Name: ____

Lab 23. Vibrations, Waves, and Sound

Activity 1. Spring Vibrations

Purpose
Classify springs by stiffness and observe the factors that determine its oscillation frequency.

Materials
Short springs, hanging weights, clamp stand, stopwatch or timer

Procedure
Hang each spring from the stand and hang weights from each spring. Rank the springs by stiffness.

1. What observation allows you to evaluate a spring's stiffness?

Hang the same weight from each spring. Set the weight into oscillation.

2. How do the frequencies of oscillation compare on the different springs?

3. What causes the difference in frequency? Why does it matter?

Hang different weights from the springs, and set them into oscillation.

4. How does the frequency of oscillation of a spring change when the weight changes?

5. Why does the mass of the hanging weight matter?

With any mass-spring combination of your preference, observe oscillations of different amplitude. Compare the frequencies of their oscillations.

6. How does amplitude of oscillation affect the frequency?

Activity2. Pendulum

Purpose
Observe the characteristics of a simple pendulum.

Materials
Clamp stand, weights on strings, stopwatch or timer

Procedure
Swing the pendulum. Try to change the frequency of its oscillation.

1. What could you do to change the frequency of the pendulum's oscillation?

Try it with a different weight.

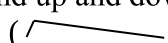
2. Did changing the weight affect the characteristics of the pendulum? What changed, and what was the same?

Activity 3: Coil Spring

Purpose
In this activity you will observe transverse waves in one-dimensional media.

Materials
Long coil spring or stretch cord, stopwatch.

Overview
You will explore the propagation of waves in a spring, and qualitatively see the factors that affect wave speed and wavelength. You will create and observe **transverse** waves in this activity.

Procedure
Have two people hold a long spring, one at each end. . (It works best if the ends are firmly fixed, for example by bracing your hand against your body, a tabletop, or a wall.) Have one person quickly move her or his end up and down once. Or, "pluck" the spring by holding the end fixed and lifting a nearby point, () then letting go.

1. What happens?

This kind of wave is called "transverse," because the spring moves in a different dimension than the wave.

Stand farther apart so that there is more tension on the spring. Again, move one end up and down quickly.

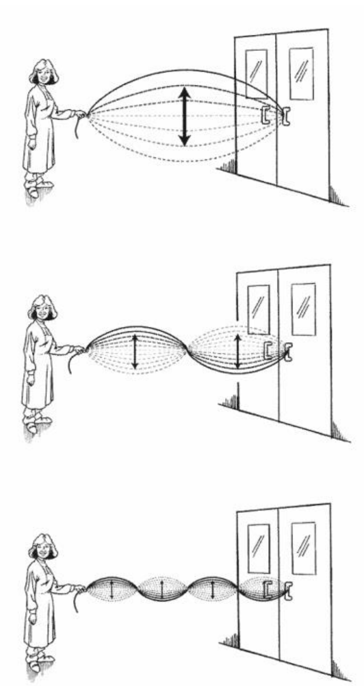
2. Is there any difference from the previous time?

Now have one person hold her or his end of the spring fixed against a table or something like that; we want as much reflected wave energy as possible.

3. Generate a single pulse from the other end. What happens to the pulse when it reaches the fixed end?

Move the free end up and down, slowly at first, and then fas With a little practice, you should be able to produce the patterns illustrated at the right. These are called **standing waves** because parts of the spring are actually standing still, and the parts between them are moving the most. The still parts are called **nodes**, and the maximally moving parts **antinodes**.

4. At what frequencies do these patterns occur? How can y measure the frequencies?



Remain where you are and change the tension in the spring or cord by feeding or taking up some slack. Create the same standing wave patterns as before.

5. Record the frequencies of the different patterns.

6. The frequencies should be different than before. How have they changed?

Verify that you can also make standing waves by moving the spring side-to-side rather than up and down.

Activity 4. Slinky

Purpose
In this activity you will observe longitudinal waves in one-dimensional media.

Materials
Slinky, stopwatch.

Overview
Pretty much the same as in Activity 3, but this time with longitudinal waves in a slinky.

Procedure

Please do not over-stretch the Slinky.

1. Now look at a Slinky. Lay it on a smooth surface such as a tabletop or the floor. Have two people hold it, one at each end. Verify that you can make transverse waves (where the spring moves side-to-side) just as you did with the long spring.

2. Now make a different kind of wave with the Slinky. Instead of moving one end perpendicular to the travel of the waves, push and pull the Slinky along the direction of its length. Watch the rest of the Slinky for a disturbance that travels along it. What do you see? (This kind of wave is called "longitudinal," because the spring moves along the same dimension as the wave.)

3. Create a single pulse by pushing or pulling the end once. Then stretch the Slinky so that it is under greater tension and create a single pulse again. How does tension affect the pulse?

4. You should be able to make standing longitudinal waves in the Slinky. How many nodes can you make?

Activity 5. Chimes

Purpose
You will investigate some of the wave properties of sound.

Materials
Metal bars, string, rubber mallet

Overview
Sound is a longitudinal wave! When sound is produced by a vibrating object, the frequency the sound wave is the object's frequency of vibration. Sometimes, however, standing waves of sound are set up inside containers of the appropriate size and shape, and the wavelength of the sound is determined by the size of the container. Sound waves can combine to make new sounds.

Procedure
1. Predict: when you hit a chime, it makes a sound. What determines the pitch of the sound?

2. Suspend a metal bar from a string tied exactly around its center. Adjust the position of the string so that the bar balances. Hit the bar lightly with a rubber mallet. (Try not to let the bar swing very fast.) What do you hear?

3. Similarly hit suspended bars of different metals and lengths. How does the sound you hear differ?

4. Does the sound depend on where on the bar you hit it with the rubber mallet?

5. Is the sound different if you hit a suspended metal bar with another metal bar?

Activity 6. Singing tube

Materials
Corrugated plastic singing tube

Procedure
Hold the tube by the flared end and swing it in a circle. Be sure not to hit anyone with the swinging tube! Adjust the speed of your swinging to obtain a clear sound from the tube

1. Describe the sound.

Change the speed of swinging. Try to produce a different note.

2. How many different notes can you make?

3. How are the different notes you produce related?

Activity 7. Wave tubs

Purpose
How do waves behave in two dimensions? Here you will observe waves on the surface of water. You will also observe how these waves move near obstacles and barriers.

Materials
Flat tub, plastic lid, water, bucket or gallon jug, large funnel

Overview
Water surface waves are complicated! The crashing surf at the beach is obviously different from a simple sine wave. Nevertheless, they do illustrate some features common to all types of waves. We use water surface waves in this activity to look more closely at the reflection of waves from barriers.

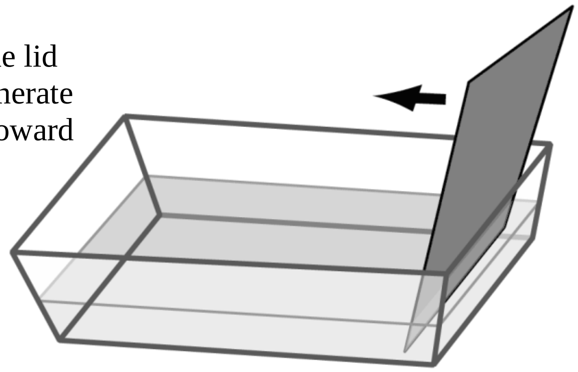
Procedure
Put some water in the tub. Allow enough for the entire bottom to be covered to at least 5 cm depth.

Generate circular wave pulses by dipping your finger in the water at different positions. Make wave trains by rhythmically moving your finger up and down.

1. What happens to the waves when they reach the side of the tub?

2. Tap a side of the tub. Describe the waves that are produced.

Hold the lid vertically in the tub, so that the lid is parallel to the short edge of the tub. Generate a straight wave pulse by moving the tray toward and away from the edge of the tub.



3. How does the pulse travel across the surface of the water?

Make standing waves by rhythmically moving the lid back and forth.

4. Can you make standing waves with different wavelengths? Sketch the pattern of the standing waves you produce.

5. Does the location of the lid in the tub affect the standing waves that you can produce?

6. Can you make standing waves if you hold the lid at an angle to the side of the tub?

7. If you can, sketch the pattern of the standing waves you produce.

Place an inverted funnel in the tub. Generate a single straight wave pulse and observe how it behaves when it reaches the funnel.

8. Describe what happens.

Tilt the tub so that it has a shallow end and a deep end. Create a wave pulse in the deep end and observe it as it travels to the shallow end.

9. Describe what happens.

With the tub tilted as before, create a straight wave pulse that travels diagonally in the tub. Observe how it behaves as it moves from the deep end to the shallow end.

10. Describe what happens.