Resonance and Sound Waves

Illusion: “Can we move objects without touching them?”

For students in grades K through 6th

Materials Note: Be sure to reuse bowls and ping pong balls

Objectives

By the end of this lesson, students will:

- **know** how that sound is caused by vibrations, and that every object has a natural frequency at which it vibrates to create a unique sound
- **understand** that vibrating objects can induce other objects to vibrate
- **be able to** recognize and demonstrate resonance through experimentation with various vibrating objects

Big Ideas:

- **Sound** occurs when something vibrates - or moves back and forth really quickly
- **Resonance** occurs when one object’s vibrations cause another object to vibrate
- Objects each have their own **natural frequency**, or how fast an object will want to vibrate when disturbed.
- When resonance causes an object to vibrate at its natural frequency, it makes the vibrations stronger.

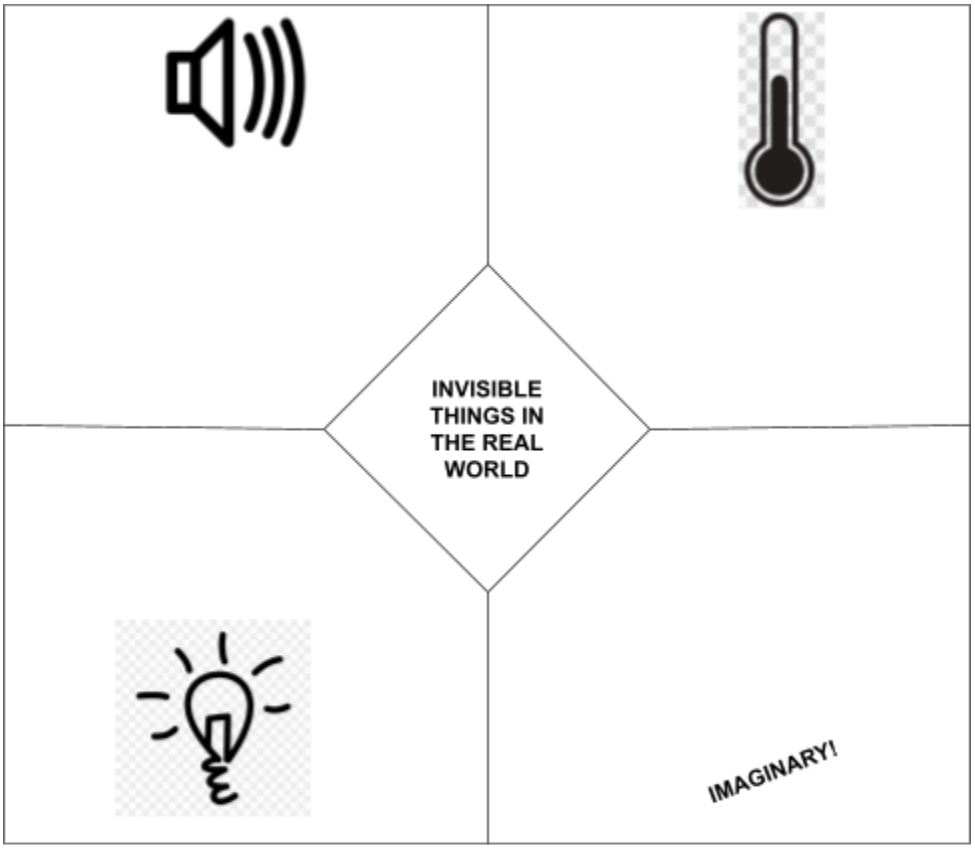
Essential Questions:

- What causes objects to make sounds?
- How are different sounds made by different objects? Why?
- How can one object’s sound make another object move? Why?
- In what ways can we take advantage of resonance to make a sound louder?

Engage:

Warm Up - Brainstorm [5 minutes]

Ask the students to name all of the things they can think of that are invisible to our eyes in the real world. Write their answers down on a white board or anchor chart. As you write their responses down, organize them to highlight a grouping of answers that include references to vibrations, waves, and sound (ex. Wind, heat, air, gasses, noise, etc.).



Sample organization method for anchor chart.

Think | Pair | Share [5 minutes]

Using anchor chart answers and flow of the discussion, note to the students that sound is one of the invisible things that they encounter every day.

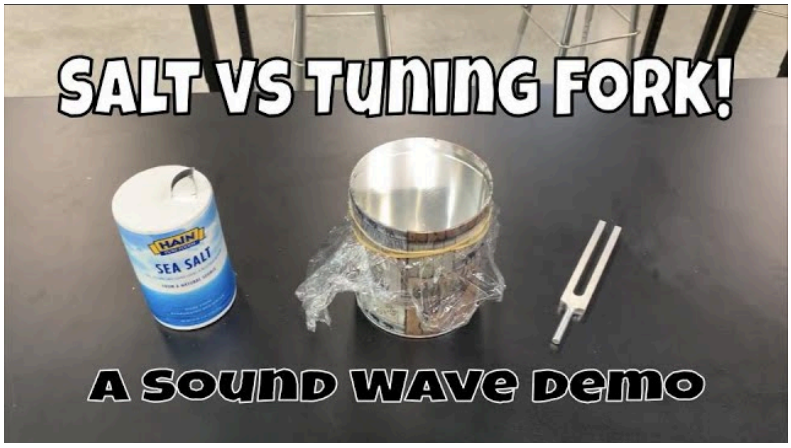
Present students with the following questions. Ask them to sit silently and think about what they believe the answers are.

*****Recommended workbook activity. Students can journal their responses there.*****

- What in the real world makes sound?
- What in the real world has waves?
- How are waves and sound related?

After a minute or two, ask students to pair up and take turns sharing their answers. Then, ask for volunteers from each pairing to share their answers with the whole group.

Impossible Science Demo - Tuning Forks and Salt [10 minutes]



TLAM Script: "Today, we are going to use an invisible force to make this salt dance."

- Stretch a layer of plastic wrap across the top of an empty bowl. Secure the wrap with a rubber band.
- Pour a thin layer of salt on top of the plastic wrap

TLAM Script: "To do this, we will not - in any way - touch the salt. We won't touch anything that is touching the salt either. Instead, we are going to create this invisible force using this magic metal (hold up tuning fork). Let's tap the magical metal (tuning fork), and see how the salt decides to dance."

- Tap a tuning fork and move it toward the salt. The salt will begin to seemingly dance and move!

TLAM Script: "The salt likes the music of the tuning fork! Let's see if changing where I move the tuning fork changes the salt's dance moves."

- Change the direction of the tuning fork and show how that affects the movement of the salt.
- Ask the students to try and explain this magic trick!

*****Recommended workbook activity. Students can draw what they think happened and explain their reasoning.*****

  - Students will ultimately need to know that, somehow, sound caused the salt to move - and today they're going to discover why.

Explore:

Activity 1: Vibrations and Your Voice [5 minutes]

- As a group, guide students through making the sounds of the vowels in the alphabet with their voices.
- Instruct students to lightly hold their fingers to the side of their necks and repeat the exercise.
- Ask them to describe what they feel. Guide them toward understanding that inside of their necks - the vocal folds in their voice box to be exact - are vibrating to create the sounds. As they progress through A, E, I, O, and U, some students may also recognize that the vibrations are coming from further and further down their throats.
  - ***Modification for younger learners:***
    - Consider a group sing-a-long of their favorite camp song!
- Summarize their discovery that the sound of their voice is produced by vibrations in their throats, and that different sounds can be made because of where their throat vibrates.

Activity 2: String Telephone [10 minutes]

- Cut a length of string approximately 10 feet long
- Poke a small hole in the bottom of each cup using scissors
- Thread one end of the string through each hole and tie a knot.
  - You may need to create a larger knot to ensure the string stays secure.
  - ***Modification for younger learners:***
    - Pre-assemble string telephones. Discuss with students the assembly process.

- Instruct student pairs to stand far enough apart such that the string is taut when they are holding the cups.
- Students should take turns speaking softly into the cup while the other student holds their cup to their ear. They should be able to hear their partner speaking.
    - Background noise needs to be minimized during this step.
- Encourage student pairs to experiment with how changing their speaking volume and the tension in their string affects the clarity and volume of sound on the receiving end.
- Summarize their discovery that sound waves travel through objects by vibrating.

Activity 3: Tuning Forks and Resonance [10 minutes]

- Have students activate the tuning fork by striking it with a block of wood, or the heel of their hand, or the bottom of a shoe. Ask them to describe the sound it makes. Is the volume loud or soft? Does it make a high-pitch or low-pitch sound? Show them how to use their hands to stop the vibrations of the tuning fork.
- Have them lightly touch the tuning fork to a variety of objects such as paper, boxes, desk surfaces, etc and notice the different tones it makes.
- Discuss what could be causing the different tones.
    - *Different materials vibrate at different natural frequencies.*
- Next, place the bowl of water on a paper towel.
- Have students activate the tuning fork again, and place it on the surface of the water (not submerged into it).
- The result: waves will form as the vibrations are transmitted through the water! Students can now see the invisible!

- Remind students that sound is all vibrations thrusting sound waves into the air, which then vibrates our eardrums allowing us to perceive sound.

Recommended workbook activity. Students can try drawing how sound waves caused the water to vibrate. Older students can be asked to use the vocabulary of the lesson to explain further.

Explain:

Watch and discuss [15 minutes]

LINK: The Power of Resonance: Objects Animate With Sound! | Impossible Science At Home

After watching the video, guide the students though a brief reflection:

- What did they notice in the video?
- How was Jason able to make the illusion work?

Define and clarify the following terms while watching the above video. Pause video and elaborate on definitions as deemed necessary based on student engagement:

- Sound
- Resonance
- Natural Frequency

Elaborate:

Experiment: Magic Ping Pong Ball [20 minutes]

- Distribute lab materials to pairs of students
- Tape one end of the 1-1.5 ft long string to the ping pong ball
- Challenge the students to use the available equipment and sound to make the ping pong ball magically swing when hanging from the string.
    - ***Modification for younger students*** - K to 2 learners may need guidance to connect principles of resonance to this activity. Provide them the following steps where necessary:
        - Task one student to hold the other end of the string away from her body, letting the ping pong ball hang from the string.
        - Without striking the tuning fork, have their partner move it toward the ping-pong ball. Ask students to discuss what happened.
        - This time, have students strike the tuning fork and move it slowly toward the ping-pong ball.
        - Discuss - What happens when the vibrating tuning fork approaches the ping pong ball? Why?
- Encourage student pairs that quickly make the magic ping pong ball to experiment further. Some suggestions may include:
    - Can you pair up with another lab group and devise a way to use more than one tuning fork to move the ping pong ball?
    - Can you pair up with another lab group and devise a way to move more than one ping pong ball?

Share Out [remaining time]

*****Recommended workbook activity. Students are tasked with using the experiment to create a diagram that summarizes how sound waves can cause objects to move. The totality of the workbook can be used to assess learning outcomes.*****

Allow students to share their creations asking them to explain how they developed their ideas.

Extend:

Extension Activity #1: Rubber Band Vibrations [10 minutes]

- Distribute a variety of rubber bands to pairs of students
- Instruct the students to stretch the rubber bands between their hands. Then, their partners will pluck the rubber bands and observe what happens.
    - Students should see the rubber bands physically vibrating to further provide concrete evidence connecting vibrations to sounds.
- Challenge the student pairs to produce different sounds with the same rubber bands. Observe the group as they do this, and provide guidance and feedback where necessary.
    - Students should observe that changing how stretched the rubber band is will affect the sound it produces.

Materials

Impossible Science Demo (per class)

- Empty bowl
- Plastic wrap
- Salt

Activity 2 (per student pair)

- 10 ft of string
- Two disposable cups (paper preferred)

Activity 3 (per student)

- Tuning Fork
- Bowl of water

Experiment (per student pair)

- Tuning Fork
- Ping Pong Ball
- String
- Tape

Extension 1 (per student pair)

- 3 random rubber bands