Power of Music: Transforming Energy

Sound is everywhere. We encounter the power of music everyday: Every time you jam out to your favorite tunes, your body is converting sound waves into energy. Sometimes, the music is so powerful that you can even feel vibrations. Our bodies are doing this every time we hear any type of sound, even if it isn't music. In this module we will be exploring what are sound waves, and how they interact with the world.

Experiment #1: String Phone

Setting the Scene

You are an electrical engineer and all telecommunications are being monitored. You are tasked with relaying top secret information to your co-worker across the street without using any existing communication systems.

Get Creative: Brainstorm how you would get this secret message across the street. You may talk to a partner. Sketch your ideas below.

The Set Up

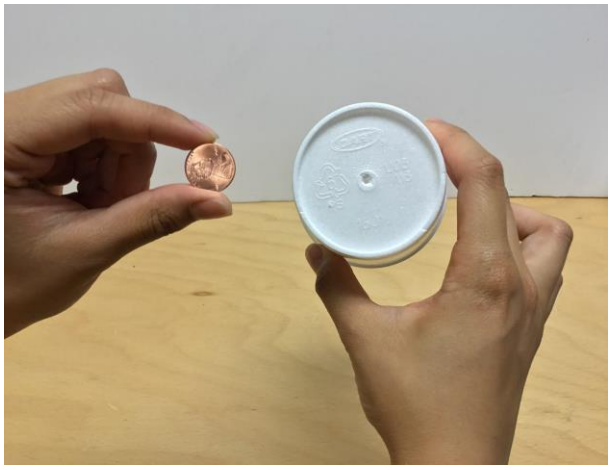
Create a phone using simple objects to explore how sound travels

Materials:

- 2 cups
- String
- Tape
- Pencil

Procedure:

1. Create a small hole in the bottom of each cup with a pencil.



2. Measure 25 feet of string and cut it.

3. Thread the string through each of the holes in the cups, securing it with a knot. It may also be helpful to tape the knot to stop it from pulling through and damaging the cup.

4. Each person obtain a cup.
5. Experiment with the string phone by whispering a secret message to your partner. See if you can hear the message and repeat it back to your partner.

Collecting Qualitative Data

What was the most successful way to operate your cup phone?

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After experimenting with the string phone make a *hypotheses* about how you are hearing the sound from your partner.

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Cut the string in half. Try it again. Was anything different? Record your observations below?

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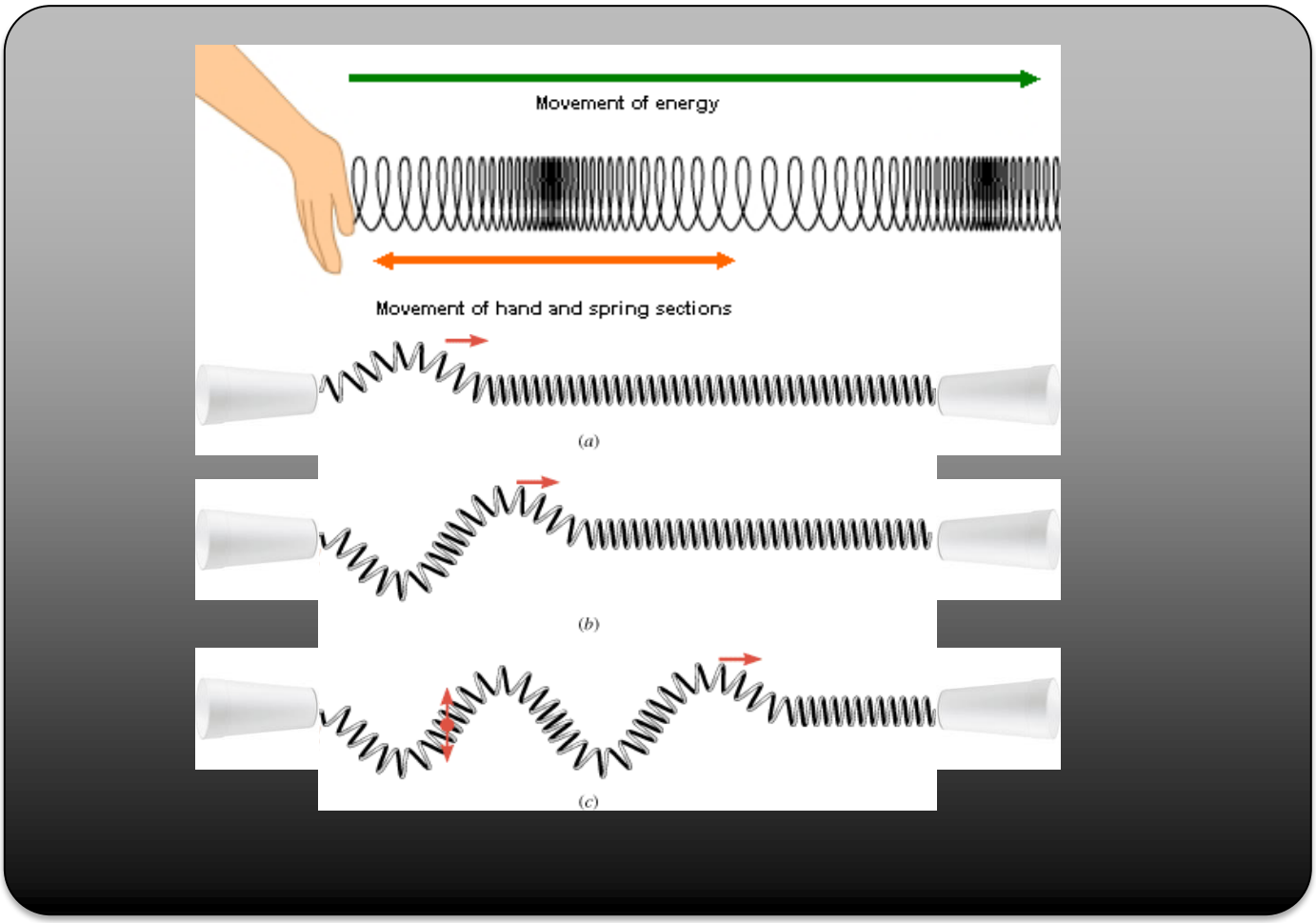
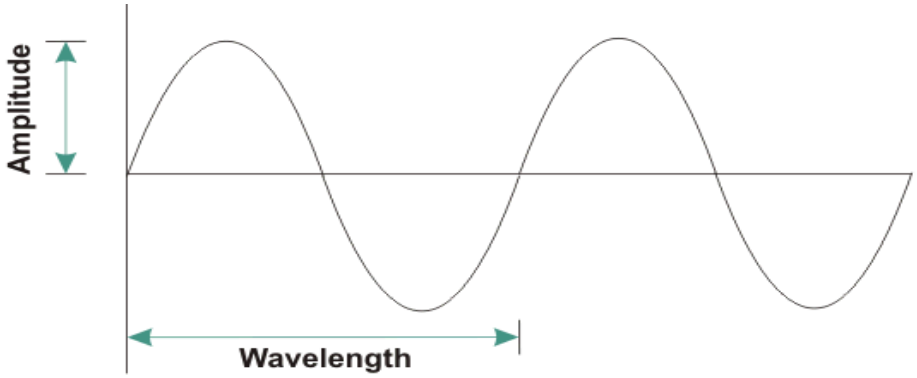
Waves move in an up-and-down motion or side-to-side motion to create vibrations to the molecules around it. Waves travel through gasses, liquids, or even solids to create sound. A material that a wave travels through is called a medium.



What is a wave?

Waves *are vibrations that transfer energy from place to place without matter (solid, liquid or gas) being transferred*. Waves move all around us constantly, without us even noticing. They influence many of the interactions we have every day by allowing us to hear and see changes in the world around us. Sound waves cause vibrations that allow us to hear things around us as they interact with them. The pitch and volume of the sound are determined by the amplitude and wavelength of wave. The **amplitude** is the half of the total height of the wave, and the **wavelength** is the distance between two crests in a wave



Reflection

Think about how sound was created and how it traveled from you to your partner. Using your experience with the cup phone and information from the text above, Sketch a diagram showing how the sound travels from one person's mouth to the other person's ears. Include in your diagram words, arrows, lines showing movement, doodles etc. to provide as much detail as possible.

Share your diagram with a partner.

Experiment #2: Model Eardrum: Converting Sound into Energy

Setting the Scene

Can you generate energy from sound?

We know that sound is made from waves, which transfer energy, but what can we do to capture this energy and make it useful? You may not know how but your body does!

You are hired as a consulting Biomedical engineer for Beats by Dre to help them make their headphone design safe for the public. You must design a simple demonstration to show them how sound affects the ear.

The Set Up

Materials:

- Plastic Wrap
- Paper Cup
- Salt
- Rubber Band
- Optional: Water

1. Cut the styrofoam cup 3 inches from the top.

2. Cover the top of the cup with plastic wrap.

3. Secure the plastic wrap with the rubber band and ensure that the plastic wrap is taut over the top.

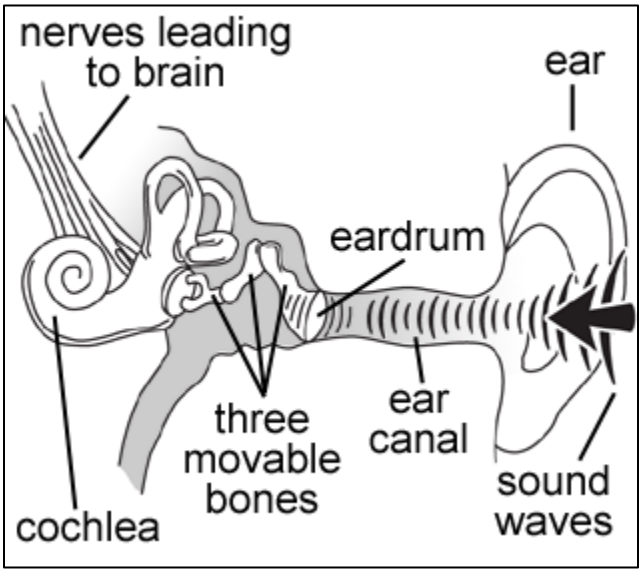
4. Sprinkle salt on top of the plastic wrap.

5. Place speakers or your phone under the model eardrum.

Try experimenting with your “eardrum” by choosing a couple other songs to play. How do the different songs change how it reacts to the sound waves? Record your observations below!

Collecting Data

Song Characteristics	Observations
Fast Beat	
Slow Beat	
Loud	



The eardrum is a thin membrane that vibrates inside of the ear when it comes into contact with sound waves. Different waves cause different frequencies of vibration, or **wavelengths**, in the eardrum. This allows us to hear different pitches while the **amplitude** of the waves determines the volume.

Reflection

You are meeting with Dre and his engineers later on today. You were asked to provide a visual demonstrating how sound travels from headphone/speaker to eardrum. You can use elements from your sketch during the first activity. Use the space below to create your visual.

Experiment #3: DIY Speaker

Setting the Scene

Dre and his engineers were so impressed by your visual demo that they would like you to design and build a simplified model of “How headphones work”. This model will be displayed in Apple stores so customers can learn how electrical energy is converted into the form of acoustic energy.

The Challenge

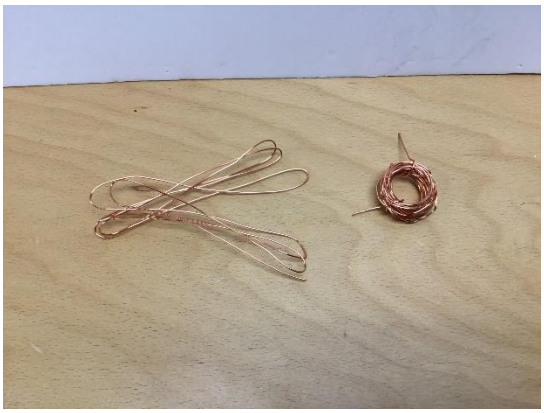
Build your own mini-speaker to explore how electrical energy is transformed into sound

The Set Up

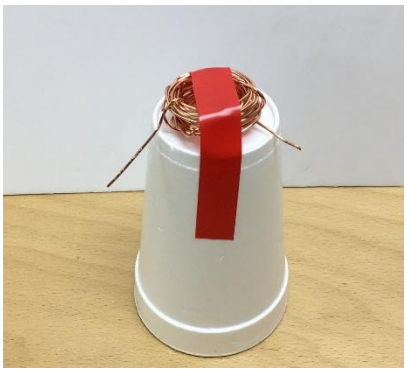
Materials:

- Soldering kit
- Copper wire
- Magnet
- Paper cup
- Electrical tape
- Small cap

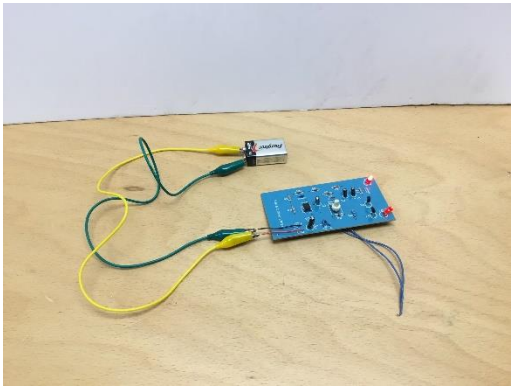
Procedure:



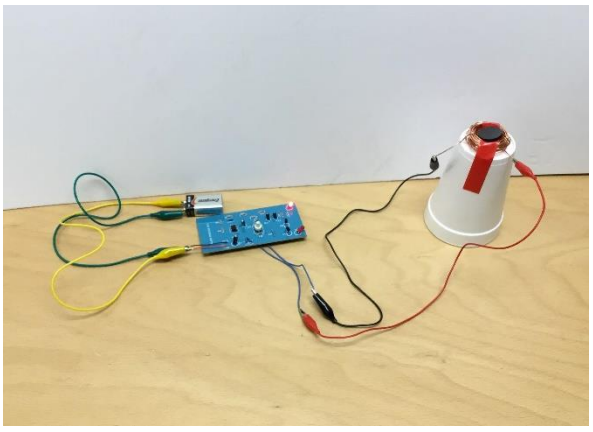
1. Coil the copper wire around a small cap. Make sure to open ends of wire are sticking out so that you can connect them to the soldering board provided.



2. Use electrical tape to secure the coil to the bottom of the paper cup.



3. Connect the (+) and (-) terminals on the 9V battery to the corresponding signs on the soldering board



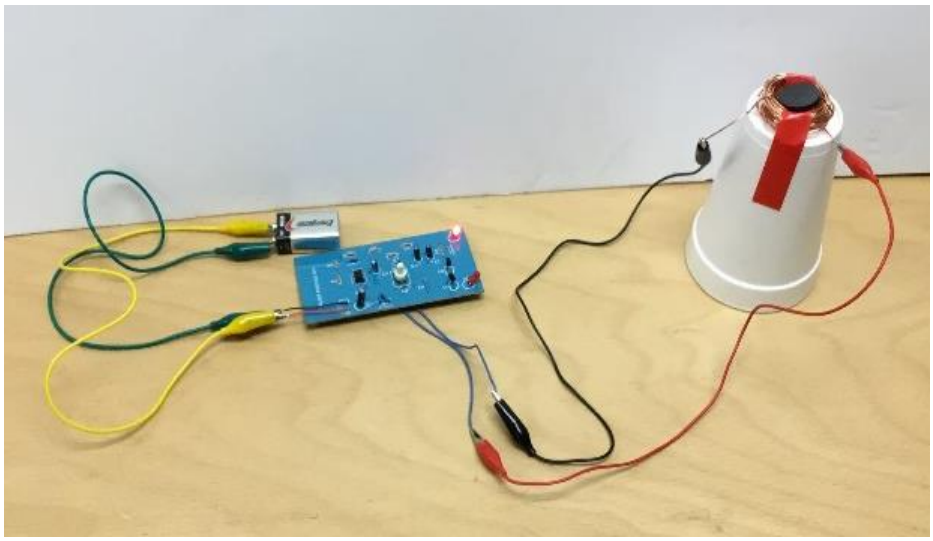
4. Connect the open ends of the coil to the open end of the wires coming from the board using alligator clips.

5. Place the cup to your ear and see if you can hear the siren. Adjust the potentiometer to see how it affects the sound.

How often do you hear music on T.V., in your headphones or in the car on the way to school? You wouldn't be able to hear music around you at all if it wasn't for speakers, electric sound-making machines. A lot of the music we hear around us is played back to us in mini-speakers in headphones or bigger speakers built into computers or cell phones.

Reflection

Look at the following diagram.



Energy Source
Wires
Magnet
Copper Wire
Styrofoam Cup

If we wanted to increase the strength of the sound, what would you change and why do you think it is a good alteration?

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Discussion

Energy exists in many different forms: **Mechanical, Acoustic, Electrical** and many more.

Mechanical: Energy of Motion

Acoustic: Energy of Sound

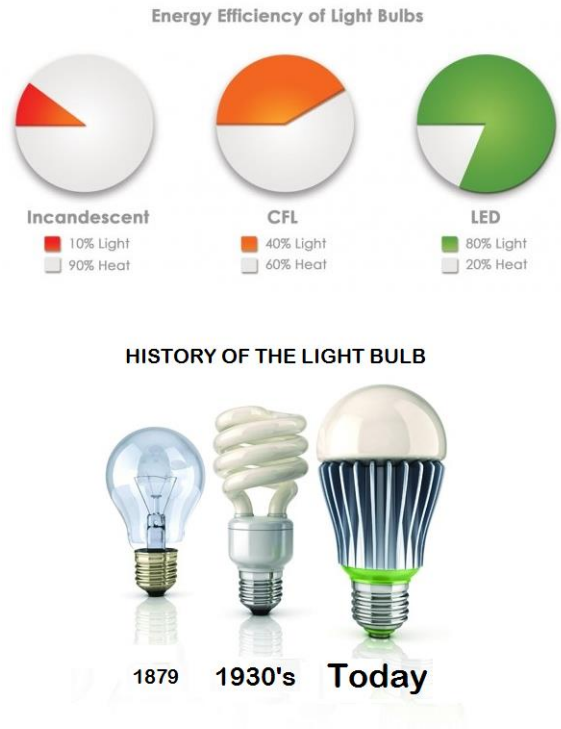
Electrical: Energy of Charge (+)

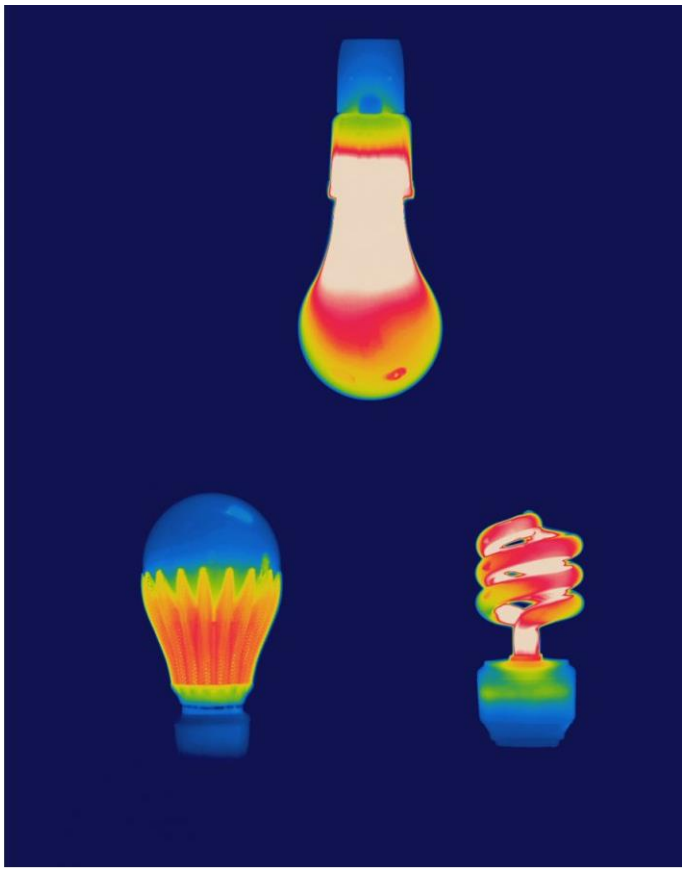
We use energy in almost everything we do, so it is very important that we know how to convert it between forms because it allows us to capture different types of energy and transform it into energy that we can use (mostly mechanical and electrical). In order for us to use renewable energy, we will have to know how to harness the different energy forms, so finding a new way to convert it may help to end the energy crisis.

For example, windmills convert the mechanical energy of the wind turning of its blades into electrical energy that can be used for everyday activities.

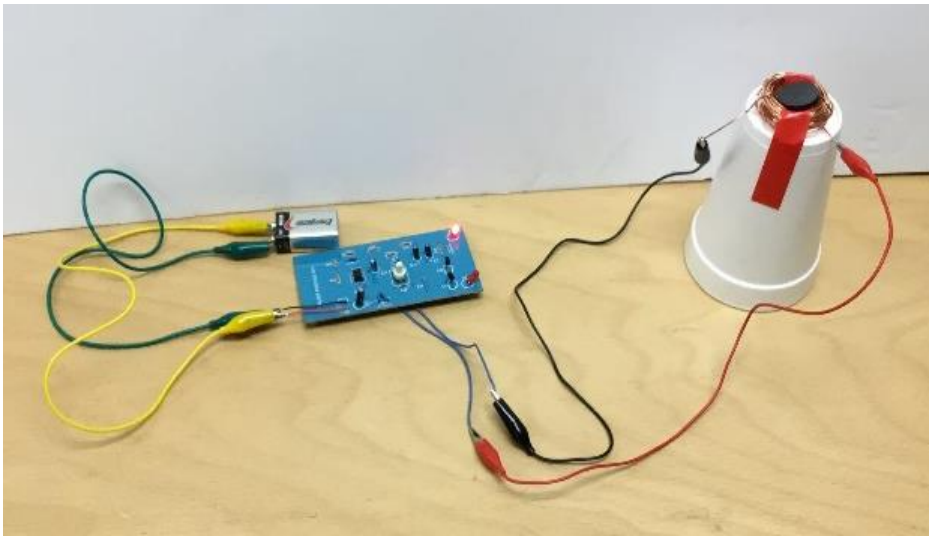
Energy conversion is not always 100% efficient. Not all energy in a system is converted to the desired form because there is some **energy loss**. Over the years, improvements in technology have minimized energy loss during conversions.

For example, incandescent light bulbs were originally used to convert electrical energy to light energy, but this conversion was extremely inefficient because this process created more heat than light (see left hand side of the image below). This can also be seen in the thermal figure (right hand side, blue background). The color white/red indicate high temperatures during use. This color dominates the incandescent bulb, while the LED and CFL light bulbs have larger sections of blue, which represent lower/cooler temperatures. This is due to their improved designs that convert energy more efficiently.





Looking at the three types of energy forms above, draw arrow(s) to show where energy was converted into 1) energy of motion, energy of sound and, energy of charge.



Now that you've learned that energy conversions are not 100% efficient, do you think that all the energy in the battery is converted into acoustic energy in the styrofoam cup?

Yes OR No

Please elaborate on why you chose YES or NO.

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