The Voice of the Drum

Learning Objectives

1. Learn the difference between transverse and longitudinal sound waves
2. Understand why each drum has a unique sound wave
3. Learn how to use a Chladni plate and be able to draw a Chladni figure

Introduction

The sound of the drum represents the heartbeat of mother earth and that each drum we make has its own voice. Just like each human has a different sounding voice, drums have different voices too. When a new drum has been made there is a ceremony to give the drum its voice, wake it up and welcome it to this world.

We see and use drums at community gatherings, powwows, and at home. The big drum that you see at Mawiomis (mah-wee-oh-me or powwows) can be heard from all around.

Physics is a branch (on the tree) of science that is concerned with the properties of energy and matter. Physics can help us understand what sound look like and how it moves. In this activity, we will look at the sounds that different drums make. We will see firsthand that they have different voices.

Figure 1: Two-Eyed Seeing Diagram

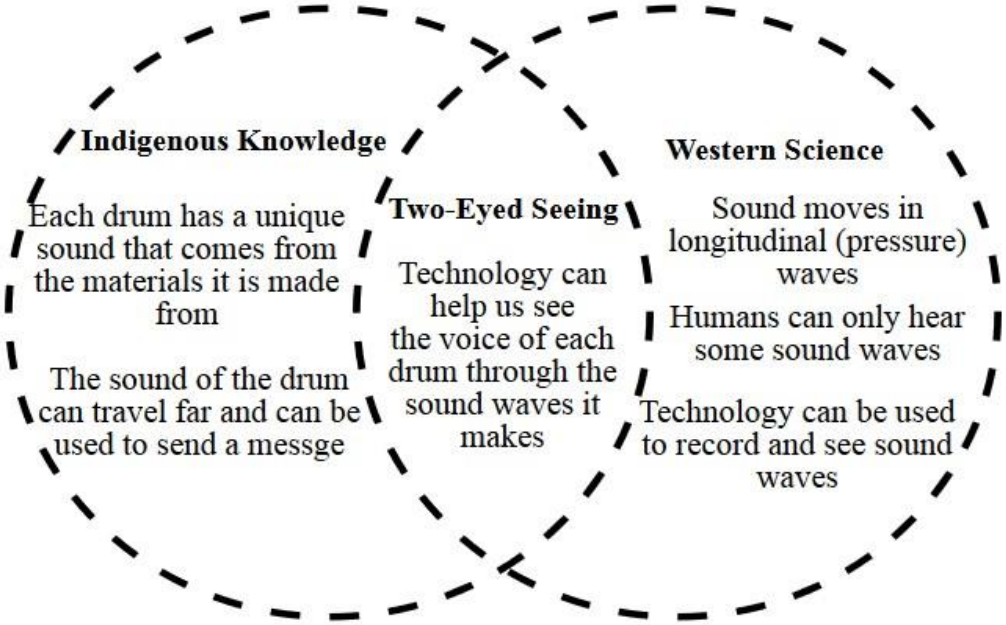

Table 1: Vocabulary

Longitudinal	Longitudinal waves are waves where the disturbance moves in the same direction as the wave (3). 
Transverse	Transverse waves are waves where the disturbance moves at a right angle to the direction of the wave (3). 
Crest	The crest is the highest part of a wave (4).
Frequency	How fast a sound wave moves is called the frequency (3,4).
Hertz (Hz)	Hertz is a unit used for measuring the frequency of sound waves (4).
Amplitude	Measures how strong a wave is. This is measured by how high and how low the wave goes (4).
Analyze Plot	A word that is used when we study something closely (5). A plot is made of points on a graph that create make a line or curve.

Questions and answers about Physics

What is physics and the science of sound?

Physics is the study of how all things work and how energy is transferred. Acoustics is a branch of physics that studies how sound works. Sound waves are made up of vibrations. Sound waves may travel through the air, water, oil, or solid objects (1).

What are acoustics used for?

Acoustics is used for many things that we use everyday. Acoustics is used to design buildings like theaters so that everyone can hear clearly. By knowing how sound moves around the room and what it will bounce off or be absorbed by, we can control how it moves (2). Acoustics are also used to see under the water by measuring how long it takes a soundwave to bounce off the bottom and come back. This is used to make a picture of the ocean floor that we can look at with a computer. It is also used in ultrasound, which is used for medical imaging (2) What kind of careers involve physics or acoustics?

- Medicine
- Nature studies
- Engineering
- Teacher
- Professor
- Researcher
- Astronaut
- Climatologist
- Acoustical Engineering

Activity 1: Recording Soundwaves

When a drum is made by hand, each drum is made a little bit different (they are unique). The type of hide, the kind of wood used, and even how tight we put the materials together all impact how a drum sounds. Some drums make a higher pitch sound like the hand drums that we are going to use today. Other drums like the larger drums that we see at powwows make a sound with a lower pitch. This makes the soundwaves travel through air at different frequencies.

What we need for our activity:

- 1 computer with microphone
- Audacity software installed (Free software; see https://www.audacityteam.org/download/)
- 3 or more drums

What we will do, step by step:

Step 1: Record the sound of the drum

With a partner, choose one person to drum and one person to record using the audacity program. You can see what the program looks like in figure 2. This is a free program that you can download from https://www.audacityteam.org/.

Follow the directions on the next pages to record the sound of the drum.

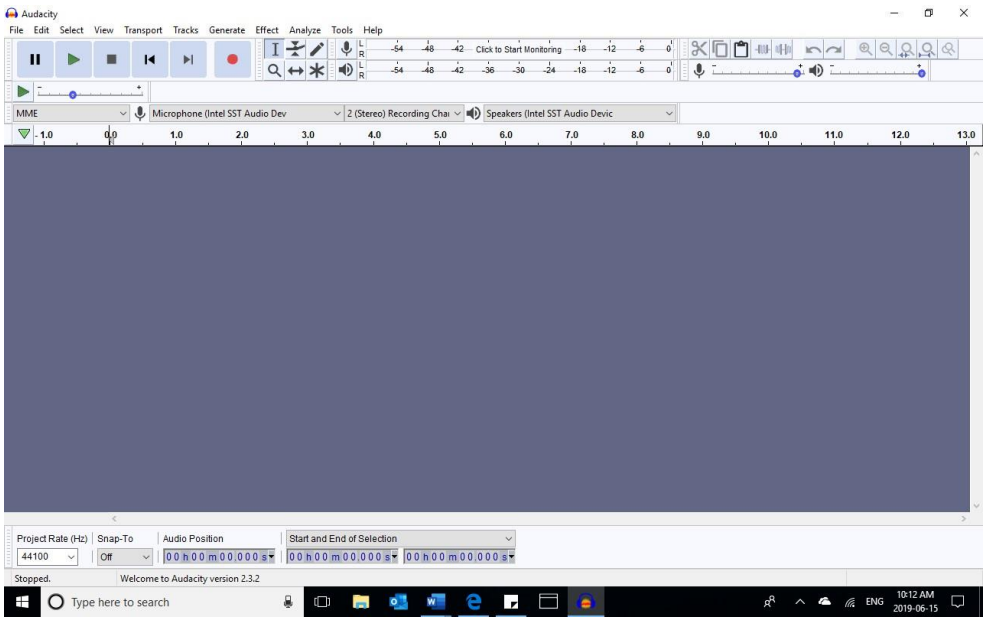

Figure 2. Audacity Program

a) The person recording presses the round, red record button  that is in the top left corner of the figure 3.

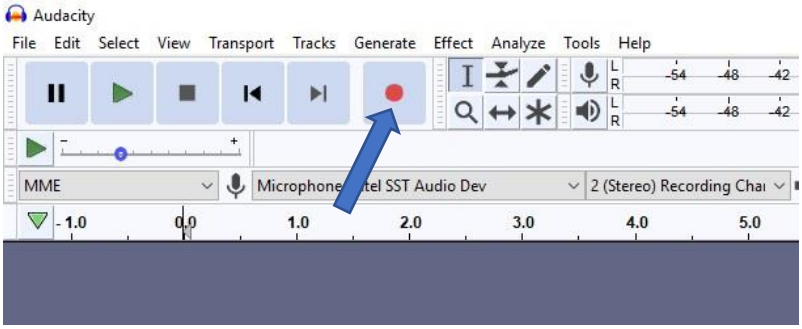

Figure 3. Press record

b) The drummer plays 5 to 10 drumbeats.

c) The recorder presses the square black stop button  that is in the top left corner of the program near the record button to stop the recording. This can be seen in figure 4.

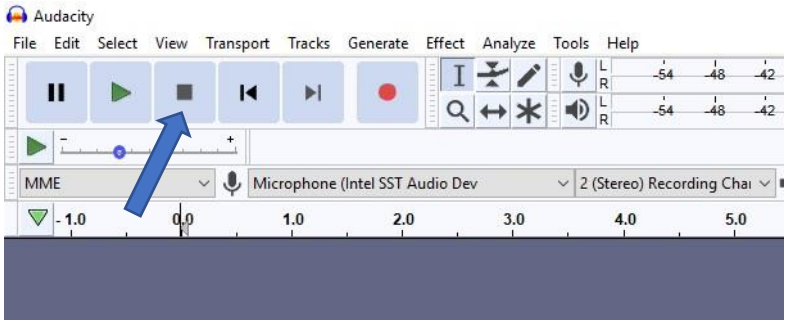

Figure 4. Press Stop

Take turns recording and playing, so everyone gets a chance.

Step 2: Review the results and plot

You will be able to see your recording on computer screen and it will look a lot like the recording in figure 5.

Follow the directions below to review your results

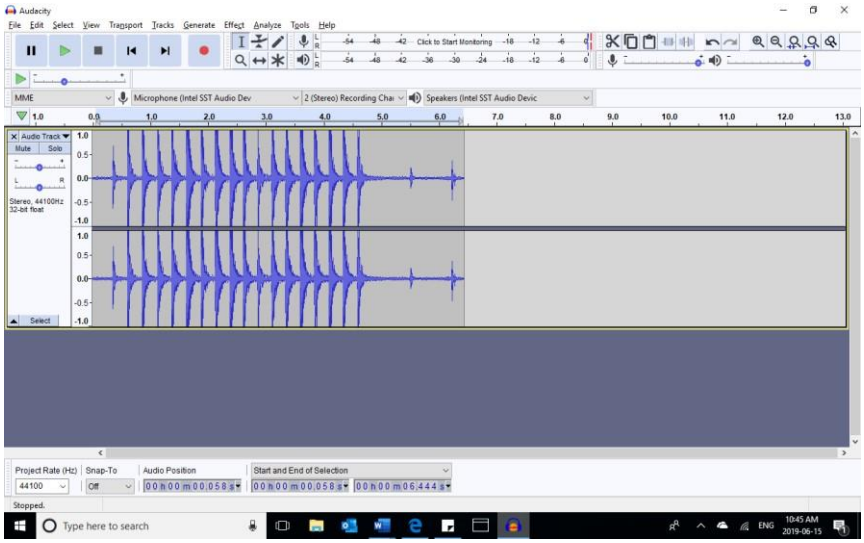

Figure 5. Recording

a) Use your computer mouse to choose your whole recording. To do this click on the left side of the recording and drag the mouse to the right end of the recording. The colour of the recording will be come lighter when you choose it. You can see this in figure 6.

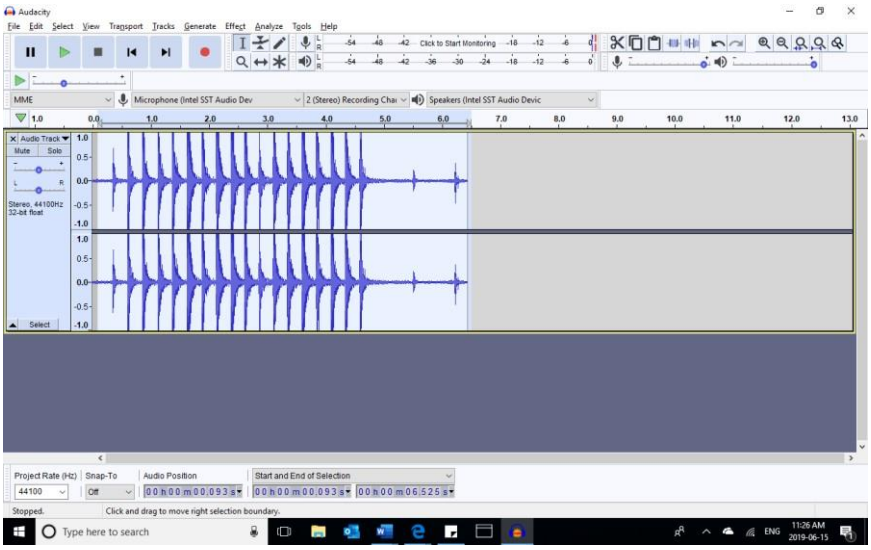

Figure 6. Recording chosen

b) At the top left corner of the program click on the Analyze menu that can be seen in figure 7. From the list that drops down that you can see in figure 8 choose Plot Spectrum.

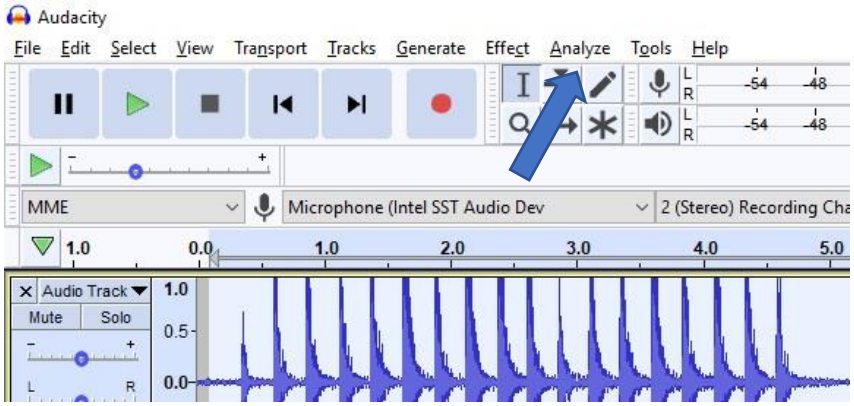

Figure 7. Choose Analyze

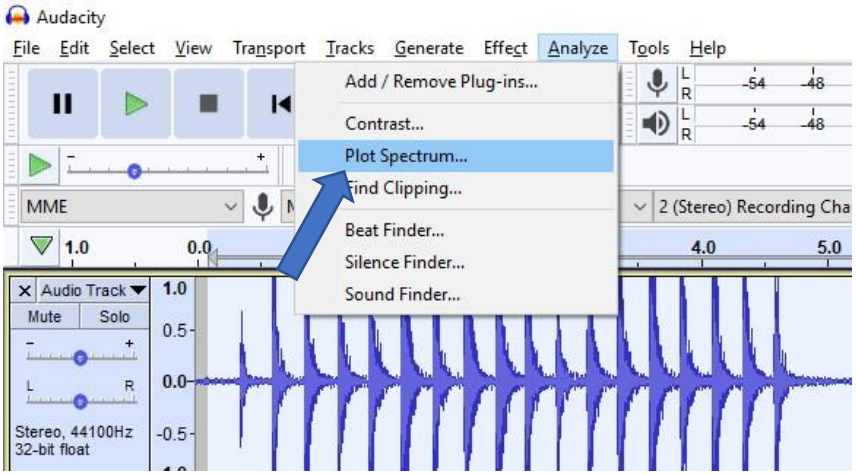

Figure 8. Choose Plot

You will see the plot in figure 9 that the program makes on the screen.

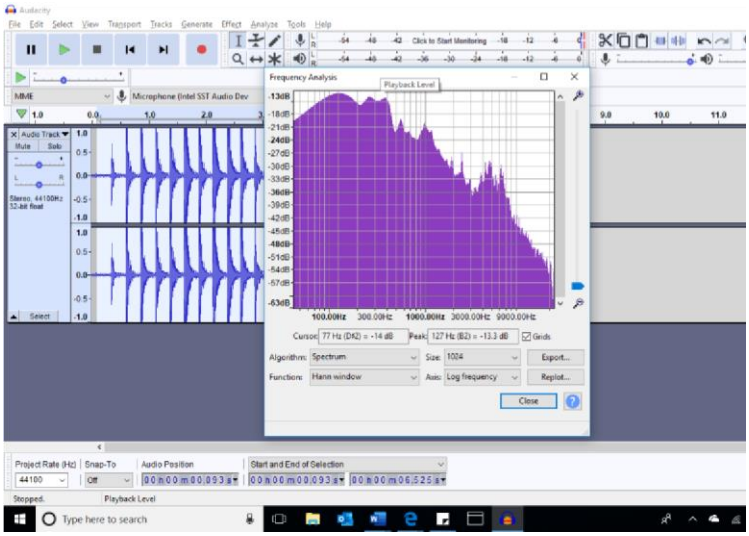

Figure 9. Frequency

The graph in figure 10 shows what the sound wave looks like if we look at the frequency. If you look at a graph of another sound, then the sound wave will look differently like you can see in figure 11.

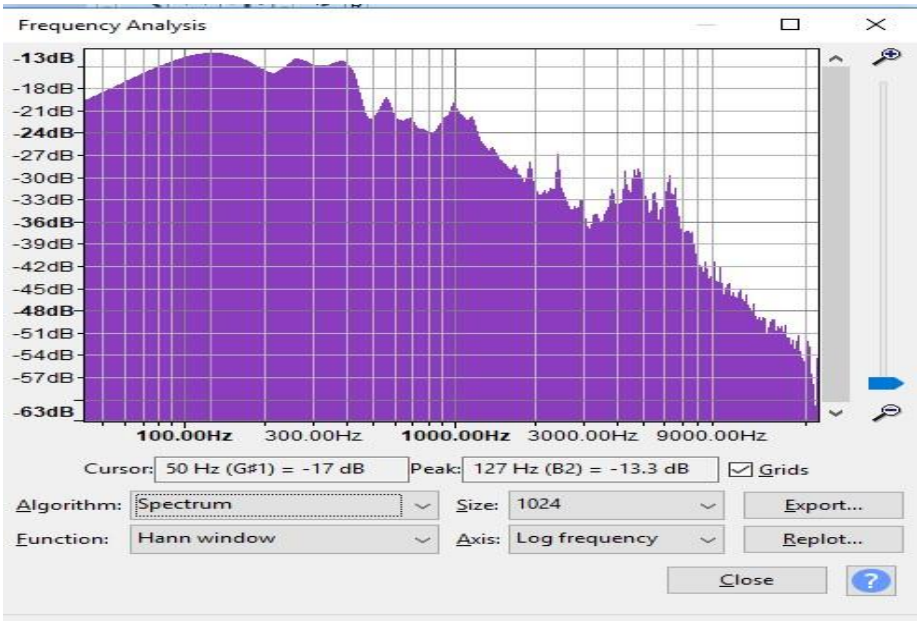

Figure 10. Sound One

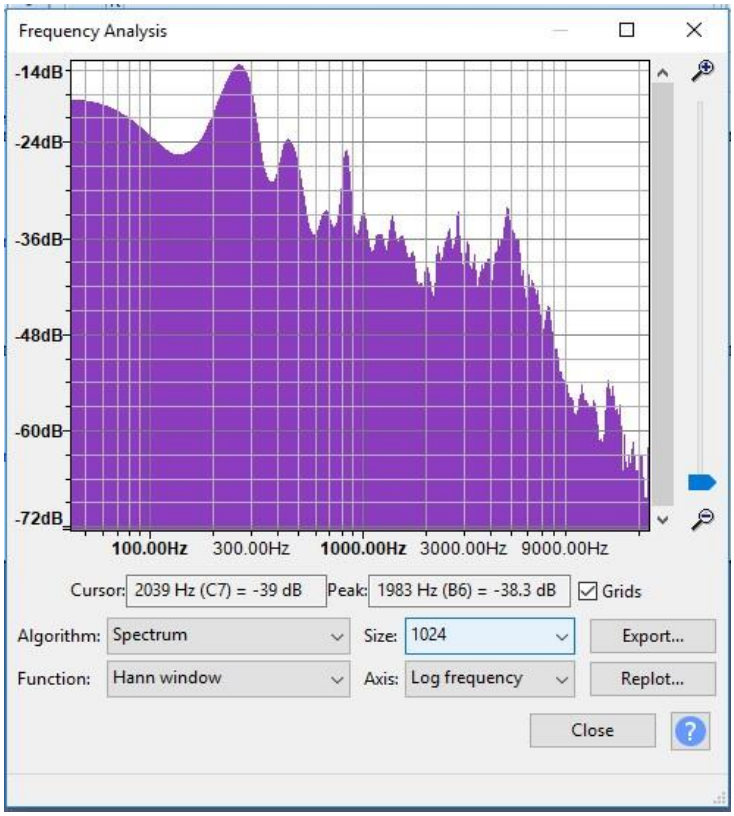

Figure 11. Sound Two

Your plot should look like what you see in figure 11.

Step 3: Find and record the dominant frequency

- Using your mouse point to the highest spot on the graph. In figure 12 you can see that the arrow is pointing to the spot that the wave is at its highest spot.

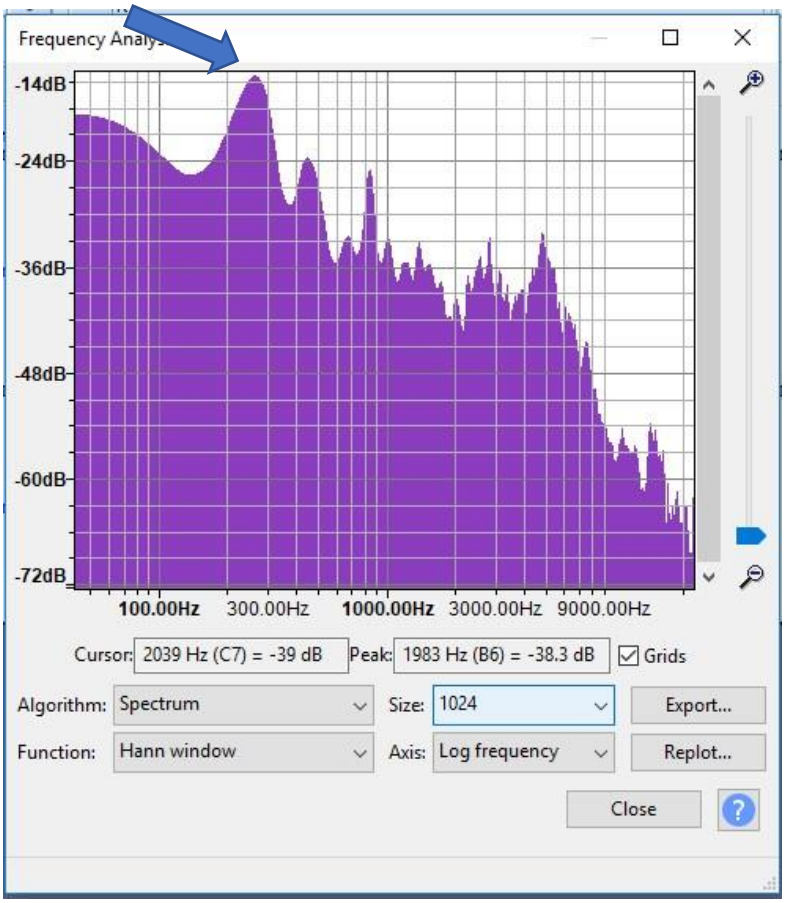

Figure 12. The Highest Point

The highest spot is called the crest. This number is the voice of the drum and it will be different for each of the drums you record.

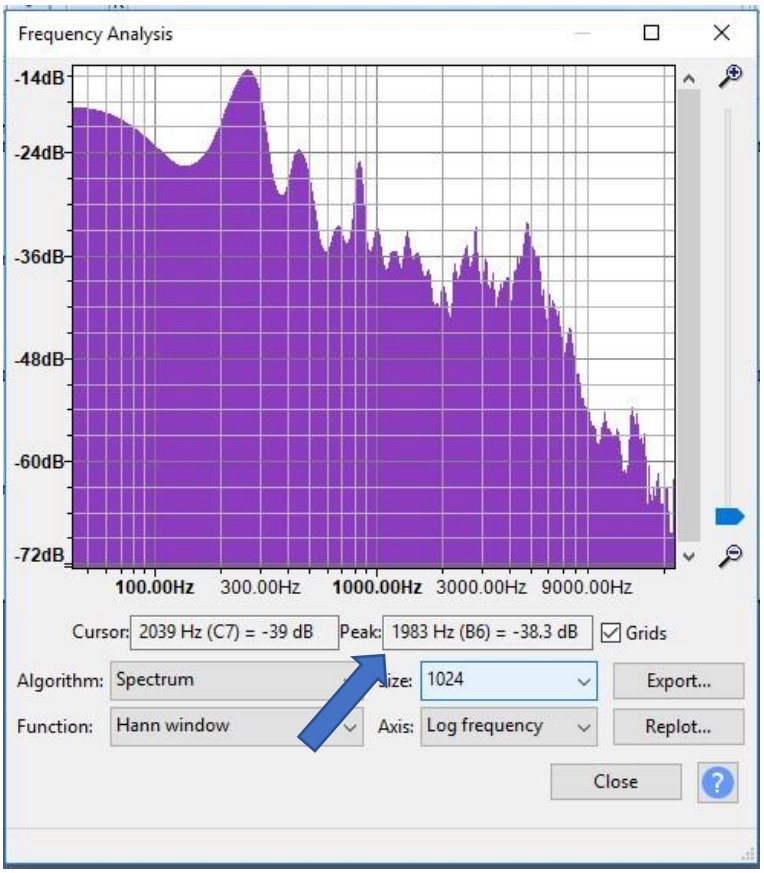

Figure 13. The Dominant Frequency

Write the number that is found in the space called peak in table 2. You can see where to find this number in figure 13.

Table 2: Dominant Frequency (Hz) for each drum.

	Drum 1	Drum 2	Drum 3	Drum 4
Group 1				
Group 2				
Group 3				
Average/ Mean				

Step 4: Draw the shape of the frequency in box 1.

Box 1: Frequency drawings

Drum 1	Drum 2
Drum 3	Drum 4

Step 5: Repeat

- Repeat Steps one to four for each different drum and record your data in table 2 and table 3.
- If you have time, do multiple replicates of each drum and find average frequency for each.

Activity 2: Slinky Waves

In this activity, you will be learning about waves using a slinky. By the end of this activity you will be able to recognize the difference between the two kinds of waves transverse and longitudinal waves.

Transverse waves

Transverse waves move upwards as they move forward. You can easily see this kind of wave when you toss a rock into the lake and watch the ripples move across the top of the water. This is also the type of wave that you see when you watch the tide come in or go out.

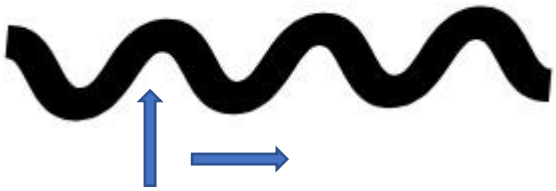

Figure 14. Transverse waves

What we need for our activity:

- 1 slinky for each group of 2

What we will do, step by step:

Step 1: Find a partner

In groups of two sit across from each other on the floor with each person holding one end of a slinky

Step 2: Create a transverse wave with the slinky

Have one person hold their end of the slinky still. Have the other person begin to move the other end of the slinky up and down, moving slowly.

Step 3: Change the frequency of the wave

Repeat step two while moving the slinky faster than the first time. This has changed the frequency of the wave.

Step 4: Change the amplitude of the wave

Repeat step two while moving your hand high and lower, the slinky wave will be bigger than the first time. This has changed the amplitude of the wave.

Step 5: Draw the slinky wave

Draw a transverse wave in box 2.

Box 2. Transverse Slinky Wave Drawings

Longitudinal waves (pressure)

Longitudinal waves move forward or backwards but do not move up and down. Sound waves are the most common kind of longitudinal wave. We looked at sound waves when we recorded the voice of the drum.

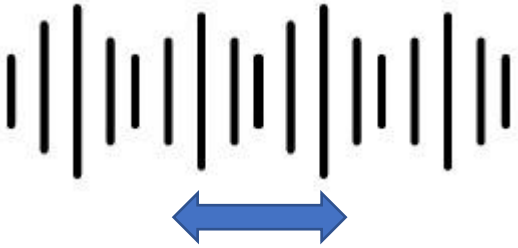

Figure 15. Longitudinal waves

Step 1: Return to your partner

In groups of two sit across from each other on the floor, each person holding one end of a slinky

Step 2: Create a longitudinal wave with the slinky

Have one person hold their end of the slinky still. Have the other person begin to move the other end of the slinky pushing towards the person holding the other end of the slinky and pulling it back, moving slowly.

Step 3: Change the frequency of the wave

Repeat step two while moving the slinky faster than the first time. This has changed the frequency of the wave.

Step 4: Draw the slinky wave

Draw a longitudinal wave in box 3 on the next page.

Box 3. Longitudinal Slinky Wave Drawings

Activity 3: DIY Chladni Plate Exercise

In this activity, we'll explore how vibrations affect metal surfaces by learning about the Chladni Plate. Then, we'll use simple materials you can find at home to try the experiment yourself!

Chladni plates

A Chladni plate is a flat sheet of metal that vibrates when sounds go through it. Just like a drum that has been hit with a drum stick the metal plate vibrates when you strike it or rub it. By using sand or salt on top of the metal sheet it is possible to see the patterns created. These patterns are called Chladni figures. When we change the frequency of the sound, we can change the pattern that we see.

Materials You'll Need:

- A speaker
- A plastic food storage container (with a removable lid)
- A flat baking sheet
- Salt or sand
- A phone, tablet, or computer

Below are some videos you can review to learn more about Chladni plates:

Chladni Plate Experiment Explained:

https://www.youtube.com/shorts/3KtuwNKFCGU

Singing plates - Standing Waves on Chladni plates:

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

Cymatics: Chladni Plate - Sound, Vibration and Sand:

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

Now we will try the experiment for ourselves! Here's what we will do, step by step:

1. **Turn on your speaker.**
2. **Enable Bluetooth** on your phone, tablet, or computer, and connect it to your speaker.
3. **Place the speaker inside the plastic container.**
    a. Remove the lid and leave it off. The speaker should sit inside the open container.
4. **Place the baking sheet on top of the container.**
    a. Make sure it lies flat and balanced.
5. **Sprinkle salt or sand** evenly over the surface of the baking sheet.
6. **Visit** OnlineToneGenerator.com using your device and experiment with different sound frequencies.
    a. Higher frequencies produce higher-pitched tones.
    b. Here are some frequencies that we tried that create interesting patterns:
        i. Circle baking sheet: **120 Hz, 176 Hz, 300 Hz**
        ii. Rectangle baking sheet: **176 Hz, 240 Hz, 334 Hz, 340 Hz**
    c. Can you find any other frequencies that create interesting movement?

7. **Enter your chosen frequency, press "Play," and turn the volume up.**
    a. Be cautious—it's loud!
8. **Observe the patterns forming on the baking sheet.**
    a. Try changing the pressure by gently placing your hands on either side of the sheet and pressing down slightly.
    b. Do the patterns change? What happens when you remove your hands?

Bonus Activity: Finding Your Drum's Voice with Chladni Plates

There are two ways you can explore the frequencies of your drum:

Option 1: Using a Voice Recording App

1. Use a recording app on your phone, tablet, or computer to record yourself hitting your drum.
2. Try changing how often (frequency) and how hard (intensity) you hit it.
3. When you're done, play the recording through your Bluetooth-connected speaker.
4. Watch the salt or sand—does it move? Can you make it dance differently?

Option 2: Using Audacity

1. Open Audacity and record yourself playing your drum.
2. Highlight the section of audio you want to analyze.
3. Go to Analyze, and then Plot Spectrum to see the frequencies present in your recording.
4. Choose the dominant frequency (or another one you're curious about).
5. Type that frequency into OnlineToneGenerator.com and play it through your speaker.
6. Observe how the salt or sand reacts!

Box 4. Drawing of Chladni figures (the shapes on your baking sheet)

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