

SOUND WAVES AND FREQUENCY

INTRODUCTION:

Sounds are vibrations that travel through a medium, usually air, and into your ears. Higher frequencies are faster vibrations, which your ears interpret as a higher pitch. Lower frequencies are slower vibrations and are heard as a lower pitch. Musical instruments are simply tools for changing and combining sound frequencies in interesting and pleasing ways.

Saxophones, trumpets and recorders are "wind" instruments – they use your breath, or wind, to create vibrations. Violins, guitars and harps are "string" instruments – vibrating strings are the source of their sound. Finally, drums, xylophones and even pianos are "percussion" instruments – hitting these instruments makes them vibrate.

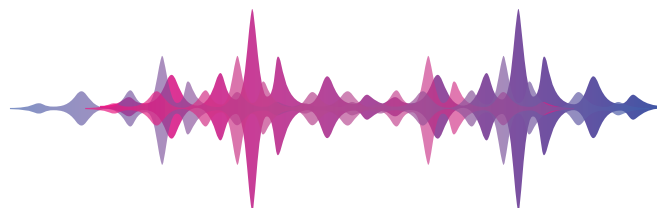
ACTIVITY: Make your own musical instruments

TIME: 30+ minutes

SAFETY:

Be careful if you're using glass. It's unlikely, but possible, to break a glass by singing or playing certain sound frequencies!

Listening to loud noises can damage your hearing. Keep the volume low. When you are unable to do that, cover your ears or wear hearing protection, like earplugs or headphones.



WHAT YOU NEED:

Most household items can be used to make sound, so materials will vary. Here are the materials for basic instruments:

- Bottle, glass or plastic
- Water
- String
- Mixing bowls
- Plastic bucket
- Empty food container
- Waxed paper
- Plastic wrap
- Elastic bands or tape

WHAT YOU DO:

In this activity, you will be building three kinds of musical instruments: wind, string and percussion. These instructions are a good starting point, but there are lots of cool ways to make instruments with household objects, so be creative! See the "More Online" section for links to some favourite homemade instruments.



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WHAT YOU DO (continued):

Build a wind instrument

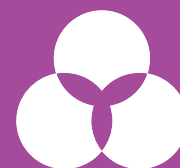
- Find a glass or plastic bottle (something with a small opening) and blow over the top to create a sound. You might have to adjust the angle of the bottle before you hear a sound. The sound is the natural frequency of the air inside the bottle.
- You can change the sound's frequency by changing the length of the air column inside the bottle. Adding water to the bottle will change the amount of air, and therefore the sound's frequency. What does it sound like now?
- Continue adding or emptying water to play different notes, or frequencies. If you have multiple bottles, you can tune them to different notes and play a song!

Build a string instrument

- The simplest string instrument is literally just a string!
- Take a piece of string and wrap it around your finger. Place your finger in your ear. (Make sure you wash your hands first!) Use your other hand to pull the string tight. When you pluck it, vibrations will travel along the string, through your finger and into your ear.
- Try shortening or lengthening the string by changing where you hold it. How does this affect the sound?
- Change the string's tension by pulling it tighter or letting it relax. What happens to the sound?

Build a percussion instrument

- To build your own set of drums, you will need several open-mouthed containers of different sizes. You could try using a plastic bucket, mixing bowls or empty food containers.
- Some containers may not need any modifications; they already make a nice sound when you hit them. For others, you can add a drum head: a tight membrane over the container's opening. The drum head material needs to be strong enough to be stretched tightly over the drum, but thin enough to carry the vibrations, like plastic wrap or waxed paper. Cut a piece that's a bit larger than your container's opening. Pull the material tight, and then use an elastic band or tape to hold it in place. Hit your drum head to see how it sounds.
- You can play different notes, or frequencies, by changing the size and shape of your drum – switching containers – or by adjusting the tension on the drumhead – making it tighter or looser. Try both, and notice how it affects the sound.



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WHY THIS MATTERS:

We often think of music as an art, but it's also a science. Every musical instrument, from guitars to pianos, is based on the same underlying physics principles.

For example, a guitar's frets are positioned to produce very specific frequencies: every twelfth fret, the frequency doubles. Physics tells us that to double a wave's frequency, you have to cut its wavelength in half. If you measure a guitar, you will find that the twelfth fret, usually indicated with a special marking, is exactly halfway between the ends of the string.

TAKING IT FURTHER: Experiment with a frequency generator

Listen to different frequencies and combine them to create complex sounds.

Open an online frequency generator like this one:

<https://www.szynalski.com/tone-generator/>

A frequency generator lets you control the exact number of Hertz (Hz), or vibrations per second, of the sound. Select a frequency — for example, 440 Hz — and play it. Pick a few different frequencies and compare the sounds.

Open another copy of the frequency generator in a second tab, so you can play two frequencies at once. In the first tab, choose a starting frequency and press play. In the second tab, play the same starting frequency. Now, try changing the second frequency to create a new, combined sound.

Continue adjusting the two frequencies up and down, and listen to the results. Which combinations sound good? Which ones sound bad? Do you notice any patterns in what

sounds good and what doesn't?

Two notes with frequencies in a 2:1 ratio — like 600 Hz and 300 Hz — produce a type of harmony called an 'octave'. Using two frequency generators, test other frequency ratios. You could try a 3:1 ratio, for example, where the first frequency is three times higher than the second. Other ratios to try are 3:2 and 5:4.

Also, try playing frequencies that are very close to each other — such as 440 Hz and 445 Hz. Carefully adjust the frequencies up and down, keeping them close together. What do you notice?

TAKING IT FURTHER: Tune up

To play your favourite song, try tuning your homemade instruments. You could do it by ear, or you can use an online tuner like the one found here: <https://theonlinemetronome.com/-free-online-tuner-for-musicians.html> (You may have to select the 'Tuner' option in the top right corner of the screen).

The microphone on a phone or laptop will pick up the sound of your instrument. The software will then calculate the sound's frequency and the corresponding musical note. Modify your instrument until you get the notes you want. Then put on a performance!



SCIENCE AT HOME

SOUND WAVES AND FREQUENCY

GRADE: **11**

SPH3U

SUBJECT: PHYSICS

STRAND: WAVES AND SOUND

TOPIC: FREQUENCY AND WAVELENGTH OF
SOUND WAVES

EXPECTATIONS: E1.1, E2.1, E2.4, E2.6, E2.7

VIDEO: youtu.be/q38c6gx2Jkc

MORE ONLINE:

How to make vegetables into instruments

<https://www.youtube.com/watch?v=KyIGh5Kfcik>

Blue Man Group - Drumbone

<https://www.youtube.com/watch?v=dOLBn8GKBIA>

How I broke a wine glass with my VOICE (using science!)

https://www.youtube.com/watch?v=Oc27GxSD_bl

The physics of playing guitar

<https://www.youtube.com/watch?v=w6EGyFAGpXU>



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