Waves

Overview

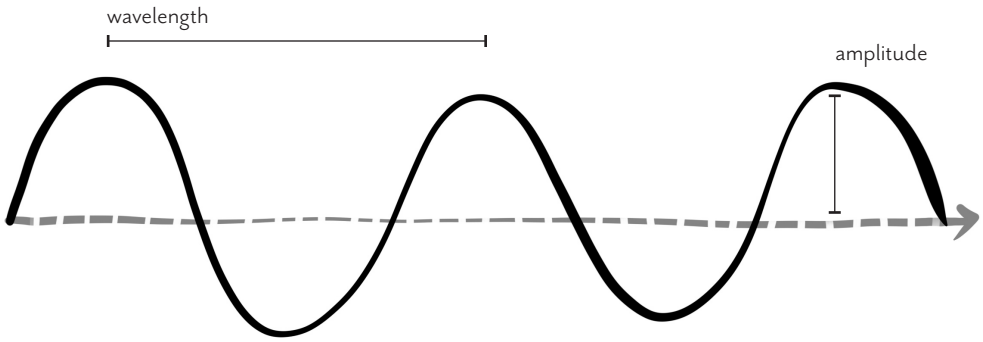
There are many different kinds of waves, from ocean waves to jump ropes to the microwave in your kitchen. Even light and sound are waves – they are everywhere around you!

Waves are an important idea in physics, because they move energy from one place to another, through some kind of material, what we call a medium. In the case of ocean waves, that medium is water; in the case of jump ropes, it's string; and in the case of sound, it's air.

This week we will explore sound waves. Have you ever wondered how a guitar makes sound? When the guitar player plucks a string, it vibrates. As it vibrates, it pushes the air around it. This energy travels outward until it hits your ear (just like a ripple traveling outward after you drop a rock in a pond).

A guitar can make many different notes by changing the length of a string. Longer strings make lower notes, and shorter strings make higher notes. By plucking harder you can make the sound louder.

In physics, we call these wavelength, frequency, and amplitude. There are complicated mathematical equations for understanding those, but you can see and hear the ideas easily yourself!



Longer strings have a longer wavelength. That means they vibrate more slowly (a low frequency), so there is a longer distance between the peaks and valleys of the wave. Your ear hears that as a low note. Shorter strings have a shorter wavelength. They vibrate more quickly (a high frequency), with a short distance between peaks and valleys of the wave, and your ear hears a high note. If you pluck a string really hard, it still has the same wavelength (the distance between peaks and valleys) but the amplitude changes – that means the waves are taller.

This week we will make our own instrument that has strings of different lengths, and we will be able to hear the different high and low notes.

Waves

Create an instrument

Ages: 5 - 13 years

Materials and Preparation
Gather and prepare the following items:

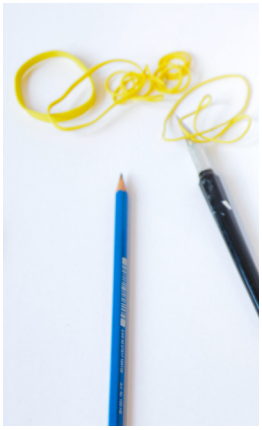
small cardboard box
such as a shoe box, a cereal box, etc.

rubber bands
5-10; if they are all the same that is helpful; but you can use whatever you have

thin stick
a crayon, or pencil may work too

cutting blade or scissors

pencil



For this activity, there are many different variables. These variables are factors and materials that impact our outcomes. Such variables include: the size and shape of the box, the size and shape of the cut out hole, the tension of the rubber bands, and the thickness of the rubber bands, among others.

We cannot control all of your variables in this activity, because what you may have on hand is different from what we have used here. And that is the exciting part of this activity! The following instructions provide a starting point and outline these variables, so that you can adjust them accordingly and tinker with the outcomes while learning the fundamental ideas.

Here we present the basic steps, the materials, and the why - so that you and your young ones may understand how the physics works, and build on these concepts to make your own unique music.

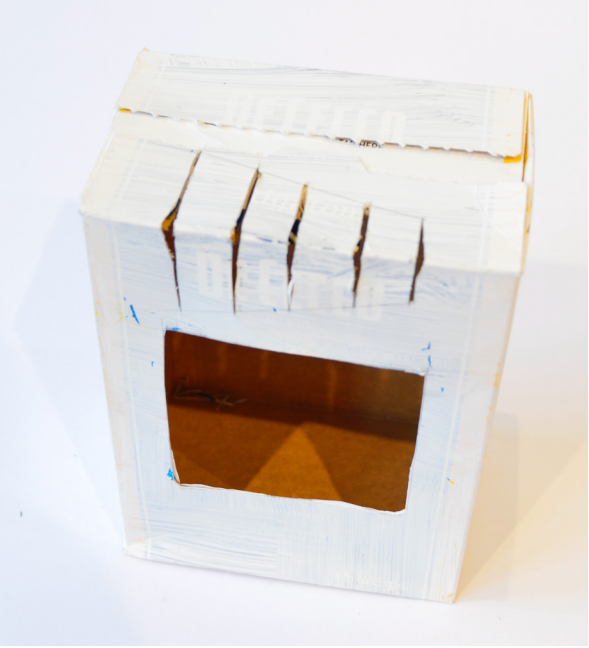
You will be creating this instrument together; so depending on the age of the child, you may be assisting more or less.

1. Mark the box

On one side of the box (not the ends, but the largest side), draw a rectangle shape that will be cut out of the box.

On the top edge of the box, mark 5 lines that are evenly spaced, and fall within the rectangle cutout.

These notches should be different lengths, as shown in the picture, so that they are creating more or less length and tension in the rubber band.



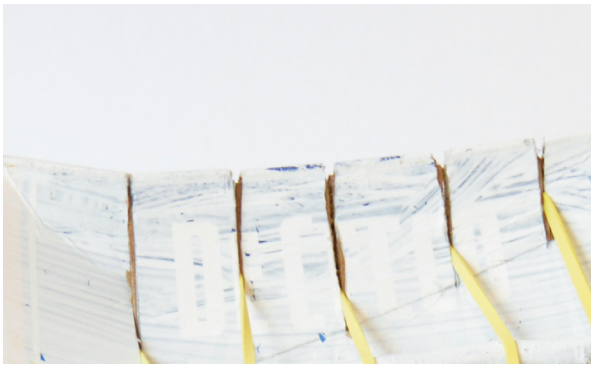
2. Cut the box

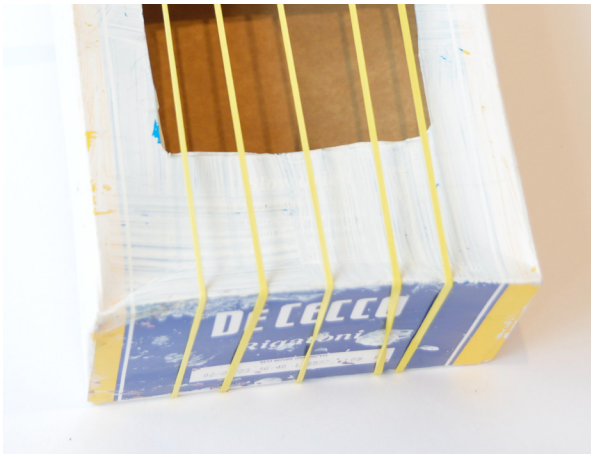
Using a blade, very carefully cut out the rectangle shape, and create the notches on the top edge.

TIP: It is a bit easier to place the rubber bands if you can cut out some additional width to the notches.

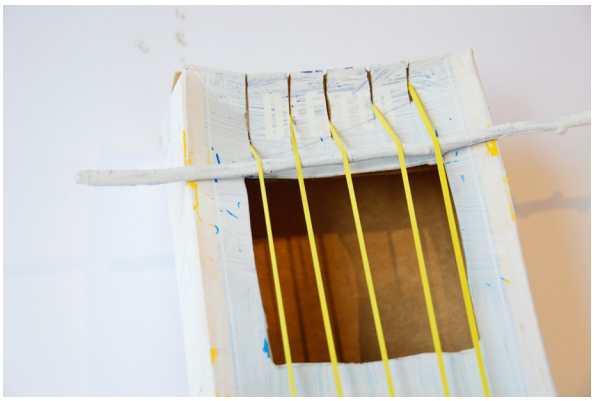
Why?

The cut out rectangle provides a box that amplifies the sound waves, so that you hear a louder, clearer sound.



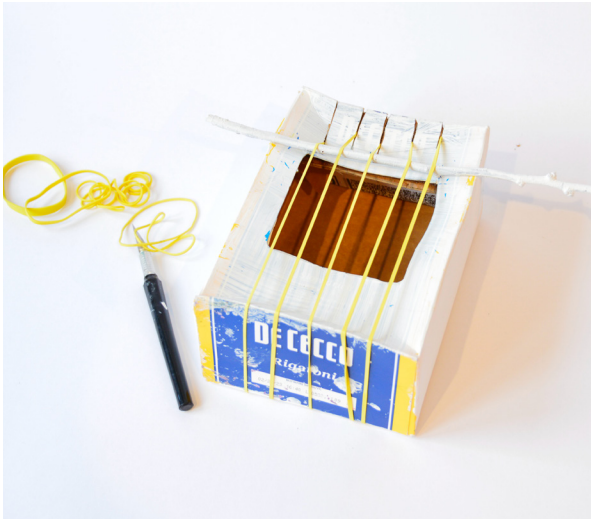


3. String the rubber bands around the box
Carefully place the rubber bands in the notches and around the box so that they are parallel to each other and not twisted.



4. Place a stick under the rubber bands.
Carefully insert the stick toward the notches, so that the rubber bands are elevated above the box.

Why?
This raises the rubber bands above and away from the box, and eliminates the sound of the rubber bands slapping on the box.



5. Tinker and adjust

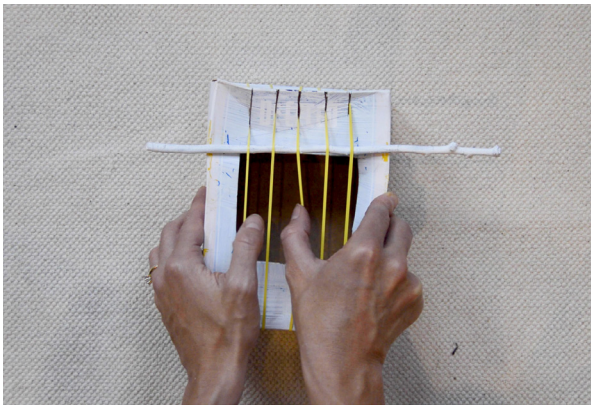
Now that you have created this instrument, pluck the rubber bands and observe what happens. *Can you hear a note? What is the relationship between the sounds of the different rubber bands? If you want to adjust one of the rubber bands, how might you do so?*

Tinker and experiment with all of your variables in order to achieve the sounds that you want.

TIP: You may want to tape or glue the box in order to reinforce it.

Why?

If you understand the basic concepts and how each of these variables creates certain outcomes, you can adjust accordingly in order to alter the sounds. Testing and iterating is a very important process in making things! *Is there something that can be improved? Maybe the box is a little flimsy? How might you reinforce it?*



6. Make music!

Now that you have a new instrument, can you make music?

Can you recruit a family member to help with percussion by making sounds with objects around the house?

Can you create a song? And can you invent a way to write down how to play your song?