# People Demos for Teaching Wavelength and Frequency

**Purpose/Overview:** The purpose of this activity is to provide students with non-visual ways of experiencing the relationship between wavelength and frequency. The activities demonstrate the meanings of wavelength, frequency and wave speed, setting the stage for exploring electromagnetic waves that have a constant speed. The focus is on transverse waves, but longitudinal waves (the type of wave sound is) will also be demonstrated.

## Standard Addressed:

**HS-PS4-1 Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.** Link to Standard

**HS-PS4-3 Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model and that for some situations one model is more useful than the other.** Link to Standard

**Note: For this standard, stress that electromagnetic (EM) radiation is modeled as a wave when it TRAVElS through space. When EM radiation interacts with matter it is modeled as a particle.*

Cross Cutting Concept: Systems and System Models
Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. **(HS-PS4-3)**

## Focus Questions:

1. What is the relationship between wavelength and frequency?
2. How does the relationship between wavelength and frequency affect wave speed?
3. How is a sound wave different from an EM wave?

## Materials:

1. Blindfolds, or sleep masks
2. Slinky
3. Access to an unobstructed wall. A hallway works well.

## In advance:

If you watched the video where astronomer Nic Bonne introduced waves (Wave Introduction by astronomer Nic Bonne), you may want to follow up with this video in which he discusses his work:

Dr. Nic Bonne

Very little advanced preparation is needed for these activities/demonstrations. Gather materials listed above, read the procedures, and you are ready to go. If you are less familiar with the wavelength/frequency relationship, here are some review suggestions:

1. Vocabulary
    a. **Transverse Wave** refers to a wave where the vibration or oscillation is at right angles to the propagation of the wave.
    b. **Longitudinal wave** refers to a wave where the vibration or oscillation is parallel (same direction) as the wave moves. These waves always need a medium to travel through, therefore they move MUCH slower, i.e., sound travels at about 340 m/s.
    c. **Frequency** refers to the rate of oscillation of the source of the wave. (Number per second, or Hertz)
    d. **Wavelength** refers to one whole crest and one whole trough. This is usually measured in meters.
    e. **Wave speed** is usually measured in meters per second, i.e How far does the wave travel in one second?
2. Recall the relationship between wave speed, wavelength, and frequency as: **Wave speed = wavelength x frequency**
3. To review the relationship between wavelength and frequency, explore the simulation from PHet - Not BVI accessible Wave on a String

## Procedures:

People Demo Prep - Let's Do The Wave!

1. Lay a slinky on the floor to show how the back and forth movement of your hand propagates a wave. A metal slinky works best because the sound is much more distinct than with a plastic slinky.
2. Focus students' attention on the fact that the wave transmits energy, not matter. The slinky does not move from the person's hand. It is the energy that propagates, not the slinky itself. You will need to be sure that BVI students are positioned at a number of different points in the demonstration so that they are able to experience this for themselves. Allow them to report what they are experiencing rather than asking them to

confirm a statement you make. For example, "What do you notice about the motion of the slinky when you are sitting here?" rather than "Do you notice that the sound of the slinking moving on the floor comes before you feel a motion at your end?" This will enable you to be certain they are perceiving the necessary points of the demonstration and allow you to adjust the demonstration as needed.

3. Compare the slinky motion of the transverse wave to the slinky motion for a longitudinal wave.

Demo 1 - "Do the Wave!"

1. Have students stand in a line holding each other's hands. The first person can start the wave by raising their free hand and then transfer that motion down the row.
2. Remind them that the top of their hand when it is up high is the crest, and when their hand is down low, that is the trough.
3. Compare this to a longitudinal wave people demo:
    a. Everyone should line up so they are all facing the same direction.
    b. Everyone put their hands on the shoulders of the person in front of them.
    c. The end person should give a little shove to the person in front of them, who in turn shoves (gently please!) the person in front of them, therefore passing the energy down the row of people.
4. Discuss the two types of waves they just demonstrated, transverse and longitudinal.

Demo 2 - Clapping

1. Students will stand in a line with a large distance between one another so that their hands are fully outstretched to touch the hands of those on either side of them. Lining students up along a wall is helpful. From this position, the students will clap their hands from the outstretched position, one after another. This should take the most time of the various wave demonstrations since the distance each student will have to cover in order to clap will be the longest.
2. Next, have the students move towards each other a bit so that their outstretched elbows are touching. Now have students drop their hands to their sides. The first person gives a short, loud clap. When the next person in line hears this clap, he/she will give one clap, bringing his/her hands up from resting at the sides, and so on. This time, the claps will be closer together since the distance between each student's hands is less than before.

3. Repeat the process again, except this time have students stand as close to one another as possible. This should be the fastest of the waves. The frequency of the wave is the highest and the wavelength is the shortest.
4. Each clap represents the completion of one cycle. The short time period between the claps represents a higher frequency wave. The distance between students is representative of the wavelength of the wave itself. Therefore, as the distance between students (wavelength) decreases, the number of claps (frequency) increases. Have students come up with this relationship as a group.

Demo 2 - High Five

1. While students remain lined up along the wall as they were in Demo 1, one student moves. This student is the "high fiver" and will walk along the line of students. The "high fiver" keeps his/her eyes closed and walks at a consistent pace along the line. Each student in line gives the walking student a high five as he/she passes. The high fives represent the frequency of a wave.
2. Repeat this process at various distances between students to communicate the relationship between frequency and wavelength (shorter wavelength, more claps).
3. Continue this activity, alternating students to be in the walking position. Although sighted students can compensate for not being the "high fiver" by observing the spacing between the standing students, be sure that each BVI student gets a chance to experience the change in frequency as you change the spacing between students.

Reflection:

1. Where are the wavelengths and frequencies shown in each of the demonstration models?
2. For each of the models, what is the relationship between wavelength and frequency?
3. Which of the models demonstrated the relationship between wavelength and frequency best? Explain.

## Accessibility Considerations:

This activity is enhanced if you have students who have low or no vision. For example, students need to think about how to deliver a high five to students with low vision. This challenge directs everyone's attention to what is important about the model. How does a delay in making contact affect the model's ability to demonstrate the wavelength/frequency relationship?

## Extensions/Modifications:

You can use any number of resources to bridge these demos to the waveform diagrams found in many textbooks or online. Be sure to have a tactile version on hand for students to use as well, such as the **3D Printed Wave Form Demos** resource.

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