Seeing Sound Waves

Overview: This section is actually a collection of the experiments that build on each other. We'll be playing with sound waves in many different forms, and you get to have fun making a loud mess.

What to Learn: Sound is made by vibrating objects and can be described by its pitch and volume.

Materials

- radio or some sort of music player
- balloon
- mixing bowl
- water
- spoon
- rubber bands

Lab Time

1. Turn on your music player and turn it up fairly loud.
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. Teachers/Parents Only: Carefully put a half-filled bowl of water on top of your speaker. You should be able to see the water vibrate. (Don't leave it there! Put it away as soon as you're done with this step.)
5. Inflate the balloon. (Get it fairly large. You want the membrane to be stretched fairly thin.)
6. Turn the music on loud (the more bass the better!).
7. Put both hands lightly on the balloon.
8. Walk around the room holding the balloon lightly between your hands. Try to feel the balloon vibrating.
9. Does the balloon vibrate more for low sounds or high sounds?
10. 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.
11. Now for the last part. Take the mixing bowl and put it on the table.
12. Smack it with the wooden spoon. Listen to the sound.
13. Put your ear next to the bowl and try to hear how long the sound continues.
14. Now hit the bowl again.
15. Touch the bowl with your hand a second or two after you hit it. You should hear the sound stop. This is called dampening.
16. Now, for fun, fill the bowl with water up to an inch or so from the top.
17. Smack the bowl again and look very carefully at where the bowl touches the water. (When you first hit the bowl, you should see very small waves in the water.)
18. Stretch a few rubber bands around the box or the bowl. If possible, use different thicknesses of rubber bands.
19. Strum the rubber bands.

20. Feel free to adjust how stretched the bands are. The more stretched, the higher the note.
21. Try plucking a rubber band softly.
22. Now pluck it fairly hard. The hard pluck should be louder.

Again, I'd like you to notice three things here. Just like the first part of the 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 softly. 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 energy). 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.

Seeing Sound Waves Data Table

Rubber Band Size	Plucking Hard or Soft?	Pitch / Volume Observations

Reading

Sound is vibrating molecules. Speakers get air molecules to vibrate, creating waves that push the air. Eardrums vibrate just like speakers do when the sound waves hit the ears.

You'll be doing a couple of different experiments with this lab. First, you'll be feeling the vibrations from a speaker playing music. You'll also notice what happens when you place a bowl of water right on top of a speaker. Next, you'll use a balloon to detect treble and bass pitches of music, and finally you'll set up your own vibrations using a homemade guitar.

Sound waves don't just travel to your eardrum. They travel all over the room, bouncing into everything they can find, including windows, tables, chairs, and the balloon you're going to be using. What's causing the objects to vibrate?

Energy. Energy causes objects to move a distance against a force. The sound energy coming from the speakers is causing the objects to vibrate. Your eardrums move in a very similar way to a balloon, which is why we're going to use it in part of our experiment. Your eardrum is a very thin membrane (like the balloon) that is moved by the energy of the sound. Your eardrum, however, is even more sensitive to sounds than the balloon which is why you can hear sounds when the balloon is not vibrating. If your eardrum doesn't vibrate, you don't hear the sound.

I want you to notice two things here. Sound is vibration. When something 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 and set it on top of a speaker, 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.

Exercises Answer the questions below:

1. What is sound?

2. How does the rubber band make different sounds?

3. What difference does it make how hard or soft you pluck the rubber bands?

Answers to Exercises: Seeing Sound Waves

1. What is sound? (Sound is vibrating air molecules.)
2. How does the rubber band make different sounds? (Thinner rubber bands are stretched more tightly, so it vibrates faster and makes a higher pitched sound.)
3. What difference does it make how hard or soft you pluck the rubber bands? (Since sound is energy, the harder you pluck, the more energy you give the rubber band, which means a larger amplitude sound wave and a higher volume or louder sound.)