


Slinky® toys easily model sound waves.
Photo © Enoch Lau CC-BY-3.0.

A Sound Education: Wacky Waves

Gregory L. Vogt, EdD
Center for
Educational Outreach
Baylor College of Medicine
Revised 2014



BioEd Online
Biology Teacher Resources from Baylor College of Medicine

A Sound Education: Wacky Waves

Image Reference

Slinky rainbow photo © Enoch Lau. CC-BY-3.0.

http://commons.wikimedia.org/wiki/Slinky#mediaviewer/File:Slinky_rainbow.jpg

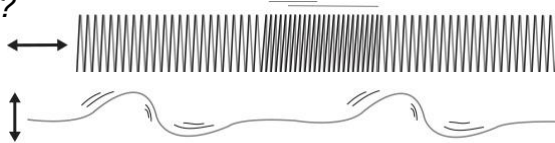
Key Words

sound, amplitude, compression wave, frequency, hearing, l-wave, longitudinal wave, oscillation, pitch, sound wave, vibration

A Sound Education: Wacky Waves © Baylor College of Medicine. Revised 2014.

Modeling Sound Waves

1. Take one end of a Slinky® and have a partner take the other end. Stand across from each other. Hold tight to the Slinky® and shake it up and down.
2. Stretch the Slinky® across a table. Without letting go of either end, compress and release the coils. Now shake Slinky® side to side.
3. Repeat the tests with a length of rope or string. *Which motion and object do you think best models sound waves?*



Modeling Sound Waves

Materials*

- Slinky® toy
- Light-weight rope or piece of string, comparable in length to the Slinky® toy when it is stretched across a table.
- Flat table or surface for two students to stretch both items across it

*Materials listed above are for one sound station or demonstration. Adjust quantities for students working in teams.

Optional

As an alternative to purchasing Slinky® toys, long, coiled springs may be purchased from school science supply catalogs.

Safety Note

Instruct students not let go of the long spring when it is stretched.

Questions to Ask

3. Which motion and object do you think best models sound waves? [Students probably will say the Slinky® is a better model. But depending on how the question is worded, either answer can be correct.]

Image Reference

Illustrations by G.L. Vogt, EdD.

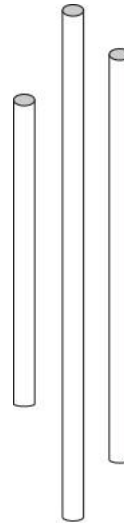
Key Words

sound, compression wave, frequency, l-wave, longitudinal wave, sound wave, wave propagation, wavelength

A Sound Education: Wacky Waves © Baylor College of Medicine. Revised 2014.

Ambient Sounds

1. Select a large sea shell and hold it to your ear. *What do you hear?*
2. Now, select a plastic tube and hold it to your ear. *What do you hear?*
3. Switch to a tube of a different length and hold it to your ear. *What do you hear now? Can you explain where the sound is coming from?*



BioEd Online
Biology Teacher Resources from Baylor College of Medicine

Not to scale.

Ambient Sounds

Air is in a constant state of vibration, due to both the random motion of its molecules and ambient sound waves. A seashell can act as a resonator that vibrates with certain frequencies of ambient noise. Almost any kind of seashell large enough to cover the ear will work, producing a sound resembling ocean waves. If you don't have a large seashell, you can cup your hand over your ear to achieve the same effect.

Similarly, plastic tubes of varying lengths also pick up ambient sound waves. A tube's length and diameter determine the frequencies with which it will resonate. Longer tubes resonate with low sounds; shorter tubes with higher pitch sounds.

Materials*

- 1/2-in. diameter plastic tubes of varying lengths
- Large sea shells, including at least one conch shell

*Materials listed above are for one sound station or demonstration. Adjust

quantities for students working in teams.

Optional

Obtain a second conch shell and cut off the tip. Have students blow into the shell and into the plastic tubes to experiment with the sounds produced.

Questions to Ask

1. Select a seashell and hold it to your ear. What do you hear? [What students actually hear is the ambient sound of the room. All external sounds are combined in the shell, producing white noise that may resemble waves or wind.]
2. Now, hold one of the plastic tubes to your hear. What do you hear? [Same as answer for item 1.]
3. Select a different tube and hold it to your ear. What do you hear now? Can you explain where the sound is coming from? [The longer the tube, the lower-pitched the sound. This same principal controls the sound of a pipe organ. Longer pipes have a lower pitch.]

Image Reference

Illustrations by G.L. Vogt, EdD.

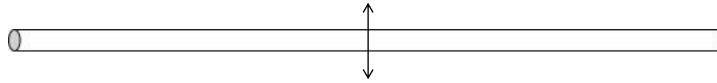
Key Words

sound, ambient sound, amplitude, frequency, hearing, pitch, sound wave, vibration

A Sound Education: Wacky Waves © Baylor College of Medicine. Revised 2014.

Natural Frequencies

1. Make sure no one is nearby. Grip the center of the PVC pipe with one hand .



2. Shake the pipe up and down. Watch the pipe ends as you shake it slowly, then gradually faster. *Is there a speed at which the pipe ends seem to be moving in time with your shaking motion? What is happening?*



Natural Frequencies

The natural frequency of an object depends on the material and its length.

Materials*

- 10-ft-long PVC pipe (1/2-in. diameter)

*Materials listed above are for one sound station or demonstration. Adjust quantities for students working in teams.

Questions to Ask

2. Is there a speed at which the pipe ends seem to be moving in time with your shaking motion? What is happening? [The ends of the pipe wave widely when the shaking speed matches the pipe's natural frequency (the speed at which the pipe ends wave). Energy transferred to the pipe from the waving hand will initiate—and magnify—the waving of the pipe. If the speed is not matched to the pipe's frequency, the vibration of the pipe will be jumbled and there will be no clear waving pattern.]

Image Reference

Illustration by G.L. Vogt, EdD.

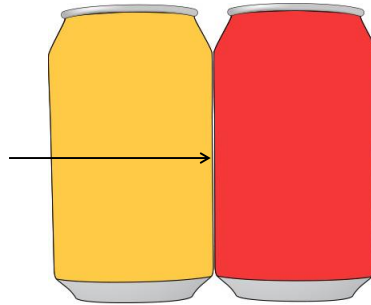
Key Words

sound, frequency, hearing, pitch, sound wave, vibration

A Sound Education: Wacky Waves © Baylor College of Medicine. Revised 2014.

Can Cacophony

1. Hold two soft drink cans together so that they lightly touch each other.
2. Blow through the middle of the cans.
Where does the sound come from?



BioEd Online
Biology Teacher Resources from Baylor College of Medicine

Modified illustration © tovan. Licensed for use.

Can Cacophony

It may take some practice to make the sound.

Materials

- 2 clean soft drink cans

*Materials listed above are for one sound station or demonstration. Adjust quantities for students working in teams.

Questions to Ask

2. Where does the sound come from? [The sound comes from air vibrating between the two cans.]

Image Reference

Modified illustration (simplified) 11430992 © tovovan. Licensed for use.

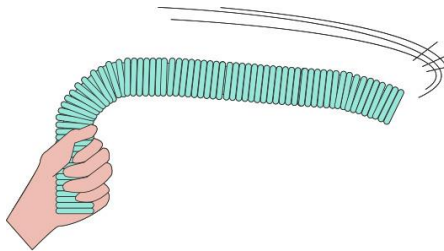
Key Words

sound, amplitude, frequency, hearing, pitch, sound wave, vibration

A Sound Education: Wacky Waves © Baylor College of Medicine. Revised 2014.

A Swinging Time

1. Make sure you have a clear area without anyone nearby.
2. Pick up the plastic tube and hold one end above your head.
3. Twirl the tube rapidly. *What happens? Why?*



A Swinging Time

Materials

•3 ft x 1 1/2-in. diameter flexible, reinforced PVC tubing (The flexible plastic tube must have inside corrugations (ridges) to produce sound.)

*Materials listed above are for one sound station or demonstration. Adjust quantities for students working in teams.

Questions to Ask

3. What happens? Why? [Sound vibrations result from the turbulence produced by air molecules tumbling across the ridges inside the tube. The pitch depends on how quickly the tube is twirled.]

Image Reference

Illustration by G.L. Vogt, EdD.

Key Words

sound, amplitude, frequency, hearing, sound wave, vibration

A Sound Education: Wacky Waves © Baylor College of Medicine. Revised 2014.

How to Make a Wooden Mallet

1. Purchase a wooden dowel with matching wooden ball (pre-drilled hole) from a craft shop.
2. Put a small dab of hot glue on one end of the wooden dowel and slide it into the hole in the wooden ball. Position the ball and wipe off any excess glue. The mallet is ready when the glue is dry.



BioEd Online
Biology Teacher Resources from Baylor College of Medicine

How to Make a Wooden Mallet

Materials*

- Hot glue gun with glue
- Wooden dowel with matching one-hole wooden balls (pre-drilled)

*Materials listed above are to make one mallet; adjust quantity as needed.

Optional

As an alternative to making the wooden mallet, you can purchase inexpensive, wooden Glockenspiel mallets (and rubber mallets) by the pair at music stores or other online stores, such as the Guitar Center for about \$3.00 - \$6.00 per pair. <http://www.guitarcenter.com/Orff-Mallets-Orff-Instruments.gc>

Image Reference

Illustration by G.L. Vogt, EdD

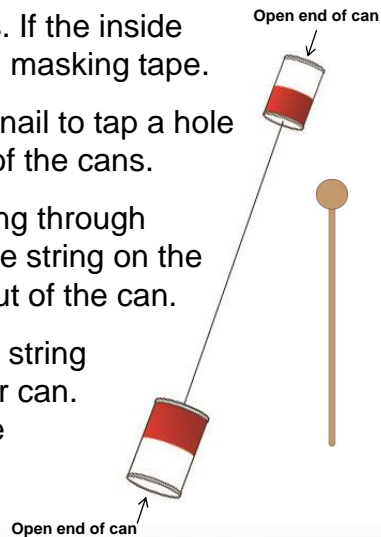
Key Words

sound, mallet, music, sound wave

A Sound Education: Wacky Waves © Baylor College of Medicine. Revised 2014.

Make a Can-ophone

1. Clean two empty soup cans. If the inside edges are sharp, cover with masking tape.
2. Use a hammer and a small nail to tap a hole in the center of the bottom of the cans.
3. Thread a 30-ft length of string through the hole of one can. Knot the string on the inside so it does not slide out of the can.
4. Thread the loose end of the string through the hole in the other can. Knot the string on the inside as before.



Modified illustration of soup cans © tekart. Licensed for use.

Make a Can-ophone

Typically, sound travels through air, but sound waves also can travel through solids and liquids. In fact, sound travels more rapidly through solids and liquids than through gases (such as air).

This activity demonstrates how sound can travel through solids (via cans and taut string). As one student speaks into his or her can, vibrations of the sound waves move from that can, through the string, and into the second can.

Materials*

- 30-ft piece of string
- 2 soup cans
- 2 wooden mallet (See slide 7 for instructions on how to make the mallets and for purchasing options.)
- Hammer
- Masking tape
- Small nail

*Materials listed above are for one sound station or demonstration. Adjust quantities for students working in teams.

Caution

Check for sharp edges where the lid was removed on each can. Cover with masking tape if necessary.

Image Reference

- 1.Modified illustration (simplified) 11430992 © tekart. Licensed for use.
- 2.Mallet illustration by G.L. Vogt, EdD.

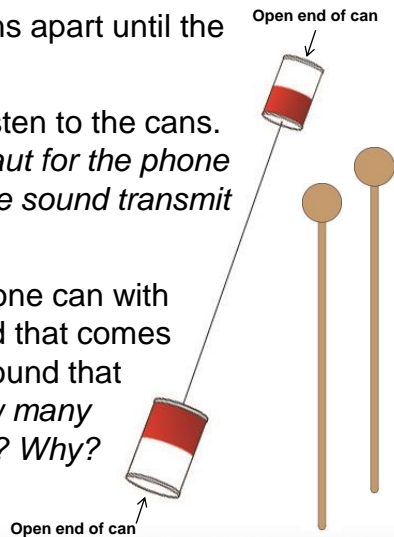
Key Words

sound, amplitude, frequency, hearing, pitch, sound wave, wave propagation, vibration

A Sound Education: Wacky Waves © Baylor College of Medicine. Revised 2014.

Test the Can-ophone

1. With a partner, move the cans apart until the string is taut.
2. Alternately speak into and listen to the cans. *Does the string have to be taut for the phone to work? Why? How does the sound transmit from one can to the other?*
3. Take turns tapping the side one can with a mallet. Listen for the sound that comes through the air and for the sound that comes through the can. *How many sounds do each of you hear? Why?*



Modified illustration of soup cans © tekart. Licensed for use.

Test the Can-ophone

Materials

- See slide 7, “How to Make a Wooden Mallet.”
- See slide 8 “Make a Can-ophone.”

Questions to Ask

2. Does the string have to be taut for the phone to work? Why? How does the sound transmit from one can to the other? [Yes. A loose string will not transmit vibrations. Sound waves travel from the can through the string to the other can.]
3. The listener hears two taps, first via the can and then through the air. Sound travels through solids faster than through the air. You can hear two sounds because sound travels through solids (can and string), faster than it does through air.]

Image Reference

- 1.Modified illustration (simplified) 11430992 © tekart. Licensed for use.
- 2.Mallet illustration by G.L. Vogt, EdD.

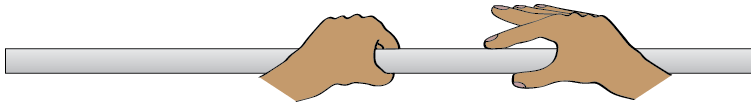
Key Words

sound, amplitude, frequency, hearing, pitch, sound wave, wave propagation, vibration

A Sound Education: Wacky Waves © Baylor College of Medicine. Revised 2014.

Rosinated

1. Hold a metal rod in its center with one hand. Dip the fingertips of the other hand into a bag of rosin.
2. Slide your fingertips away from the hand holding the rod. Repeat two or three times. *What happens?*



Rosinated

Rosin is made from the resin of pine trees. It is used to increase the friction between the hair of the bow and the string of an instrument such as a violin.

Materials

- Bag of rosin (available at school science supply stores)
- 20-in. (or longer) smooth metal rod

*Materials listed above are for one sound station or demonstration. Adjust quantities for students working in teams.

Questions to Ask

What happens? [As the coated fingertips move across the rod, the rosin causes them to “slip” and “stick” in a rapid cycle. This causes the rod to vibrate and produce sound. Quickly repeating the movement increases the amplitude as more sound waves are added to the first.]

Image Reference

Illustration by Christopher Burnett, BA.

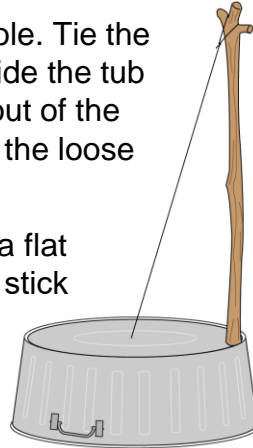
Key Words

sound, amplitude, frequency, friction, hearing, music, pitch, rosin, sound wave

A Sound Education: Wacky Waves © Baylor College of Medicine. Revised 2014.

Make a Washtub Bass

1. Punch a hole in the bottom center of a steel washtub.
2. Insert a wire (or string) through the hole. Tie the end of the wire to a metal washer inside the tub (to keep the wire from slipping back out of the hole). Turn the tub upside down. Pull the loose wire to the outside of the tub.
3. Saw one end of a long stick to make a flat "bottom." Have a partner position the stick at the edge of the tub vertically.
4. Pull the loose wire until it you can loop it around the top of the stick (see illustration, right).



BioEd Online
Biology Teacher Resources from Baylor College of Medicine

Make a Washtub Bass

A washtub bass, or "gutbucket," is a stringed instrument used in American folk music. It employs a metal washtub as a resonator to produce the deep bass sound. The tension of the gut string or wire determines the pitch created when the instrument is when it is plucked.

Materials

- Hammer
- Metal washer (or peg)
- Piece of guitar or piano string, longer than the stick (You also may use cotton or nylon string, but wire is more durable.)
- Saw
- Small nail
- Steel washtub
- Stick with a few knobs on one end (see illustration)

*Materials listed above are for one sound station or demonstration. Adjust

quantities for students working in teams.

Optional

To create the washtub base with a modified broom handle, follow the steps below.

1. Follow steps 1 and 2 for the washtub and wire.
2. Saw off the bristle end of a broom, leaving a flat end.
3. Cut a notch across the center of the flat end, roughly the same size as the raised bottom of the washtub.
4. Drill a hole through the rounded end, about 2 inches from the top.
5. With a partner, position the notched end of the broom handle over the raised bottom ridge of the washtub so that it “stands” vertically.
6. Pull the loose wire outside of the washtub and thread it through the hole at the top of the broomstick. Tie the wire to secure it.

Image Reference

Illustration by G.L. Vogt, EdD.

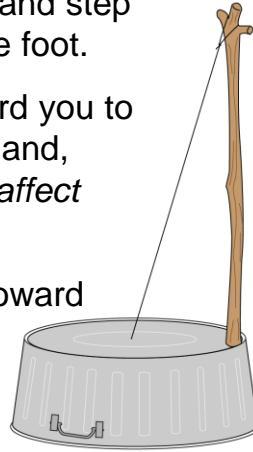
Key Words

sound, amplitude, frequency, gut bucket, hearing, jug band, music, musical instrument, pitch, resonance, sound wave, vibration, washtub base

A Sound Education: Wacky Waves © Baylor College of Medicine. Revised 2014.

Play a Washtub Bass

1. Position yourself behind the stick and step on the rim of the washtub with one foot.
2. Pull the top of the stick back toward you to tighten the wire. With your other hand, pluck the wire. *How does the tub affect the sound?*
3. Pull the stick a little further back toward you. Pluck the wire. *Does moving the string have an effect? If so, what effect?*



BioEd Online
Biology Teacher Resources from Baylor College of Medicine

Play a Washtub Bass

Materials

- See slide 11, “Make a Washtub Base.”

Questions to Ask

2. How does the tub affect the sound? [The tub magnifies the sound produced by the vibrating string. When the string is plucked, it vibrates, which also causes the tub to vibrate.]
3. Does moving the string have an effect? If so, what effect? [The tighter the string is stretched—by pulling back on the stick—the higher the pitch produced. This is the same principle behind many musical instruments such a piano, drum, or even a mechanical music box.]

Image Reference

Illustration by G.L. Vogt, EdD.

Key Words

sound, amplitude, frequency, gut bucket, hearing, jug band, music, musical instrument, pitch, resonance, sound wave, vibration, washtub base

A Sound Education: Wacky Waves © Baylor College of Medicine. Revised 2014.