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| Strand: 8.2 | Standard: 8.2.5 | Episode 3 | Big Idea: The structure of a wave affects its ability to be reflected, absorbed, or transmitted through various materials. |
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| Title: Wave Behaviors | Time: 45-120 minutes | CCCs: <u>Structure and function</u> <u>Developing and Using Models</u> | Practices: Cause and Effect |
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Narrative of episode: Students will engage in a variety of exploration activities to investigate how the structure of light waves **causes** them to change when they move from one medium to another. They will experience reflection, absorption, transmission, and refraction. They will develop a drawn model of each of these to demonstrate their understanding.

Gather

In this first activity, the students will be exploring the different ways that light behaves when it contacts mediums with different properties.

Provide each group with the following items:

- Aluminum foil (REFLECTION)
- tissue paper of various colors (TRANSMISSION AND ABSORPTION)
- mirror (REFLECTION)
- wax paper (TRANSMISSION AND ABSORPTION)
- your finger (TRANSMISSION AND ABSORPTION)
- plastic wrap (TRANSMISSION AND REFLECTION)
- cardstock (ABSORPTION)
- a flashlight

Instruct the students to shine the flashlight onto the various objects. They will come up with a list of things that happen to the light as it shines on the different objects. They will record their observations on the [Student Sheet Part 1](#) .

In a class discussion, have students share and compare their results. List these on the board. Results will vary, depending on the exact materials and light sources used, but in general, expect:

- reflective materials, such as aluminum foil and the mirror, to reflect the light
- solid, non-transparent materials, such as wax paper, body parts, notebook paper and cardboard paper, to absorb the light
- materials that have varying degrees of transparency, such as plastic saran wrap and tissue paper, transmit the light
- the lighter colored tissue paper to most likely transmit more light than the darker colored tissue paper
- materials such as fingers and notebook paper transmit some light, but absorb most of the light

The students will not be able to observe refraction using the above activity. To explore refraction the students will do the following:

Begin by telling the students that you are going to show them a [clip from Mythbusters](#) in which the team will be using a property of light to disprove a myth. Ask them to watch for the property of light that is being used and record it on their student sheets when they think they know what it is. The clip illustrates the principle that light always travels in a straight line (laser pointers). Discuss this briefly with the class.

Light Box: Each team will now investigate refraction of light by using a small clear plastic box and laser as a **model** to observe light waves. Students will use a laser pointer and observe how it interacts with the box for each of the following scenarios. Tell the students to move the laser around at different angles to the box/water.

Step#1: Empty box.

Step #2: Partly fill with water.

Step #3: Place a few drops of cream on top of the water without stirring it.

Step #4: Stir the cream into the water.

Students will have about 25 minutes to progress through four activities in which the structure of the model is changed resulting in changes in the behavior of the light. Student will then need to record observations, look for patterns as they summarize and respond to some questions. This activity is shown in this [video](#).

(Teacher's note: Students have observed waves bouncing back, changing speeds, and bending as they travel through different mediums. It is best not to tell students what to look for! Students should not spend more than a couple of minutes on step 1. They should take more time on steps 2 and 3, and then they should focus the bulk of their time on step 4. Remind students to describe as much as they can, especially in step 4. Remind students to use words and diagrams/pictures. When they are done with step 4, instruct students to RINSE the milky water completely out of the plastic box. Then use a soft towel to dry it. Most paper towels will scratch the box.)

Have a class discussion where students share their understanding about what they discovered doing the Light in the Box investigation. Build the conversation around the following questions:

- What did you observe?
- What repeating patterns did you notice?

Reason

Introduce the students to the terms absorption, transmission, reflection, and refraction if you have not already done so. On their [student sheet part 2](#) are four drawings of these processes. They will need to match the correct illustration with the correct term. Below the picture, write a brief description of each one.

Wave Demos

In this next step, students will practice identifying which process is occurring in several demonstrations. Let the students experience as many of these themselves as possible. You can set them up as stations around the room and have them rotate to each one.

Some possible examples to use (Note: prisms will be used in the next episode):

- Straw in a beaker
- Picture of a reflection on a lake or pool
- Video of an [echo](#) or [echo2](#)
- Tuning fork placed on cotton while ringing
- Heat lamp on black vs. white paper - measure temperature of each one
- Whale song video: [TedEd on Whale Song](#) or Examples of [Whale Song](#)
- Parallel narrow colored light beams moving through concave and convex lenses
- Fisherman trying to spear fish in a river
- [Ocean waves reflecting off a barrier](#)
- Eyeglasses

Communicate

After experiencing the demo, the students will develop a model by drawing what is happening to the waves in each example, including which type of energy transfer is occurring (refraction, reflection, absorption,

transmission), the directions the wave is moving, and identifying the type of energy involved (light or mechanical).

Assessment: Students will develop models illustrating what is happening to mechanical and light waves in various situations.

Materials, resources, handouts, etc:

- Exploring waves [student sheet part 1](#)
- Exploring waves [student sheet part 2](#)
- Flashlights
- Various mediums such as
 - Aluminum foil
 - Wax paper
 - Tissue paper of various colors
 - Plastic wrap
 - Cardstock
 - Mirror
- Square Acrylic Containers (available on Amazon from Acrylic USA),
- cream or creamer (3-4 drops of cream in each tank)
- Laser pointers
- Water
- Towels (microfiber are great because they don't scratch the acrylic)

- Beaker
- Straws
- Tuning Forks
- Heat Lamps
- White and Black Paper Sheets
- Thermometers
- Acrylic Lenses
- Parallel light beam source such as the one in [this kit](#) (more inexpensive versions of this kit can be found on amazon)
- Eyeglasses