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WAVE PROPERTIES

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 investigate waves in a coiled spring to learn about waves in general. 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.

Equipment

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

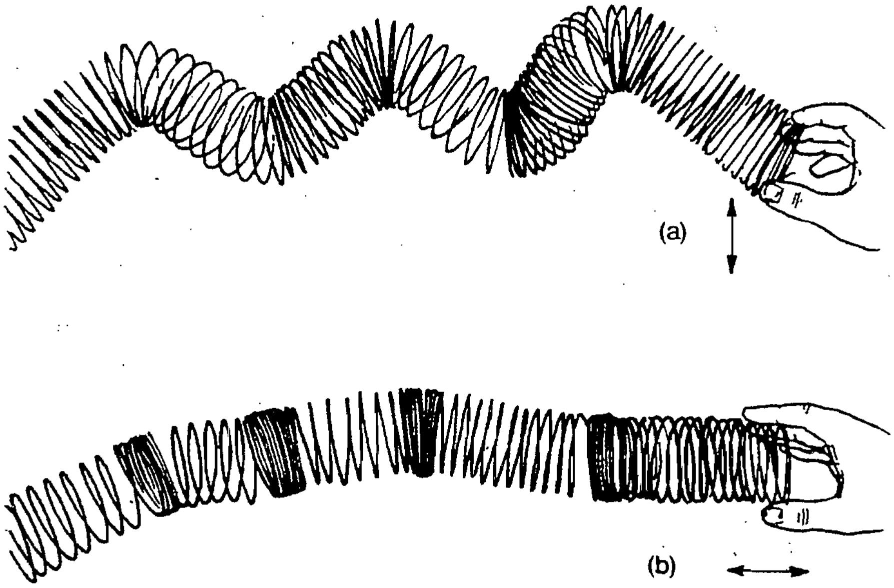

Figure 25–1. (a) Transverse waves cause the medium to vibrate at right angles to the wave motion. (b) Longitudinal waves cause vibration parallel to the wave motion.

Objective

During this investigation you will
observe some basic wave characteristics.

Procedure

Record your observations in the spaces provided in the Data and Observations section of this investigation.

A. Transverse and Longitudinal Waves

1. 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.
2. 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.

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

1. 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. Groups of pulses form waves. Shake the spring back and forth to generate waves of different amplitudes and frequencies. Compare the speeds of the waves.

C. Wavelength and Frequency

1. 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.

D. The Interference of Waves

1. Have your partner grasp one end of the spring while you grasp the other end. Practice sending pulses toward 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 equal pulses toward each other with both partners initially displacing the spring to their rights. Now try the same experiment with one partner displacing the spring to the right while the other partner displaces it to the left.

E. Reflected Waves

1. Have your partner hold one end of the spring very firmly. Send a transverse pulse to the rigid end and observe the phase of the reflected pulse.
2. Now tie a long thread to one end of the spring. Have your partner hold the thread while you send a pulse toward the end supported by the string. (The thread represents a less rigid medium than the one in which the wave has been traveling.) Observe the phase of the reflected pulse.

F. Wave Transferral from One Medium to Another

1. Connect the slinky with the other coil spring. Consider the spring and the slinky as two different media. 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.

Data and Observations

A. Transverse and Longitudinal Waves

1. Compare the direction of particle motion to the direction of wave travel in a transverse wave. (Put a piece of masking tape on one coil and define this mark as a "particle.")

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2. Give examples of other transverse waves.

3. Compare the direction of particle motion to the direction of wave motion in a longitudinal wave.

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

4. Describe the speeds of pulses of different amplitudes and different frequencies in a given medium.

5. Compare the speeds of waves of different amplitudes and frequencies in a given medium.

C. Frequency and Wavelength

6. Compare the wavelengths of waves with higher frequencies with the wavelengths of waves with lower frequencies.

D. The Interference of Waves

7. Describe the magnitude of the displacement when two pulses in phase meet in the spring.

8. Describe what happens when two pulses of equal amplitude and 180° out of phase meet in the spring.

9. What happens if the two pulses are in phase?

10. Describe the pulses after they pass through each other.

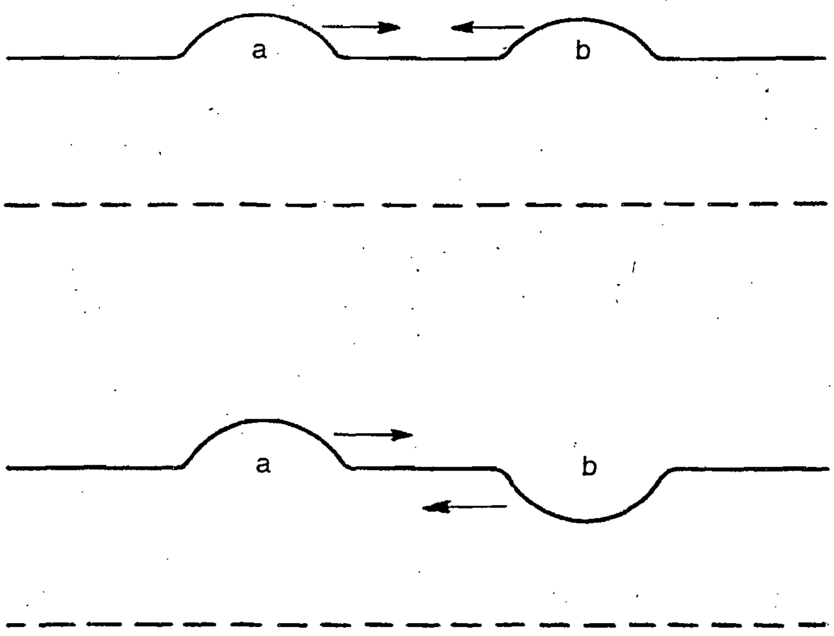

Figure 25-2. Complete this diagram using your observations from Procedure D.

E. Reflected Waves

11. How does reflection of a wave from a rigid barrier affect its phase?

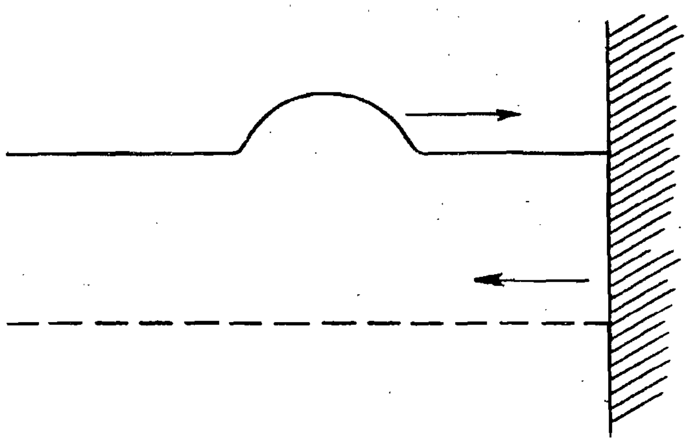

Figure 25-3. Complete this diagram using your observations from Procedure E.

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12. Reflection of a pulse from a less rigid medium has what affect on its phase?

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F. Wave Transferral from One Medium to Another

13. Describe what happens to a wave when it reaches the boundary between the two springs.

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14. From your observation of one medium change, what do you think might happen to the speed of a wave when it enters a new medium?

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15. What happens to the wavelength of a wave when it enters a new medium?

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16. What happens to its frequency?

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Interpretation

1. How do your observations in Sections B and C support the wave equation in which $v = f\lambda$?

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2. Summarize the major characteristics of wave motion you observed in this investigation.

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3. Where in your environment can you observe some of the general properties of wave motion?

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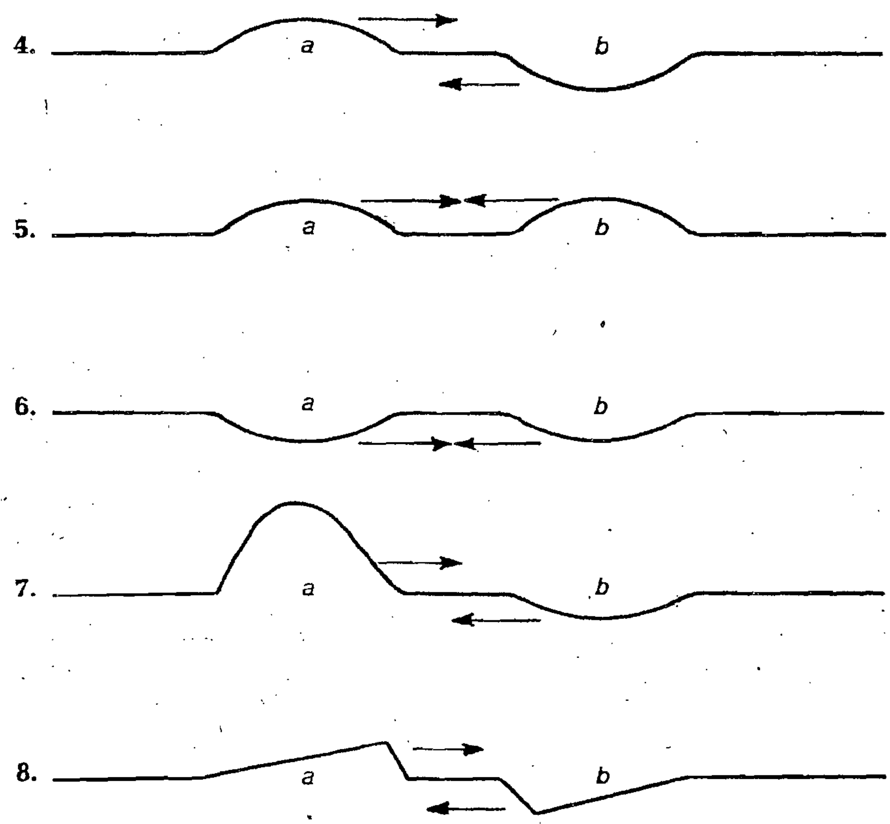

Figure 25–4. Use this diagram to answer questions 4–10.