Experiment 10

Waves

INTRODUCTION

Waves are a means of propagating energy from particle disturbances. Most students are familiar with water waves, sound waves, light waves, and waves in stretched strings like piano or guitar strings. Particle disturbance means that the particle has been displaced from its equilibrium position by some agent. Once displaced, the particle tends to return to its original position. In the process, a wave will be propagated outward from the disturbance, transferring energy. The propagation of energy from the disturbance is called **wave motion.**

Waves are classified as transverse or longitudinal. **Transverse waves** have the particle displacement perpendicular to the motion of the wave. **Longitudinal waves** are those in which the particle displacement is in the same direction as the wave motion.

All waves have certain fundamental properties. A few of these properties are velocity, wavelength, period, frequency, and amplitude. These are illustrated in Fig. 10.1 on the next page.

The **velocity** of the wave is the distance the wave travels per unit of time, and in this experiment it is measured in centimeters per second. The **wavelength** is the distance between two similar points on any two consecutive waves measured in centimeters or some other unit of length. The **period** of a wave is the time required for one wavelength to pass any point along the direction of travel. The **frequency** is the number of vibrations or cycles per unit time the particle disturbance is taking place. Frequency is usually measured in cycles per second, or Hertz. The period is the reciprocal of the frequency. You will recall that the reciprocal of a number is one divided by the number. The relation here, therefore, would be written as

$$T = \frac{1}{f}$$

where T = period in seconds and f = frequency in cycles per second.

The relation among velocity, frequency, and wavelength is shown by the equation

$$v = \lambda f$$

where v = velocity,
λ = wavelength,
f = frequency.

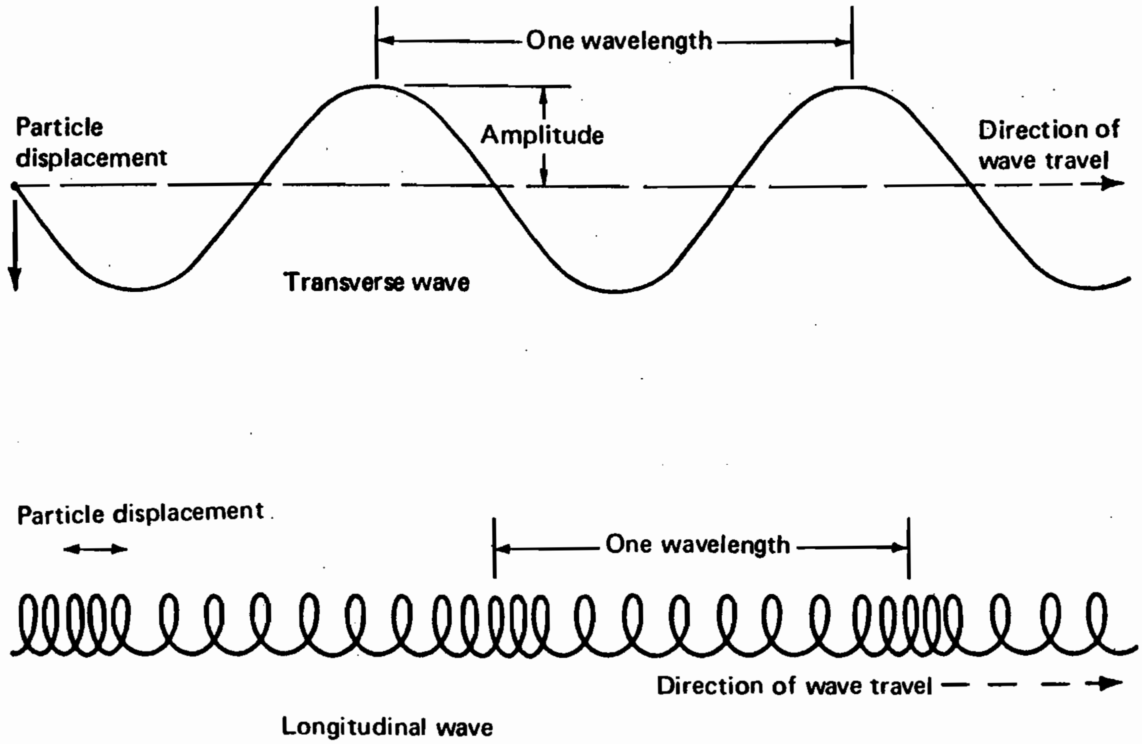

Figure 10.1

LEARNING OBJECTIVES

After completing this experiment, you should be able to do the following:

1. Define the terms wave, wavelength, frequency, period, and amplitude of a wave.
2. Differentiate between longitudinal and transverse waves.
3. Demonstrate the transfer of energy by waves.
4. Measure the wave velocity in a stretched rubber rope.
5. Measure the wavelength of a sound wave.

APPARATUS

Metal can with plastic lid (large-size coffee can), candle, 2-m meter stick, rubber cord, timer, coiled spring, tuning forks (use frequencies high enough to give two or three maximum and minimum points for air column in closed pipe), rubber hammer, resonance apparatus, large water tray, cork stopper.

EXPERIMENT 10 NAME (print) ______________________________ DATE __________

LAST FIRST

LABORATORY SECTION ________ PARTNER(S) ______________________________

PROCEDURE

1. Assemble the metal can, meter stick, and candle as shown in Fig. 10.2. Determine if you are able to extinguish the candle flame 1 m (or less) from the can by lightly thumping the plastic lid with a rubber hammer. Explain your results.

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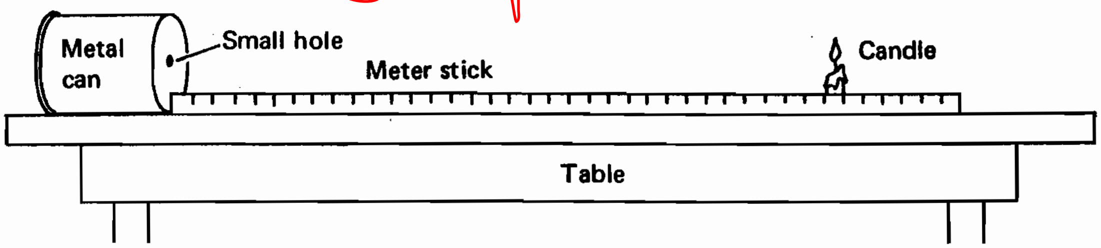

Figure 10.2

2. The velocity of a wave in a stretched string or rubber cord is given by the following:

$$v = \sqrt{\frac{F}{m/L}}$$

where v = velocity,

F = tension in cord measured in units of force,

m/L = mass per unit length.

Attach the rubber cord to one wall of the laboratory, then apply tension to stretch the cord across the full length of the room. Displace the cord as shown in Fig. 10.3. Observe the wave travel the length of the cord, be reflected at the wall, and return to your hand.

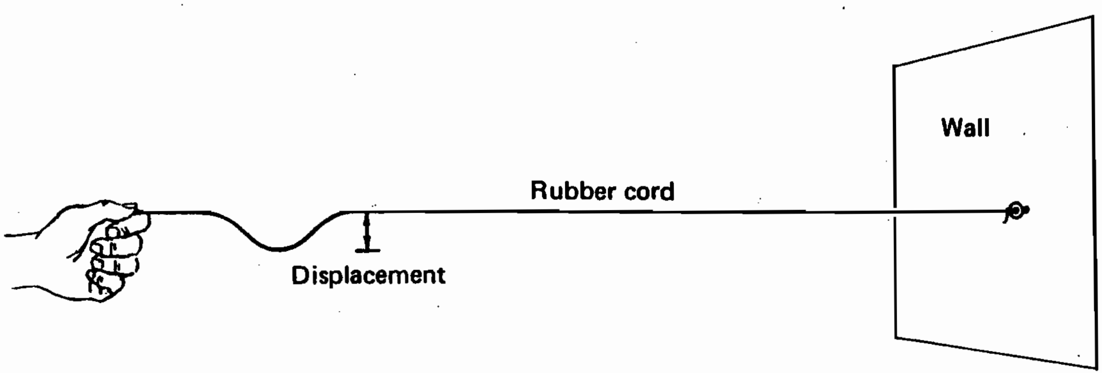

Figure 10.3

With the electric timer determine the time (three trials) it takes a wave to travel the total distance. Measure the distance traveled and calculate the velocity of the wave.

$$v = \frac{s}{t} = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

Repeat the experiment with increased tension in the cord.

$$v = \frac{s}{t} = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_$$

What type of wave is traveling in the cord? Explain your answer.

3. Stretch the coiled spring along the floor. Displace the spring at one end by compressing a few coils and releasing. Observe the wave motion along the spring. Explain the type of wave observed.

X 4. Fill the large tray with water, then place it on the laboratory table. Place the cork stopper in the water near one end of the long dimension of the tray as shown in Fig. 10.4. Disturb the water near the other end of the tray by dropping a coin flat into the water.

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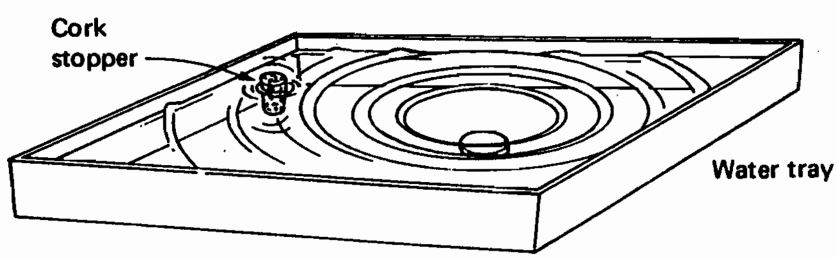

Figure 10.4