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LAB 15 LABORATORY INVESTIGATION

Making Waves

Key Concept: The speed of a wave is defined by the wavelength and the frequency of the wave.

Skill Focus: Observing, predicting, making models, measuring, calculating, controlling variables

Time Required: 40 minutes

◆ Pre-Lab Discussion

The speed of a wave is how far the wave travels in one unit of time. The speed also equals the wavelength multiplied by the wave's frequency. If you know any two of the quantities in the speed formula—wavelength, frequency, or speed—you can calculate the third.

In this experiment, you will model waves and investigate the relationship of the frequency and length of the wave to its speed.

1. Write the equation for the speed of a wave.

s

2. Define wavelength.

3. If a wave travels 6 m in 2 s, what is its speed?

If the same wave has a frequency of 10 Hz, what is its wavelength?

◆ Problem

How does a wave's speed relate to its frequency and wavelength?

◆ Materials *(per group)*

Alternative Materials: You can use 2 or 3 layers of newspaper instead of brown paper.

- meterstick
- ruler
- masking tape
- plain brown paper
- paper cup
- pencil
- string
- graduated cylinder, 100-mL
- water
- stopwatch or clock with a second hand
- marker

◆ Safety

Review the safety guidelines in the front of your lab book.

To prevent slips or falls, immediately wipe up any water spilled on the floor.

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◆ Procedure

1. Work with two other students. Measure off 4 m on the floor. Mark the starting and end points with masking tape. Lay the brown paper on the floor between the two marked points.
2. Poke a tiny hole in the bottom of a cup with a pencil point. Poke two larger holes near the top of the cup on opposite sides.

Keep the bottom hole small, or the water will come out too fast.

3. Thread a string through the holes near the top of the cup and attach the string to the pencil. See Figure 1. The pencil acts as a handle that lets the cup swing freely.
4. Read Steps 5–9 before continuing with the investigation.
5. Have a classmate stand at the end point with a stopwatch or a clock with a second hand. That student will time how long it takes the second student to walk the measured distance.
6. Stand behind the starting point and hold the pencil ends so the cup can swing freely.
7. Have a second classmate hold the cup while plugging the bottom hole with one finger. That student should fill the cup with 100 mL of water and hold the cup 5 cm to one side, so that the cup will swing from side to side when it is released.

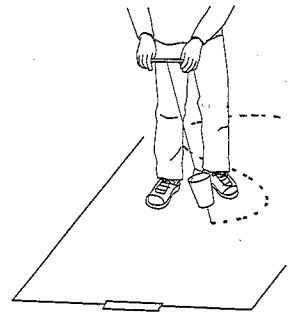

Figure 1

8. When the first student gives a signal, he or she should start the stopwatch, and the second student should let go of the cup. At the same time, walk at a steady pace along the marked distance, holding the pencil away from your body. As you walk, the cup will swing from side to side, and the water will drain through the hole. The water will trace a wave on the paper.
9. When you reach the end point, the first student should stop the stopwatch. In the Data Table provided on the next page, record the time it took to walk the 4 m. Properly dispose of any water remaining in the cup.
10. If necessary, use the marker to retrace the wave on the paper. Measure the wavelength and count the number of crests in 4 m. Record these values in the table.
11. Calculate the frequency of the wave—the number of complete waves per second. Round off your number to the nearest complete wave. Record this value in the table.
12. Predict whether you would have more or fewer crests if you repeated the experiment while walking faster. Give a reason for your prediction.

Have students add a drop of food coloring to the water to make the water more visible as it drips on the paper. Have a container at the end of the course to collect the leaking cups.

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13. Check your prediction by repeating Steps 5–11, but at a faster pace than in the first trial. Record your results in the Data Table.

14. Predict whether you would have more or fewer crests if you repeated the experiment while walking slower than at first. Give a reason for your prediction.

15. Check your prediction. Record your results in the Data Table.

◆ Observations

Data Table Sample Data

Trial	*Time (s)*	*Wavelength (m)*	*Waves in 4 m*	*Frequency (Hz)*
1				
2				
3				

◆ Analyze and Conclude

Answers will vary. Answers given apply to the sample data in the Data Table.

1. Calculate the speed of each wave from the distance traveled and the time.
   Trial 1: speed = distance/time =
   Trial 2: speed = distance/time =
   Trial 3: speed = distance/time =

2. Calculate the speed of each wave from the frequency and the wavelength.
   Trial 1: speed = wavelength × frequency =
   Trial 2: speed = wavelength × frequency =
   Trial 3: speed = wavelength × frequency =

3. Compare the speeds you calculated for Questions 1 and 2.

4. Compare the frequencies and the wavelengths of each wave. What would happen if the frequency increased?

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◆ Critical Thinking and Applications

1. Was your first prediction in the Procedure correct? Explain why the number of crests changed.

2. If you made more crests over a given distance by walking at a different speed, did the wavelength increase? Why or why not?

3. Blue light has a higher frequency than red light. Does blue light travel faster than red light in the same medium? Give a reason for your answer.