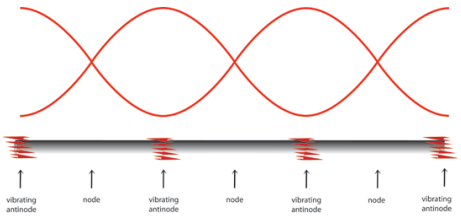
Process Explained

1. Stroking the rod with sticky fingers creates longitudinal vibrations in the rod. Longitudinal vibrations are waves that travel along the length of the rod. The waves travel to the end of the rod in which they transmit vibrations to the surrounding air molecules. Longitudinal vibrations of air molecules are then interpreted by your ears as sound. However, that is only part of the story. Some of the vibrations traveling toward the end of the aluminum rod are reflected. The reflected waves return and head back in the opposite direction toward your fingers. On their way back, they collide in a head on collision with similar waves created by your sticky fingers!

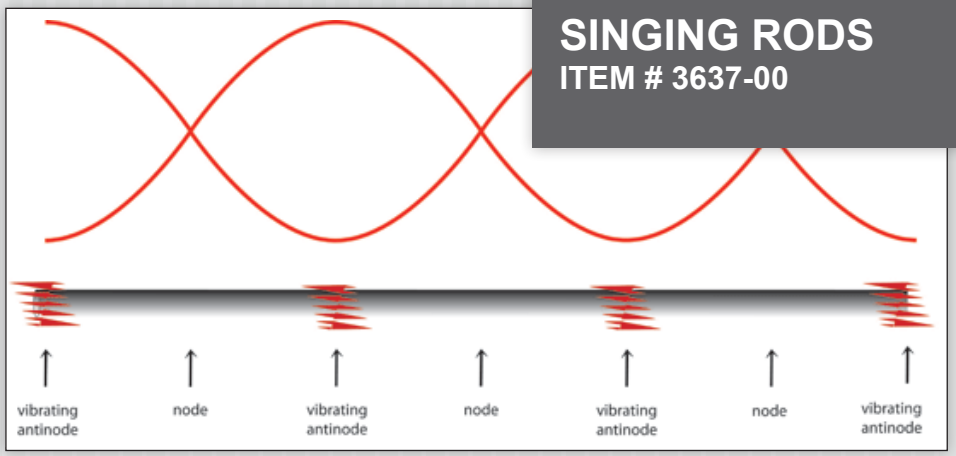
2. Now don't worry, a wave collision is not quite a massacre. Waves can either interfere constructively or destructively depending on how they meet. The points on rod where the waves interfere destructively are called nodes. Waves at the nodes cancel each other out. Hence there are no vibrations at the nodes.

3. Then where is the rod vibrating? Naturally, the points where the rod is vibrating are called the antinodes. Waves at the antinodes meet constructively and add up to create bigger waves. When you pinch the rod in the center, you restrain it from vibrating. This creates a node at that point. If you rub the rod slowly, you will produce waves of a relatively low pitch. These waves will create an antinode at the end of the rod. This pitch is called the natural frequency of your rod. Long rods will have a lower natural frequency than short rods. Try both sizes.

4. Now to go beyond the natural frequency, you will rub the rod more aggressively. This will create a higher pitch sound that your parents might describe as shrieking or just plain unpleasant. These vibrations are called harmonics.



TEACHERS GUIDE



SINGING RODS
ITEM # 3637-00

ENERGY - SOUND

Here's a classic science demonstration that is sure to grab your students' attention... and the people down the hallway... and every dog in the neighborhood! When your fingers are slid repeatedly along this long metal rod, an ear-piercing sound is generated. You control how loud the sound gets from a whisper to an auditorium-filling shriek. Absolutely incredible! This is a great experiment to demonstrate the difference between longitudinal and transverse waves.

Materials

- singing rods
- 1 bag of rosin powder (included)
- lots of patience

Activities

1. Hold a rod in the middle with your index finger on top and your thumb supporting the rod from below. The key is to make as little contact with the rod as possible so as not to dampen the vibrations.

> **NOTE:**
> It is always best to DO an experiment ahead of time to be able to best present it to the class.

2. Apply some rosin to the thumb and fingers of your other hand and lightly coat the aluminum rod with a bit of rosin.

3. Use your rosin coated fingers to pinch the metal while sliding your fingers from the middle to the end of the rod. As soon as your fingers reach the end, repeat this pinch-n-slide process from the middle of the rod to the end, back to the middle...and again...and again... maybe upwards of 20 times before the metal bar begins to resonate. Don't give up.

1. Because of the sticky nature of rosin, your fingers should stick and slide across the rod causing it to resonate.

2. The sound of the vibrations will be soft at first but will strengthen with each successive stroke. The resulting high pitch sound will be ear- piercing! Each stroke reinforces the vibrations of the last. Pinch and slide, pinch and slide, pinch and slide...don't give up!

3. Try holding the bar in the middle and tapping on the sides. Compare this sound to the sound produced by hitting the bar directly on the end. How does this sound compare to the sound made by stroking the bar?

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Process Explained

1. "Vibrations...the reason the bar makes the sound is because of vibrations."
Your students might be inclined to offer this simple explanation before you increase their level of understanding by asking these additional questions:

   - Why did the pitch of the bar sound different when you tapped the bar instead of stroking the bar?
   - Why does the metal bar vibrate when you rub it with your fingers? Why is the rosin necessary?
   - Where is the high pitch sound coming from (middle, sides, or ends of the bar) and why?

2. In terms of making the bar vibrate, the rosin is responsible for making your fingers stick and slide as they move across the bar. In turn, this repeated stick and slide action sets up vibrations in the bar.
You probably noticed that holding the bar in the middle and tapping it on the sides produced a lower pitch sound and striking the bar on the very end created a higher pitch sound. The same high pitch sound is also made by stroking the bar with your fingers. In either case, the high pitch sound resulted from the formation of compression waves or longitudinal waves throughout the bar. Each successive stroke of the bar reinforces the strength of the previously established longitudinal wave, resulting in a louder sound.

3. Here's a way to illustrate a longitudinal wave using a Slinky toy. Picture a Slinky stretched out on the floor with another person holding the Slinky at the other end. Compress a section of the spring and let go. Notice how the energy of the released coil moves up and down the length of the spring. This is an example of a compression or longitudinal wave. The high pitch sound of the metal rod is the result of a longitudinal wave which travels throughout the entire length of the bar.

If the rod is held in the middle and tapped on the side with a solid object, a transverse wave is created. These waves have much longer wavelengths and, as a result, have a much lower tone or pitch compared to the higher pitched longitudinal wave.

A transverse wave is made by moving the Slinky in an up and down motion, creating nodes and antinodes. Notice the formation of standing waves. Practice hitting the bar with a solid object close to the end with a slight diagonal stroke. By doing so, you can actually create both longitudinal and transverse waves at the same time, and you'll be able to hear both sounds at once.