Strand: **8.2**	Standard: **8.2.4**	Episode 4	**Big Idea**: The amplitude of a wave is related to the energy of the wave.

Title: Sound of Science	**Time**: 45 - 60 minutes	CCCs: Cause and effect	Practices: **Developing and using models**

Episode Snapshot:
Students will observe that changing the energy of a sound wave changes how we hear it by placing ringing tuning forks in water. They will then use musical instruments, computer and physical simulation **models** to identify that changing the amplitude and wavelength of a sound wave causes us to hear different volumes and notes.

Gather
Provide each group with a tuning fork and mallet and a container of water. Explain what tuning forks are used for and that they work by vibrating the tines to create a sound wave. Give the students time to experience using the forks. Now ask the students to place the tuning fork into the water and record observations about what happened on their student sheet. If this is done correctly, the energy in the vibrating tuning fork will transfer to the water, causing it to splash. If possible, allow students to record this phenomenon on their phone and play it back in slow motion.

Class discussion: What effects did you notice?What caused the water to splash? Where did the energy come from? If they were observant, they should have heard the note from the tuning fork go down in pitch and volume after it was placed in the water. Point this out to the class if they missed it. Avoid explaining why it happened at this point; they will discover the answer by the end of the episode.

Ask the students to make a prediction on their student sheets. How do they think changing the amplitude and wavelength of a sound wave will change the way our ears hear it?

Provide each group with a one meter length of string. Have them tie one end to something such as the leg of a table or chair. Ask the students to experiment with it for a few minutes to find ways they can make different sounds with the string. Come back together and ask the class what they found. If they do not mention that they can change the sound by changing where they hold the string when they pluck it and by how hard they pluck it, guide them to these ideas. Tell the class that when they change the sound, they are changing the sound's wave. Ask them what part of the wave they think changes when they hold the string at different lengths. What part changes when they pluck the string harder? They will use the following oscilloscope model to see if their guesses are correct.

Reason
Oscilloscope Model
Provide the students with the link to the oscilloscope simulation model. It is best if they stay on sine waves since that is the type of wave they are used to seeing. Set both dials in the top box to 1 and then leave them alone. They can use the keyboard to change the volume and notes that are displayed in the oscilloscope. At this point you may want to remind the students how many variables are tested at one time by a good experiment. If they start playing with both the volume and different notes at the same time, they won't know what is causing the results they are seeing. Give them time to experiment with the simulator to watch how the wave changes when they change the volume and notes that are played. They will record their results on the student sheet.

Discuss the results as a class. Remind the students that when wavelength is changed it will also change the frequency of the wave.

Musical Instruments
Ask the class how we can use this knowledge to make music? Have available various musical instruments that the students can use to experience making different sound waves. You can take the time to let students make homemade instruments in class using these instructions from this site or this one, or you can provide the students with existing instruments, either homemade, or instruments like guitars, violins, flutes, penny whistles, xylophones, goblets with water, boomwhackers, etc.

Each group should look at at least two instruments of different types; one string instrument and one wind or percussion instrument, etc. After experimenting with them, they will make a claim on their student sheet about how this instrument changes the amplitude and wavelength of sounds. Allow them to research this if needed.

Communicate
Provide each student with a copy of the foldable. Students will complete the sound portion of the Wave Energy foldable demonstrating their understanding of a wave's wavelength relationship to pitch, and amplitude to the loudness of a sound.
On their student sheets, students will write a conclusion about how the amplitude and wavelength of sound waves change the sound we hear. They will then explain how the phenomenon they observed with the tuning forks is connected to wavelength, amplitude and energy.

Assessment: Student will complete the sound parts of the Wave Energy Foldable and glue into their Science Journal.	**Materials, resources, handouts, etc:** ● Tuning forks with mallets ● Container of water ● Phone video cameras ● String ● Computers ● Oscilloscope simulation ● Musical Instruments such as guitars, flutes, pan pipes, recorders, boomwhackers, drums OR take the time to have the students build some instruments themselves ● Student Sheet ● Wave Energy Foldable