Exploring Waves through Sound

Each of the lessons linked below can be explored independently or within a larger unit of sound/waves. The order below is a recommended learning sequence in exploring the basics of soundwaves. This lesson sequence uses the anchoring phenomenon of a deaf person claiming he can feel music. Throughout each lesson, students will have to use evidence from their activities to explain this phenomenon.

Sequence	Lesson Name	Learning Outcomes
1	Deaf People Feel Music	**Anchoring Phenomenon**: **Shaheem Sanchez is a deaf dancer. He claims he can feel music.** **Learning Outcomes:** ● Ask questions about sound and format questions as cause and effect questions that can be tested. **Resources:** ● **Slideshow Directions** (for teacher presentation via Zoom/Google Meets and/or student guided learning) ● **Student worksheet** (for accompanying slideshow directions as accountability in noting key learning points
2	Listening to Simple Waves: Using the Signal Generator	**Investigative Phenomenon**: **Electronic music can be made by creating electrical signals and sending them to a speaker.** **Learning Outcomes:** ● Analyze and interpret data of wave patterns and their properties by changing the quantity of amplitude & frequency and connecting those measurements to the volume and pitch of a sound. ● Construct an Explanation of how a change in speaker movement affects the amplitude and frequency of a sound **Resources:** ● **Signal Generator Online Tool** (Listeningtowaves.com) ● **Tutorial for using signal generator** (scroll down for signal generator) ● **Slideshow Directions** (for teacher presentation via Zoom/Google Meets and/or student guided learning) ● **Student worksheet** (for accompanying slideshow directions as accountability in noting key learning points)
3	Detecting Waves: Using the Signal Generator to Test Hearing Range	**Investigative Phenomenon**: **Humans can detect different ranges of frequencies.** **Learning Outcomes:** ● Design and perform an experiment for testing the human ear's capacity to detect different frequencies. ● Construct an Explanation of how the structure of the human ear allows it to convert soundwaves into an electrical signal for the brain. **Resources:** ● **Signal Generator Online Tool** (Listeningtowaves.com) ● **Tutorial for using signal generator** (scroll down for signal

		generator) • **Slideshow Directions** (for teacher presentation via Zoom/Google Meets and/or student guided learning) • **Student worksheet** (for accompanying slideshow directions as accountability in noting key learning points)
4	**Recording Waves: Using the Oscilloscope**	**Investigative Phenomenon**: **A microphone can detect soundwaves and convert them to an electrical signal that can be seen on an oscilloscope.** **Learning Outcomes:** • Analyze and interpret data of wave patterns and their properties as digitized signals by playing with their scale, proproportion, and quantity • Construct an Explanation of how mechanical movement detected by a computer microphone is converted into an electrical signal the computer can detect and display.. **Resources:** • **Oscilloscope Online Tool** (Listeningtowaves.com, NOTE: Does not work well on ipads or phones) • **Tutorial for using oscilloscope** (scroll down for oscilloscope) • **Slideshow Directions** (for teacher presentation via Zoom/Google Meets and/or student guided learning) • **Student worksheet** (for accompanying slideshow directions as accountability in noting key learning points)
5	**Engineering Waves**	Students are challenged to create a simple instrument, identify a variable that can be changed and design and carry out a test of how that variable affects the quality of the sound using their ear, the oscilloscope and spectrogram as evidence. **Resources:** • **Signal Generator Online Tool** (Listeningtowaves.com) • **Tutorial for using signal generator** (scroll down for signal generator) • **Slideshow Directions** (for teacher presentation via Zoom/Google Meets and/or student guided learning) • **Student worksheet** (for accompanying slideshow directions as accountability in noting key learning points)
6	**Visualizing Waves: Using pHet simulation**	**Investigative Phenomenon**: **Shaheem Sanchez (a deaf dancer) can feel music across a distance** **Learning Outcomes: (draft)** • Construct an explanation of the differences between a sound wave & air particle movement. • Construct an Explanation of how sound can travel across distances through a medium **Resources:** • **pHet Simulation: Waves Into (Sound Waves)** • **Slideshow Directions** (for teacher presentation via Zoom/Google Meets and/or student guided learning) • **Student worksheet** (for accompanying slideshow directions as accountability in noting key learning points.

7	**Measuring Waves: Connecting Particle Movement to Signal Generator**	**Investigative Phenomenon**: **Sound from a car's speaker can move things.** **Learning Outcomes: (draft)** ● Construct an explanation of how soundwaves can move objects ● Use measuring tools to measure different aspects of sound ● Connect the measurements from the pHet simulation to the measurements seen on the Signal Generator **Resources:** ● **pHet Simulation: Waves Into (Sound Waves)** ● **Signal Generator Online Tool** (Listeningtowaves.com) ● **Tutorial for using signal generator** (scroll down for signal generator) ● **Slideshow Directions** (for teacher presentation via Zoom/Google Meets and/or student guided learning) ● **Student worksheet** (for accompanying slideshow directions as accountability in noting key learning points
8	**Comparing Pure & Complex Waves: Using the Signal Generator**	"IN THE WORKS… COMING SOON" Using the Signal Generator to see the individual waveforms for each frequency as well as their combined waveform
9	**Fingerprinting Waves: Using the Spectrogram**	"IN THE WORKS… COMING SOON" Using the Spectrogram to analyze individual frequencies within a complex sound.
10	**Making Waves: Using Wavemakers Docuseries**	Students are challenged to choose one of five mini-documentaries about a young scientist whose work revolves around waves and write a one-paragraph report about who the "wavemaker" is, how his/her work is related to waves and how he/she got into their current field of study. **Resources:** ● **Wavemakers Docuseries** (Listeningtowaves.com) ● **Slideshow Directions** (for teacher presentation via Zoom/Google Meets and/or student guided learning) ● **Student worksheet** (for accompanying slideshow directions as accountability in noting key learning points.

Targeted NGSS Standards

MS-PS4-1. **Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.** [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] [Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.]

MS-PS4-2. **Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.** [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.]

MS-PS4-3. **Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.** [Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.] [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]

PS4.A: Wave Properties

- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)

- A sound wave needs a medium through which it is transmitted. (MS-PS4-2)