LOUD CITY SOUND

Understanding how sound waves are created, travel, and vary in volume.

Thunder fans in Loud City are great at getting the noise and excitement levels way up! But what is sound exactly? What makes sound louder? Let's do some experiments to see how sound waves work!

HERE'S WHAT YOU'LL NEED:

- **A small tub**
- **Water**
- **Toothpicks**
- **A variety of differently sized marbles or pebbles**
- **Poster board or card stock**
- **A decibel meter (or decibel meter app)**
  ***See Coach's Corner for free app suggestions**
- **A notebook or journal**
- **A meter stick**

WARMUPS

Let's try an activity to explore the vibrations made by sound. Place your hand or fingers on the front of your throat so you can feel your vocal cords. Say something in your normal speaking voice. **What did you feel?**

Now say something in a whisper. **What did you feel that time?**

Lastly, shout something as loudly as you can. **What did that feel like? Use your journal to write down and describe the strength of the vibrations you feel in your vocal cords for each of these three activities. How does the vibration change as you change the volume of your voice?**

Now that we've felt how vibrations cause sound waves, let's see if we can create a model that will show a visual representation of how sound waves move throughout the world. While it's extremely hard to see how things move through air, water is a great model for air, because they're both fluids and behave the same way. Grab your tub, water, toothpicks, and pebbles/marbles for this next experiment.

1. Fill up your tub about halfway full of water.
2. Break up several toothpicks and float them on top of the water. Make sure that the toothpick pieces are not touching each other or the sides of the tub. The toothpicks represent the individual molecules of air.
3. Make sure the water in your tub is completely still. Gently drop a small pebble/marble directly in the center of the tub.

What way do the ripples go when the pebble/marble hits the surface of the water? Draw a diagram or picture of what the ripples look like. Do the toothpick pieces move with the ripples? What is moving through the water?

4. Repeat this experiment with the same pebble or marble at least two more times. Observe if the results are always the same.
5. What would happen if you dropped something other than a pebble/marble into the tub of water? Try a marble or pebble of a different size, or a penny, or some other small object you have available. **Record in your journal how these different objects cause the ripples to behave, and if there are any similarities or differences.**

What size ripples do the original small pebble/marble make in the water? What size ripples do a larger pebble/marble/object make? We're using the water experiment as a model of how sound waves behave. With the idea of sound waves in mind, consider how the differently sized objects affect the sizes of ripples in the tub. **What effect do you think volume has on sound waves?**

GAME TIME

Now that we've explored how vibrations create sound waves and how those waves travel, let's take a look at how the power of sound is measured.

Have you ever been told to turn down the volume on the TV or your ear buds? Can sounds that are too loud damage your hearing?

The volume of sound is measured in *decibels*. A decibel is a unit used to express the intensity of a sound wave. The number is an indication of the loudness of the sound.

Get your decibel meter or open your decibel meter app. Let's conduct a series of experiments to see how sound is affected by distance. Create a table to record your results. Make sure to include the distance at which you'll be standing, as well as what type of sound you'll be making.

1. Begin by having a friend stand 2 meters away from you while holding the decibel meter. Make sure you're standing directly in front of each other. Whisper something to your friend. Write down what the reading on the meter is in the appropriate spot on your table.
2. Now, say something in your normal speaking voice to your friend. Record the reading on the decibel meter for this on your table.
3. Next, shout something at your friend as loud as you can. Add this meter reading to your findings.
4. The next variable we're going to explore is distance. Move so that you and your friend are 4 meters apart. Repeat steps 1-3 and record the data for how the meter reads at 4 meters instead of 2 meters. Be sure to always stand directly in front of your friend for these experiments

What differences did you find in the results between standing 2 meters away from your friend and standing 4 meters away? How big of a difference in decibels was there between your whisper, your normal voice, and your scream?

Now that we have a basis and general understanding of decibels, let's introduce a third variable into our experiment—a homemade megaphone. **How do you think directing your voice through a cone-shaped apparatus will impact the decibel readings and your friend's ability to hear you?** Create a second table just like your first table, but designate this one to record megaphone data.

5. Roll a piece of card stock or poster board into a cone megaphone shape. Be sure to leave a hole big enough on the small end for your mouth to approximately fit in.
6. Repeat steps 1-3 standing 2 meters away from your friend. Whisper, speak normally, and scream/shout through the megaphone at your friend with the decibel meter. Record your results for each of these experiments
7. Move 4 meters away from your friend, and repeat steps 1-3 again with the megaphone. Record these results as well.

What were your findings with the megaphone experiments and the decibel meter? How did the results differ from not using the megaphone? Did your friend notice a difference in what they heard between you speaking with the megaphone and without it?

ANALYZE THE REPLAY
What happened?

Compare the data from your two different tables that you created with the decibel meter experiment. **What have you learned about the difference in the volume or intensity of a sound? What effect does focusing a sound in a specific direction, as opposed to letting it spread out (using the megaphone vs. not using it) have?**

Based on all the information about sound waves and volume we've gathered through all of these experiments, **draw a diagram or image of what you think a sound wave for a whisper looks like and what a sound wave for a shout looks like.**

OVERTIME
Let's take it further

Want to take it further? Let's try changing our megaphone! What happens if you make it a different size? What if you make it a different shape? Does it make any difference if you make the megaphone out of a different material other than card stock or poster board?

What are other variables you could introduce to this experiment? What if you didn't face your friend and the decibel meter directly during the experiment? Is there a difference in the readings if your friend stands to your right or left, or even behind you? Try the megaphone experiment with your friend and decibel meter standing in numerous positions in a circle around you. (Pro tip: Try having them stand in the positions of the numbers on a clock face while you stay in the center!)

COACH'S CORNER
Additional information and explanations for parents and educators

In the first two experiments, we learned how vibrations create sound waves by moving the air particles around us and we explored how sound waves move using water as a model. When a sound source sends a sound out the air doesn't start vibrating all at once. The air next to the source vibrates first. It pushes on the molecules nearest it and starts them vibrating. This process repeats over and over again in all directions. As the sound moves away from the source, its energy is spread out over a larger and larger area. The further it travels, the more energy it loses. This causes the intensity or the amplitude of the wave to be diminished.

When the air particles inside our ears begin moving, that is when we hear a sound. It makes our eardrums vibrate. Those vibrations are passed on to hairs in our inner ear. The hairs connect to nerves that send a signal to our brain. When the brain receives the signal, we hear sound. As long as the sound vibration has energy to keep moving the air particles, a sound wave will continue.

Decibels are a unit of measure used to designate the intensity of a sound wave. Maybe you've heard that a rock concert is about 120 decibels (dB) and can be damaging to our hearing, but what does that actually mean? Because our ears are incredibly sensitive, the decibel scale has a very wide range. The quietest noise possible (say, an almost silent room) would be 0 dB. A sound 10x more powerful than that is 10dB. (Breathing is normally about 10 dB.) A sound 100x more powerful than near silence is 20 dB. A sound 1,000x more powerful is 30 dB, and the decibel scale just keeps going up and up. Anything above 85 dB is considered damaging to human hearing and can cause hearing loss, depending on the length of the exposure.

APP SUGGESTIONS: Decibel 10 – dBA Meter (iOS), dB Volume Meter (iOS), deciBel (Android)

DO YOU WANT TO LEARN MORE?
Research: Amplitude, decibel, sound wave

OKLAHOMA ACADEMIC STANDARDS - SCIENCE

STANDARD		3RD GRADE	4TH GRADE	5TH GRADE
PS1-1	Matter and its interactions			●
PS2-1	Motion and stability	●		
PS2-2	Motion and stability	●		
PS3-2	Energy		●	
PS3-3	Energy		●	
PS3-4	Energy		●	
PS4-1	Waves and their applications		●	
PS4-3	Waves and their applications		●	
LS1-2	Molecules to organisms structure and processes		●	