Strand: **8.2**	Standard: **8.2.5**	Episode 2	**Big Idea**: The structure of a wave affects its ability to be reflected, absorbed, or transmitted through various materials.

Title: Waves and Mediums	**Time**: 45 min	CCCs: Patterns	Practices: **Developing and using models**

Narrative of episode:
In this episode students will use physical and computer **models** to identify patterns that occur when waves move from one medium to another. They will identify that waves change speed as they move through mediums of different densities and that while mechanical waves need a medium to travel, light waves do not.

Gather
Ask the students to complete the predictions section on their student sheet. They will be looking at three different **models** of waves moving through different mediums. You may want to show them what the models for #1 and #2 look like first (don't send waves down them yet) so they have a better idea what they are writing about.

Model 1: Gumdrop Model
Construct a wave model similar to the one in this video.
(Teacher Note: This link wave machine using gummies, bamboo skewers, and duct tape shows how to build the wave machine (first 2 minutes.) Instead of using the jelly babies, use the spice drops, gum drops, or larger jelly candies. At 3:02 he demonstrates how to change the speed of the wave by changing the machine. Let the students make discoveries rather than watching the video!)

Give the students time to experience using the model to create waves. You may want to take this time to review amplitude, wavelength, and frequency.

Remove the candies from one half of the model. Send another wave down the model and have the students record their observations of what actually happened. They should notice that the wave travels faster when the candies are removed.

Model 2: Slinky Model

If the students have not yet had a chance to experience making waves with slinkies, give them a few minutes to experiment with them so they can see how waves normally behave on a slinky. Take two different slinkies, such as a metal slinky and a plastic slinky and join them together (or use a tighter coiled slinky such as this one). Send a wave down the slinky and ask the students to record observations about what happened. You should notice a difference in the speed of the wave as it transfers from one slinky to the next, as it does in this video. Discuss what the students have observed.

Model 3: Sound in a Tunnel
Read the following scenario to the students:

> "You are in a long mining tunnel deep under the earth. You have a friend that is several thousands of feet away from you in the tunnel. You tell this person using a walkie talkie to yell and clang on the pipes on the tunnel floor at the same time."

After the students have predicted what will happen and recorded their prediction on their student sheet, direct them to this website to play the animation and see if they were right.

On their student sheet, the students will record patterns they observed after working with the three models. They should have observed that the speed of the wave changed in all three cases.

Reason

Discuss what the students know about sound. (This amazing video shows video of sound waves changing the density of the air as they travel away from a source.) Write some of the answers the students give on the board. What is sound? What kind of wave is it (longitudinal)? How fast is it? How fast is it compared to light? Can we change the speed of sound?

Illustrate the differences between the way sound moves through different mediums by striking a tuning fork and letting the students listen to the sound. Then have the students put their ears on the desk. Strike the tuning fork again and place the handle end on the desk. Students hear a sound that is much louder through the desk. Discuss why the sound is different when you hear it through the desk vs. the air. Does it have anything to do with the phase/density of the waves? Tell the class that the different types of matter that waves can travel through are called *mediums*. Waves will travel at different speeds depending on the medium they are traveling through. Ask them to give examples of some of the mediums they have encountered today.

Dominoes Race

This activity will help the students visualize what is happening to a sound wave as it moves through mediums of different densities. Provide each group with 15 to 20 dominoes (60 if you want to run all 3 tests at once). Ask them to come up with a way they can use the dominoes to **model** solids, liquids, and gases. Guide them to the idea that if each domino represents a molecule they can set up the dominoes very close together to represent solids and far apart to represent gases. They can show energy moving through the molecules by knocking over the dominoes. If you have enough dominoes then each group can set up all three phases at once then knock down all three at once as a race to see which row falls first. Which situation knocks the dominoes over the fastest? (You can use this video to illustrate this.)

Ask the students to summarize what they have learned on their student sheet.

Ask the students to predict how sound would travel if there were *no* molecules present. Once they have written their predictions on their student sheet, show this video. If you have access to a vacuum you could do this one in the classroom.

Give each group a copy of the Waves and Mediums sorting cards. Ask them to divide the cards into two groups: waves that need a medium and waves that can travel without a medium. Discuss the results. They may make the observation that all the waves that do not need a medium are part of the electromagnetic spectrum. These are light waves. Tell them that the waves that do need a medium are called mechanical waves. After the class discussion the students will record their results on their student sheet.

Communicate

Students will complete an exit ticket to demonstrate their understanding of waves and mediums.

Assessment: Students complete an exit ticket to demonstrate their understanding of waves and mediums.	**Materials, resources, handouts, etc:** ● Waves and Mediums Student Sheet ● wave machine using gummies, bamboo skewers, and duct tape ● Large slinky & wave modeling spring (or plastic slinky) for each group ● Tuning Forks ● Dominoes (ideally 60 per group) ● Vacuum chamber and bell or alarm clock (or watch the video) ● Waves and Mediums sorting cards ● Waves and Mediums Exit Ticket