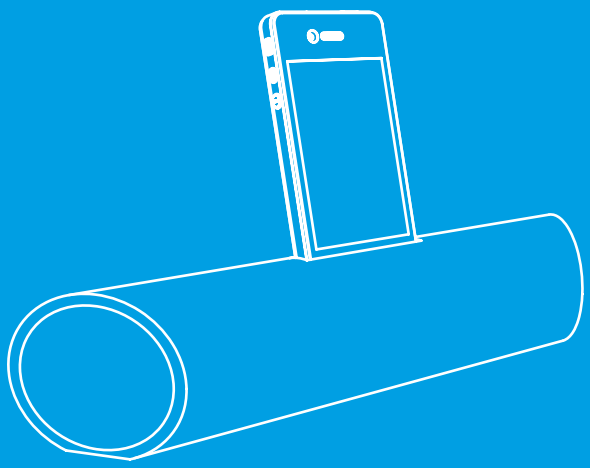
# Louder sounds.

This activity has been designed for one session of approximately 2 hours.

During this activity you will introduce ideas about sound waves, resonance and materials selection. Students will apply these ideas during an exciting hands on activity!



Bamboo speaker example

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# 1 Introduction.

People have always enjoyed music. Most people hear some music every day! Today we have the luxury of electric factory made speakers, but how did they blast their favorite tunes in the past? They used physics to make passive amplifiers! Take a phonograph, those funny looking record players:

Believe it or not, these used to be the iphones of the day to play music! How they work is that the sound is encoded into the grooves of the record, which cause a needle to vibrate as it spins. These tiny vibrations recreate the sound and are then amplified through the flaring horn to make it audible. A flaring horn works by directing the sound towards the people, and amplifying the volume. When sound waves leave a source and go directly into the air, some get reflected backwards, reducing the volume. Using a flaring horn, the sound travels down the horn, gradually getting wider until the sound emerges. This reduces the backwards reflections, making the music sound louder! You can try this yourself by rolling a piece of paper into a cone and speaking into it. Note how the cone changes the volume of your voice.

**Phonograph**

# 2 Case study: stethoscope

You might be wondering, why live in the past with gramaphones? Well there are applications of sound physics today as well. One of the most familiar is the stethoscope a doctor uses to listen to your heart! The wide metal bit that the doctor places on your chest has a thin, tightly stretched skin of plastic called a diaphragm. This vibrates when your heart beats. These vibrations travel up a hollow tube and directly into the earpieces of the doctor allowing them to hear if the heart is healthy.


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# ❸ Mini task: optional!

Create your own telephone
Take hollow cans or paper cups and connect them with a string.

Have two people pull the string taught with one person talking into the can and the other person listening. This will demonstrate that sound can travel along a string.

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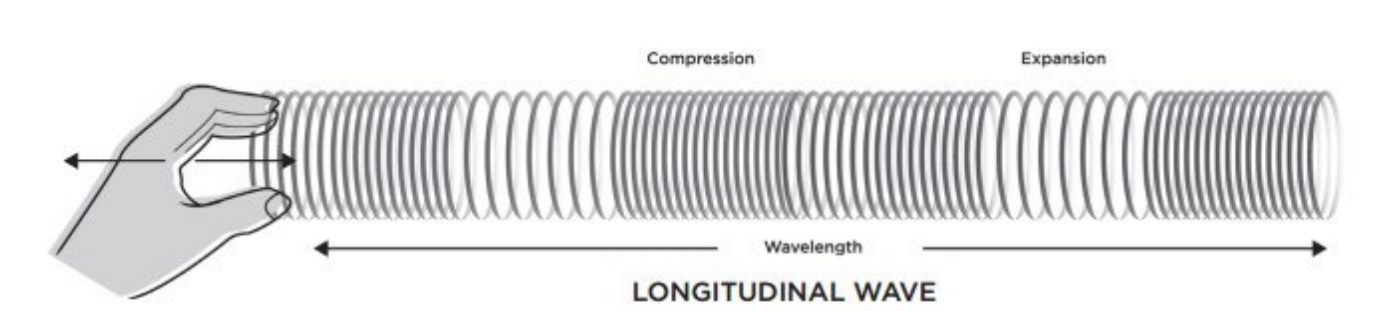
# 4 Explanation of sound

Sound is produced when something vibrates, causing the air around it to vibrate. This creates a wave with areas of high pressure (compression) and low pressure (rarefaction).
Imagine a slinky stretched out and think about what happens when you pinch an area of the slinky and then let it go. The bit where you pinched the coils together will travel down the slinky when you let go. This is similar to how a sound wave travels.

When these vibrations reach our ears, we can then hear the sound!




# 5 Resonance: what makes sound loud?

Resonance is when a vibration causes an object to absorb energy and vibrate at a larger amplitude. In the case of sound, a larger amplitude means a louder sound. Tubes are good for resonance because they cause standing waves which can produce all the harmonics of the fundamental frequency.

This means that sounds of different pitches, such as in a piece of music, can cause resonance and lead to a louder sound!

The diagram above shows the waves that are set up in the tube from sound. The fundamental frequency is when the air column is half the wavelength of the sound wave. This causes the amplitude to be highest at each end of the tube, creating a loud sound.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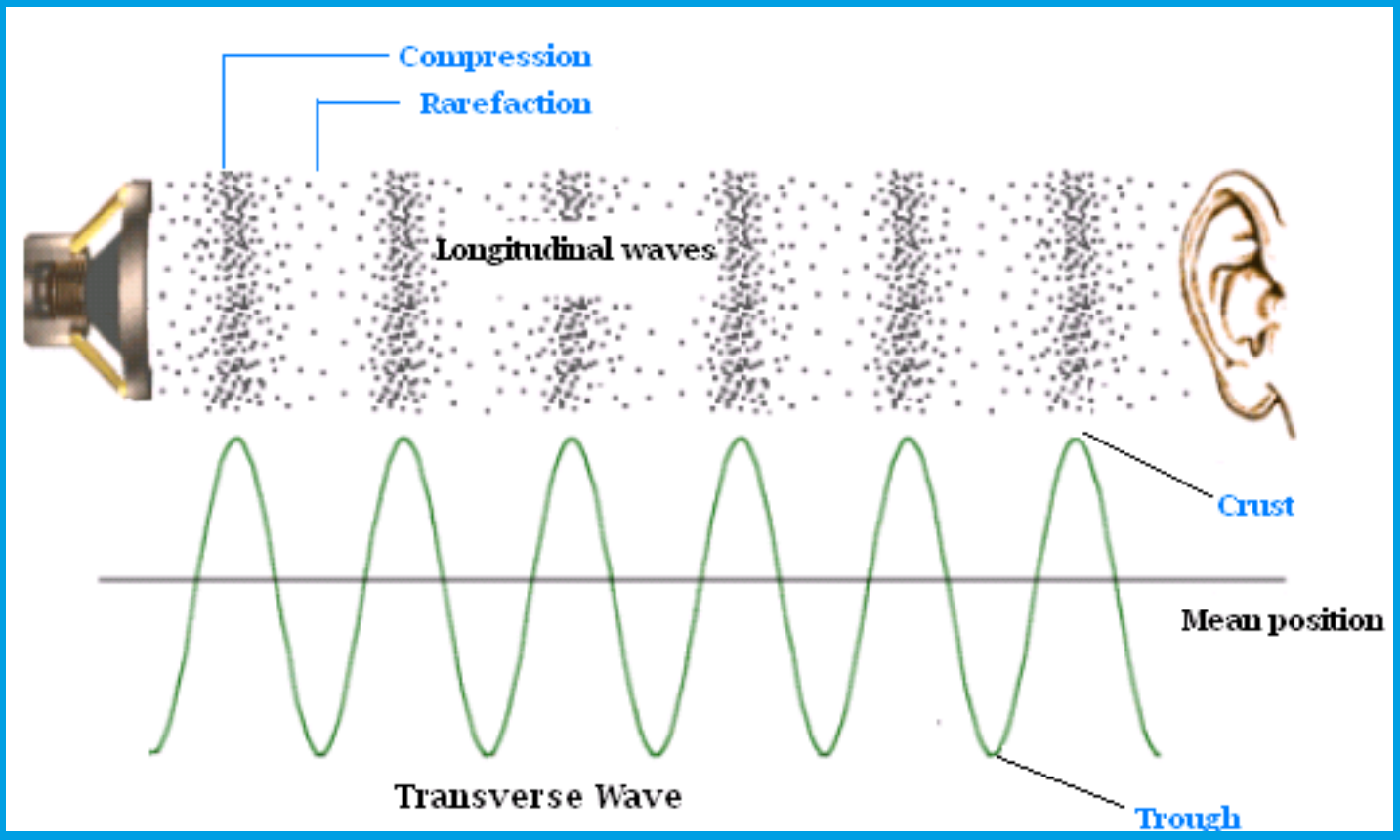


# 4 Why bamboo

Bamboo is a versatile and eco friendly material, which makes it advantageous compared to something like plastic. By making a speaker out of bamboo you also save electricity, which is good for the environment! Bamboo is naturally tube shaped, so to make a speaker, it's as simple as cutting the tube to the desired shape and making sure that your phone will fit. Follow the build kit to make your own bamboo resonator to listen to your favorite tunes!

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# 5 Making the speaker

Follow these simple steps to make your own bamboo speaker and amplify your sounds!

## What you need?:

Bamboo selection cut to size
2 small bamboo pieces for a speaker stand

## What else do you need? (Teachers)

Masking tape
Hand drill (12+)
Tape Measure
Hot glue gun
Drill bits - 8mm/10mm depending on phone
File
Sandpaper (coarse and fine)
Hand saw (optional)

## Helpful Hints:

Teachers should start the session by asking the students what properties they think will make a good speaker. Should it be made out of a hard or soft material? What shape should the speaker be? Review the features of waves so that students understand the concepts of frequency and resonance.

Teachers should set up a few supervised stations for cutting the bamboo and drilling the phone slot. This can be done on a rotational basis, with the other students reading the explanation and attempting the questions for understanding.

Safety: All people using hand tools should wear appropriate PPE, including eye protection. Children under 12 should not use the hand tools, and children over 12 should be supervised while using the tools.


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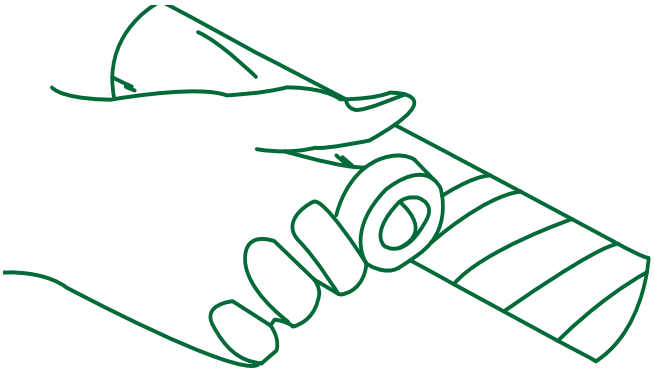
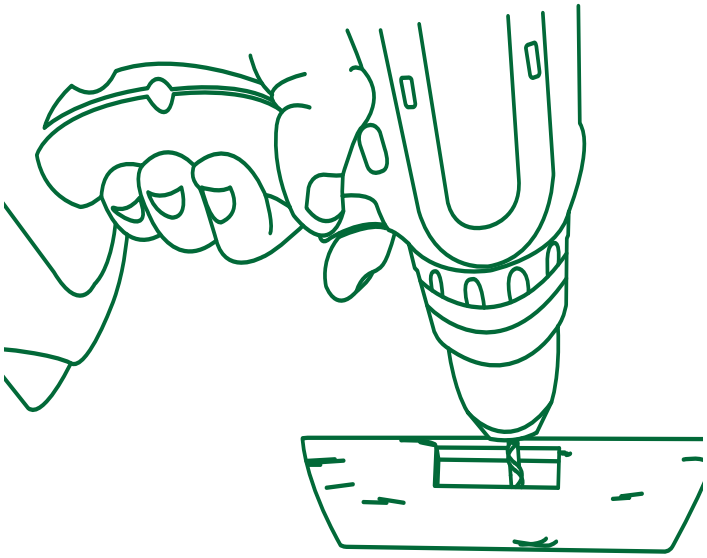
## Step 1:  Preparing

Using masking tape, cover the entire surface of the bamboo as shown.
#insert picture 1#

Drill holes in a straight line along the width of the phone. These will become the slot to hold the phone. Teachers should do this for students who are under 12, and 12+ students should have supervision and appropriate PPE.

NOTE: There will be a raised join in the middle of your bamboo tube. Do not drill this fully through, as this will be used to support the bottom of the phone.



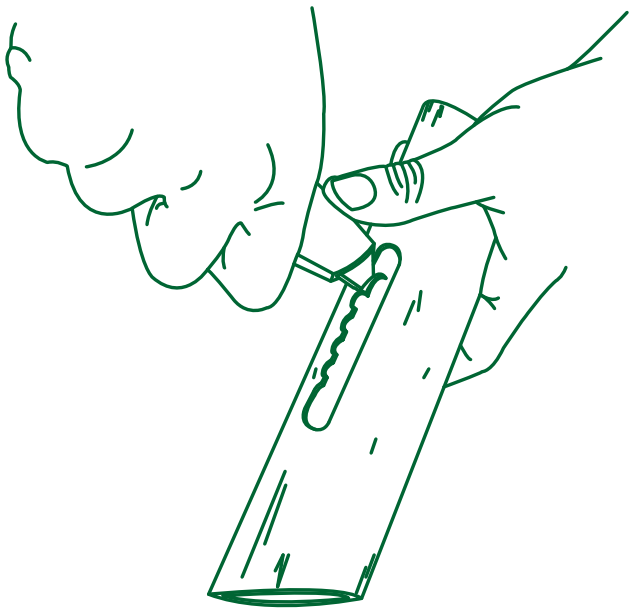


## Step 2: Creating the Slot for the Phone

Position the speaker firmly upright and use your phone as a template to mark on the tape the width of the phone. You want the phone to be in the middle join of the bamboo.

## Step 3: Opening the slot

Use a file to remove excess material from the drill points. Widen the slot and file it down smoothly so that the phone can fit. File down the middle join just enough to allow the phone to be supported in the speaker.



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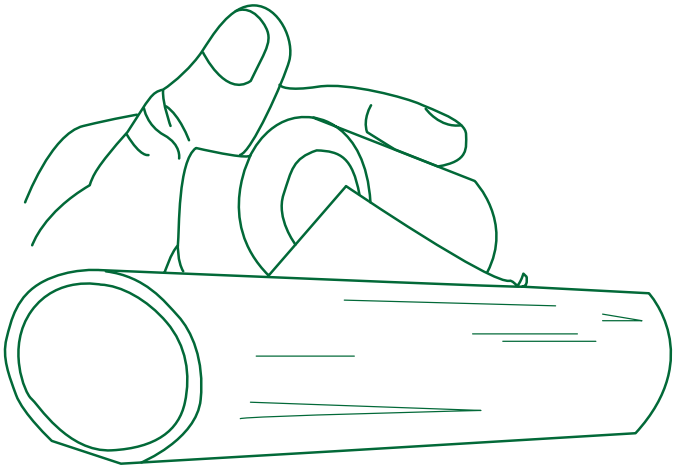

## Step 4: Flattening the Base of the Speaker

Turn the bamboo piece over, such that the slot is flat on the table. Using the course sandpaper, sand down the top side of the bamboo, creating a flat base.

## Step 5: Supporting the Speaker

Take the two small bamboo pieces provided and file the edge down to fit on the back of the speaker. Super glue these on the bottom of the speaker on either side of the join to keep the speaker upright.

## Congrats! You've made your very own bamboo speaker!

## Optional: Finishing and Painting:

Add angles to your speaker. Draw guidlines on the tape for a diagonal cut. Using a saw, cut along the dashed lines to create a curve on either side of the bamboo.

Use a 60 grit sandpaper to remove the first layer of bamboo and clean away any imperfections. You can increase to 120 grain sandpaper to gain a smooth and uniform finish. This step is crucial if you want to finish your speaker with wax or paint, as these can not be applied to the outer layer of the bamboo.

You can enhance and protect your speaker with a layer of wax. It is completely colourless, but it will make the bamboo look great and protect it. Use a sponge or a wax brush to apply the wax and then wipe off the excess. Buff to a shine with a lint free cloth.


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# 6 Vocabulary

Wavelength- the distance between a point on one wave and the same point on the next wave. It is often easiest to measure this from the crest of one wave to the crest of the next wave

Frequency- the number of waves that pass a certain point each second.

Fundamental Frequency- the lowest frequency of a periodic waveform

Standing waves- a vibration of a system in which particular points (nodes) remain fixed while others between them vibrate with the maximum amplitude.

Resonance- The increase in amplitude of oscillation of a system exposed to a periodic force whose frequency is equal or very close to the natural undamped frequency of the system.

# 7 Questions For understanding:

What factors are likely to affect the sound produced by the amplifier?
Eg: shape, material, the acoustics of the room, initial source of sound

What types of other materials could work?
Eg: plastic, steel, other types of wood.

What other things resonate?
Eg: strings, instruments eg: violin, guitar, bridges in wind: ex: Tacoma bridge, Washington US- https://www.youtube.com/watch?v=XggxeuFDaDU

TASK:
Use maths to find the fundamental frequency of your speaker!

Measure the length of the tube. Be careful of units!
Rearrange this equation to solve for the frequency of the sound wave that will cause your speaker to resonate at its fundamental frequency (first harmonic). Take the velocity of a sound wave in air at room temperature to be 343 m/s.

velocity= frequency x wavelength

Hint: How does the length of your speaker relate to the wavelength of the fundamental frequency?
(teacher answer: the wavelength of the fundamental frequency is 2 x the length of the tube.)

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About the project:

Bamboo Bicycle Club teach people to build bamboo bikes. They work with schools to set up after school club or curriclium projects to promote the building of bikes in school.

To learn more or for more info,

w:bamboobicycleclub.org
e:info@bamboobicycleclub.org
t: +44 330 330 9025

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