Sound and Vibrations

At this point you may be thinking to yourself, "O.K. Jim, I know our ears are our sound antennas, and I know that sound is pretty fast, but what is sound?" Good question. We're going to use a lot of that knowledge you've gained in the last few lessons to answer that question.

Sound is a form of energy. Energy is the ability to move something over a distance against a force, remember? What is moving to make sound energy? Molecules. Molecules are vibrating back and forth at fairly high rates of speed, creating waves. Energy moves from place to place by waves. Sound energy moves by longitudinal waves (the waves that are like a slinky). The molecules vibrate back and forth, crashing into the molecules next to them, causing them to vibrate, and so on and so forth. All sounds come from vibrations.

Do you remember when we talked about frequency and Hertz? Those are both terms to describe vibrations, right? Frequency describes how fast something is vibrating. Hertz is a measurement of frequency and one Hertz is one vibration per second.

Our ears are our sound antennas. When something vibrates it causes energy to move by longitudinal waves, from the object vibrating to our ears. If that something is vibrating between about 60 Hz and 20,000 Hz it will cause your ear drum to vibrate. This is sound.

When something vibrates, it pushes particles. These pushed particles create a longitudinal wave. If the longitudinal wave has the right frequency and enough energy, your ear drum antennas will pick it up and your brain will turn the energy into what we call sound.

Let's try a bunch of stuff with sound and vibrations to see if you can "catch the vibe."

Experiment 1

Feel Those Good Vibrations

You Need:

Radio, CD player, or some sort of music player

As large a speaker as you have

1. **Turn on your music player and turn it up fairly loud. (Tell your parents that it's for science!)**
2. **Take a look at your speaker. You should be able to see it vibrating. If there's a song with a lot of bass, you should really be able to see it moving.**
3. **Put your hand on the speaker. Can you feel the vibrations?**
4. **If you want to, you can carefully put a bowl of water on top of your speaker. You should be able to see the water vibrate.**

Remember that sound is nothing more than vibrating molecules. All speakers do is get molecules of air to vibrate, creating longitudinal waves. They push air. Your eardrums vibrate just like the speakers do when the longitudinal waves of sound energy hit your ears.

Experiment 2

To The Beat of your own Ear Drum

You need:

Radio, CD player, or some sort of music player

As large a speaker as you have

A balloon

Synthesizer or piano keyboard (optional)

1. **Inflate the balloon. Get it fairly large.**
2. **Turn the music on loud (the more bass the better).**
3. **Put both hands lightly on the balloon.**
4. **Walk around the room holding the balloon lightly between your hands.**
5. **Try to feel the balloon vibrating.**
6. **Does the balloon vibrate more for low sounds or high sounds?**
7. **If you have a synthesizer (piano keyboard) you may want to try turning it up a bit and playing one note at a time. You should notice that the balloon vibrates more or less as you go up and down the musical scale. At very high notes, your balloon may not vibrate at all. We'll talk more about why this happens in the next lesson.**

What's causing the balloon to vibrate? Energy. Energy causes objects to move a distance against a force. The sound energy coming from the speakers is causing

the balloon to vibrate. Your ear drums move in a very similar way to the balloon. Your ear drum is a very thin membrane (like the balloon) that is moved by the energy of the sound. Your ear drum, however, is even more sensitive to sounds than the balloon which is why you can hear sounds when the balloon is not vibrating. If you ear drum doesn't vibrate, you don't hear the sound.

Experiment 3

Ringing the Bells of Science

You need:

A mixing bowl (one of those metal bowls)

Something to hit it with (a wooden spoon works well)

Water

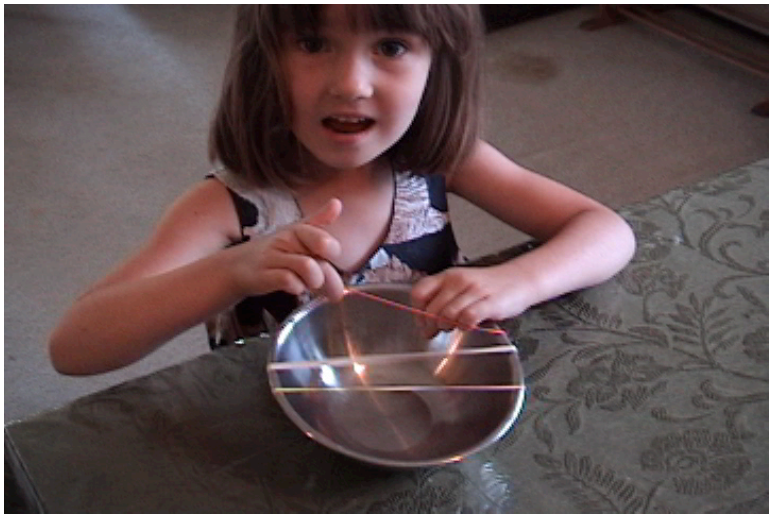
1. Take the mixing bowl and put it on the table.
2. Smack it with the wooden spoon.
3. Listen to the sound.
4. Put your ear next to the bowl and try to hear how long the sound continues.
5. Now hit the bowl again.
6. Touch the bowl with your hand a second or two after you hit it. You should hear the sound stop. This is called dampening.
7. Now, for fun, fill the bowl with water up to an inch or so from the top.
8. Smack the bowl again and look very carefully at where the bowl touches the water.
9. When you first hit the bowl, you should see very small waves in the water.

I want you to notice two things here. Sound is vibration. When the bowl is vibrating, it's making a sound. When you stop it from vibrating, it stops making sound. Any sound you ever hear, comes from something that is vibrating. It may have vibrated once, like a balloon popping. Or it may be vibrating consistently, like a guitar string.

The other thing I want you to notice is that you can actually see the vibrations. If you put water in the bowl, the tiny waves that are formed when you first hit the bowl are caused by the vibrating sides of the bowl. Those same vibrations are causing the sound that you hear.

Experiment 4

The Rubber Band Band



You need:

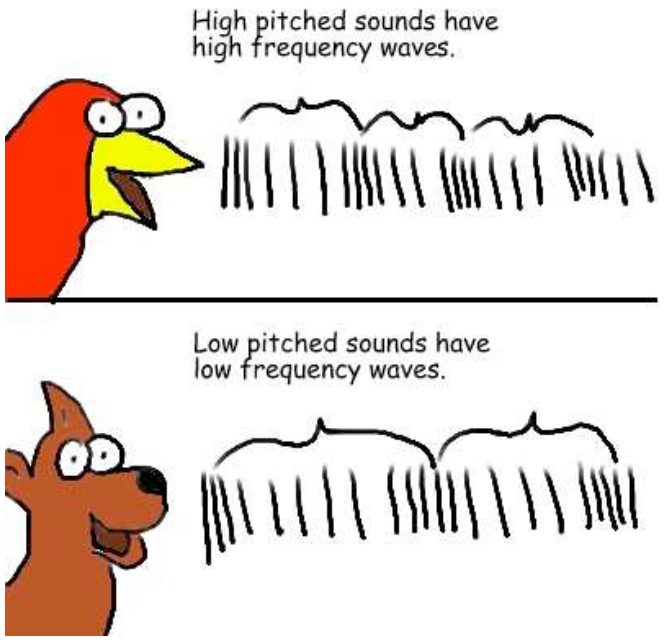
Shoe box or a mixing bowl

As many different sizes of rubber bands as you have (3-6 is good)

1. Stretch a few rubber bands around the box or the bowl. If possible, use different thicknesses of rubber bands.
2. Strum the rubber bands.
3. Feel free to adjust how stretched the bands are. The more stretched, the higher the note.
4. Try plucking a rubber band softly.

5. Now pluck it fairly hard. The hard pluck should be louder.

Again I'd like you to notice three things here. Just like the last experiment, you should see that the sound is coming from the vibration. As long as the rubber band vibrates, you hear a sound. If you stop the rubber band from vibrating, you will stop the sound. Sound is vibration.



The second thing I'd like you to notice is that the rubber bands make different pitched sounds. The thinner the rubber band, or the tighter it's stretched, the faster it vibrates. Another way to say "vibrating faster" is to say higher frequency. In sound, the higher the frequency of vibration, the higher the pitch of the note. The lower the frequency, the lower the pitch of the note. The average human ear can hear sound at as high a frequency as 20,000 Hz, and as low as 20 Hz. Pianos, guitars, violins and other instruments have strings of various sizes so that they can vibrate at different frequencies and make different pitched sounds. When you talk or sing, you change the tension of your vocal cords to make different pitches.

One last thing to notice here, is what happened when you plucked the rubber band hard or softly. The rubber band made a louder noise the harder you plucked it right? Remember again that sound is energy. When you plucked that rubber band hard, you put more energy into it than when you plucked it softlt. You gave energy (moved the band a distance against a force) to the rubber band. When you released the rubber band, it moved the air against a force which created sound energy. For sound, the more energy it has, the louder it is. Remember when we talked about amplitude a few lessons back? Amplitude is the size of the wave. The more energy a wave has the bigger it is. When it comes to sound, the larger the wave (the more energy it has) the louder it is. So when you plucked the rubber band hard (gave it lots of energy), you made a louder sound.

I said this in the beginning but I'll repeat it here, hoping that now it makes more sense. When something vibrates, it pushes particles against a force (creates en-

ergy). These pushed particles create longitudinal waves. If the longitudinal waves have the right frequency and enough energy (loudness), your ear drum antennas will pick it up and your brain will translate the energy into what we call sound.

Next lesson, we'll get a bit more into frequency and a really fun concept called resonance. In the meantime, be sure to make some noise! Remember, it's for science!

In a Nutshell

Sound is a form of energy.

Sound is molecules moving back and forth (vibrating) creating longitudinal waves.

All sound comes from something vibrating.

Frequency of sound waves determines the pitch.

Sound waves with a high frequency have high pitches. Sound waves with low frequencies have low pitches.

The human ear can hear sound energy as low as 20 Hz and as high as 20,000 Hz.

The more energy sound has, the larger the wave is (higher amplitude) and the louder it is.

We hear sound because vibrating particles vibrate our eardrums and our brain translates those vibrations into sound.

Did You Get It

1. If sound is a form of energy, what's moving?

2. All sound comes from what?

3. What kind of a wave is sound?

4. What does frequency have to do with sound?

5. What does amplitude have to do with sound?

6. What made the balloon vibrate when we played sound over the speakers?

Answers

1. Energy is the ability to move something against a force. In the case of sound, molecules are moving.

2. Vibrations. No vibration, no sound.

3. Longitudinal wave.

4. Frequency determines the pitch of the sound. The higher the frequency, the higher the pitch. The lower the frequency the lower the pitch.

5. The higher the amplitude of the wave, the louder the sound is. Higher amplitude means more energy which means louder sound.

6. Energy. Energy causes objects to move a distance against a force. The sound energy coming from the speakers is causing the balloon to vibrate.