wave behavior associated with diffraction and interference.
- **Predict** the behavior of diffraction with two openings.

Procedure

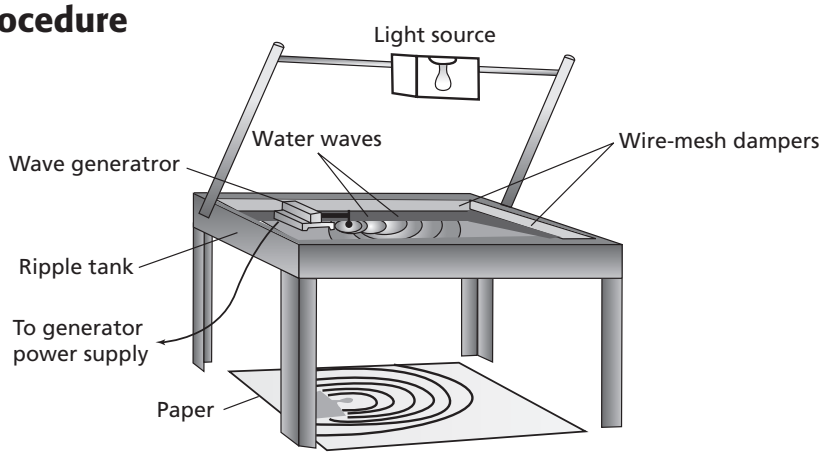

Figure A

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A. Setup

1. Set up the ripple tank as shown in **Figure A.** Do not install the wave generator until part C.
2. 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.
3. Add water to a depth of 5–8 mm.
4. Turn on the light source. While creating small waves with a pencil, adjust the light source and water depth so that clear images of waves appear on the picture screen made of paper.

B. Diffraction

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.
2. Arrange two wood or paraffin blocks, as shown in **Figure B.** Using the dowel, send plane-wave pulses toward the opening between the blocks. Observe the diffraction of the waves. Make a sketch of the diffraction of the waves for a wide opening in the item 1 space of **Table 1.**

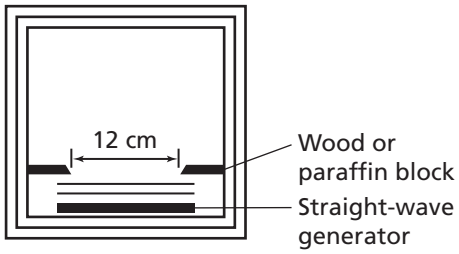

Figure B

3. While one lab team member continues to generate plane waves at a regular rate, have another lab team member slowly narrow the opening. Make a sketch of the diffraction of the waves for a narrow opening in the item 1 space of Table 1.
4. Increase the wave-generator frequency. Observe the resulting wave diffraction for the narrow opening. Make a sketch of the diffraction of the waves in the item 2 space of Table 1.
5. Remove the dowel and the blocks from the ripple tank.

C. Interference

1. Place the two-point-source wave generator in the tank near one end. Attach the variable power supply to the generator. Turn the power supply to a low voltage setting so that the point sources produce a continuous series of circular waves of long wavelength. The superposition of the waves from the two sources should produce an interference pattern in the tank. Nodal lines should be visible. They are lines of calm water. Antinodal regions will be between the nodal lines. They are regions of water with visible waves. Make a sketch of the interference pattern of the waves in the item 1 space of **Table 2.**
2. Increase the wave-generator frequency and observe the resulting interference pattern. Make a sketch of the interference pattern of the waves in the item 2 space of Table 2.

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Data and Observations

Table 1	
1 Sketches of Diffraction of Waves	
Wide Opening	**Narrow Opening**
2 Sketch of Diffraction of Waves with Higher Wave Generator Frequency	

Table 2	
1 Interference Pattern	**2 Interference Pattern at Higher Wave Generator Frequency**

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Analysis and Conclusions

1. Identify the wave parameter that is controlled by the wave generator.

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2. Explain the effect that increasing wave frequency has on the waves produced by the generator.

3. Summarize the superposition that occurs with diffraction.

4. Describe the superposition of waves that occurred on nodal lines in the interference experiment. Describe the superposition of waves that occurred in antinodal regions in the interference experiment.

5. Compare the diffraction patterns of the wide and the narrow openings.

6. Analyze the effect of increasing wave-generator frequency on diffraction.

7. Analyze the effect of increasing wave-generator frequency on two-source interference.

Extension and Application

1. Integrate your observations of diffraction and interference to predict the pattern of waves that would be produced by a barrier with two narrow openings.

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