Curiosity Guide #609
Waves

Accompanies Curious Crew, Season 6, Episode 9 (#609)

Speaker Standing Wave

Investigation #5

Description

Play with waves of sound!

Materials

- Exposed speaker
- Wooden dowel, $\frac{1}{4}$ inch in diameter and 8 inches in length
- Saw
- Wood base, 2 by 2 inches and $\frac{3}{4}$ inch thick
- Drill
- Tape
- String or thin rope
- Ring stand
- Computer with tone-generator software
- Long box, 5 feet in length
- Scissors
- Black spray paint
- High-speed camera

Procedure

1) Cut the long face off of two sides of a long, skinny box so that there are two square ends and two long, thin, adjacent sides intact.
2) Spray-paint the entire inside of the two flat faces and ends.
3) On one end, place a ring stand.
4) On the opposite end, lay the speaker so that it faces upward.

5) Cut a small 2 by 2-inch wood block, $\frac{3}{4}$ inch thick.
6) Drill a small hole in the block.
7) Insert the dowel perpendicular to the base.
8) Place the dowel block on the center of the speaker.
9) Carefully tape the dowel block down to the speaker. Be careful to extend the tape to the edge of the speaker and not stick the tape to the speaker fabric.
10) Hook the speaker up to the computer.
11) Tie the rope from the center of the dowel shaft to the ring stand so that the rope is level.
12) Open the tone-generator software and play a frequency.
13) What do you notice?
14) What happens if you were to lightly pinch one end, or node, of the rope?
15) Look at the action with a high-speed camera.
16) What do you notice?

My Results

Explanation

When the computer sends out a tone, the speaker pulses up and down and sends a transverse wave down the string. The wave then gets reflected back toward the speaker. The ends, or nodes, appear to have little movement, while the center has a high peak and low trough. This is called the antinode. Nodes result from two opposite waves canceling each other out, which is called destructive interference. Antinodes result from two opposing waves combining to the maximum oscillation. This is called constructive interference. Adjusting the tone frequency and string tension can create a center node as well, so that the wave looks like three loops, or three nodes and two antinodes.

If the string makes a stable shape, it is called a standing wave. A single standing wave, like a jump rope, is a fundamental wave, or first harmonic, and has half a wavelength. Each successive harmonic is a multiple of the frequency. The wave with three nodes or 2 loops is a second harmonic and shows one complete wavelength. Having a standing wave with four nodes is the third harmonic and shows 1 $\frac{1}{2}$ wavelengths. Doubling that frequency will result in the sixth harmonic with six loops and three wavelengths.

Touching a node will not interfere with the standing wave. Looking at the waves with a high-speed camera makes seeing the up and down motion of the wave easier.

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