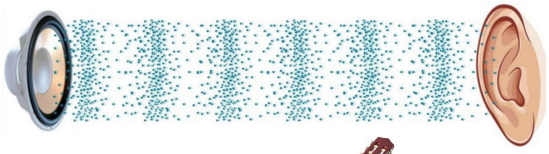
Playing with Sound: Vibrations, Waves, and Resonance

- **Sound** is a **longitudinal wave** carried by the back-and-forth **vibrations** of a material.
- Every musical instrument involves something that vibrates and a hollow **resonance chamber** that amplifies **standing waves** of sound.

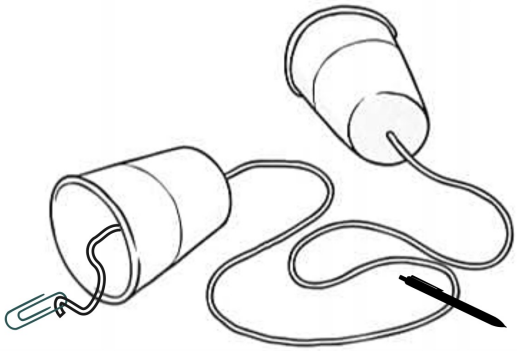


Sound in a String

1. Poke a hole in the bottom of two cups.

2. Cut a long piece of string and tie a pencil to the middle.

3. Thread each side of the string through the hole in each cup. Tie a paper clip on the end of each string, on the inside of the cup.



4. Stand close together so the string is loose. Try holding and tapping the pencil while listening from the cup. Do you hear the taps clearly?

5. Now, stand farther apart so that the string is taut, and try tapping the pencil again.

Do you hear the taps: more clearly or less clearly?

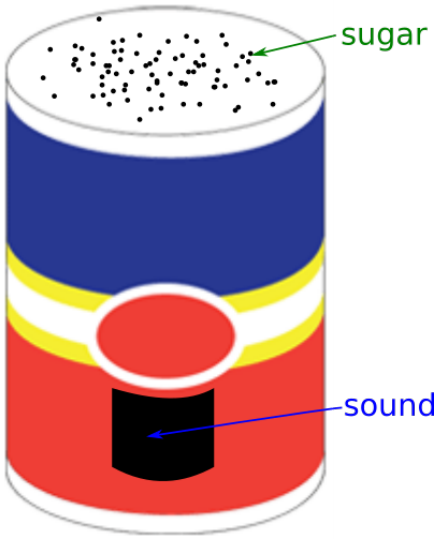
6. Make a prediction: If you pinch the string, will you hear the taps
more clearly or less clearly?

Try the experiment. Was your prediction correct? Yes / No

When the string is pulled tight (under **tension**), vibrations in one part make the neighboring parts vibrate, letting a **sound wave** move all the way across the string. Because the sound stays "focused" in the string and does not spread, it is still loud on the other side.

"Seeing" Sound

Sound waves can also move through air!



1. Cut a square hole in the side of a cylindrical container.

2. Stretch a piece of plastic-wrap over the open top of the container. Use a rubber band to hold it in place.

3. Sprinkle some colored sugar on top of the plastic wrap.

4. Strike a tuning fork with your pencil, and hold it near the sugar.

Discuss:
What happens if you touch the tuning fork to the plastic wrap?

Can you make the sugar jump by holding the fork nearby, **without** touching it or the plastic wrap?

Sound is a **wave** that travels through the air. Sounds are made by vibrating objects (like the tuning fork) which push air back and forth. When sound waves hit the plastic wrap, they make it vibrate in turn, making the sugar dance.

5. Have one partner hum into the hole on the side, while the other observes the sugar on the lid. Try humming at different pitches (low vs high sounds). Then trade places.

Discuss:
What happens? Is humming at some pitches more effective than others?

If the frequency of the hum is just right it will set up a **standing wave** in the container. Like we saw when shaking slinkies last time, a small disturbance (quiet hum) can become amplified into a strong (loud) wave. A container that amplifies specific frequencies of sound waves is called a "**resonance chamber**".

"Musical" Instruments
(if you have time)

Musical instruments all work on the same principle:
1) Something vibrates (string, reed, your lips, …)
2) A **resonance chamber** amplifies standing sound waves with some frequencies.
3) The amplified sound waves travel through the air to your ear. You hear a musical note.

Try making these toy instruments:


https://stevespanglerscience.com

1. **The Musical Balloon**

a) Put a hex nut in a balloon
b) Blow up the balloon and tie it shut.
c) Swirl the balloon in circles to make the nut spin around the inside.

Discuss: What is vibrating? What forms the resonance chamber? Does the pitch changes as you speed up or slow down the swirling?

2. **The Duck-in-a-Cup**

a) Cut the string between your two cups. Rearrange so that the paperclip is on the outside.
b) Slide a wet paper towel along the string, pulling away from the cup.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Discuss: What is vibrating? Why do you need the cup?

3. **The "Laser Gun"**
a) Wedge the bottom of a large cup into the slinky.
b) Wiggle the slinky around

Discuss: What do you hear? Does the cup change the sound compared to the slinky by itself?

What musical instruments can you think of? Which part vibrates and what does the resonance chamber look like for each of them?