INTRODUCTION

In this exercise, students will experiment with their natural surroundings to discover what absorbs or reflects sound. Vegetation, topography, and atmospheric conditions all affect sound. More sound energy is absorbed by vegetation like redwood trees than an open landscape like a desert. Materials have different rates of absorbing or reflecting sound. Typically flat, hard, or high density surfaces reflect sound while soft, “fluffy,” and low density materials absorb sound. Hard, flat, dense surfaces like rock can block sound and also reflect the sound into another area. Low frequency or pitch has longer waves and can be heard over a much longer distance than a high frequency, short wave sound. Higher pitch sounds are absorbed by small things like leaves, grass, etc.

Air temperature and wind speeds also affect sound. For example, sound travels farther in colder temperatures. Powdery snow absorbs sound. Strong winds can “knock high frequency sounds off target” and raise their pitch.

Sound Basics:
Amplitude is the relative strength of sound waves (transmitted vibrations) that are detected by hearing organs (ears), which we perceive as loudness or volume. Amplitude is measured in decibels (dB), which refer to the sound pressure level or intensity.

Humans can hear as low as 0 dB.
A normal speaking voice is under 60 dB.
Vacuum cleaner is ~70 dB.
Rock concerts are ~125 dB which is at the human pain threshold.
A typical suburban area is 50 to 60 dB.
People and animals begin to have hearing loss, raised stress hormone levels, and hypertension At 50-60 dB.
Traffic noise commonly ranges from 70 to 80 dB 50 feet (15 m) from highways. (federal highway administration https://www.fhwa.dot.gov/publications/publicroads/03jul/06.cfm).

The image below illustrates the concepts of frequency and amplitude. The magenta wave has one half the amplitude of the black wave and produces a quieter sound. The green wave completes half as many cycles as the black wave, meaning its frequency is one half the black wave and has a lower pitch.
TERRESTRIAL SOUND
Traveling Noise Activity

ACTIVITY INSTRUCTIONS

Location
Outside preferred (inside if enough room)

Materials
Traveling Sound Worksheets
Tuning fork
Tape measure (optional if measured by foot instead)
Pencils
Different sound/noise devices (timers, musical instruments, whistles, radio, drum, metal sheet or garbage can lid to make thunder) that make low pitch and high pitch sounds

Preparation
If you can, find an area with different topography, large boulders and vegetation. For example, trees with an open meadow or near a dirt road (if safe for kids).

Instructions

Begin by having students close their eyes and listen to the sounds around them. What sounds are the loudest? What sounds are the most difficult to hear? Have students record (or have a discussion about) the sounds they hear, how loud they are (on a scale of 1 to 10, 1 being just barely audible, and 10 being fireworks), and whether they are natural or man-made (anthropogenic). Also have the students list if the sound is high (a whistle) or low pitch (thunder sound) or in the middle. For younger students, it may be helpful to use a simpler scale, like Very Quiet, Quiet, Normal, Loud, Very Loud. The idea is to get students thinking about the different volumes of everyday sound.

Next, students will measure the distance traveled by different sounds.

- Divide students into groups of two or more. Students will have different roles: listening, recording, measuring distance, and making noise.
- Begin by demonstrating a very soft noise like snapping fingers or whispering. The listener of each group will walk away from the sound until they can no longer hear it, then walk back towards the sound and stop as soon as they hear it again. The measurer/recorder will measure and record the distance between the sound and the listener, based on the distance when they last could hear the sound.
- Do this again with noises made by different devices, or by clapping, snapping fingers, whispering, yelling, different noise devices, etc. If working in a small area, it may be useful to use and focus on softer sounds.
- Experiment with different pitches either using voices or noise devices. Speak in a very low voice, and a very high pitch voice at the same volume. Which pitch travels furthest?

KEY DEFINITIONS

- **Amplitude**: the relative strength of sound waves (transmitted vibrations) and can be detected by hearing organs, which we perceive as loudness or volume.
- **Decibels (dB)**: refers to the sound pressure level or intensity; amplitude is measured in dB.
- **Frequency (pitch)**: defined as the number of times per second that a sound pressure wave repeats itself and is expressed in terms of hertz (Hz).

TAKE IT FURTHER

Try the same test in different settings: in an open area, with bushes, rocks and trees as obstacles. You can also use a body of water or a combination of obstacles. Is it easier or more difficult to hear? In each of these settings be sure to note the background noise, which may impact listening range.

Have the students compare and discuss the results. Did their results match their hypotheses? Were they surprised by any of the results?

FOR OLDER STUDENTS:
Use a noise meter app (see app page) to determine the amplitude and frequency of each noise maker before testing. Have the listeners first record what they hear and then use the noise meter to compare. Record hypotheses, results and write their conclusions.

They can plot their results on charts vs. obstacle type. Each line will be the device, the y axis will be the dB and the x axis the distance. Compare the charts of each obstacle type.
State your hypothesis for how the noise from different devices will travel on the landscape.

______________________________________________________________________________________

**Test #1:**

Instrument(s) used______________________________________________________________

Estimate of distance until you can't hear the sound ________________________________

Measured distance between noise makers and listeners______________________________

Results/Observations____________________________________________________________

______________________________________________________________________________________

**Test #2:**

Instrument(s) used______________________________________________________________

Estimate of distance until you can't hear the sound ________________________________

Measured distance between noise makers and listeners______________________________

Results/Observations____________________________________________________________

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**Test #3:**

Instrument(s) used______________________________________________________________

Estimate of distance until you can't hear the sound ________________________________

Measured distance between noise makers and listeners______________________________

Results/Observations____________________________________________________________

______________________________________________________________________________________

Was your hypothesis correct? What is your conclusion? ________________________________

______________________________________________________________________________________
Try the same test in different settings - in an open area, with bushes, rocks and trees as obstacles.
You can also use a body of water or a combination of obstacles. Is it easier or more difficult to hear? In each of these settings, be sure to note any background noise which may impact your listening range.

State your hypothesis. How will sound travel in different habitats/landscapes and from different types of noise?

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**Test #1:**

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Estimate of distance until you can't hear the sound ____________________________________________

Measured distance between noise makers and listeners ____________________________________________

Results/Observations _______________________________________________________________________

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**Test #2:**

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Estimate of distance until you can't hear the sound ____________________________________________

Measured distance between noise makers and listeners ____________________________________________

Results/Observations _______________________________________________________________________

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**Test #3**

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Estimate of distance until you can't hear the sound ____________________________________________

Measured distance between noise makers and listeners ____________________________________________

Results/Observations _______________________________________________________________________

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Was your hypothesis correct? What is your conclusion? ________________________________________
Gas powered machines like cars, lawn mowers, airplanes and boats are a major source of today's noise pollution. If we could reduce our use of oil and gas, how would the Earth and you benefit?

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Which habitat is more impacted by noise? Does noise travel father and louder in an open meadow compared to a wooded area?

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What can be done to reduce noise?

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