LESSON 28

MAPPING WAVE MOTION WITH A SIMPLE PENDULUM

Experience the visual beauty of wave motion by using a pendulum to etch wave patterns into sand. In this lab, you'll uncover how to measure and interpret wave characteristics, transforming abstract concepts into tangible, observable phenomena.

Supplies

- Styrofoam cup
- Ring stand or other support
- Length of thin string, 50 cm
- Masking tape
- Meter stick
- Nail
- Sand
- Scissors
- Stopwatch
- Parchment paper, at least 30cm wide

Instructions

1. Prepare your cup. Use a small nail to poke a small hole in the bottom of a styrofoam cup. Make two additional holes near the rim of the cup, on opposite sides.

2. Thread the string through the holes near the rim and tie the ends of the string securely together. Hang the cup using the string from a ring stand or other stable support.

3. Cover the hole at the bottom of the cup with a piece of masking tape. Fill the cup with sand, ensuring the tape remains in place to prevent sand from spilling out.

4. Unroll a section of paper, and mark a length of one meter with lines at each end.

5. Roll the paper back up and position it beneath the pendulum.

6. Complete a test run of the experiment before gathering and recording any data.

   a. Remove the tape from the bottom hole of the cup.

   b. Start the pendulum swinging while one person lightly holds the paper roll and the other pulls the paper slowly and steadily, perpendicular to the pendulum's swing.

   c. Try to pull the paper in a straight line with a constant speed. The sand should look similar to the curves we have been drawing for transverse waves.

   d. After the pendulum has moved across the entire meter length of paper, stop it and cover the bottom hole of the cup with the tape again.

   e. Clear the sand from the paper and return it to the cup.

7. Repeat the process outlined in step 6, but this time, start the stopwatch when the curve reaches the first line. Stop the stopwatch when it reaches the second line. Record the time in your data table.

8. Calculate average wavelength.

   a. For the section of the curve between the lines, measure the distance from the first crest to the last crest.

   b. Divide this distance by the number of crests between the lines to find the average wavelength. Record this value in the data table under "average wavelength".

9. Calculate average amplitude.

   a. Measure the vertical distance from each crest to the adjacent trough within the curve.

   b. Add all these distances together, then divide by the number of measurements to get the average distance.

   c. Divide this average distance by two to find the average amplitude. Record this value in the data table.

Data

Length along paper	Time (s)	Average wavelength (m)	Average amplitude (m)
1 meter			

Questions

1. Calculate the average speed at which the paper was pulled using the length along the paper and time measurements. (HINT: Remember the velocity equation!)

1. Use the wave speed equation shown below to calculate the average wave frequency.

$$\text{Average frequency} = \frac{\text{average wave speed}}{\text{average wavelength}} \quad (f = \frac{v}{\lambda})$$

2. If you repeated this experiment, what do you think you could do to change the wavelength of the wave? How could you change the amplitude?

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