Demonstrating Acoustics

Materials

- Parchment or wax paper
- A large rubber band that will fit around the top of a glass bowl (An elastic headband works well, too.)
- A small glass bowl large enough to rest a Bluetooth speaker at the bottom
- Sugar or salt (To help you see the results better, you can use colored sugar sprinkles or you can color the sugar or salt yourself with food dye.)
- A portable Bluetooth speaker
- A phone or other device that can connect to your speaker (For this activity you will play one single tone at time from the device. There are several free tuner apps available as well as YouTube videos that you can use to play single tones from your phone.)

Preparations

1. Place the speaker in the bowl; make sure it is on and connected to the phone or device you will be using.

2. Cover the top of the bowl with a sheet of wax paper.

3. Wrap the rubber band around the edges of the bowl to secure the paper in place.
4. Sprinkle a layer of sugar or salt over the paper. Make sure that the granules are spread evenly across the paper; try to avoid piles.

Procedure

1. Open the tuner app (or a YouTube video playing one single tone) on the phone or device. Start with the lowest frequency tone available. Set your volume to the lowest possible setting and hit Play.

(While the tone plays, observe the sugar or salt granules on the paper. *What do you notice about the granules? Are there any changes? If so, what are they?)*

2. Slowly increase your phone's volume. Each time you increase it pause to observe the sugar or salt.

(What do you notice? Have the granules changed? In what way?)

3. Continue to increase the volume, observing any changes to the sugar on the paper.
   (Important: Keep your speaker volume within a comfortable range. *What effect does increasing the volume have on the sugar or salt? What do you think is causing this change?*

4. When you see an effect on the sugar or salt, try pausing the tone and then restarting it. *When the tone stops, what happens to the granules? What about when you restart the tone? Why do you think the tone has this effect on the granules? Do you notice any patterns in how the granules behave when the tone is playing?*
5. Pause the tone and reset the sugar or salt so that it is evenly spread across the paper again.
6. Set your phone back to the lowest volume and change the frequency of the tone that you are playing to a higher frequency.

7. Repeat the activity, slowly increasing the volume for this new tone.

(How is the new tone different? Does it sound higher or lower? How does the new tone affect the granules? Is the effect different than what you observed with the first tone? If so, in what way? What do you think causes the difference between the two tones?)

Demonstrating Acoustics: Tutor's Guide

Notes

This is a great activity to do as a group. Begin with single tones as described in the lesson, then have students choose their favorite song – preferably with a good base beat – and have them "see" their song!

1. Discuss with students: How well do you know your eardrums? You probably know that your eardrum is an essential part of your ear, allowing you to hear the world around you. But why do we call it a drum? It turns out that calling it a drum is a very accurate description of what your eardrum looks like—and what it does inside your ear. To understand how your eardrum works, imagine using a drumstick to bang on a real drum, and then touching the drum with your hand. When you do this, you can feel the vibrations moving through the drum material. Our eardrums work in a similar way, but instead of from the beat of a drumstick, our eardrums vibrate in response to sound waves hitting it. We can't see these sound waves with our eyes. But we can see how they cause vibrations in things around us, just as they do in our eardrums!
2. Let them know we will make a fake eardrum, which will allow us to see music. Do the experiment
3. After they have done the experiment, let the choose their favorite song and play it – then they can see the vibrations of their favorite songs!

The Science

What we experience as sound is actually a mechanical wave, produced by the back-and-forth vibration of particles in the air (or whatever medium is around our ears—remember sound travels through water, too!). To understand this, imagine (or try) clapping your hands underwater. As your hands move toward each other they gather water, creating a space behind them that the surrounding water particles rush to fill. Once your hands meet, the water particles between your hands are squashed together. You can see the result both of these events as ripples moving away from your clapped hands through the water. Sound waves travel through air in a similar way. When you clap your hands, you displace (or move) the air particles between and around your hands. This creates a compression wave that travels through the air (much like it did in the water). A continuous sound (such as the one produced by a tuning fork) is caused by the vibrations of the fork tines. The tines' vibrations repeatedly compress and displace the air particles around them, causing a repeating pattern of compressions that we hear as a single, continuous tone. The faster the tines move, the less time there is between each compression, causing a higher-frequency sound wave.

When this wave hits your ear, it encounters your eardrum. Your eardrum is a very thin membrane that acts as a barrier between the outside world and your inner ear. Although it protects the inside of your ear, your eardrum's real purpose is to transmit sound. When the sound waves hit your eardrum, they cause it to vibrate—the same way that a real drum vibrates when you hit it with a drumstick. The vibrations in your eardrum are then transferred via three tiny bones inside your ear into a fluid-filled chamber called the cochlea (pronounced KOK-lee-uh). Vibrations in your cochlea are transformed into electrical signals that your brain interprets as sound. We hear different sound pitches (highs and lows) based on the sound wave's frequency—the higher its frequency, the higher its pitch.
In this activity you will be observing the vibrations caused by sound waves as they pass through a model membrane, just like the vibrations that go through our eardrums!

Source: https://www.scientificamerican.com/article/making-sound-waves/