STEM Sound Investigations
Analyzing Waves
Student Inquiry Sheet

Name_____ Class_____ Date_____

In this inquiry, you will make some sound waves using a great software program that is totally free—Audacity!

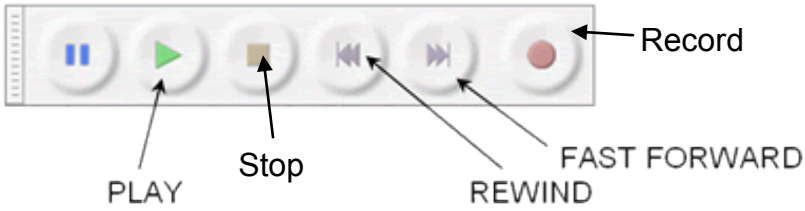
- If you want a copy for your home computer, go to: http://audacity.sourceforge.net/
- To learn more about how to use the program, go to: http://audacity.sourceforge.net/manual-1.2/tutorials.html

If possible, you should work with a partner on a computer with two sets of headphones. This way you both can hear the computer sound output without bothering the other students in the room.

Be sure to wash your hands after handling the headphones. The plastic wire insulation contains lead, and that is not good for you!

The following steps will teach you how to make a sound track using Audacity. Once you learn the basics, explore, inquire, and have fun!

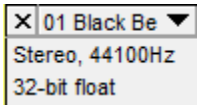
1. Open Audacity.
2. Practice using the buttons by recording your voice and playing it back.



The positions of the buttons may not be the same as pictured, but the symbols represent the same function.

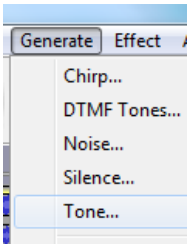
3. To expand the track and see sound waves, click on the magnifying glass with the plus (+). Click on the  magnifying glass with the minus (-) to zoom out and condense the track.

4. To remove the track, click on the (x) in the upper left corner of the track.

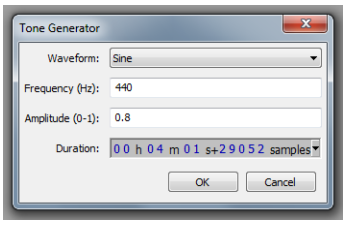


5. You can make 2 or more tracks on the same screen. Click on the screen below the first track and hit "record" or "create a track". You can play them together by pressing "play" or play them separately by clicking the "mute" button on one of the tracks.

6. Now go to the top Menu Bar and click on "Generate", then select "Tone".



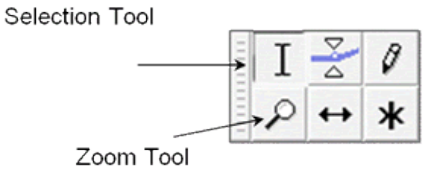
7. This opens the Tone Generator window where you can make sounds with different waveforms, frequencies, amplitudes, and durations. To start, use Waveform = sine and Duration = 1 second. You will have to learn how to select the proper units in the Duration Box.



8. Now it is time to inquire! Keep the amplitude the same and generate 1 sec. of a tone using a <u>frequency</u> you and your partner choose. Using the playback Control Toolbar, "rewind" to the beginning. Then click on “play."

9. Next, generate another tone with the <u>same amplitude, but different frequency</u>. *It is important that you make sure the curser is at the end of your sound track before you do this step. Just click on the " fast forward" or " go to the end of the track" button before you generate this tone.* Try some other frequencies.

10. Audacity lets you see your sound track. Right now it might look like a blue blur. Use the selection tool and put the curser on the track where the frequency changes. Use the zoom tool to make the individual waveforms visible. Then compare how the waves change as the frequency changes. Draw an example of 2 different frequency waves and describe below how the sound changes as you change the frequency.



Check Point

11. Make 2 separate tracts and generate 255 Hz (frequency of 255 vibrations per second) on one track and 256 Hz on the other track. Listen to the sound when you play both tracks at once. Try other combinations such as 255 Hz and 266 Hz.

    a. Take 2 tuning forks (255 Hz and 256 Hz). Tap them and hold them close together by the microphone. Record the sound. What does the sound wave look like? You can also use any other 2 frequencies such as 255 HZ and 275 Hz. Describe the sounds you hear and invent an explanation of what may be happening to cause the sounds.

12. Now that you have learned about frequency and how to use Audacity, repeat the above. But, this time, keep the frequency (pitch) the same and vary the amplitude (loudness). Listen to it and look at it. Draw a picture of how the wave form changed when the amplitude was changed.

13. Most people hear sounds of frequencies between 20 Hz and 20,000 Hz. Some animals, such as dogs, can hear higher frequencies than people. Test your ability to hear different frequencies by generating different frequencies on Audacity and playing them back to see if you can hear them. Keep the amplitude the same for all frequencies. What is the range of frequencies that you can hear?

Frequency Tried	**Can I Hear It?**

15. The Doppler effect is a way a sound can appear to change without changing the frequency. A sonic boom is an example of the Doppler effect. There are a variety of videos on line that provide more information on the Doppler effect and sonic booms. Take a few minutes and watch the videos listed below:
    - *http://www.youtube.com/watch?v=JX_A99Bq9AI*
    - http://www.youtube.com/watch?v=-d9A2oq1N38
    - *http://paws.kettering.edu/~drussell/Demos/doppler/doppler.html*

    Do a search on YouTube for other examples and list them below:

16. A sonic boom is cased by “squeezing” sound waves together. Where have you heard the Doppler effect? Describe where you were and what you heard.

17. Design your own special sound using Audacity. You can use recorded sounds or sounds you generate. Cut and paste or mix and match. Play your sound for other people and ask them if the sound is “you.” What is the recipe for your sound?

Check Point

Measuring the Speed of Sound

When you see a flash of lightening during a thunderstorm, you usually hear thunder a short time later. The light from the lightening travels to you almost instantly at a speed of 186,000 miles per hour. Sound travels much slower. It clocks in at about 768 miles per hour. A single beam of light could go completely around Earth about 7 times in 1 second if it could travel in a circle. It would take a sound 31 hours to travel around the Earth.

You can measure how far away you are from the lighting strike by counting how many seconds it takes you to hear the thunder after you see the lightening. If it takes 1 second for you to hear thunder after the lightening flash, the distance is about 1,100 feet or about 4 football fields away. If you hear the thunder 5 seconds later, the distance is about 1 mile. Ten seconds between seeing lighting and hearing thunder means the lightening is about 2 miles away. The next time a thunderstorm occurs, get a stopwatch and see if you can measure how far you are from the lightening strike.

1. Imagine that you are standing at the edge of a big canyon. You look across the canyon and shout your name. In about 5 seconds, you hear the echo come back to you. Calculate the approximate width of the canyon and explain how you found out how wide it is.

2. Distance can be measured by using sound. What are some ways that the speed of sound can be measured? The speed can be calculated by using these formulas:
   - Speed = distance divided by time,
   - Distance = speed multiplied by time,
   - Time = distance divided by speed.

   One way to measure the speed of sound is to use a 4 foot to 10 foot PVC pipe between 3/4”inch and 2 inches in diameter and a sound recording and editing program like Audacity. Since a noise in a pipe makes echoes, you can measure the time it takes a sound to move up and down the pipe just like the sound in a canyon.

   Working with a group, try this: You will need a microphone hooked to the computer to put at the opening of the pipe, a tape measure to measure the length of the pipe, and a clicker to make a noise. Then use Audacity or another sound editor to record the sound from the clicker and measure the time between the click and the echo. Then calculate the speed of sound and post your results in the classroom. Show your calculations here:

NOTE: You can use any audio editor for measuring and analyzing sounds as long as the program shows the wave form of the sound and a time bar. A good app for the iPad and iPhone is Hokusai Audio Editor.

Check Point