Science Background for Teachers

AN OVERVIEW OF SOUND

Sound and sound waves are one of those topics that seem more complicated to learn than they actually are. With clear instruction even first graders can understand what sound *is*.

What *is* sound?

Well, all sounds are created from vibrations. One might even say that sounds *are* vibrations. When people talk about "sound waves" they are talking about the vibrations that travel through the air (or water, or other materials).

What *creates* sound?

Vibrations are created from two objects hitting, your voice, or even moving air. All these things create vibrations in the air. The vibrations travel through the air and into your ear.

How do you hear sounds?

Inside your ear sound vibrations vibrate your *eardrum*. The eardrum is thin and easy to vibrate (think of a trampoline). When your eardrum vibrates, your ear sends signals to your brain that it heard a sound.

Close-up photograph of an eardrum.

IMPORTANT DEFINITIONS

Vibration: A back and forth movement. These movements can occur in an object (like a washing machine on the spin cycle) in water, or in air.

Sound Wave: Vibrations that travel through air, water and other materials.

Eardrum: A membrane in the ear that vibrates in response to sound.

Amplitude: The amplitude of a sound is related to how loud it is. Sounds with bigger amplitudes are louder.

Decibel: The unit that describes the loudness of a sound. For reference, a whisper would be around 20 decibels (dB), normal talking is about 50 dB and a blender about 80–90 dB.

Pitch: A word used to describe how high or low a sound is. For example, nails on a chalk board are high-pitched, and a burp is low-pitched. In an instrument like a xylophone, longer keys make low-pitched sounds, and shorter keys make high-pitched sounds.

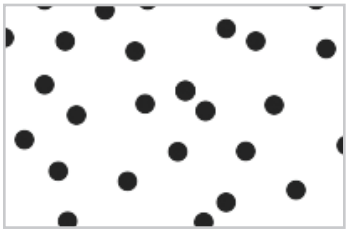
Speed of Sound: Sound travels at 741 mph in air. This is much, much, much slower than light, which travels at 670 million miles per hour.

SOUND: THE NITTY GRITTY

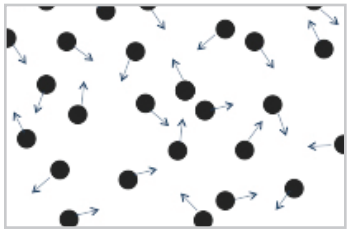
Let's back up so we can fully understand sound, sound waves and vibrations.

First, remember that air is made of small molecules. These molecules can be moved and pushed around. (The force from air molecules can be strong—think of wind knocking down a tree).

Let's say you hit a table with a spoon. The force from the spoon hitting the table creates small movements, or vibrations, in the table and the spoon. The vibrations in the spoon and table



Air is made of molecules. You can think of air as being made of tiny invisible balls, like above.



Air molecules are always moving. The movement is shown in this picture with arrows.

All About Sounds and Vibrations

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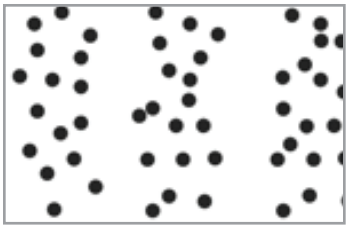
vibrate the air molecules right around the spoon and table. Those air molecules in turn vibrate the molecules around them, and so on.

When vibrations travel through the air, it pushes the air molecules back and forth in a wave like- pattern. Air molecules get *compressed* in some places and spread out in other. These sound waves move through the air in the same way that a wave moves through a slinky.

The movements, or vibrations, created by the force of the spoon hitting the table can travel quite a long distance through the air. But the farther you get from the source of the sound, the weaker the vibrations will get. To visualize sound waves, imagine ripples in water. Like ripples, the sounds waves will get smaller and smaller in size or *amplitude* before they die out.



In this figure, each dot represents an air molecule. Vibrations traveling through the air create patterns like the one shown here. The air molecules are pushed, or compressed together by the sound wave in repeating patterns.

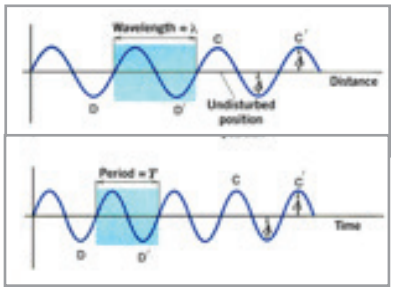
Looking at ripples in the water can help us envision how sound waves move through air.

The easiest way to describe sounds with young children is to discuss loudness and pitch. On a xylophone, for example, short keys will produce a higher pitch, and long keys will produce a lower pitch. All other things being equal, on a guitar or other string instrument, thick strings will produce lower pitches and thin strings will produce higher pitched sounds.

Pitch is determined by the *frequency* of the sound waves. A high frequency wave creates higher sounds and a lower frequency wave produces lower sounds. (No need to discuss frequency with first graders.)

Another quality of sound is the *timbre*. Timbre is harder to describe and can also be called the "tone quality" or "tone color" of a sound. For a real life example, a piano and violin can both produce sounds with the same loudness and pitch, but the sounds still sound different. This difference would be referred to as different timbres.

Note that sound waves are often represented by graphs like the one to the right. However, this graph only represents features of the wave, it is *not* how the actual sound waves look when they move through the air.



Features of sound waves are often put in graphs like these. This is *not* what the sound waves actually look like.

RELATING SOUND TO REAL LIFE

Burst Eardrum

Have you ever heard of a burst eardrum? Burst eardrums can happen in response to very loud sounds. Loud sounds create big vibrations. When the vibration is *too* big it can stretch the eardrum to the point of ripping, or popping.

The Loudest *Known* Sound Ever on Earth

The Krakatoa volcanic eruption in 1883 was so loud you could hear it 3,000 miles away. That is greater than the distance from California to New York. Needless to say, sound this loud would kill you. Even 40 miles away, this sound popped people's eardrums.

No Sound in Space

A lot of kids have heard that there is no sound in space, and this is correct! The reason is that there is no air or atmosphere in space. As we have learned, sound moves through air by vibrating through it. Sound *needs* molecules to vibrate, or the vibrations will not spread. Because there are very few air molecules in space to vibrate, sound will not travel. (There will be sound on some planets because some planets have atmospheres).

Dog Whistles

Sounds are simply vibrations traveling through the air. There are vibrations that travel through the air that we cannot hear, they just do not stimulate our eardrums in the right way! Dogs can hear sounds at higher frequencies (higher-pitched) than humans can. This is why dogs can hear a high-pitched dog whistle but humans cannot.

Over time, most people suffer some hearing loss. The most easily damaged part of our ear are those that respond to high frequency sounds. Therefore, many kids can hear high frequency sounds that adults cannot hear.

All About Sounds and Vibrations

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Sound in Water

Although most of the time we hear sounds that are traveling through air, sound can travel through water too. Think about it—water can vibrate and sounds are vibrations, so sound can travel through water. However, when your ears are submerged under water, the sound will be distorted compared to what you are used to hearing.

COMMON MISCONCEPTION

Kids might think sound cannot travel through materials. Show them that sound can travel through "stuff" by closing the door to your classroom and yelling "Hello" to them. Can they hear you? This is because the sound literally vibrated the door, and then vibrated the air on the other side of the door. (Of course, "sound-proof" materials will not transmit sound.)

RESOURCES

Articles

Wait, But Why (great graphics of sound waves): https://waitbutwhy.com/2016/03/sound.html

Decibel Comparison Chart (great, if slightly advanced, overview of sound, excellent pictures to show sound waves): https://ehs.yale.edu/sites/default/files/files/decibel-level-chart.pdf

Loudest Known Sound on Earth: https://kottke.org/14/10/the-worlds-loudest-sound and https://fivethirtyeight.com/features/the-loudest-sound-in-the-world-would-kill-you-on-the-spot/

Video

NASA segment on sound. Around 3:15 has a nice animation of vibrations in the ear: https://www.youtube.com/watch?v=_ovMh2A3P5k

Goes over parts of the ear (some advanced vocabulary): https://www.youtube.com/watch?v=HMXoHKwWmU8

More Fun Sound Activities

Spoons on a string: http://www.metrofamilymagazine.com/October-2014/Simple-Science-Experiment-The-Ringing-Spoon

Rubber Band Guitar (this can be done in a simple way—by just putting rubber bands on open boxes—or a more complicated way, as shown in this link): https://diy.org/skills/instrumentmaker/challenges/8/make-a-string-instrument

Sound eggs—fill them with anything! http://homelearningfrombirth.blogspot.co.uk/2010/08/sound-eggs.html

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