LABORATORY INVESTIGATION **24**

Wave Properties

Apparatus

coil springs (slinky of about 10-cm diameter and coil spring of about 2.5-cm diameter)
thread
stop watch or watch with second hand

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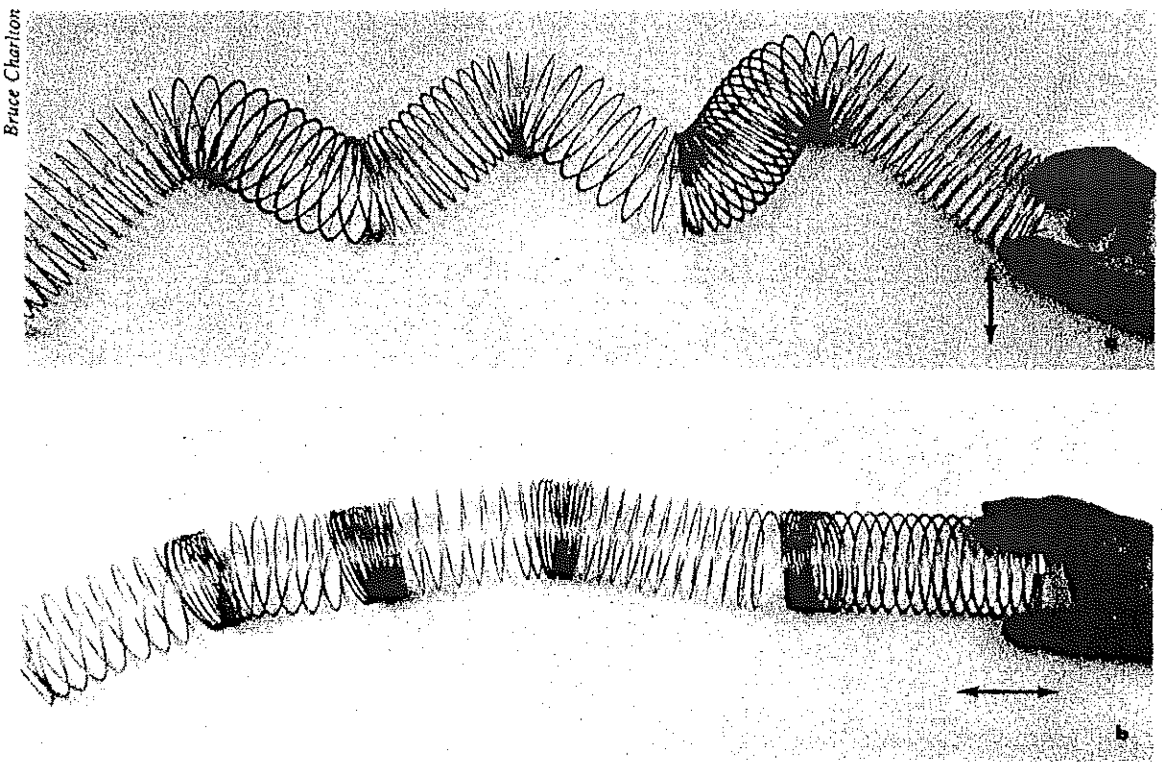

Figure 24-1. (a) Transverse waves cause the medium to vibrate at right angles to the wave motion. (b) Longitudinal waves cause vibration parallel to the wave motion.

The Investigation

The wave characteristics you will observe at this time are common to *all* waves. There are not separate characteristics for sound waves, light waves, water waves, and other kinds of waves. In general, all waves follow the same rules. Because this is so, you can work with waves in a coiled spring to learn about waves in general.

During this investigation you will have an opportunity to become familiar with some of the major characteristics of wave motion. To do this in an orderly manner, each characteristic will be outlined clearly in the procedure along with any instructions you might need in order to observe them.

Procedure

Record your observations in the spaces provided in the Procedure section of this investigation.

Name ______________________ Class __________ Period __________

Partner ______________________ Date ______________

A. Transverse and Longitudinal Waves

Have your lab partner hold one end of the slinky and stretch it along a smooth floor until it is about 10 m long. Practice shaking your end of the spring sideways until you are able to send a clear pulse along its length. Several pulses together will form a *transverse wave* train. Notice the direction in which the pulses travel and the direction in which the coils of the spring move.

1. In a transverse wave the particles of the medium vibrate ______________ ______ (*in the same, perpendicular to the*) direction in which the wave travels.

2. Other examples of transverse waves are ______________ waves and ______________ waves.

Reach a short distance down the spring's length and gather the coils toward you and then quickly release them. The pulse that travels along the spring is a *longitudinal* pulse.

3. In a longitudinal pulse the particles of the medium vibrate ______________ ______ (*in the same, perpendicular to the*) direction in which the wave travels.

B. The Speed of all Waves of the Same Kind in a Given Medium Is the Same

Generate a transverse pulse in the coil. Keep the stretch of the coil constant. Estimate the speed of the pulse in the medium. Generate a second pulse but make it larger or smaller than the previous pulse. Compare the speeds of the pulses. If you are undecided you might try timing the pulse with the stopwatch. Try to generate a pulse that travels along the spring at a different speed.

4. The speeds of different pulses in a particular medium are ______________ ____ (*the same, different*).

C. Wavelength and Frequency

Shake the spring back and forth rapidly to generate wave trains in the spring. The wavelength of a wave in the spring is the distance from a crest on one side of the spring to the next crest on the same side. The frequency of the wave is the same as the frequency at which you shake the spring. Try shaking the spring regularly but slowly and then regularly but rapidly. Observe the wavelengths of the waves.

5. Higher frequency waves have __________ (*long, short*) wavelengths.

6. Low frequency waves have __________ (*long, short*) wavelengths.

7. If groups of pulses form waves and the speed of all the pulses you generated in the coil are the same then the speed of all the waves generated in the coil should be ______________ (*the same, different*).

Name ______________________ Class __________ Period __________

Partner ______________________ Date ______________

8. The speed of any wave in any medium is equal to the frequency of the wave times its wavelength ($v = f\lambda$). All the waves that you generated in the spring travel at the same speed. Does it follow from these two facts that high frequency waves must have short wavelengths while low frequency waves must have long wavelengths? ______________________

D. The Interference of Waves

You and your partner can practice sending pulses towards each other at the same time. Try this and closely observe the pulses when they come together and also after they pass through one another. Try pulses of the same and different shapes. Send a pulse down one side of the spring while your partner sends a pulse down the other side. What happens when they meet?

9. When two pulses meet in the spring their displacements ______________________ (*add up, are the same as one displacement*).
10. When two pulses of about equal displacements approach each other from different sides of the spring they ______________________ (*add up, cancel*) while they meet.
11. After the pulses pass through one another they are ______________________ (*changed, unchanged*).

E. Reflected Waves

Have your partner hold one end of the spring very rigidly. Send a pulse to the rigid end and observe the reflected pulse.

12. A pulse reflected from a rigid medium undergoes ______________________ (*no change in phase, a 180° change in phase*).

    Now tie a long string to one end of the spring. Have your partner hold the thread and send a pulse toward the end supported by the string.

13. A pulse reflected from a medium less rigid than the one in which it has been traveling undergoes ______________________ (*no change in phase, a 180° change in phase*).

F. Wave Transferral From One Medium to Another

Connect the slinky with the other coil spring. Stretch the slinky as before. Have your partner hold the end of the spring and you hold the end of the slinky. Try sending pulses and short waves down each spring. Observe their behavior at the boundary between the two springs. Observe how a wave changes as it passes from one medium into the other.

14. Each time a wave reaches the boundary between the two springs it is ______________ (*partially, totally*) reflected and ______________ (*partially, totally*) transmitted.
15. When a wave enters a new medium its speed is ______________________ (*the same, different*).
16. When a wave enters a new medium its wavelength is ______________________ (*the same, different*).