Singing Rods

P7-7250

BACKGROUND:

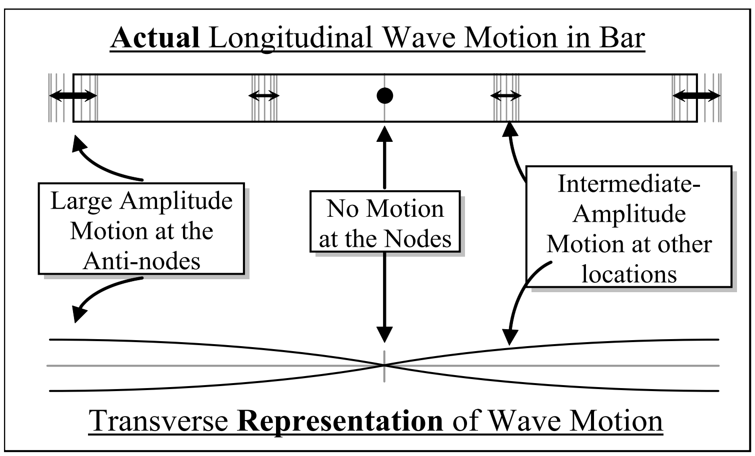
The Singing Rods "sing" because of resonance, the building up of standing longitudinal waves. These waves are created by the repeated sliding of your hand down the length of the rod, which causes vibrations within the metal. This action is helped by the addition of rosin, which causes your thumb and forefinger to stick to the rod more and vibrate as they traverse the length of the rod. The pitch of the sound can be varied by changing where one holds the Singing Rod or by changing the length of the rod itself.

KIT CONTENTS:

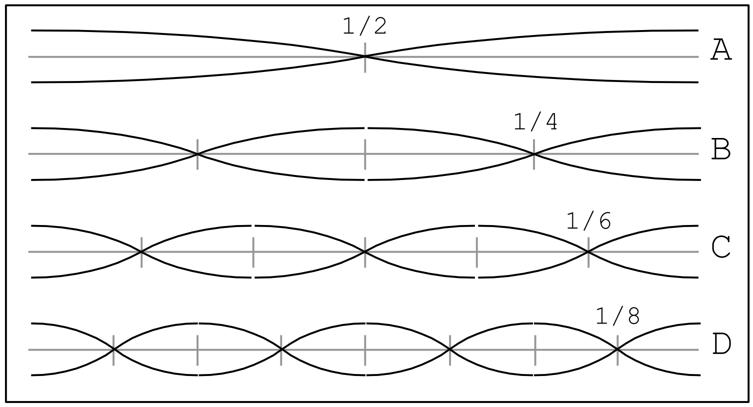
1 75 cm Singing Rod
1 50 cm Singing Rod
1 bag of rosin

STANDING WAVES:

Although the waves in the singing rod are longitudinal, they are more easily represented by showing a transverse standing wave. The diagram to the right shows how the motion is represented. When an object such as the Singing Rod resonates, standing waves result.



A standing wave in the rod has nodes, or regions where the rod does not vibrate at all, and antinodes, or regions where the rod is vibrating at its maximum. A rod will always have antinodes at its ends. The lower diagram shows the four standing wave patterns that will occur in the singing rods. Each pattern has antinodes at the ends of the rod and equally spaced nodes in between.



When you cause the rod to vibrate longitudinally, you can force it to vibrate in one of these wave patterns by holding the rod at the place you don't want it to vibrate. The damping from your fingers will cause a node to occur there.

INSTRUCTIONS:

Each Singing Rod is marked in its center. The longer of the two is also marked near either end at a fourth of the length of the rod. The trick to making the Singing Rods sing is in how the rod is held and in the generous use of rosin. Begin by holding the center of one rod firmly between the thumb and forefinger of one hand (using the edges of your fingers to minimize the area of contact). Place some rosin on your other thumb and forefinger and pinch the rod while pulling your fingers towards its end. Each successive stroke on the rod will add to the amplitude of the vibrations within the rod until you can begin to hear them. By continuing this action the sound will become louder and louder. With a little practice you will be able to generate a sound that will certainly get your students' attention as well as cause teachers in classrooms down the hall to wonder what mischief you're up to.

If you do not want your hand to get as dirty, try putting rosin on a heavy cloth and rubbing the cloth on the rod. As you use your Singing Rods more, and as more rosin coats the surface, it will be easier to generate a sound.

ACTIVITIES:

A basic lesson that can be seen immediately is causing the longer of the two Singing Rods to "sing" by holding the marked center point of the rod and noting its pitch (wave pattern A). Then take the same rod and hold it by one of the marks near the end. When the rod begins to sing, a noticeable change in pitch can be heard (wave pattern B). This will reinforce the idea of the inverse relationship between frequency and wavelength. Examine the diagrams above and notice that the wavelength of wave pattern B is half that of wave pattern A. That means that the frequency is doubled. You may be able to notice that the higher tone is exactly one octave above the lower.

Note: The tone you hear is not the only wave occurring in the rod. When you force a node in the center of the rod, higher resonant frequencies with nodes in the center also exist. The longest wave is the loudest, though, and that is the one you hear. Ex: When you produce wave pattern A, wave pattern C also exists, although you cannot hear it.

Next, while the rod is "singing" in wave pattern B, grasp it at the mark near the opposite end. Since the mark represents the other node in that wave pattern, grasping it there will not stop the vibration. Touching the rod anywhere else will stop the sound.

Other wave patterns can be produced in the rod (wave patterns C, D, and beyond), but their pitches are too high for most people to hear. For that reason, only the nodes for the longest two waves have been marked on the longer rod. The shorter rod has only been marked in the center, but some people can hear wave pattern B (with a very high pitch) in it also. Estimate or measure 1/4 of the rod length and try to force a node there.

Measure the frequency produced by each rod. Use that, along with the wavelength (determined from the diagrams above) to find the speed of sound in aluminum. Compare that to the speed of sound in air.

Use a sound level meter to measure the loudness of the sound produced down the length of the bar. Show how the sound intensity increases at the antinodes and decreases at the nodes.

Demonstrate the Doppler Effect by tying a string around the rod at its middle node. Make the rod sing and swing the rod as a pendulum. You will hear the sound change pitch as it approaches and recedes. You can also spin the rod on its string. Since the sound is mostly coming from the ends of the rod, as the rod spins you hear a combination of the approaching and receding ends, resulting in a beat frequency.

You can also produce transverse waves in the singing rod. Hold the rod at the middle node and strike it with a mallet on the side near the end of the rod. You will hear a lower pitch that dies away. The higher pitch of the longitudinal waves persists longer. The production of transverse waves in the singing rods is more complex. They do not follow the same pattern as the longitudinal waves.

RELATED PRODUCTS:

If you run out of rosin, re-supply with **Extra Rosin** (P7-7250-01).

Our **Super Slinky** (33-0130) and **Snaky** (33-0140) can further enhance your demonstration of the behavior of longitudinal and transverse waves.

Wave Sticks (P7-7310) are a hands-on approach to learning about torsional and transverse waves which is intriguing and visually exciting.

Boomwhackers (P7-7400) can be used to demonstrate resonance and standing waves in open and closed tubes

BIBLIOGRAPHY:

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